ST Nucleo & STM32Cube™

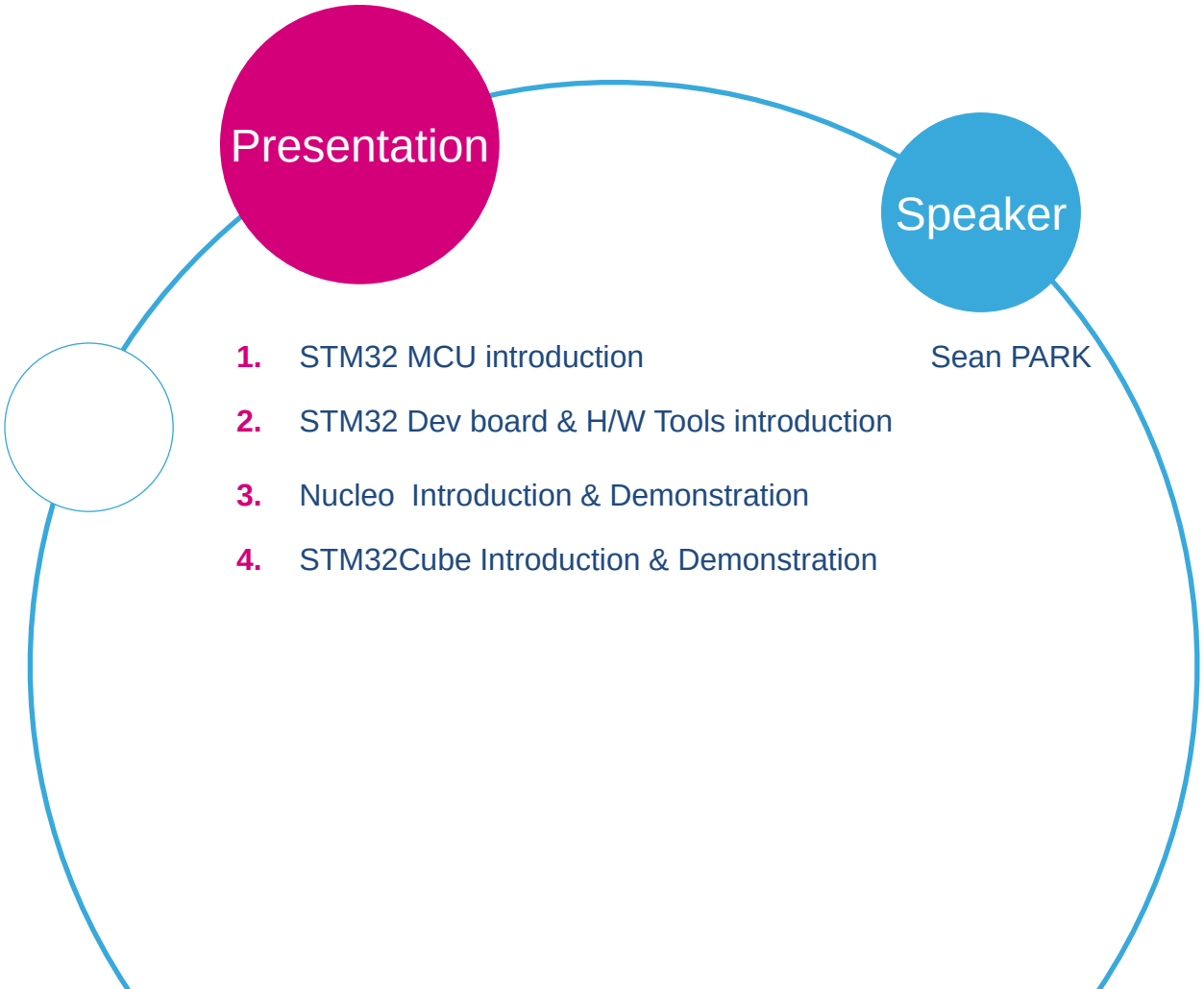
ST Nucleo board & STM32Cube™ Platform

MMS

May 2014

life.augmented

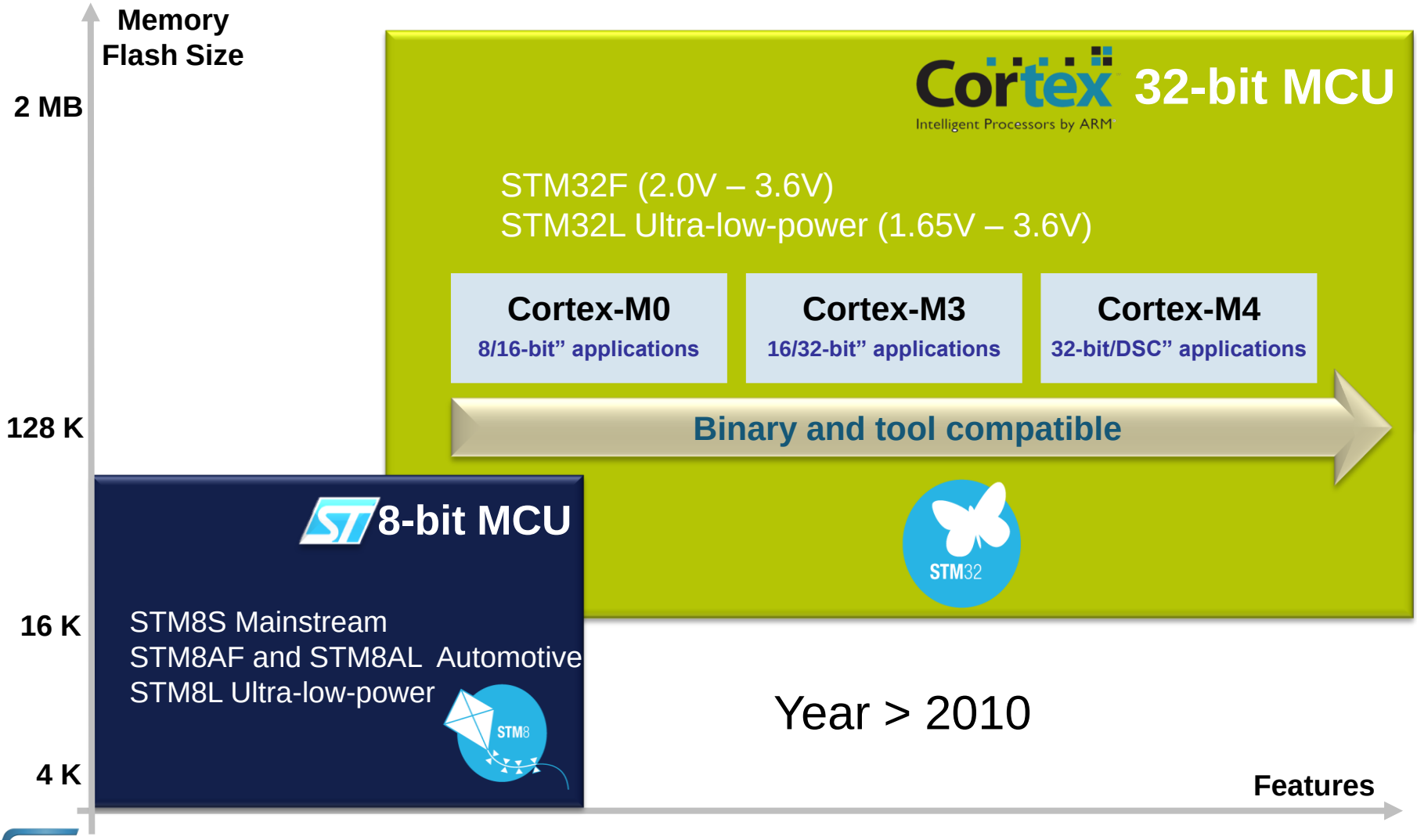
Agenda



1. STM32 MCU introduction — Sean PARK
2. STM32 Dev board & H/W Tools introduction
3. Nucleo Introduction & Demonstration
4. STM32Cube Introduction & Demonstration

STM32 Products

ST MCU Market Vision



ST Licensed ALL Cortex-M® Cores

No more traditional 8/16/32-bit classifications

- Seamless architecture across all applications
- Every product optimised for ultra low power and ease of use

Cortex-M0	Cortex-M3	Cortex-M4	Next
“8/16-bit” applications	“16/32-bit” applications”	“32-bit/DSC” applications”	*ST is Lead Partner*

Binary and tool compatible

5 Reasons to Choose STM32

Real-time performance

STM32 Dynamic Efficiency ™, ART Accelerator™, Chrom-ART Accelerator™, CCM-SRAM, Multi-AHB bus matrix, Excellent real-time up to 180 MHz/ 225 DMIPS Zero-wait state execution performance from Flash

Outstanding power efficiency

< 1 µA RTC in V_{BAT} mode, ultra-low dynamic power consumption 140 µA/MHz, with lowest dynamic conso (from L0); 1.65 to 3.6 V V_{DD}, 0.45 µA Stop mode and 0.3 µA Standy mode

Superior and innovative peripherals

USB-OTG High speed, Ethernet, CAN, LCD-TFT controller, SRAM interface, crypto/hash processor, true RNG*, PGA, 16-bit ∑Δ ADC and 12-bit ADC (up to 5 MSPS), external memory interface, CEC

Maximum integration

Reset circuitry, voltage regulator, internal RC oscillator, PLL, WLCSP packages

Extensive ecosystem

ARM + ST ecosystem (eval boards, discovery kits, software libraries, RTOS)

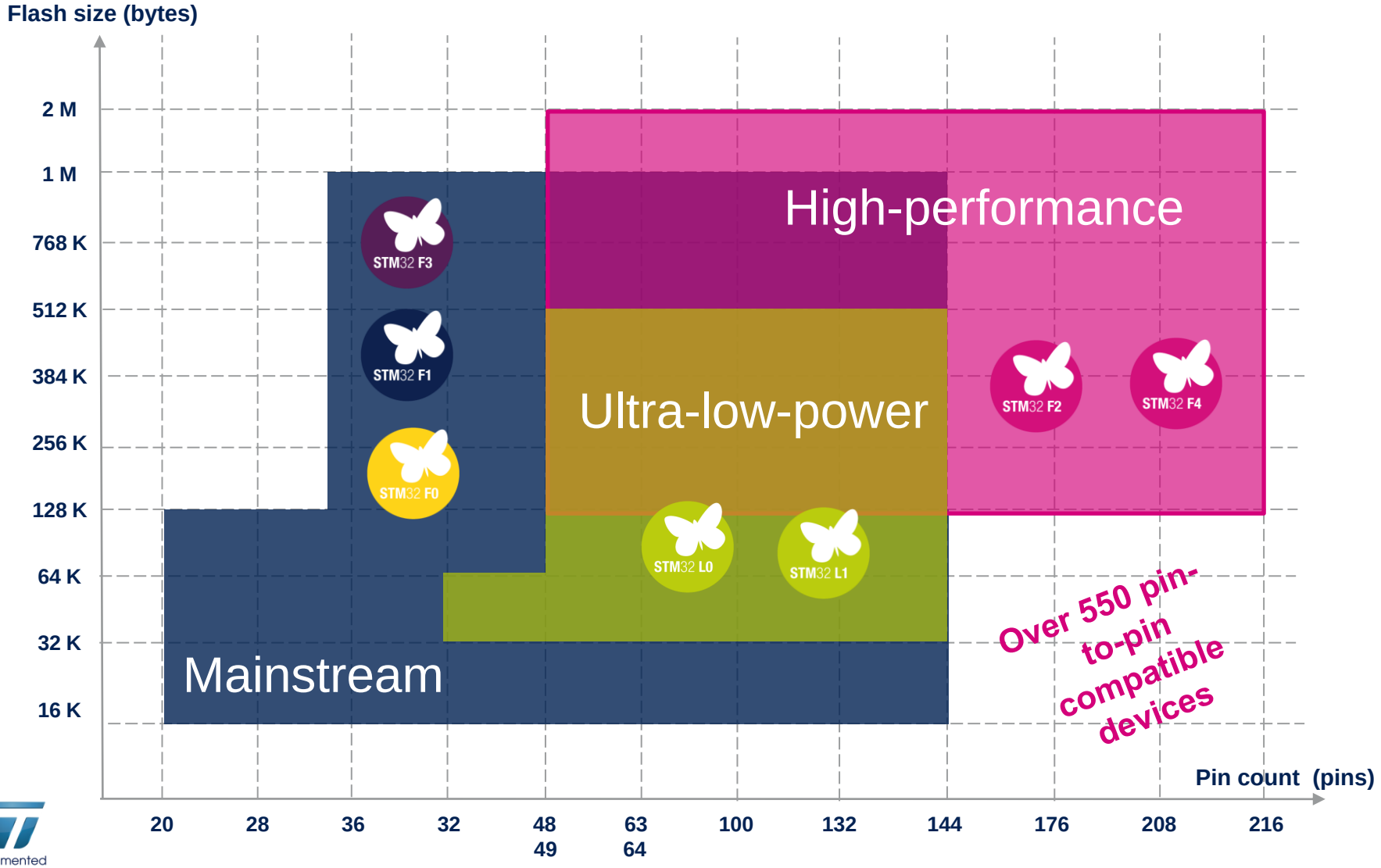
*Random Number Generator

> 550 Compatible Devices

life.augmented

STM32 today – platform effect

Select your fit product inside a wide, compatible portfolio



STM32 – 7 product series

Common core peripherals and architecture:

- Communication peripherals: USART, SPI, I²C
- Multiple general-purpose timers
- Integrated reset and brown-out warning
- Multiple DMA
- 2x watchdogs Real-time clock
- Integrated regulator PLL and clock circuit
- Up to 19x 12-bit DAC
- Up to 4x 12-bit ADC (Up to 5 MSPS)
- Main oscillator and 32 kHz oscillator
- Low-speed and high-speed internal RC oscillators
- -40 to +85 °C and up to 105 °C operating temperature range
- Low voltage 2.0 to 3.6 V or 1.65/1.7 to 3.6 V (depending on series)
- Temperature sensor

STM32 F4 series - High performance with DSP (STM32F401/405/415/407/417/427/437 and 429/439)

Up to 180 MHz Cortex-M4 DSP/FPU	Up to 2-Mbyte Flash	Up to 256-Kbyte SRAM	2x USB 2.0 OTG FS/HS	1x 12-bit AMC timer	2x CAN 2.0B	SDIO 2x I²S audio Camera IF	Ethernet IEEE 1588	LCD-TFT SDRAM I/F

STM32 F2 series - High performance (STM32F205/215 and 207/217)

120 MHz Cortex-M3 CPU	Up to 1-Mbyte Flash	Up to 128-Kbyte SRAM	2x USB 2.0 OTG FS/HS	1x 12-bit AMC timer	2x CAN 2.0B	SDIO 2x I²S audio Camera IF	Ethernet IEEE 1588	Crypto

High-performance

+

STM32 F3 series - Mixed-signal with DSP (STM32F301/302/303/373/x8)

72 MHz Cortex-M4 with DSP and FPU	Up to 512-Kbyte Flash	Up to 80-Kbyte SRAM CCM-SRAM	USB 2.0 FS	3x 16-bit AMC timer (144 MHz)	CAN 2.0B	Up to 7x comparator 4x 12-bit DAC 4x PGA	HDMI CEC	3x 16-bit ΣΔ ADC

STM32 F1 series - Mainstream - 5 product lines (STM32F100/101/102/103 and 105/107)

Up to 72 MHz Cortex-M3 CPU	Up to 1-Mbyte Flash	Up to 96-Kbyte SRAM	USB 2.0 OTG FS	1x 12-bit AMC timer	Up to 2x CAN 2.0B	SDIO 2x I²S audio	Ethernet IEEE 1588

STM32 F0 series - Entry-level (STM32F030/x1/x2 and x8)

48 MHz Cortex-M0 CPU	Up to 128-Kbyte Flash	Up to 16-Kbyte SRAM 20-byte backup data	USB clock free	USB 2.0 FS Crystal less	CAN 2.0B	DAC Comparator	CEC

Mainstream

STM32 L1 series - Ultra-low-power (STM32L100/151/512/162)

32 MHz Cortex-M3 CPU	Up to 512-Kbyte Flash	Up to 80-Kbyte SRAM	Up to 16-Kbyte EEPROM	USB 2.0 FS device	LCD 8x40 4x44	Op-amps comparator	BOR MSI VScal	AES 128-bit

STM32 L0 series - Ultra-low-power (STM32L0x1/x2/x3)

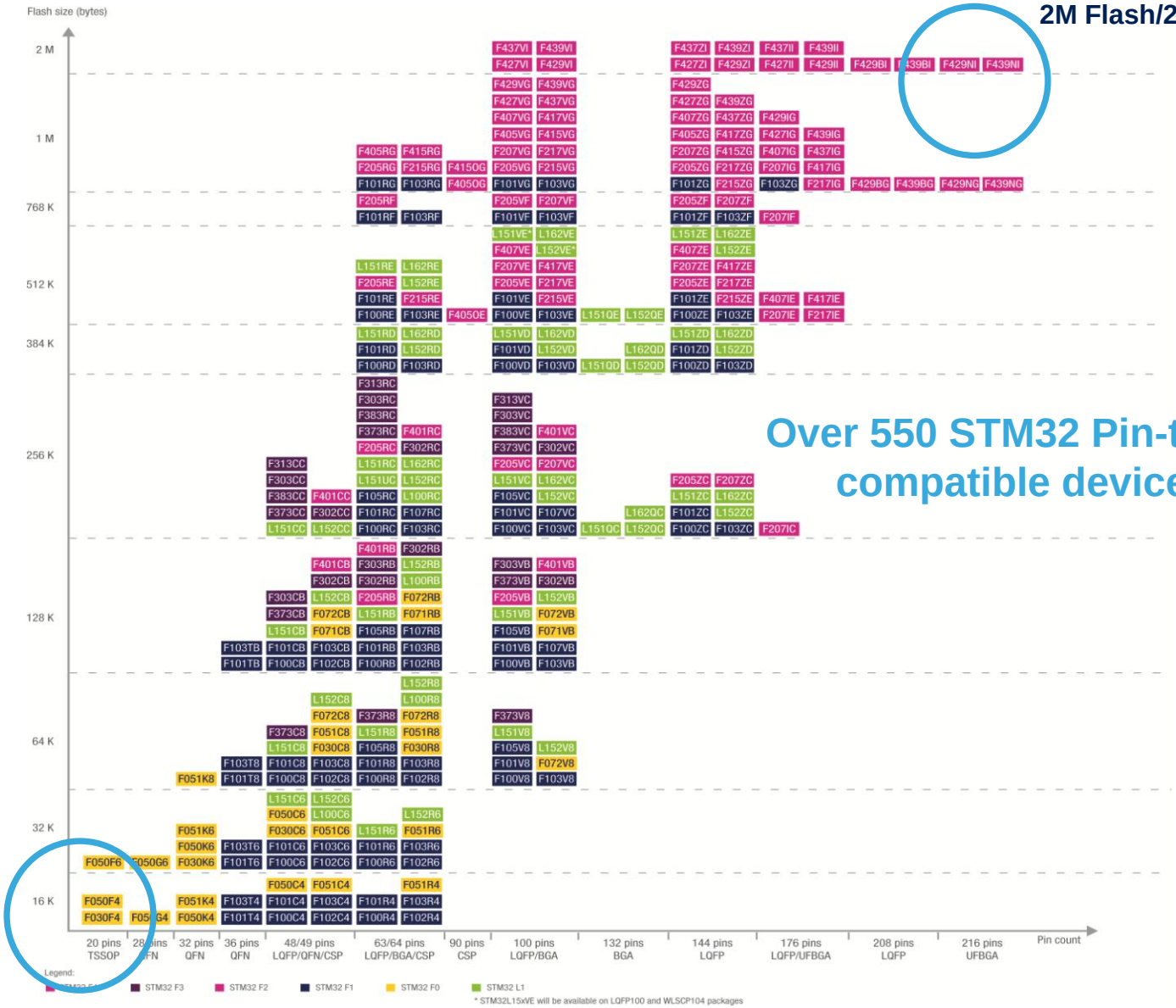
32 MHz Cortex-M0+ CPU	Up to 64-Kbyte Flash	Up to 8-Kbyte SRAM	Up to 2-Kbyte EEPROM	USB 2.0 FS Crystal less	LCD 8x28 4x32	True RNG	BOR MSI VScal	AES 128-bit

Ultra-low-power

life.augmented

A rich & reliable product base and…

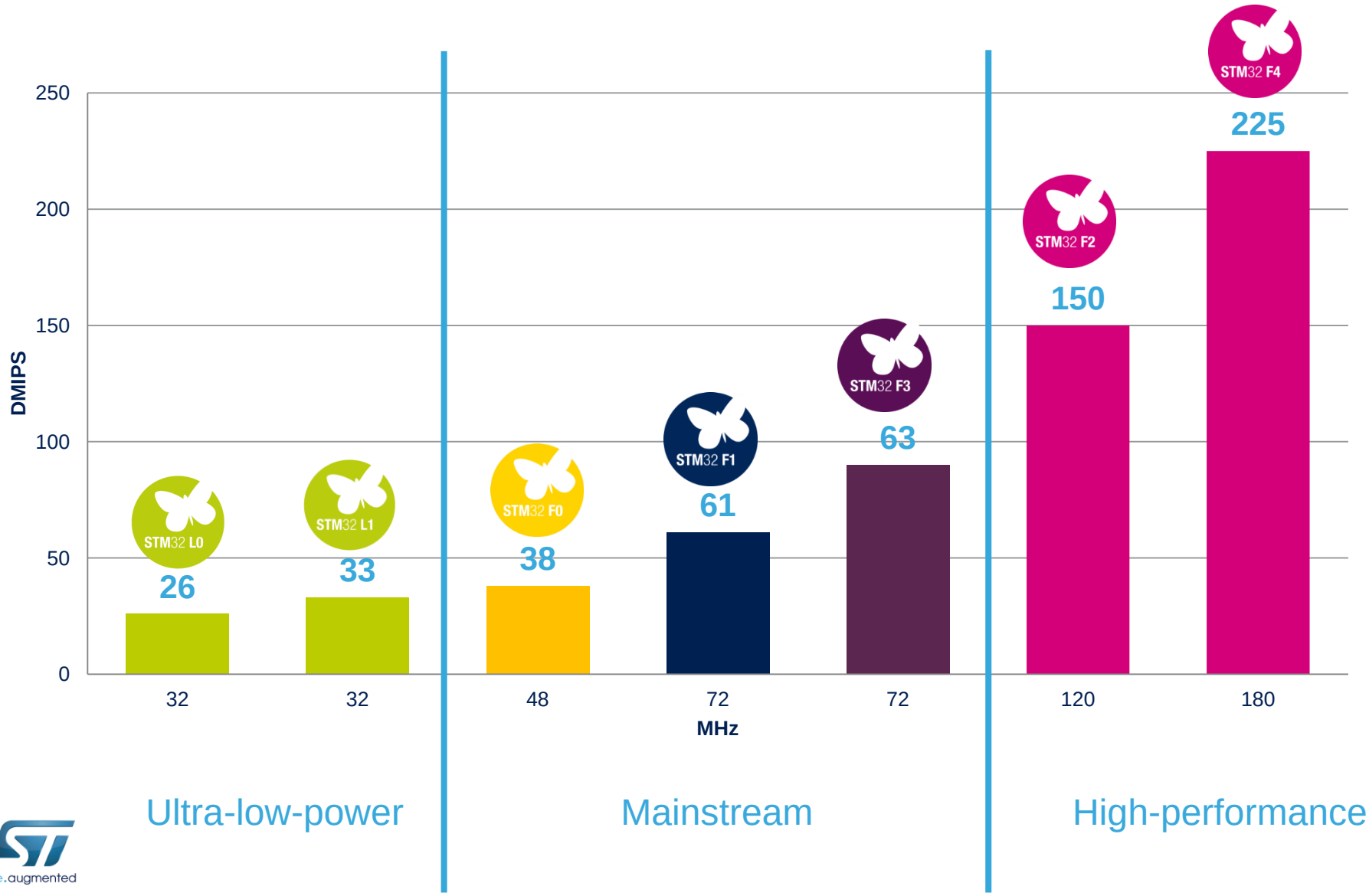
2M Flash/256KSRAM



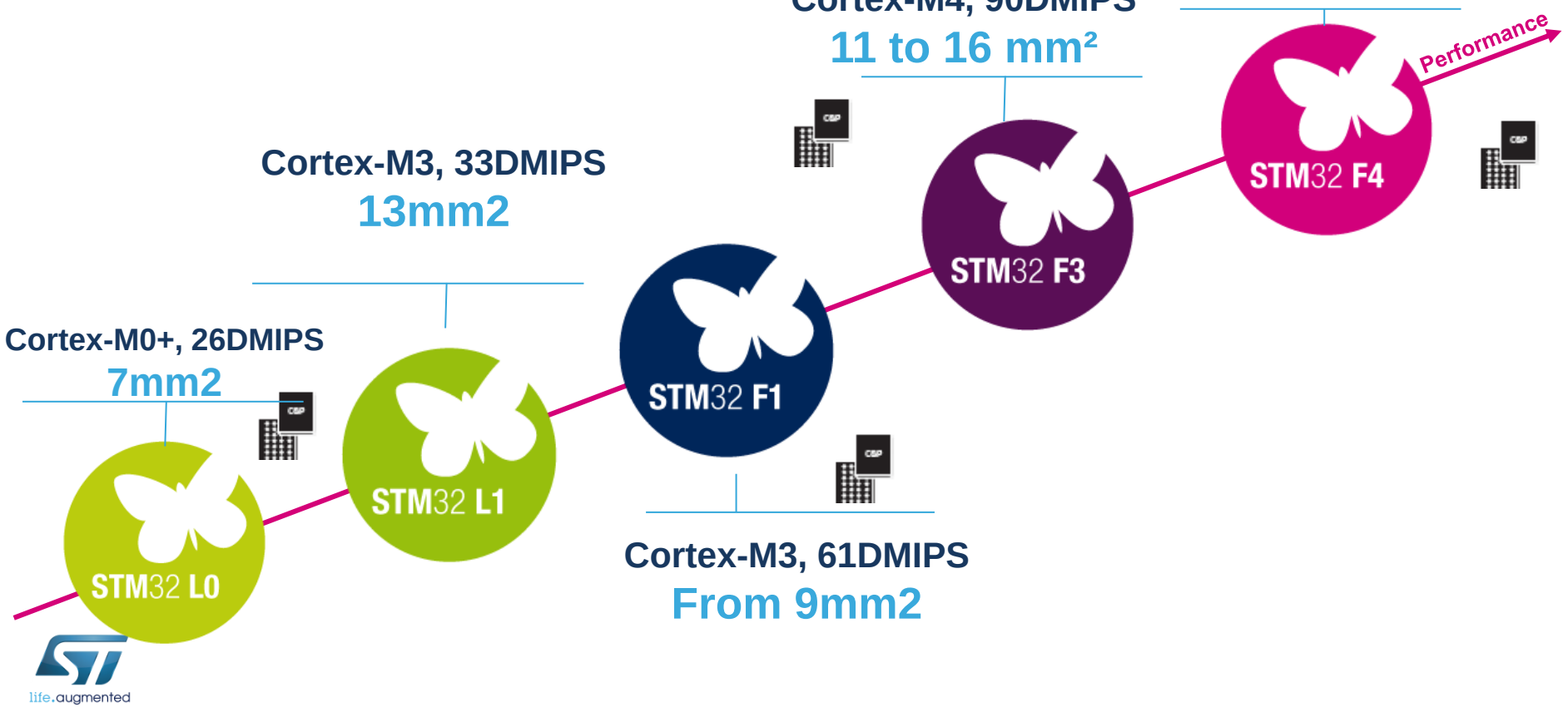
Over 550 STM32 Pin-to-pin compatible devices

20 PIN / 16KFlash

STM32 DMIPS performance



High integration for small IoT and wearable products
STM32 smallest package sizes



life.augmented

New **ST MCU Finder** Application

- Quickly find the right ST MCU
- Easy access to technical materials
- Latest news from ST MCU world
- Ready now on Google Play ‘ST MCU FINDER’

ANDROID APP ON Google play

Available on the App Store

March 2014

Windows Store

April 2014

life.augmented

STM32 Dev board & H/W Tools

life.augmented

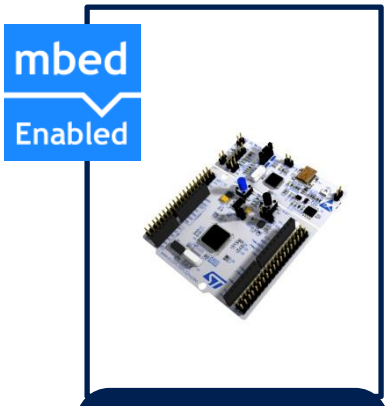
Evolution of ST Evaluation Tools

- Discovery kits :
  - Easy-to-use STM32 samples with a flavoured set of companion devices.
  - Self-contained environment with limited extension capability.

- Evaluation boards :
  - Premium dvt platforms implementing the full range of STM32 peripherals.
  - Large extension capability with proprietary pinout for each STM32 device.

Need for affordable tools with unlimited unified extension capability

Hardware Development Tools (1/2)



	STM32 Nucleo	Discovery kits	Evaluation boards	3rd parties
Typical use case	Flexible prototyping, Community	Prototyping, Creative demos	Full feature evaluation	From full evaluation to open hardware
Extension possibilities	+ + +	+ +	+ + +	
Connectivity	Arduino™ ST Morpho	ST	ST	

Hardware Development Tools (1/2)

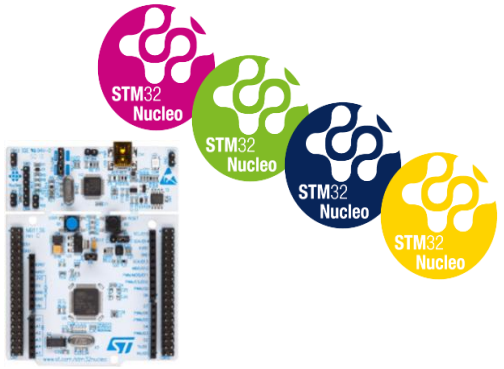
- A wide offer of Debugging Probes and Programming Tools
  - ST ST-LINK/V2, low cost in circuit debugger/programmer
  - Raisonance Rlink
  - SEGGER J-Link
  - ARM/Keil ULink

- Ability to evaluate completely our STM32 series:
  - via our Evaluation Boards
  - via partners boards, like IAR, ARM/Keil or Raisonance ones

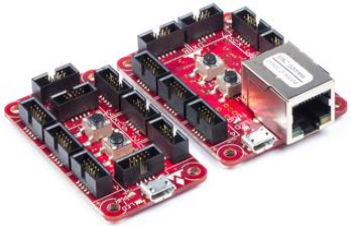
Hardware Development Tools (2/2)

- Low-cost evaluation boards
  - ST Discovery Kits
  - Raisonance Primers
  - Hitex Kits

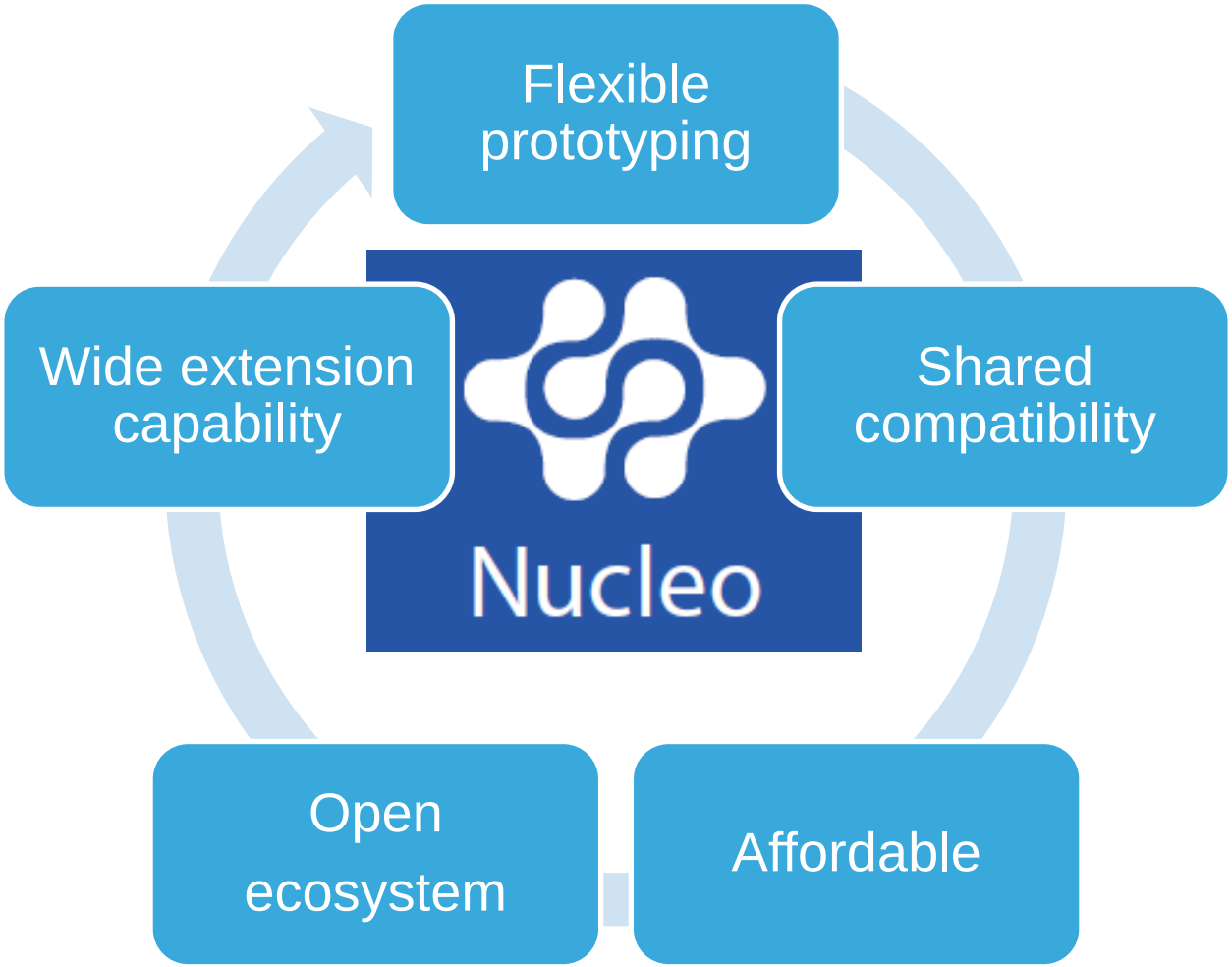
- **New** high connectivity Low-cost Nucleo boards
  - Arduino-compatible and full access to STM32 pins
  - Usable with mbed.org online development environment
  - Open hardware



- Low-cost open hardware from 3rd parties
  - Arduino-compatible, like Leaflabs Maple, Olimexino-STM32, SecretLabs Netduino
  - Gadgeteer-compatible, like Mountaineer, GHI Fez-Cerberus,

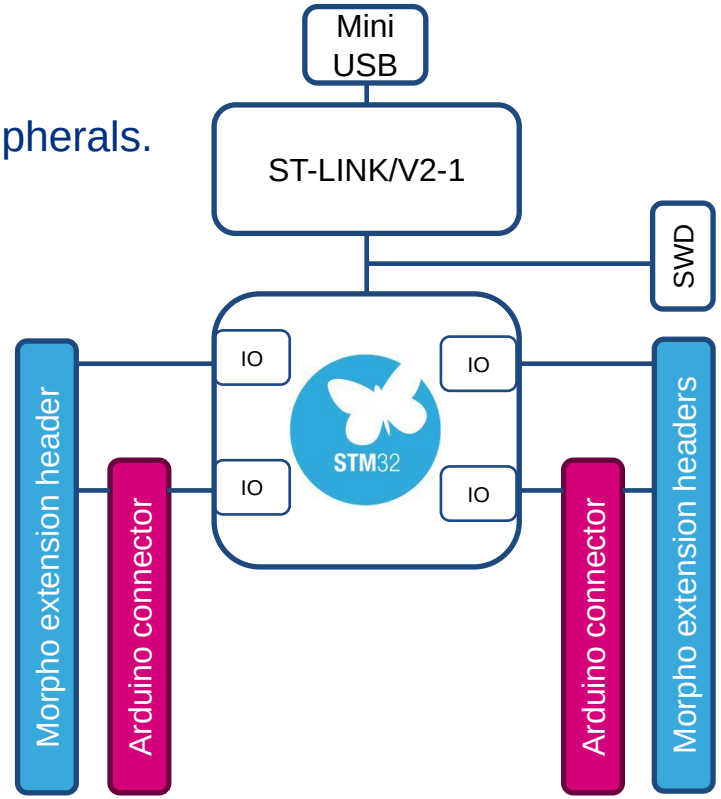


STM32 Nucleo value proposition



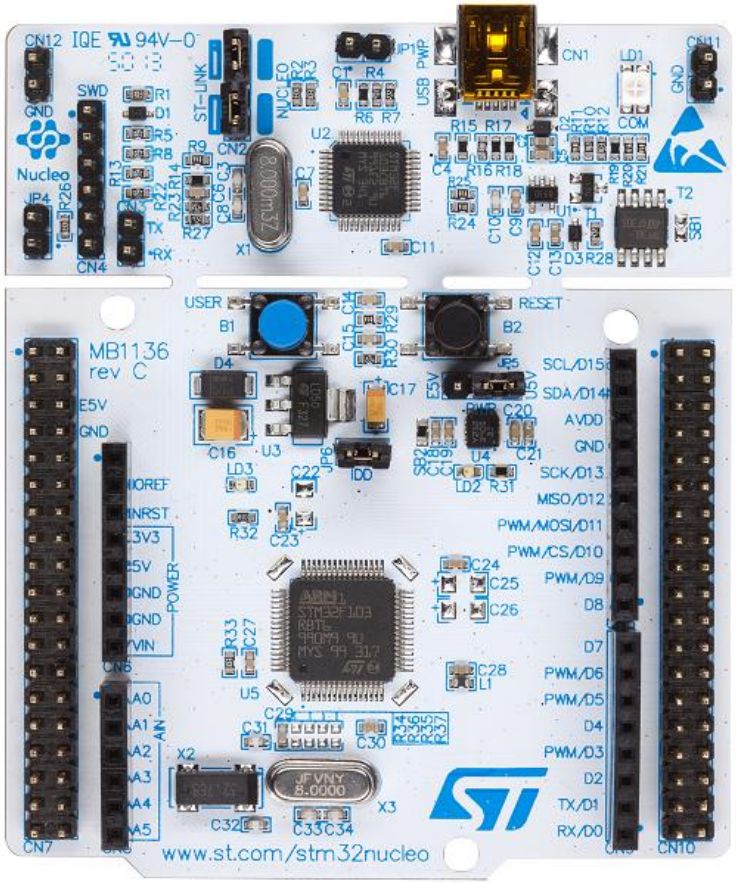
STM32 Nucleo structure

- Each STM32 Nucleo board leverages one flavor of STM32 MCU.
- Two types of extension ressources :
  - Arduino Uno v3 connectivity.
  - Morpho headers for easy access to all MCU peripherals.
- Integrated ST-LINK/V2-1 debugger and programmer :
  - can target on-board STM32 or external STM32-based application.
  - supports drag-and-drop flash programming.



STM32 Nucleo key assets

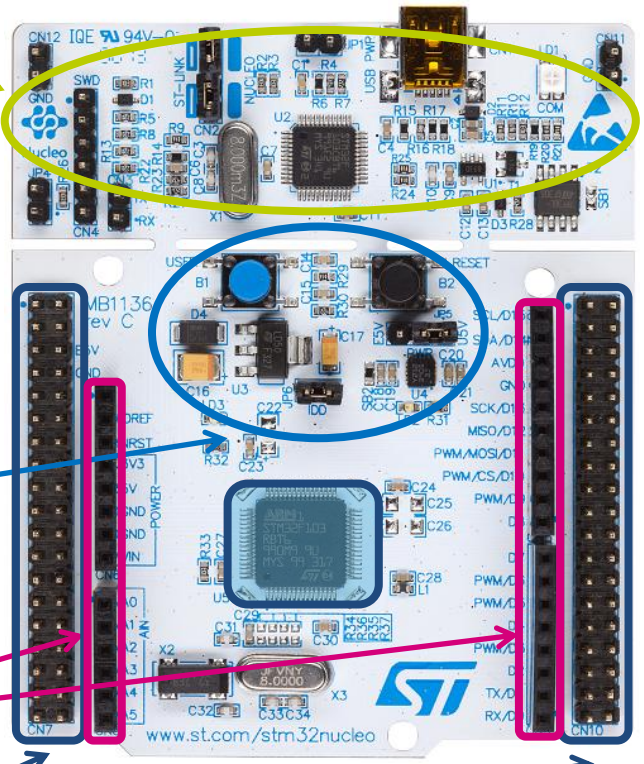
- Flexible prototyping.
  - Affordable STM32 boards sharing the same association scheme (headers+connectors).
  - Reduction of financial risks through easy HW/SW tuning.
- Benefit from Open Hardware initiatives.
  - Unlimited extension capability.
  - Instant access to a large ecosystem of peripheral shields (Arduino).
- Simply expose the entire STM32 portfolio to dvt communities.
  - Extension shields are compatible with all Nucleo flavors at once.
  - Free access to mbed online IDE at mbed.org



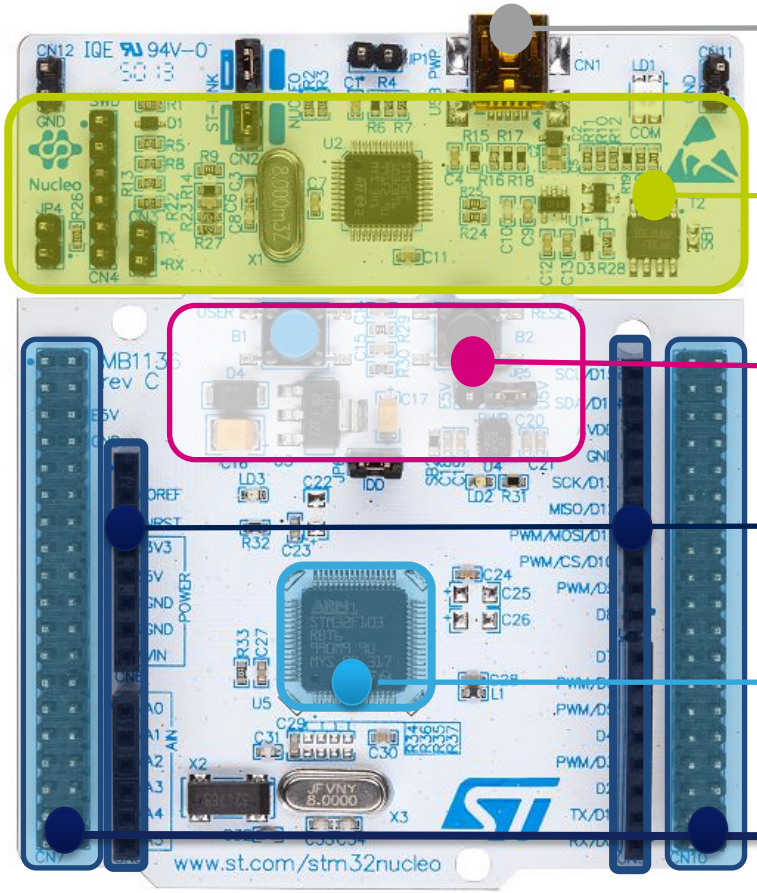
Make creation more fluid

STM32 Nucleo features

- One STM32 MCU with LQFP64 package.
- On-board ST-LINK/V2-1 debugger/programmer with SWD connector.
  - supports virtual serial port and mass storage programming.
- Flexible board power supply :
  - through USB or external source.
  - power measurement access point.
- 2 push buttons, 2 color leds.
- Easy association with Arduino shields :
  - through extension connectors.
- Direct access to all STM32 I/Os :
  - through Morpho extension headers.



STM32 Nucleo features



Flexible board power supply
Through USB or external source

Integrated ST-Link/V2-1
Mass storage device flash programming

2 push buttons, 2 color LEDs

Arduino™ extension connectors
Easy access for add-ons

One STM32 MCU flavor with 64 pins

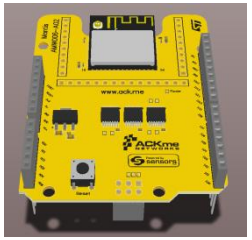
Morpho extension headers
direct access to all MCU I/Os

Available for STM32F401, STM32L152, STM32F030 and STM32F103. Deployment on other STM32s ongoing

Nucleo shields under development

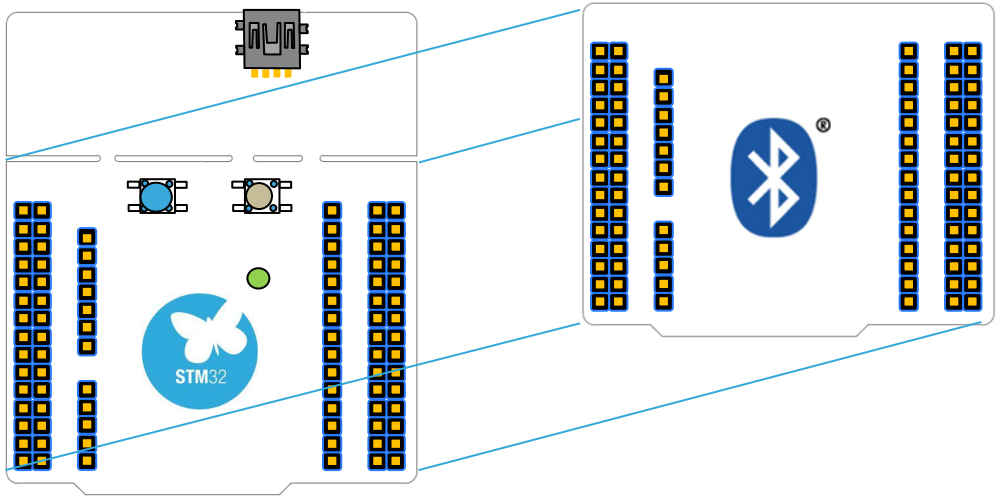
- NORDIC SEMICONDUCTOR qualified Bluetooth LE

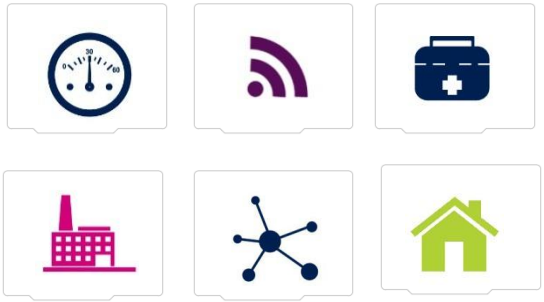
- ACKme NETWORKS certified WiFi b/g/n & WPS
  supports all WiFi SOHO security types
  (Open, WEP, WPA-PSK, WPA2-PSK)

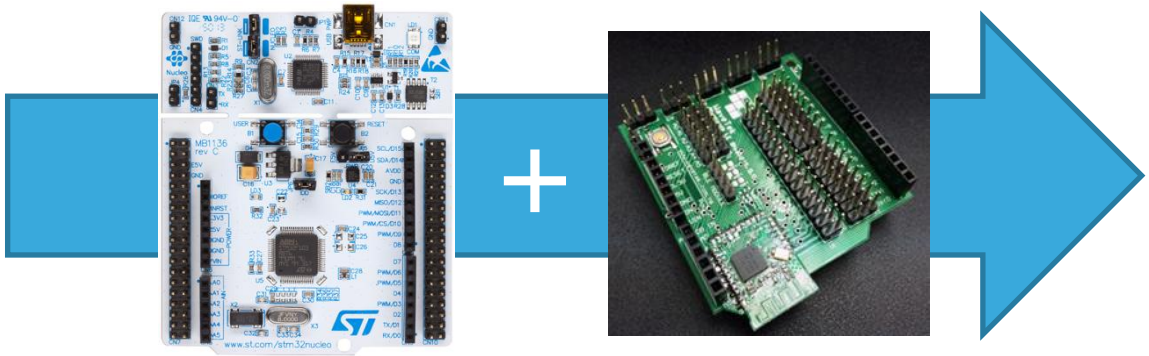


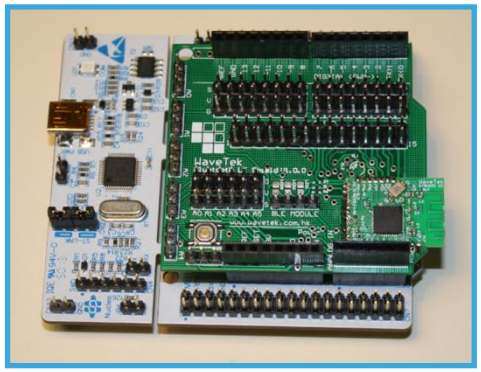
- CSR Bluetooth/GPS/WiFi opportunity
- life.augmented Audio (MEMS mics),
  Visual (VL6180 proximity and ALS sensor),
  Home/Building Automation (Spirit1)

Association with shields







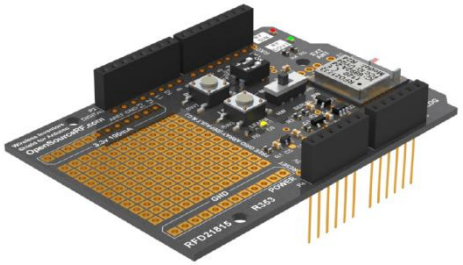


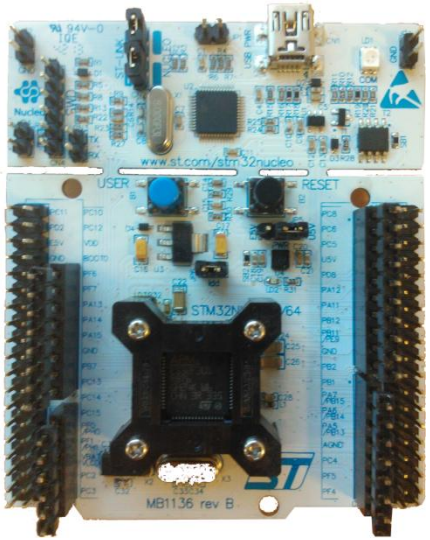
Simply scalable : No limit to possibilities

STM32 off the shelf BLE solution

- Goal: A “Plug&Play” solution to enable customers to add BLE to any STM32 application

- Hardware : Nucleo board + nRF51 shield

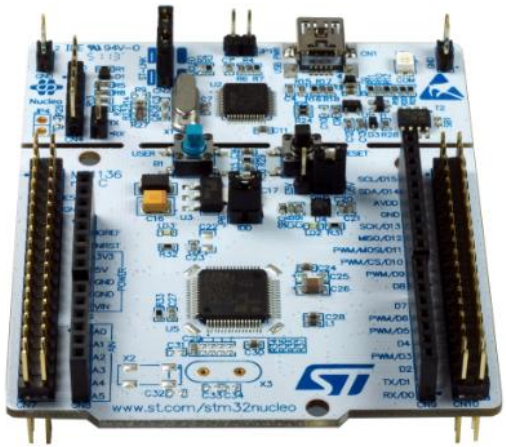




Not contractual photo

ACKme Wi-Fi Module with STM32 Nucleo Shield

ACKme Wi-Fi modules provide cloud connectivity…



…for the STM32 Nucleo system

ACKme Wi-Fi Module

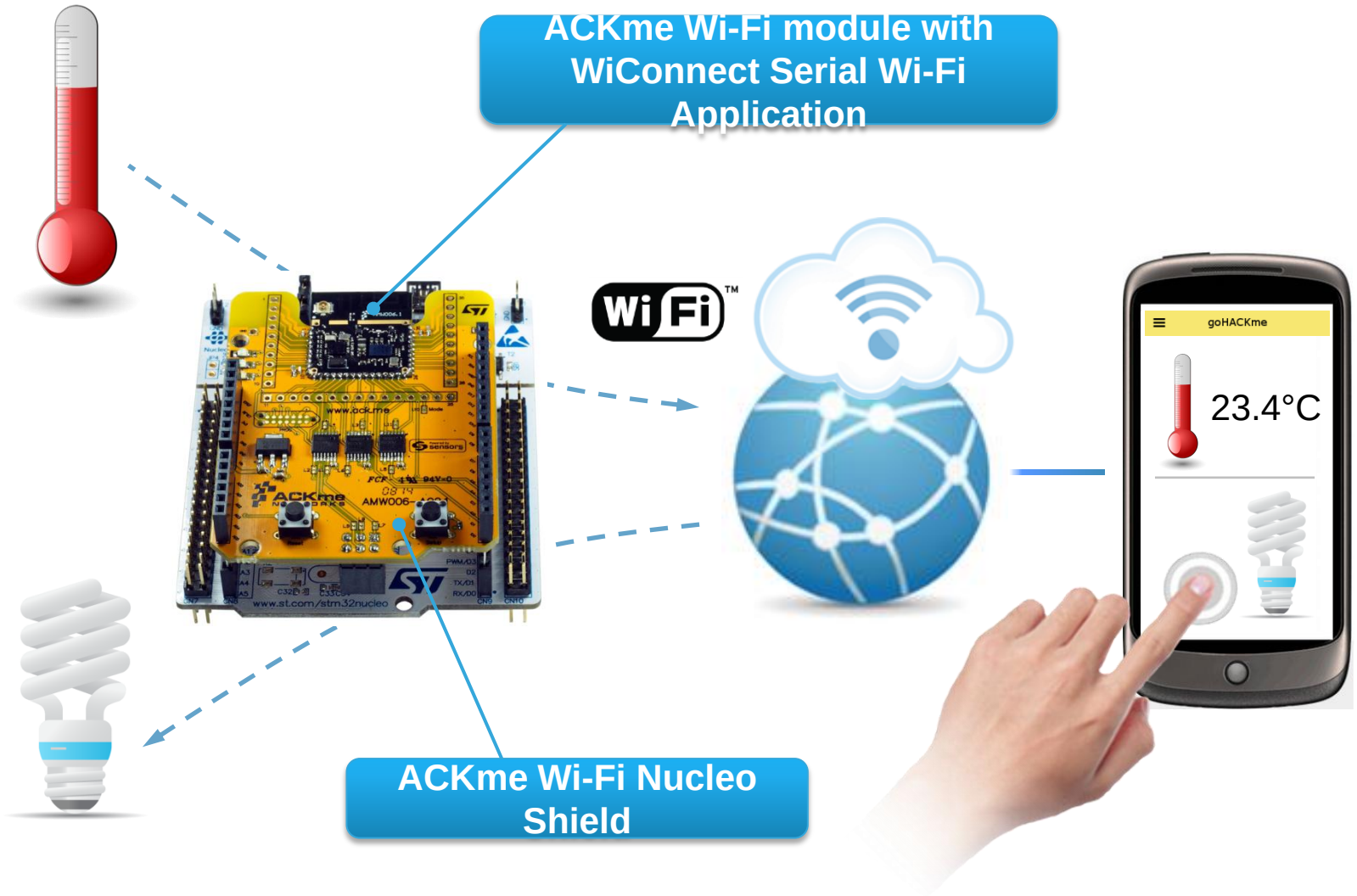
- FCC/CE/IC certified
- STM32F401
- Broadcom Wi-F.
- WiConnect Serial-Wi-Fi Application

STM32 Nucleo Board

- Choose your STM32
- 2 header styles
  - Arduino & Morpho
- Integrated ST-Link programmer and debugger

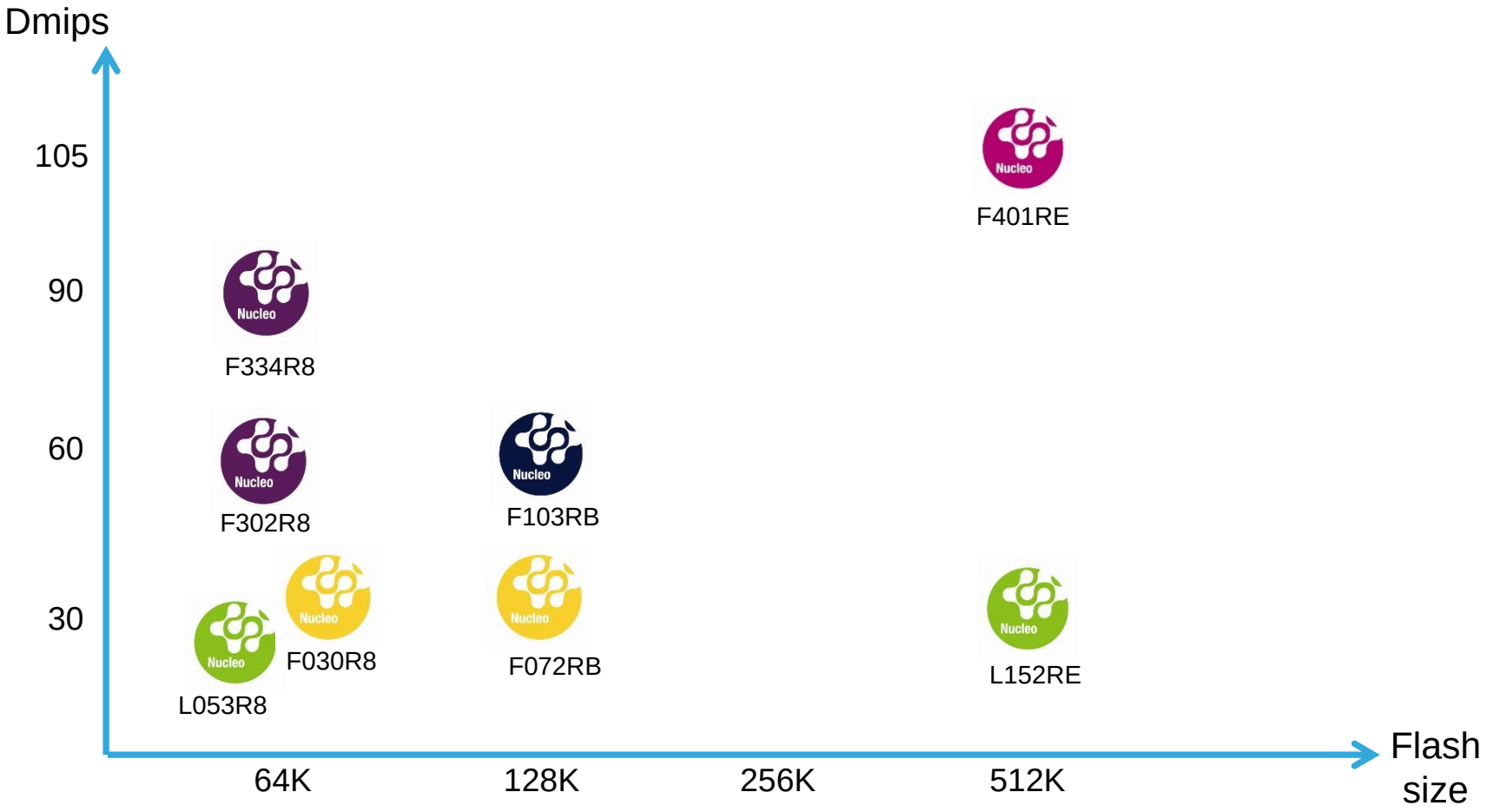
life.augmented

Cloud Connected Application Ideas



life.augmented

Nucleo portfolio

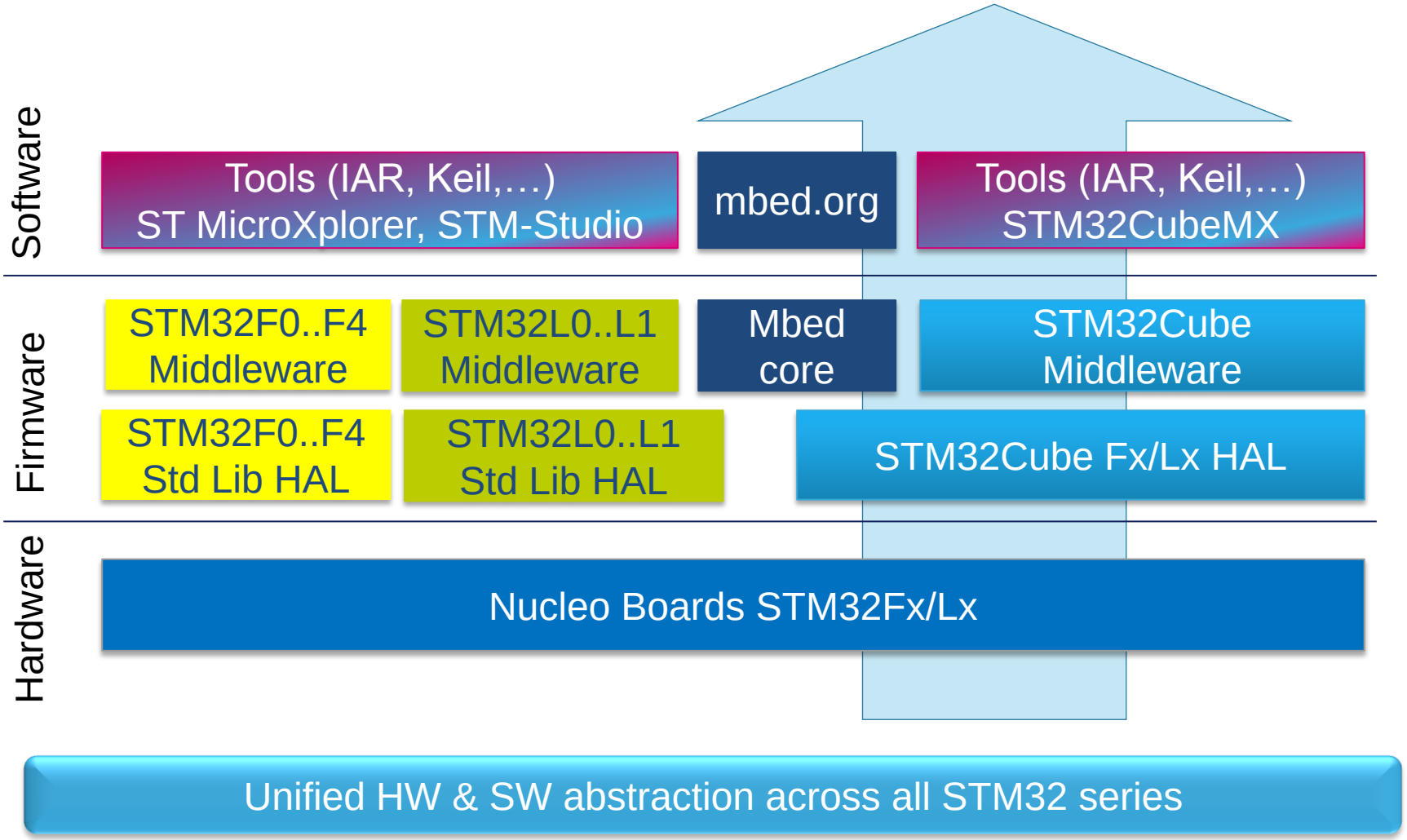


Nucleo exposes the whole family of STM32 microcontrollers

STM32 Nucleo IDEs

- Nucleo boards work with several IDEs, including :
  - IAR EWARM,
  - Keil MDK-ARM,
  - GCC-based IDEs (Atollic TrueStudio…),
  - ARM online tools at mbed.org (no more need for SW installation).

System benefit



Summary

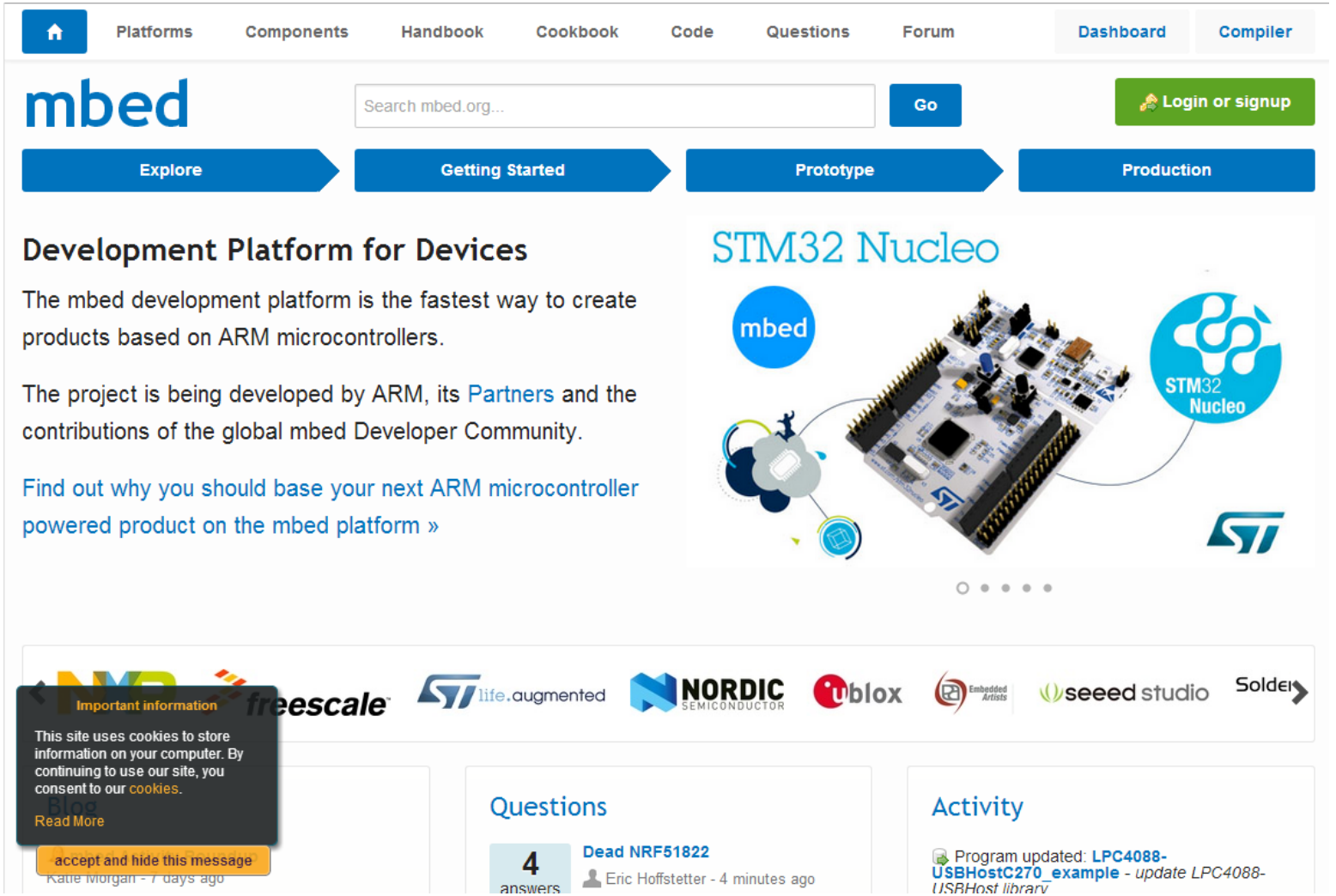
- The STM32 Nucleo open development platform enables you to try out new ideas simply and to create prototypes on any STM32 MCU.
- Sharing the same Arduino connectors and Morpho headers, STM32 Nucleo boards may be easily expanded through a large ecosystem of specialized application shields.
- Each STM32 Nucleo affordable board comes with an integrated ST-Link debugger/programmer : no need for a separate debug probe.
- All STM32 Nucleo adopters get free access to mbed online IDE at mbed.org : feel free to enjoy any STM32 Nucleo flavor in few minutes !

mbed & Nucleo Demonstration

life.augmented

mbed introduction

http://mbed.org/



Introduction

CMSIS COMPLIANT
ARM® Cortex™ Microcontroller Software Interface Standard

Platform vendor

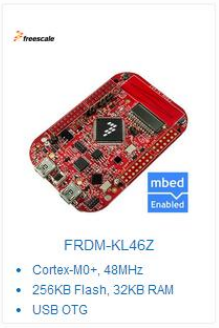
- Embedded Artists
- Solder Splash Labs
- Seeedstudio
- STMicroelectronics
- NXP Semiconductors
- NGX Technologies
- Nordic Semiconductor ASA
- Freescale Semiconductor, Inc.
- Switch Science Inc.
- u-blox AG

Target vendor

- Freescale Semiconductor, Inc.
- STMicroelectronics
- NXP Semiconductors
- Nordic Semiconductor ASA

EA LPC11U35 QuickStart Board
- Cortex M0, 48MHz
- 64KB Flash, 10KB RAM

ST Nucleo F103RB
- Cortex-M3, 72MHz
- 128-KB Flash, 20-KB SRAM

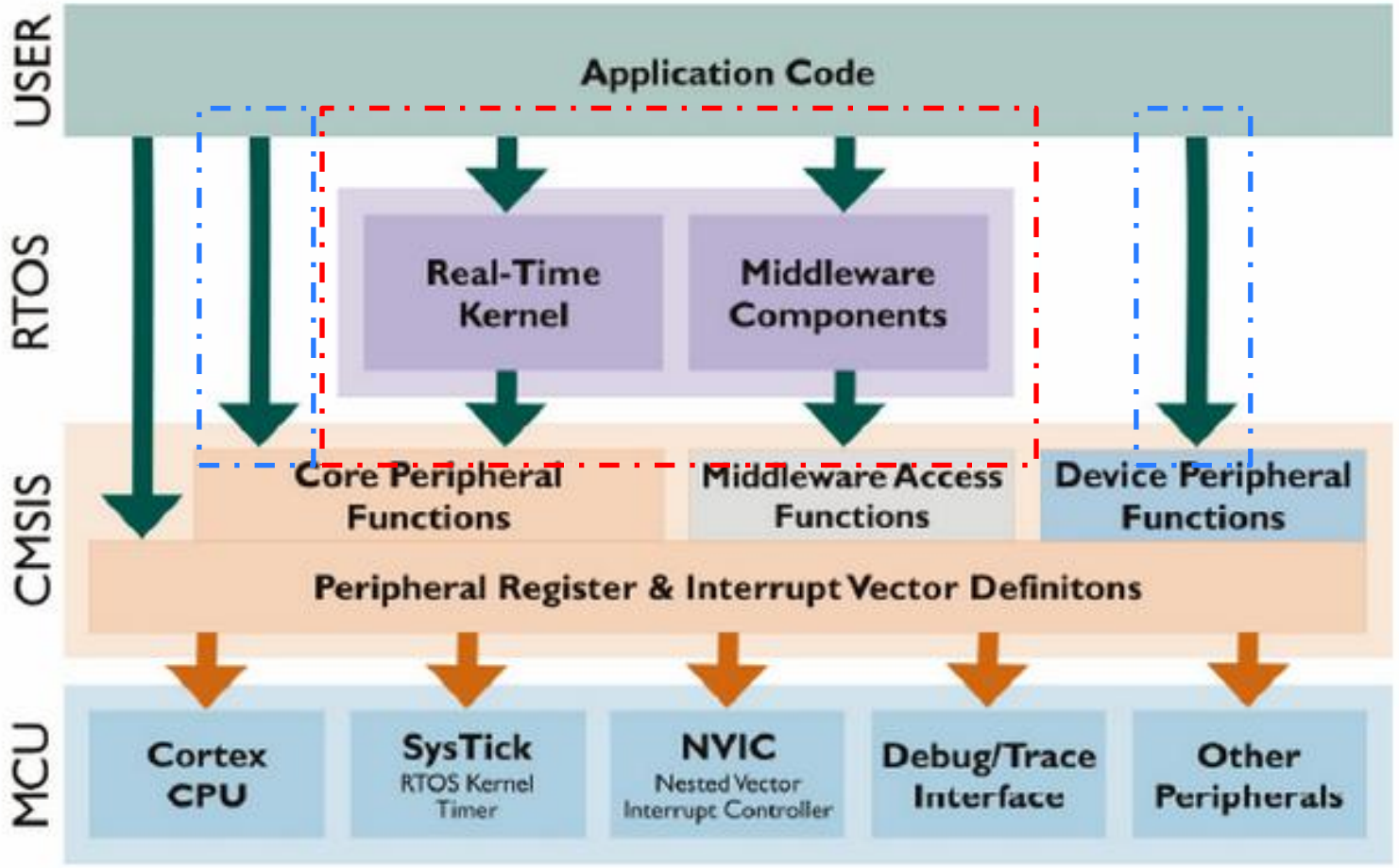


FRDM-KL46Z
- Cortex-M0+, 48MHz
- 256KB Flash, 32KB RAM
- USB OTG

- Interface
  - Ethernet, USB Device, CAN, SPI, I²C, I/O, etc…

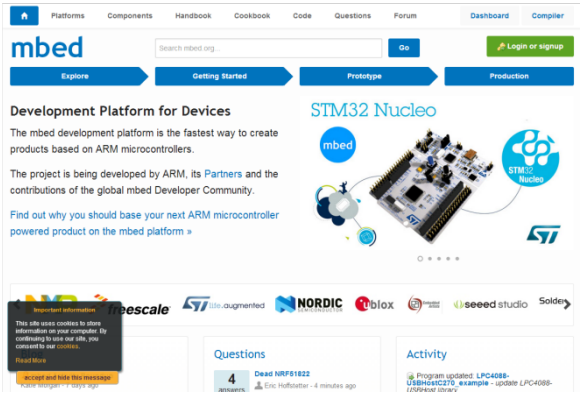
Introduction

CMSIS COMPLIANT
ARM® Cortex™ Microcontroller Software Interface Standard



Point of mbed

- mbed
- Advantage
  - On-line compile
  - Source version management
- Disadvantage
  - Debugging
- ST NUCLEO
  - Pin-compatible of Arduino Shield
  - USB programming (ST-Link)
  - Low price
  - Scalability

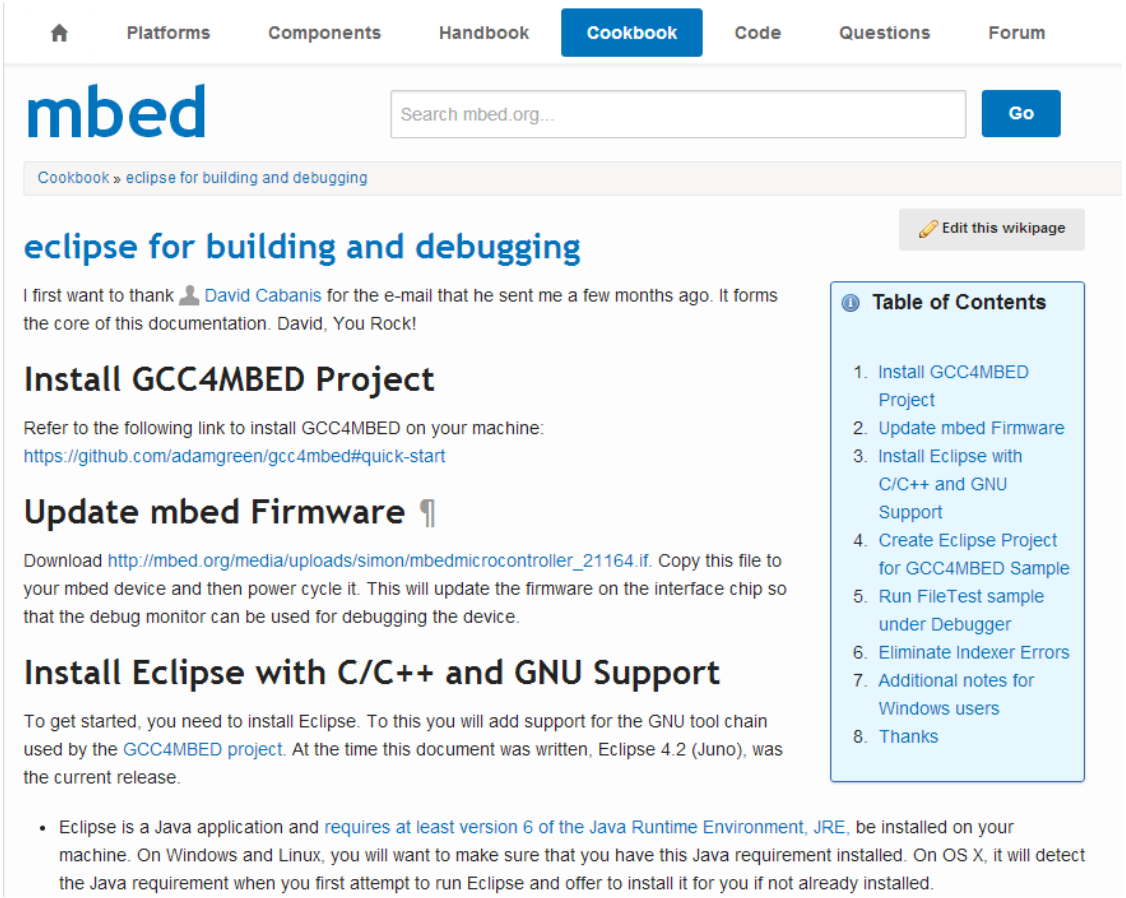


ST NUCLEO Setup & Demo

- Demonstration

ST NUCLEO Setup & Demo

https://mbed.org/cookbook/eclipse-for-building-and-debugging



Platforms Components Handbook **Cookbook** Code Questions Forum

mbed

Search mbed.org... Go

Cookbook » eclipse for building and debugging

Edit this wikipage

eclipse for building and debugging

I first want to thank David Cabanis for the e-mail that he sent me a few months ago. It forms the core of this documentation. David, You Rock!

Table of Contents

1. Install GCC4MBED Project
2. Update mbed Firmware
3. Install Eclipse with C/C++ and GNU Support
4. Create Eclipse Project for GCC4MBED Sample
5. Run FileTest sample under Debugger
6. Eliminate Indexer Errors
7. Additional notes for Windows users
8. Thanks

Install GCC4MBED Project

Refer to the following link to install GCC4MBED on your machine:
https://github.com/adamgreen/gcc4mbed#quick-start

Update mbed Firmware ¶

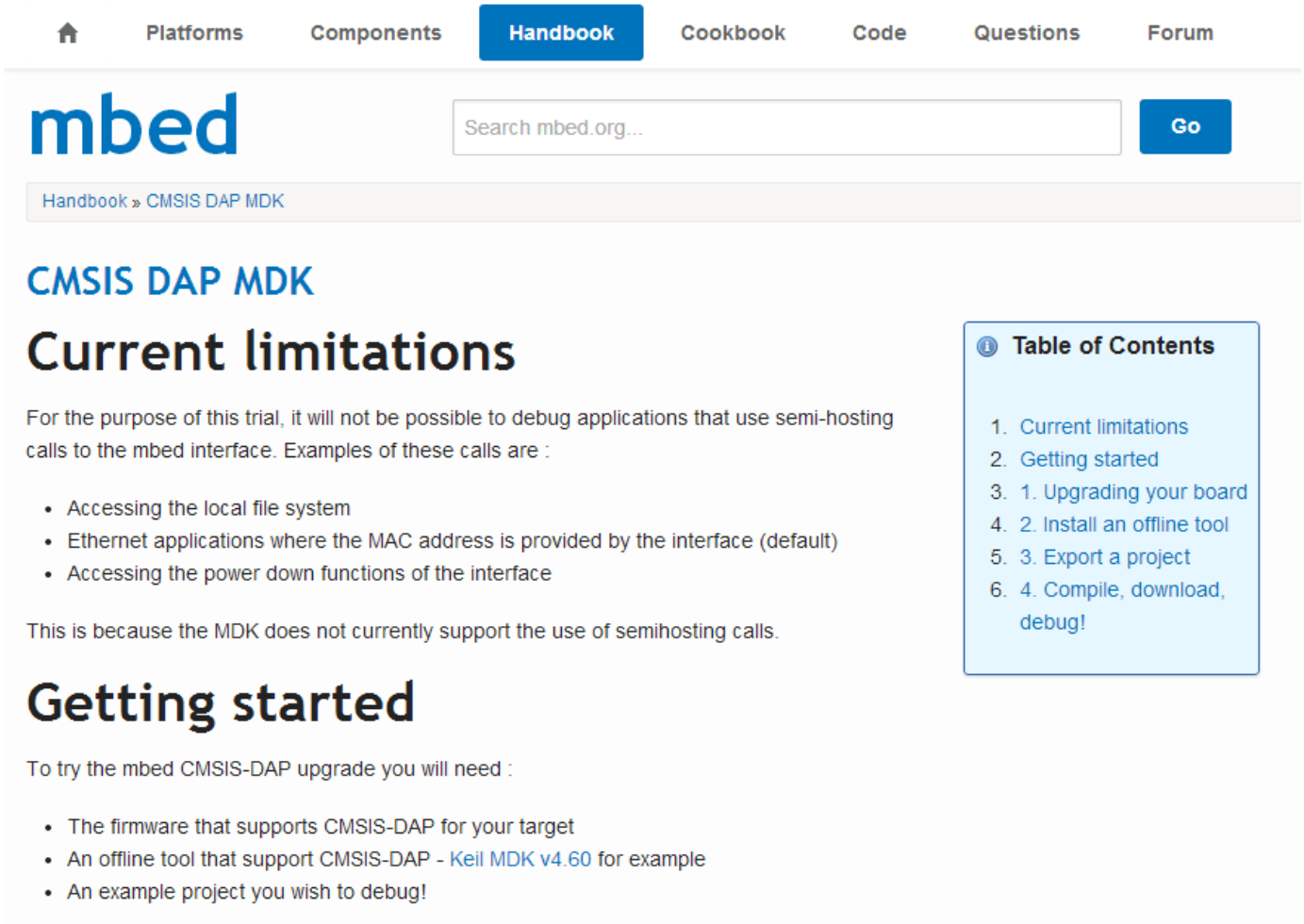
Download http://mbed.org/media/uploads/simon/mbedmicrocontroller_21164.if. Copy this file to your mbed device and then power cycle it. This will update the firmware on the interface chip so that the debug monitor can be used for debugging the device.

Install Eclipse with C/C++ and GNU Support

To get started, you need to install Eclipse. To this you will add support for the GNU tool chain used by the GCC4MBED project. At the time this document was written, Eclipse 4.2 (Juno), was the current release.

- Eclipse is a Java application and requires at least version 6 of the Java Runtime Environment, JRE, be installed on your machine. On Windows and Linux, you will want to make sure that you have this Java requirement installed. On OS X, it will detect the Java requirement when you first attempt to run Eclipse and offer to install it for you if not already installed.

ST NUCLEO Setup & Demo



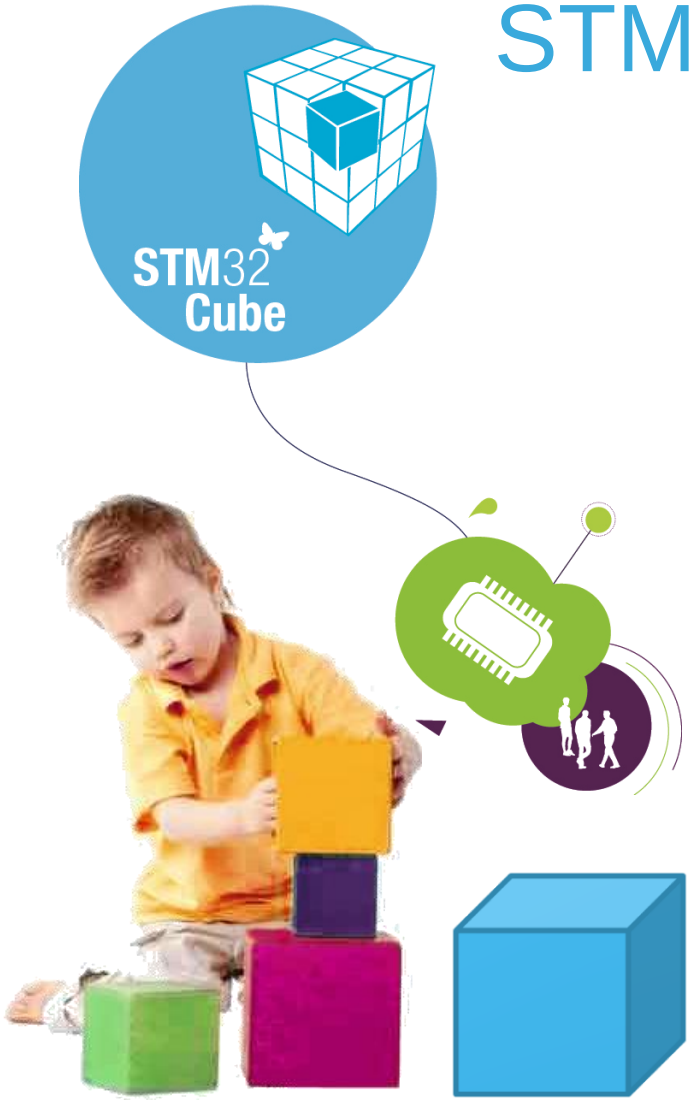
http://mbed.org/handbook/CMSIS-DAP-MDK Keil MDK v4.60

life.augmented

ST32 CUBE & Demonstration

life.augmented

STM32Cube™ Introduction

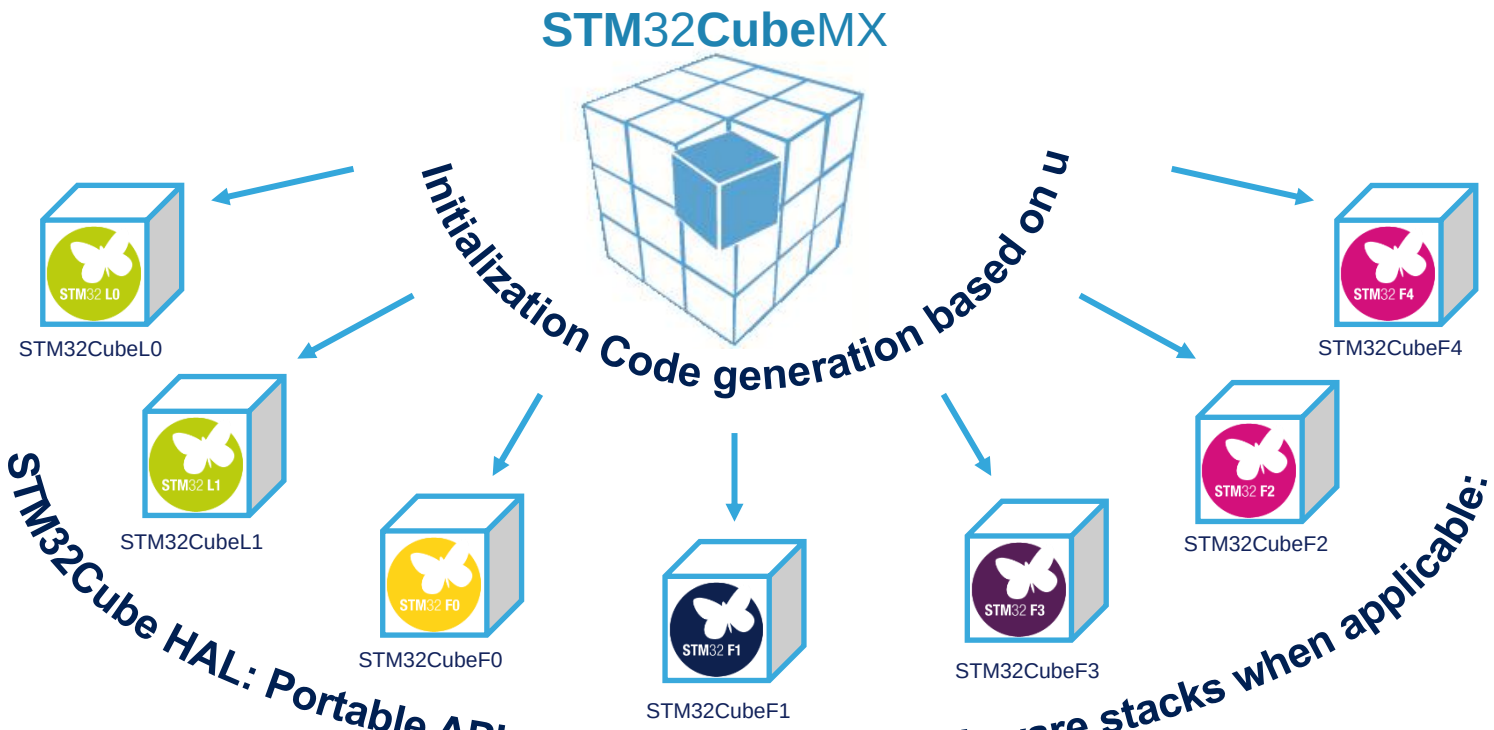


- STMCube™ is an STMicroelectronics original initiative to ease developers life
  - By reducing development efforts
  - By reducing development time
  - By reducing development cost, with free solutions
- STM32Cube™ applies on STM32 portfolio

www.st.com/stm32cube

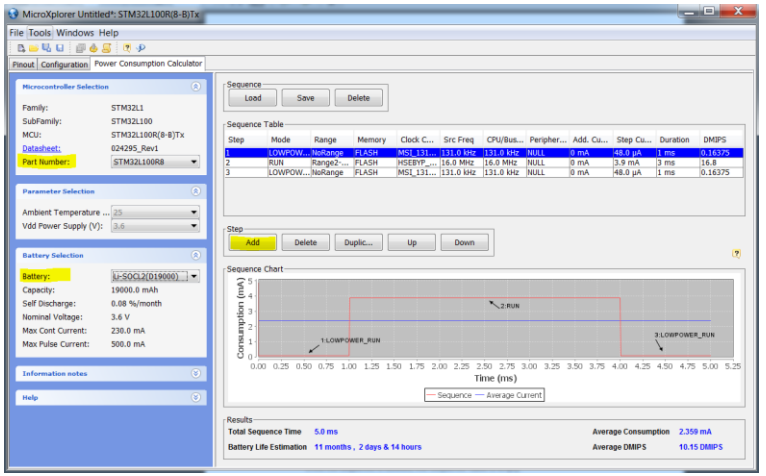
STM32Cube™ V1 Introduction

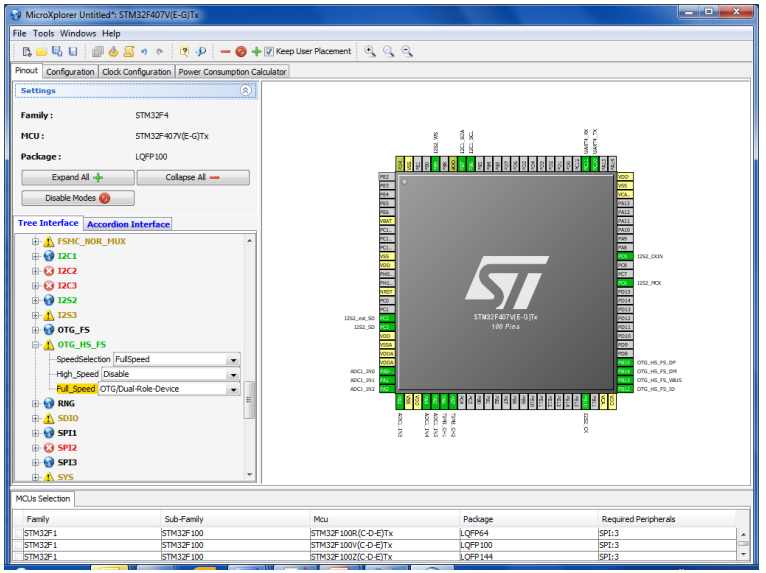
- STM32Cube™ Version 1 includes:
  - A configuration tool, STM32CubeMX generating initialization code from user choices
  - A full embedded software offer, delivered per serie (like STM32CubeF4) with:
    - An STM32 Abstraction Layer embedded software: STM32Cube HAL
    - A consistent set of Middlewares: RTOS, USB, TCP/IP, Graphics, …



STM32Cube™ V1 – Software Tool in brief

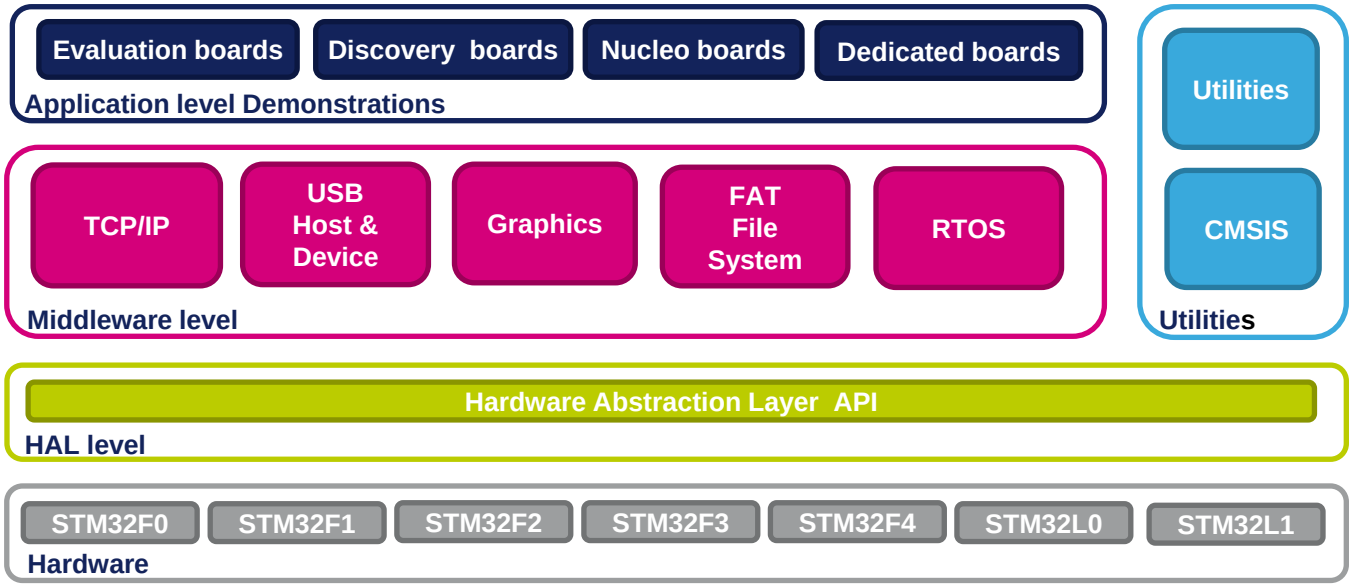
- STM32CubeMX is an extension of today existing MicroXplorer tool:
  - Step 1: Select the microcontroller
    - Smart Selector with advanced portfolio filtering choices
  - Step 2: Configure the microcontroller via wizards:
    - Pin out wizard, solving conflicts !
    - Clock Tree wizard
    - Peripherals and Middleware wizards, from SPI to TCP/IP !
    - Power consumption wizard
  - Step 3: Initialization code generation
    - Generates code for your favorite IDE !
- Automatic check for updates on st.com





STM32Cube™ V1 – Embedded software in brief

- The delivered embedded software is a layered approach
  - HAL level: Hardware Abstraction Layer (HAL), with libraries and examples
  - Middleware level: set of libraries with examples like RTOS, USB, TCP/IP …
  - Application level: demonstrations coming on ST boards
- Embedded software is delivered by series (STM32F4, STM32F0, …).
  - Common behaviors are covered with fully portable APIs
- Embedded software initialization code can be generated through STM32CubeMX
  - Customer can remain focused on the core application code



STM32CubeTM V1 – Key Benefits

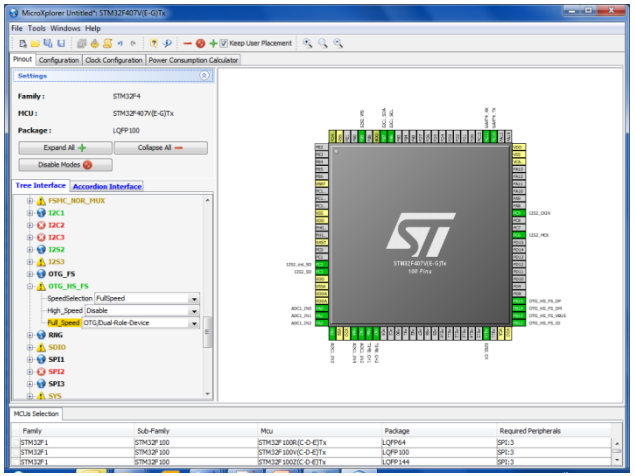
- **Consistent and Complete embedded software offer !**
  - Maximized portability between STM32 Series: seamless switch between series!
  - No more dependency headache: HAL and Middleware delivered altogether!
  - Easy to understand: Examples and demonstrations at all levels
  - Advanced demos putting altogether all the embedded software components
  - Fully documented

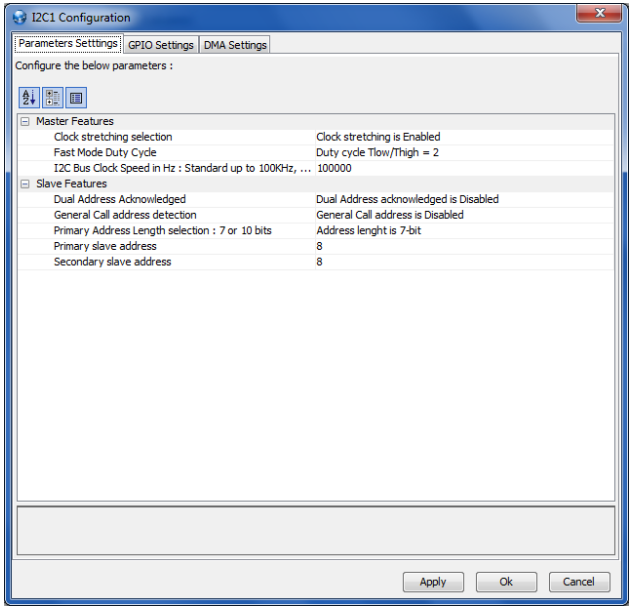
Layer	Category	Provided Embedded software	Provided Examples
HAL	Analog	Analog/Digital conversions, Comparators, OpAmps, …	150 examples on ST evaluation boards* !
	Timers	Timers, RTC, Watchdogs, …	
	Cryptography	CRC, AES, 3DES, Hash and Random Number generator, …	
	Connectivity	I2C, USART, SPI, I2S, SDIO, CAN, CEC, USB, Ethernet, …	
	Interface	External Memory, Display, Camera, Audio,…	
Middleware	RTOS	FreeRTOS open source RTOS, with CMSIS-RTOS wrapper	40 examples on ST evaluation boards* !
	USB	USB Host and Device cores Host Classes: HID, MSC, CDC, Audio, MTP Device Classes: HID, MSC, CDC, Audio, MTP, DFU, CCID	
	TCP/IP	LwIP open source stack with DHCP, DNS, ICMP, TCP, UDP, TFTP, HTTP, SSL/TLS (PolarSSL)…	
	File System	FatFS open source file system with enhanced mechanisms like NAND handling	
	Graphic	STemWin professional stack coming from SEGGER and available in binary form	
Application	Demonstration	Full demonstrations for ST boards	~23 boards will be supported !

*: STM32 F4 Serie

STM32Cube™ V1 – Key Benefits

- **Simplify and Speed up Application Development for STM32!**
  - Through STM32CubeMX:
    - Get the right MCU for your application using the MCU selector, filtering STM32 portfolio
    - Configure your peripherals using a graphical display
    - Use the power consumption wizard to check if your application fits the power budget
    - Generate initialization code based on your choices
    - Add your own code and keep it safe across new code generation
  - Through automatic updater systems
    - Ensuring the developer is aware of new versions and fixes, as well as new components
  - Through extensive set of examples, with ready project files for IAR, Keil and GCC



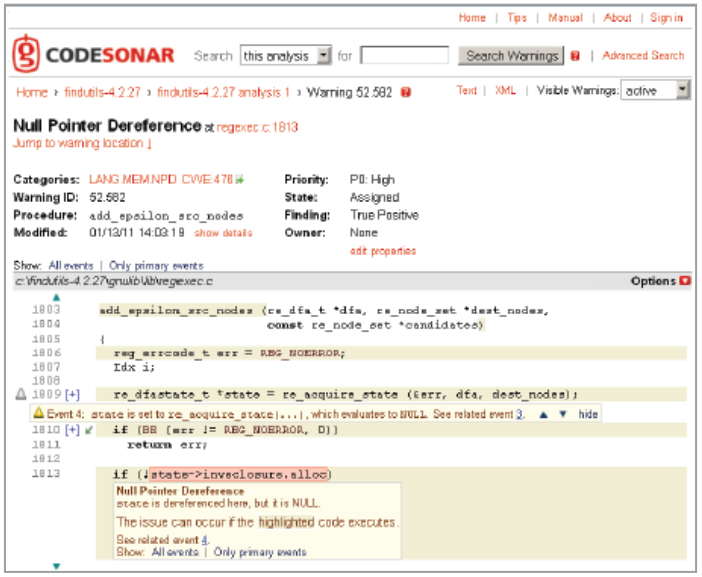


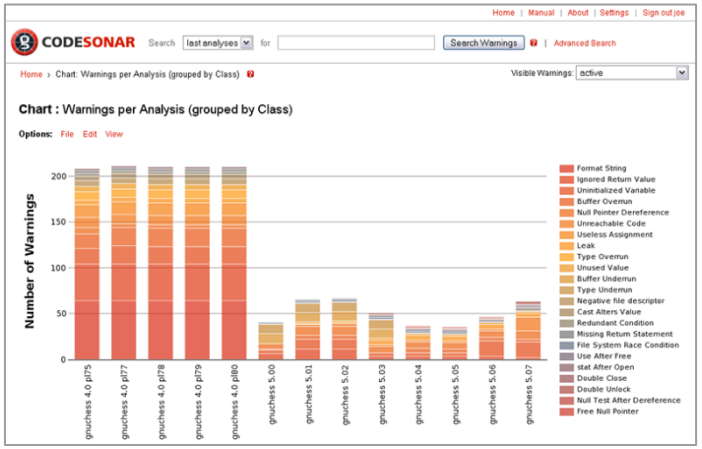
STM32Cube™ V1 – Key Benefits

- **More than Cost-friendly !**
  - 100% FREE embedded software!
  - 100% FREE software tool !
  - One-time shop: ST-branded, ST-supported !
  - Users gain time with initialization code generation, and remain focused on their key application code

STM32Cube™ V1 – Key Benefits

- **High quality solution !**
  - Based ST embedded software solutions ready for production, and de-facto open source standards
  - HAL following standard C coding rules:
    - ANSI C
    - MISRA C-2004
- **HAL going through Code Analysis Tool: CodeSonar™ from Grammatech!**
  - Industry reference tool identifying vulnerabilities at compilation time





STM32Cube™ V1 – Key Benefits

- **Open Approach !**
  - HAL level coming with most permissive open source license: BSD one !
  - Middleware based partly on well-known open source solutions
    - Thus portable to other platforms
  - Other embedded software parts are ST-made[2] !
    - They come with license model allowing easy reuse provided it runs on an ST device!

Middleware	Chosen open source solution	Comment
RTOS	FreeRTOS	FreeRTOS is number 1 RTOS in embedded market !
TCP/IP	LwIP	Lightweight IP, the can't be avoided reference, improved by ST
	PolarSSL[1]	SSL/TLS secure layer, sitting on top of LwIP
File System	FatFS	De facto embedded standard, enhanced by ST

1: PolarSSL is either GPL or commercial license

2: But STemWin is available under binary form, and based on a partnership with SEGGER around emWin product

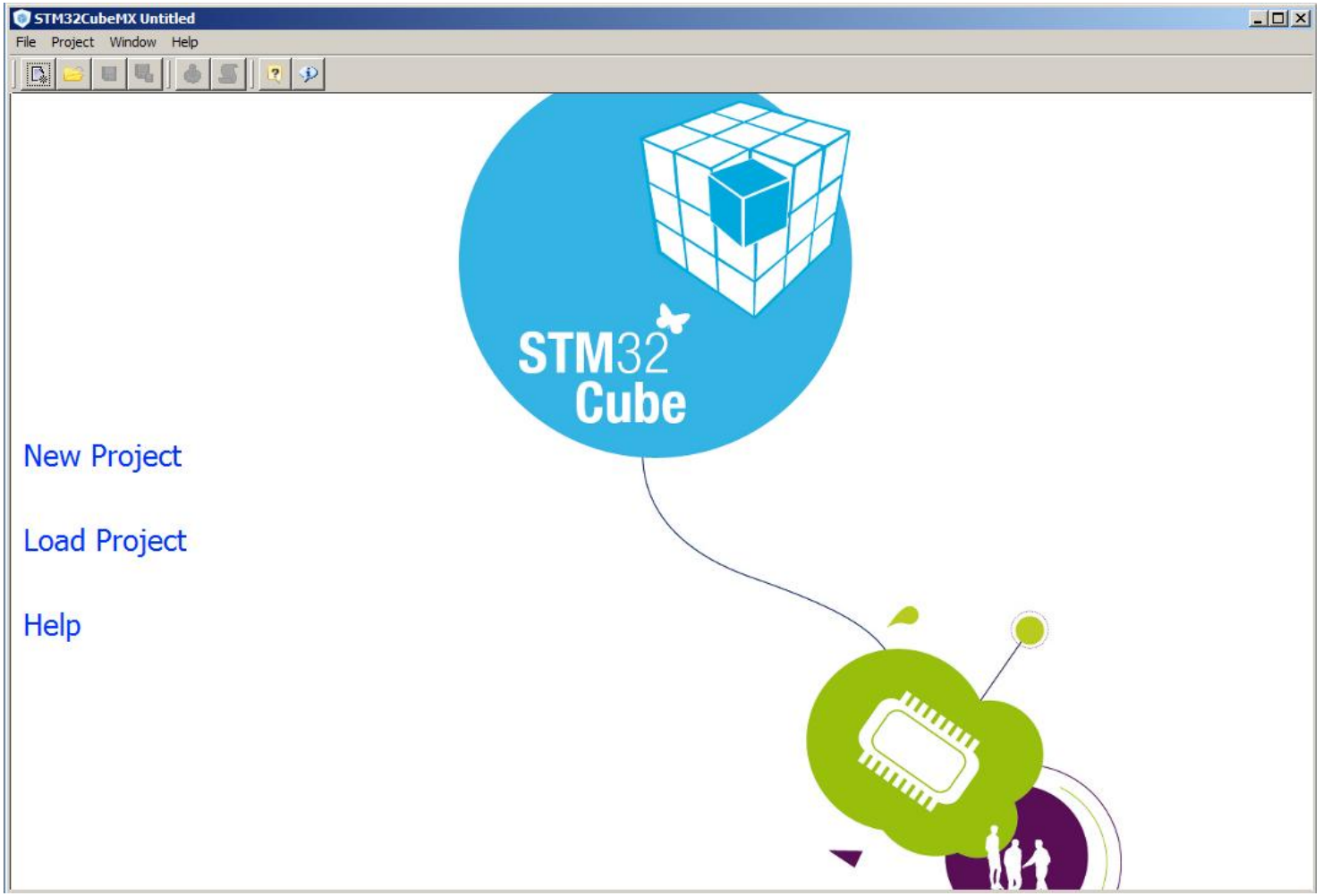
STM32Cube™ V1 – Key Benefits

- **“Connected” to the world !**
  - STM32CubeMX available as stand-alone or Eclipse plugin
    - Makes it easy to use within an open source tool chain and editor
  - Automatic or on demand update mechanism in STM32CubeMX
  - Compliant to ARM CMSIS initiative, through:
    - CMSIS-CORE: API for Cortex-M processor and core peripherals
    - CMSIS-DSP: DSP Library with 61 functions for Cortex-M
    - CMSIS-RTOS: API for RTOS integration, coming with FreeRTOS in STM32Cube™
    - CMSIS-DRIVER*: through a wrapper layer on top of HAL

*: Ongoing, for STM32 F4

ST CUBE Setup & Demo

- Demonstration




Thank
You