STM32L5 MCU series
excellence in ultra-low-power with more security

STM32L5 series

MPU					**STM32MP1** 4158 CoreMark 650 MHz Cortex –A7 209 MHz Cortex –M4
High Perf MCUs		**STM32F2** Up to 398 CoreMark 120 MHz Cortex-M3	**STM32F4** Up to 608 CoreMark 180 MHz Cortex-M4	**STM32F7** 1082 CoreMark 216 MHz Cortex-M7	**STM32H7** Up to 3224 CoreMark Up to 550 MHz Cortex -M7 240 MHz Cortex -M4
Mainstream MCUs	**STM32F0** 106 CoreMark 48 MHz Cortex-M0	**STM32G0** 142 CoreMark 64 MHz Cortex-M0+	**STM32F1** 177 CoreMark 72 MHz Cortex-M3	**STM32F3** ● 245 CoreMark 72 MHz Cortex-M4	**STM32G4** ● **550 CoreMark** **170 MHz Cortex-M4**
				Optimized for mixed-signal Applications	
Ultra-low Power MCUs	**STM32L0** 75 CoreMark 32 MHz Cortex-M0+	**STM32L1** 93 CoreMark 32 MHz Cortex-M3	**STM32L4** 273 CoreMark 80 MHz Cortex-M4	**STM32L4+** 409 CoreMark 120 MHz Cortex-M4	**STM32L5** 443 CoreMark 110 MHz Cortex-M33 — **STM32U5** 651 CoreMark 160 MHz Cortex-M33
Wireless MCUs			**STM32WL** 162 CoreMark 48 MHz Cortex-M4 48 MHz Cortex-M0+	**STM32WB** ● 216 CoreMark 64 MHz Cortex-M4 32 MHz Cortex-M0+	

● Optimized for mixed-signal applications   ● Cortex-M0+ Radio co-processor

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LONGEVITY 10 YEARS COMMITMENT

Main concerns for embedded design

- **Security**
  - Increase the robustness against attacks

- **Low power consumption**
  - Long life time, small battery size

- **Integration, performance, ecosystem**
  - Best fit versus the application requirements

# First STM32 based on Cortex-M33

STM32L5 is the answer

- More security with TrustZone and ST security implementation
  - HW to increase resistance to logical and board level attack

- Lower Power consumption
  - STM32 ultra-low-power technology

- Integration, performance, ecosystem
  - More performance, choice of packages and wide ecosystem
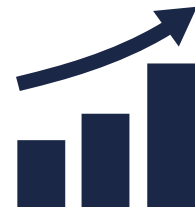
Security: TrustZone for isolation

ST implementation provides a high granularity of isolation

STM32**L5**

Un-Trusted	Trusted
Un-Trusted Application	Trusted Application
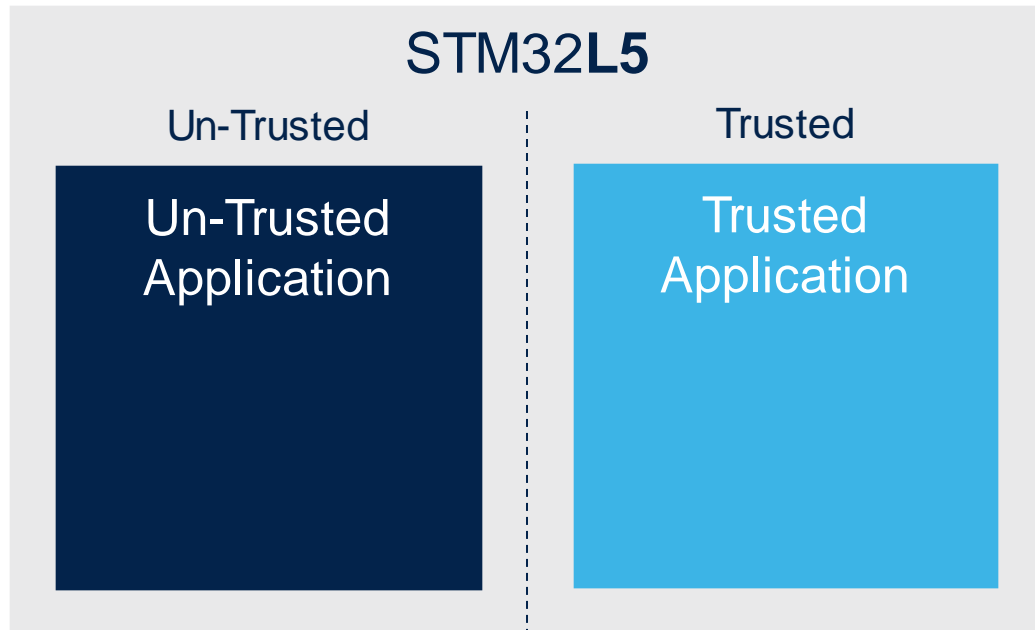
- **Each** GPIO or peripheral, DMA channel, clock configuration register, ART or small part of Flash memory or SRAM can be configured as **Trusted** or **un-Trusted**

- **Full isolation** of trusted and non-trusted worlds

TrustZone provides full isolation

Example of IoT application implementation

STM32**L5**

Un-Trusted

Un-Trusted Application

Trusted

Trusted Application

RF

Sensors
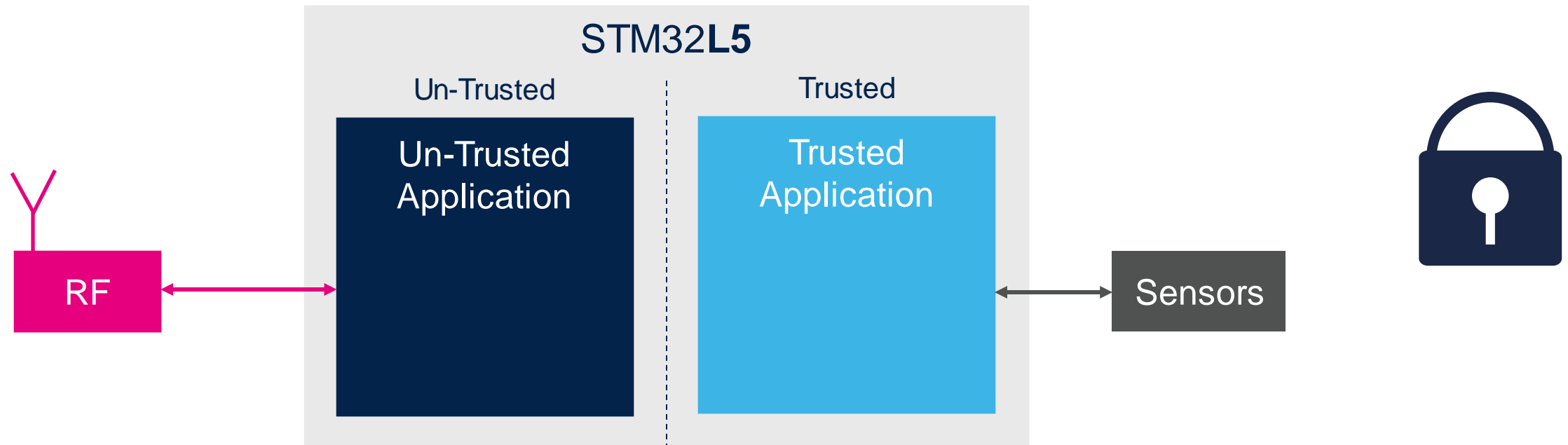
Security: TrustZone and privileged zones

STM32**L5**

	Un-Trusted	Trusted
Privileged	Un-Trusted & Privileged	Trusted & Privileged
Un-Privileged	Un-Trusted & Un-Privileged	Trusted & Un-Privileged
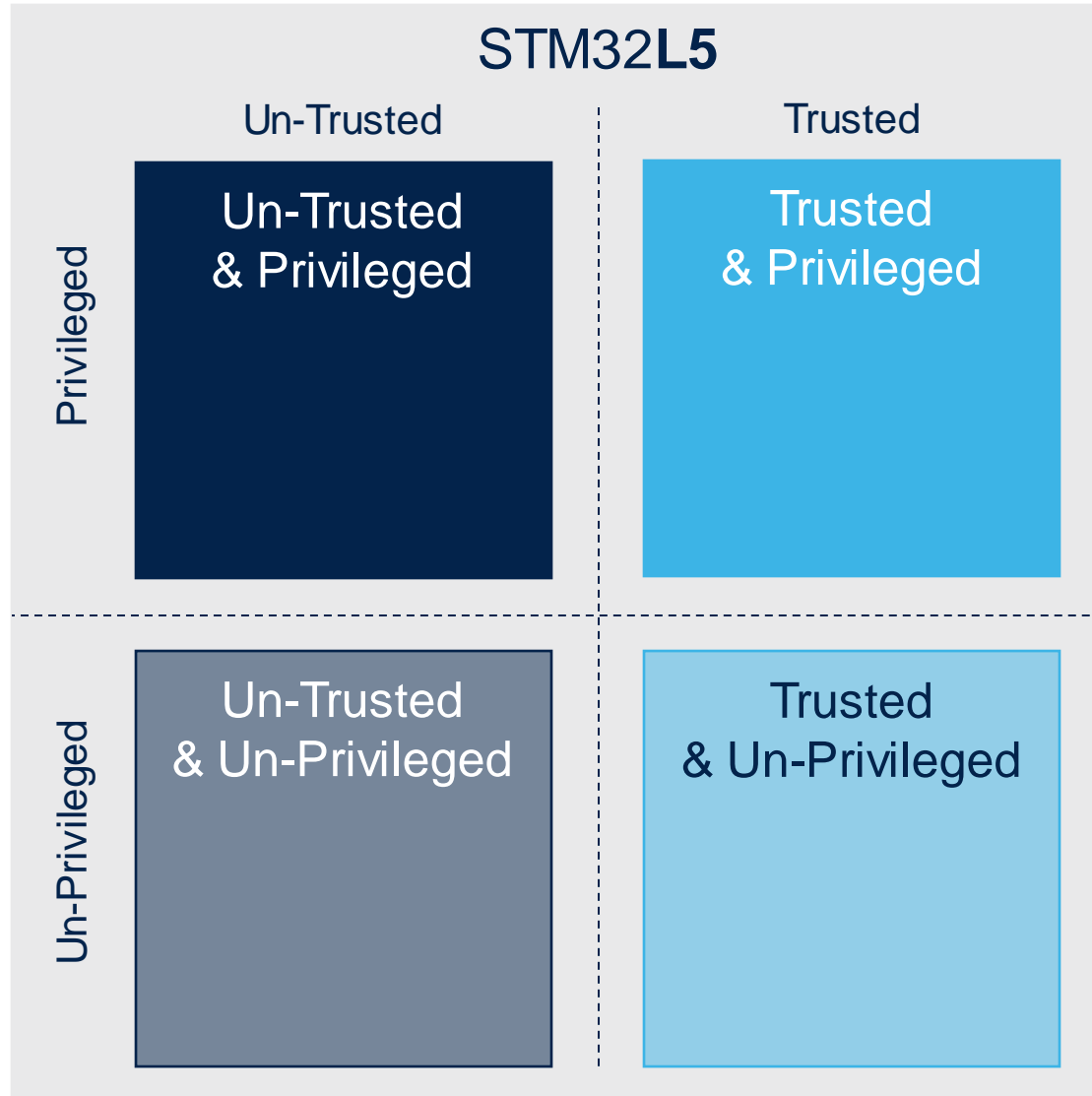
- More partitioning

- Possibility to separate the trusted and un-trusted area with **privileged and un-privileged** zone

- Strong **granularity** to define each part of memory or each peripheral, DMA channel as privileged or un-privileged

TrustZone: example

STM32**L5**

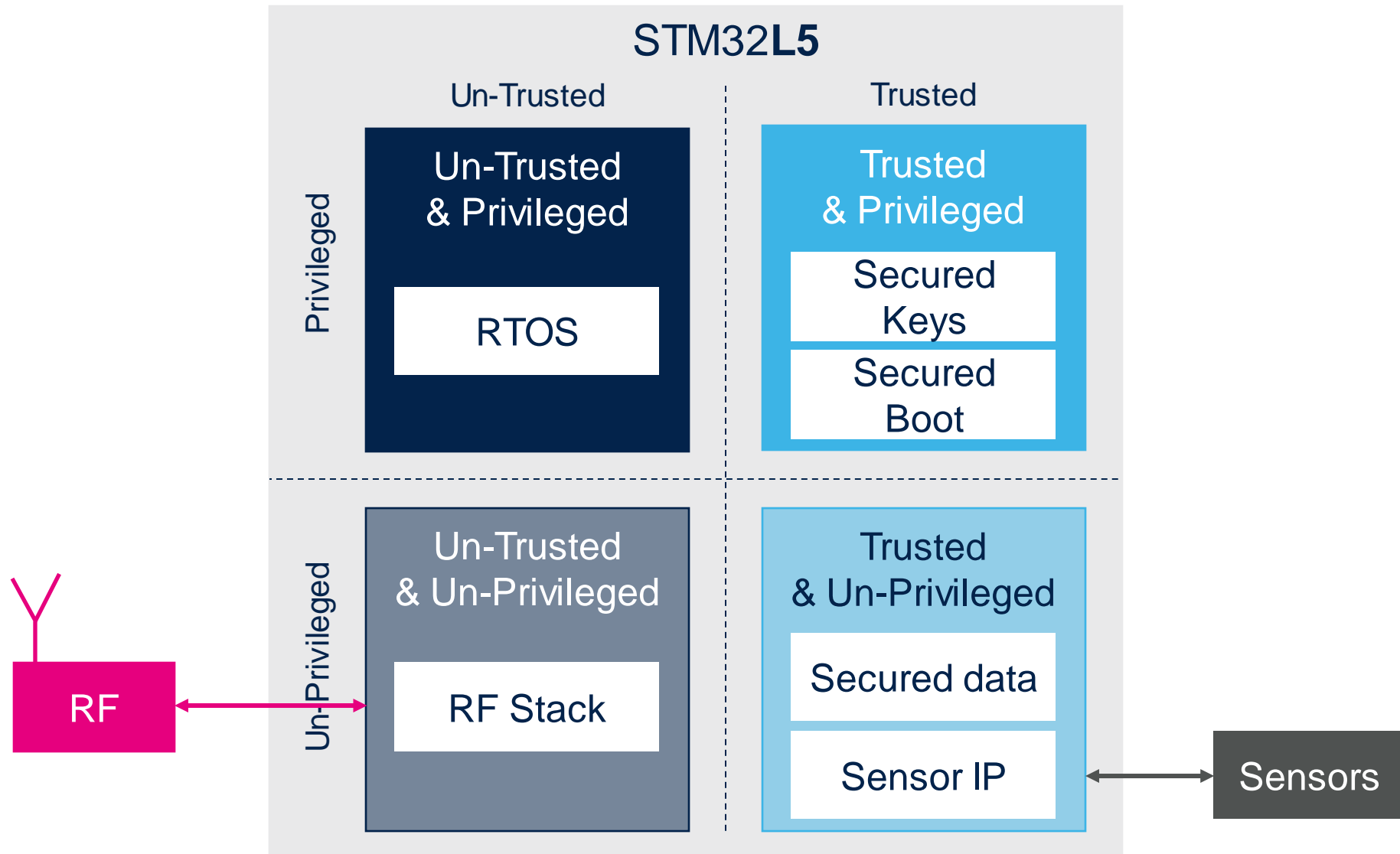|	Un-Trusted	Trusted
Privileged	Un-Trusted & Privileged RTOS	Trusted & Privileged Secured Keys Secured Boot
Un-Privileged	Un-Trusted & Un-Privileged RF Stack	Trusted & Un-Privileged Secured data Sensor IP

RF

Sensors

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Encryption Decryption Authentication

- AES-128/256 Encryption
- SHA-256 Authentication
- **Public Key Acceleration (PKA): for RSA, Diffie-Hellmann or ECC (Elliptic Curve Cryptography)**
- Certified Crypto library
- True Random Number Generator
- Unique ID
- OTP Zone

STM32**L5**

Memory & IP Protection

- **Active and static Anti-tamper detection**
- Memory Protection Unit (MPU)
- Secure Boot
- Read and Write Protection
- **HDP (Hide Protect)**
- **Unique Boot Entry**
- **OTFDEC (On-the-fly decryption) on Octo SPI to protect external memory**
- JTAG fuse
- **TrustZone**
- **SFI (Secure Firmware Installation)**

Extends battery lifetime

- STM32L5 reuses the STM32L4/L4+ technology achieving **best-in-class** power consumption

- STM32L5 integrates an optional **SMPS** (DC/DC buck voltage regulator) which can be enabled/disabled on the fly to avoid external noise for external RF or data acquisition.
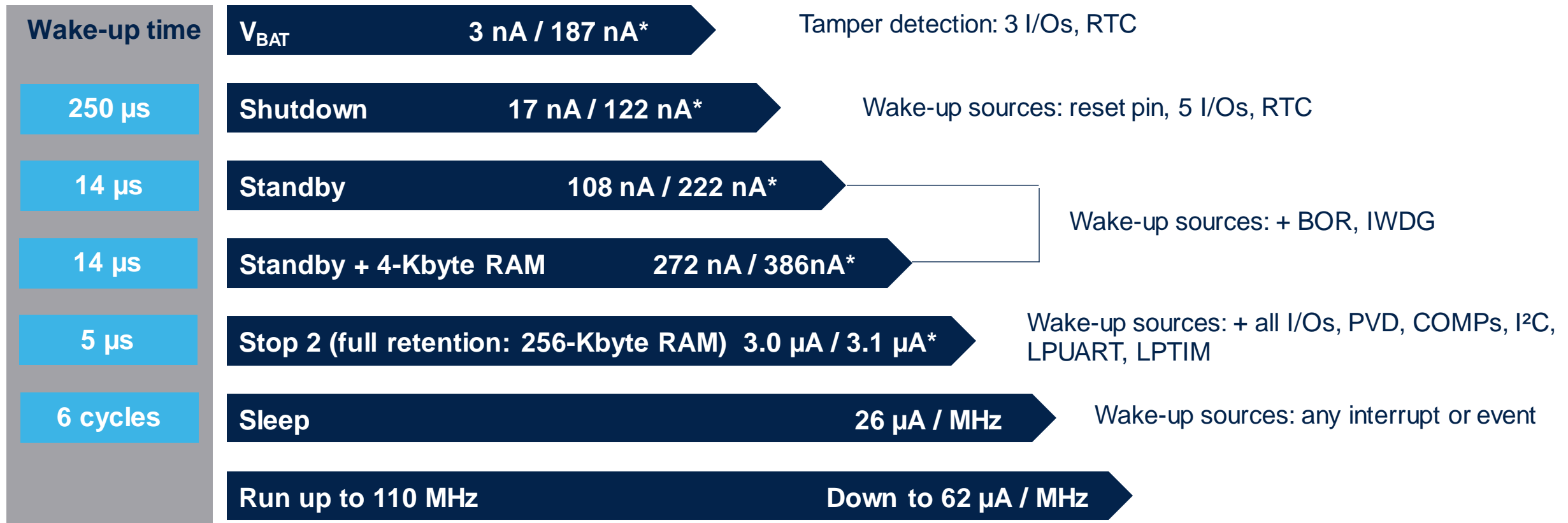
- Proven by EEMBC test results:

ULPBENCH™ An EEMBC Benchmark **370 ULPMark-CP**

ULPBENCH™ An EEMBC Benchmark **54 ULPMark-PP**

Ultra-low-power modes

Best power consumption numbers with full flexibility

Wake-up time		
	V_{BAT}	3 nA / 187 nA*	Tamper detection: 3 I/Os, RTC
250 µs	Shutdown	17 nA / 122 nA*	Wake-up sources: reset pin, 5 I/Os, RTC
14 µs	Standby	108 nA / 222 nA*	Wake-up sources: + BOR, IWDG
14 µs	Standby + 4-Kbyte RAM	272 nA / 386nA*	
5 µs	Stop 2 (full retention: 256-Kbyte RAM)	3.0 µA / 3.1 µA*	Wake-up sources: + all I/Os, PVD, COMPs, I²C, LPUART, LPTIM
6 cycles	Sleep	26 µA / MHz	Wake-up sources: any interrupt or event
	Run up to 110 MHz	Down to 62 µA / MHz	

Note : * without RTC / with RTC

More performance

Better responsiveness of the application

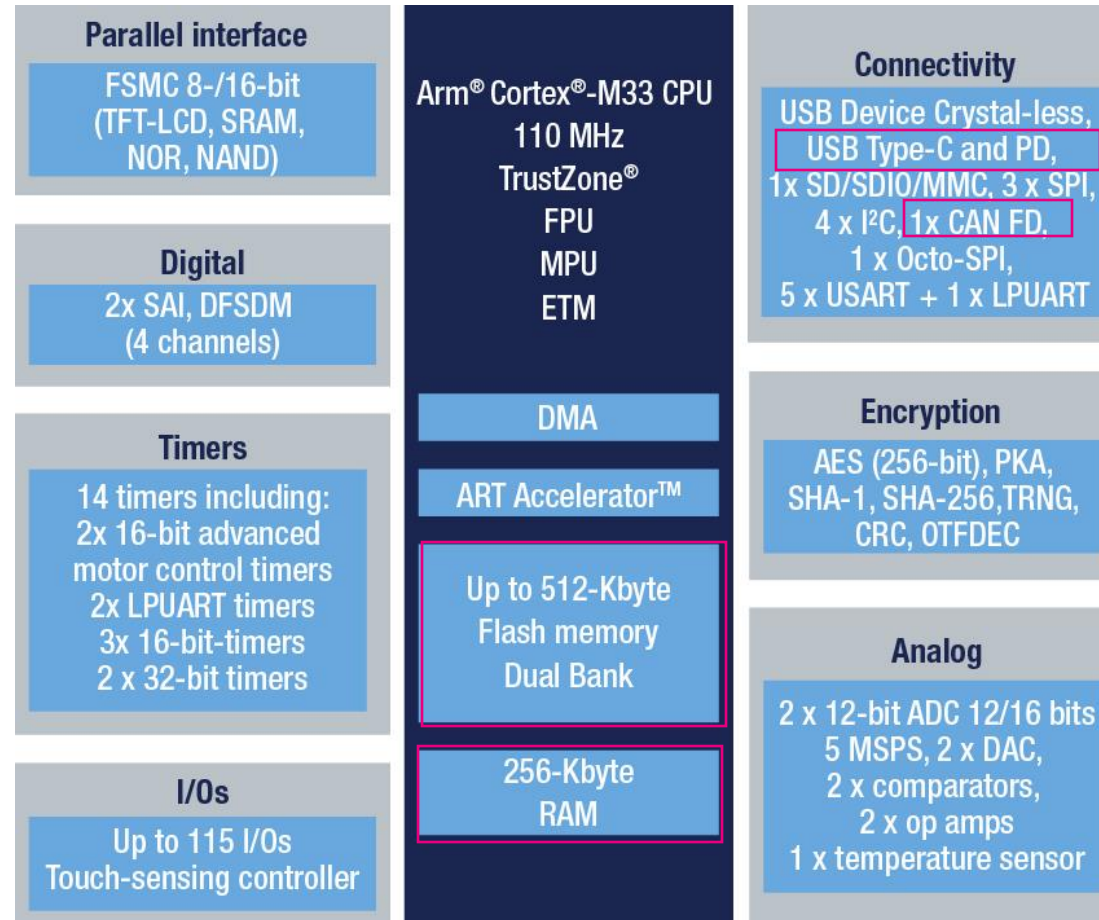- **New** Arm® Cortex®-M33 performance: **+20%** versus Cortex-M4

1.5 DMIPS/MHz 4.02 CoreMark/MHz	→	165 DMIPS 442 CoreMark
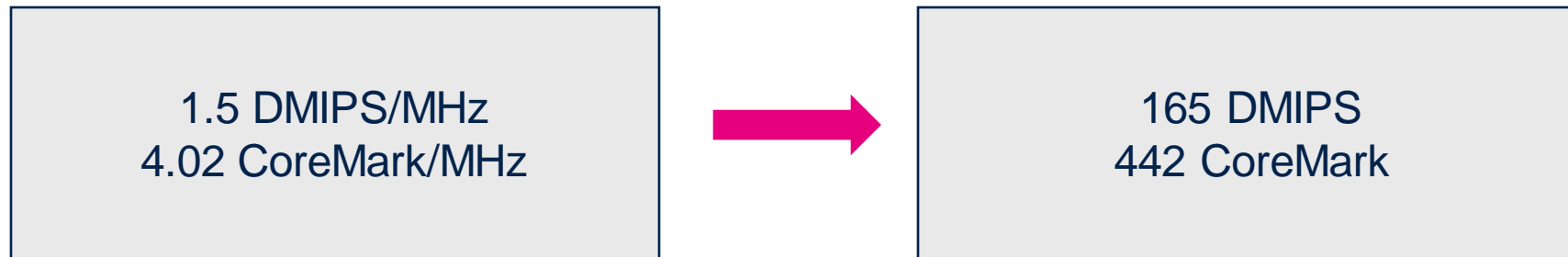
- **New** ST ART Accelerator™: working both on internal and **external** Flash
  - 8 Kbytes of instruction cache

Large memory, USB Type-C™ w/ power delivery controller, CAN FD

Parallel interface
FSMC 8-/16-bit
(TFT-LCD, SRAM,
NOR, NAND)

Digital
2x SAI, DFSDM
(4 channels)

Timers
14 timers including:
2x 16-bit advanced
motor control timers
2x LPUART timers
3x 16-bit-timers
2 x 32-bit timers

I/Os
Up to 115 I/Os
Touch-sensing controller

Arm® Cortex®-M33 CPU
110 MHz
TrustZone®
FPU
MPU
ETM

DMA

ART Accelerator™

Up to 512-Kbyte
Flash memory
Dual Bank

256-Kbyte
RAM

Connectivity
USB Device Crystal-less,
USB Type-C and PD,
1x SD/SDIO/MMC, 3 x SPI,
4 x I²C, 1x CAN FD,
1 x Octo-SPI,
5 x USART + 1 x LPUART

Encryption
AES (256-bit), PKA,
SHA-1, SHA-256,TRNG,
CRC, OTFDEC

Analog
2 x 12-bit ADC 12/16 bits
5 MSPS, 2 x DAC,
2 x comparators,
2 x op amps
1 x temperature sensor

13

7 packages, several options

Flash memory size / RAM size (bytes)

	48-pin LQFP/QFN	64-pin LQFP	81-pin WLCSP	100-pin LQFP	132-pin UFBGA (0.5 mm pitch)	144-pin LQFP
512 K / 256 K	STM32L562CE	STM32L562RE	STM32L562ME	STM32L562VE	STM32L562QE	STM32L562ZE
	STM32L552CE	STM32L552RE	STM32L552ME	STM32L552VE	STM32L552QE	STM32L552ZE
256 K / 256 K	STM32L552CC	STM32L552RC		STM32L552VC	STM32L552QC	STM32L552ZC

Pin count

Legend: ☐ without HW crypto ■ with HW crypto

14

STM32L ULP portfolio

STM32L5 completes the ultra-low-power subclass

| Cost-smart ULP champion	Broad-range foundation	ULP With performance	ULP with more performance	Advanced security
STM32L0	**STM32L1**	**STM32L4**	**STM32L4+**	**STM32L5**
Cortex-M0+ at 32 MHz 1.65 to 3.6V 8-/16-bit applications Wide range of pin-counts	Cortex-M3 at 32 MHz 1.65 to 3.6V Wide choice of memory sizes	Cortex-M4 w/ FPU at 80 MHz 1.71 to 3.6V High-performance, advanced analog circuits	Cortex-M4 w/ FPU at 120 MHz 1.71 to 3.6V Wide choice of memory sizes	Cortex-M33 w/ FPU at 110 MHz 1.71 to 3.6V Wide choice of memory sizes
3 product lines, Cost-effective, Smaller packages, USB, LCD, Analog 8 to 192 Kbytes of Flash, Up to 20 Kbytes of SRAM	3 product lines, USB, LCD, AES, Rich Analog True EEPROM, Dual-bank Flash memory (RWW), 32 to 512 Kbytes of Flash, Up to 80 Kbytes of SRAM	5 product lines, 5-MSPS ADC, PGA, Compar., DAC, Op Amp, USB OTG, LCD, AES 64 Kbytes to 1 Mbyte Up to 320 Kbytes of SRAM	3 product lines, 5-MSPS ADC, PGA, Compar., DAC, Op Amp, USB OTG, LCD, AES 1 to 2 Mbytes of Flash, Up to 640 Kbytes of SRAM	1 product line, 5-MSPS ADC, PGA, Compar., DAC, Op Amp, USB Type C, AES 256 to 512 Kbytes of Flash, Up to 256 Kbytes of SRAM

A Complete Ecosystem

STM32 CubeMCU Packages

STM32Cube MCU Packages
STM32Cube MCU Middleware
STM32Cube HAL & LL drivers
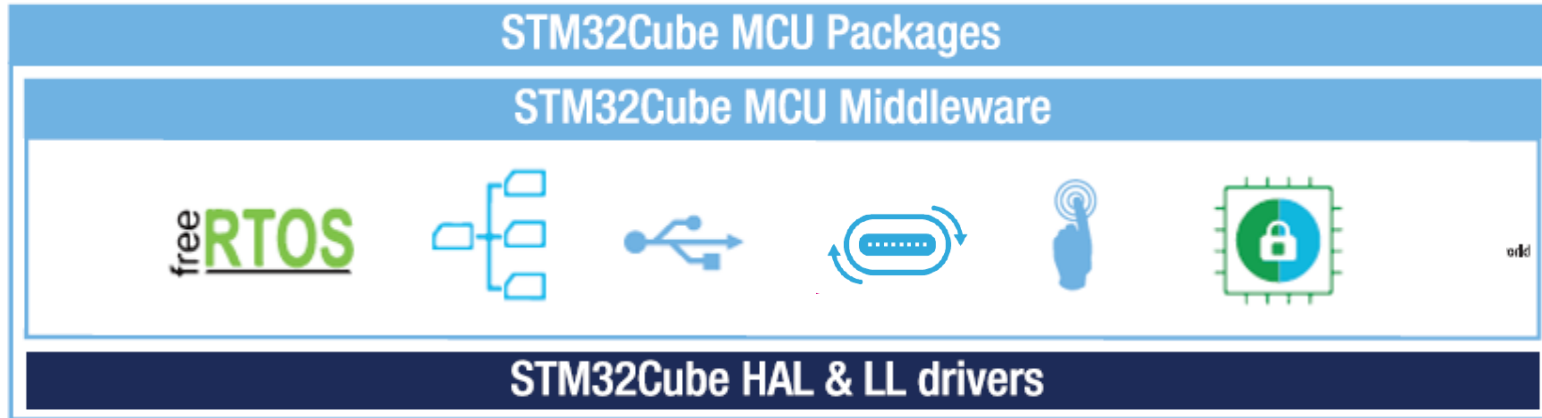
Peripheral drivers

HAL API
Hardware Abstraction Layer, highly portable and easy to use

LL APIs
Low-Layer APIs, light weight and highly optimized for runtime efficiency

STM32Cube Middleware

Generic Middleware
- **FreeRTOS**
- FatFS file system
- **mbedTLS** and **mbedCrypto**
- USB Device stacks

Dedicated Middleware
- **Secure Boot and Secure Firmware Update**
- **TF-M for trusted execution environment**
- **USB-PD device driver**
- STM32 Touch Sensing library

Project Examples

STM32CubeMX ready
More than 300 project examples for KEIL, IAR and STM32CubeIDE toolchains, with a STM32CubeMX configuration file

www.st.com/stm32cubel5

SBSFU and TF-M in STM32CubeL5

Reference code framework for a trusted Execution Environment

STM32L5

- Un-Trusted Un-Privileged
- Un-Trusted Privileged
- TF-M (Application Root of Trust)
- TF-M (PSA Root of Trust)
- SBSFU TF-M (PSA immutable Root of Trust)
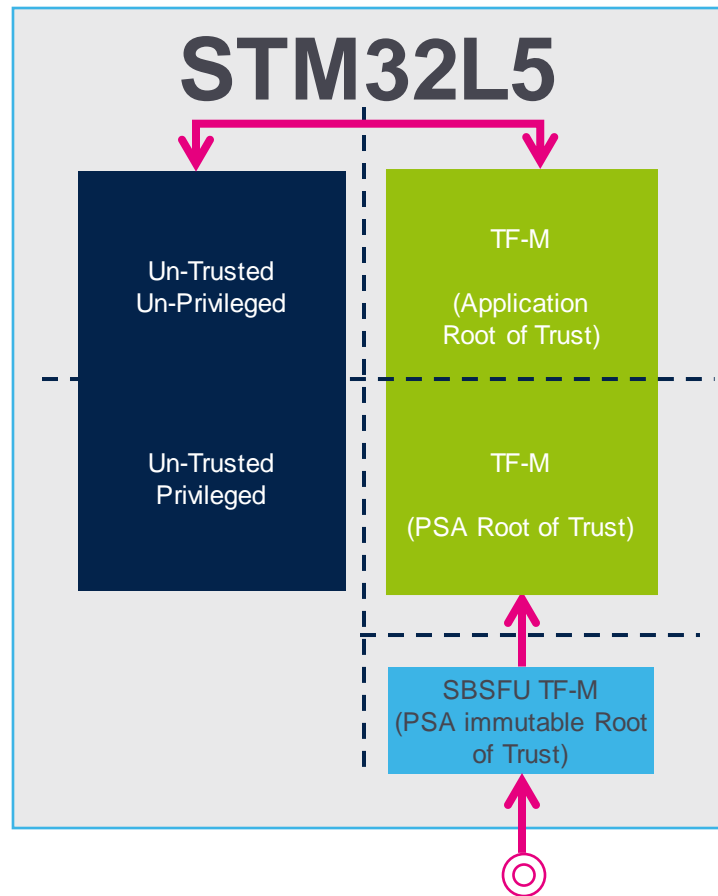
TF-M Framework

- Isolation and Secure execution
- Secure services (crypto, initial attestation, secure storage)
- Easy addition of user secure services
- Leveraging STM32L5 security features

SBSFU TF-M

- Secure Boot
- Secure Firmware Update

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STM32L5 is one of the first MCU PSA Level 2 certified

psacertified™
level two

All-in-1 STM32 development tool
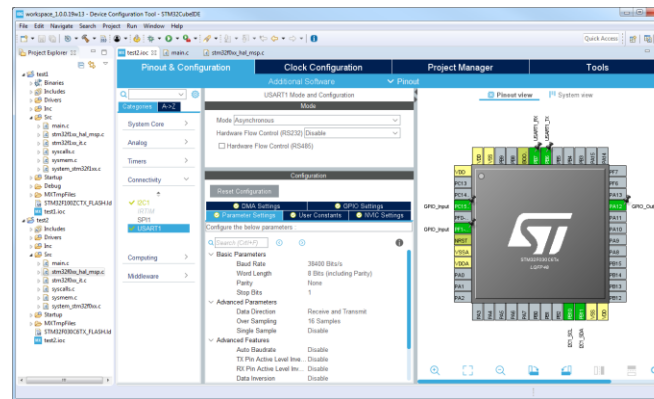
Configure and generate code	Develop code, Compile and Link	Program and Debug
STM32CubeMX integrated	**TrustZone support**	**TrustZone support**

- • TrueSTUDIO / SW4STM32 importer
- • Advanced editor
- • GNU C/C++ for Arm® toolchain

- • GDB and OpenOCD debugger
- • Support of ST-Link and J-Link debug probes

Arm V8-M TrustZone architecture support
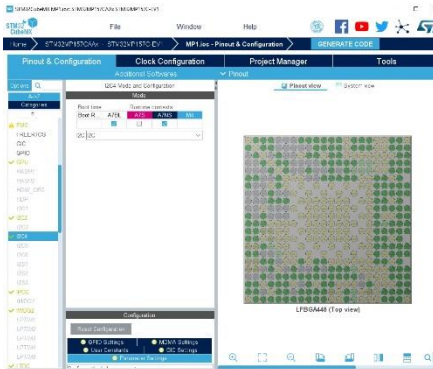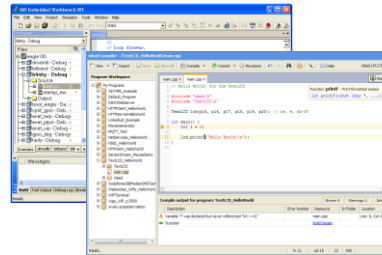
STM32CubeMX	IDEs Compile and Debug	STM32 Programming Tool
STM32CubeMX enhanced for TrustZone	**TrustZone Support**	**STM32CubeProgrammer**
• Peripherals/middleware configuration • Resources allocation to security domains	• Partners IDE • STM32CubeIDE based on Eclipse • TrustZone debugging	• Device and memory configuration • Program the application • Secure Firmware Install

Optional step

Configuration tool

Power Consumption Calculator

MCU or board Selector

macOS®

Windows

Load an Example .ioc file

- STM32Cube_FW_L5_V1.0.0
  - _htmresc
  - Drivers
  - Middlewares
  - Projects
    - NUCLEO-L552ZE-Q
    - STM32L552E-EV
    - STM32L562E-DK
  - Utilities

Code Generation

CODE

TrustZone support

STM32 CubeMX

Pinout Configuration

Middleware Parameters

FreeRTOS
FatFS
USB device

Clock Tree Initialization

Peripherals Configuration

TrustZone configuration and GPIOs, memories, DMA, peripherals allocation to security domains

CAN   I2C   SPI   UART

All-in-one programming software tool

macOS®

Windows

STM32 CubeProgrammer
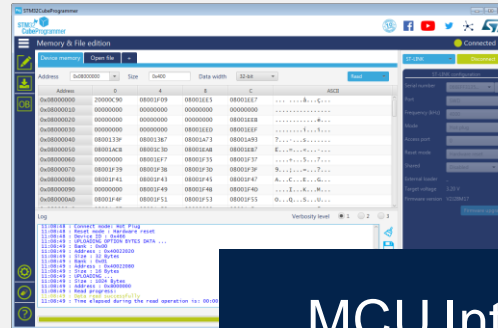
MCU Internal Flash and external Flash services
MCU configuration (Option bytes)

Intuitive GUI
Command Line Interface for scripting
API DLL for Custom Integration

STLink (JTAG, SWD)
STM32 Bootloader Interface (USB, UART, SPI, I2C, CAN)
Secure Firmware install (SFI)

Speed-up evaluation prototyping and design

$275

$76

$20

Evaluation Boards	Discovery Kit	Nucleo Boards
Full feature STM32L5 evaluation	**Flexible prototyping & demo**	**Affordable and quick prototyping**
• STM32L552E-EV	• STM32L562E-DK	• NUCLEO-L552ZE-Q

Discovery kit

Prototype your wearable or sensor application with STM32L562E-DK

Fan-out expansion board
included
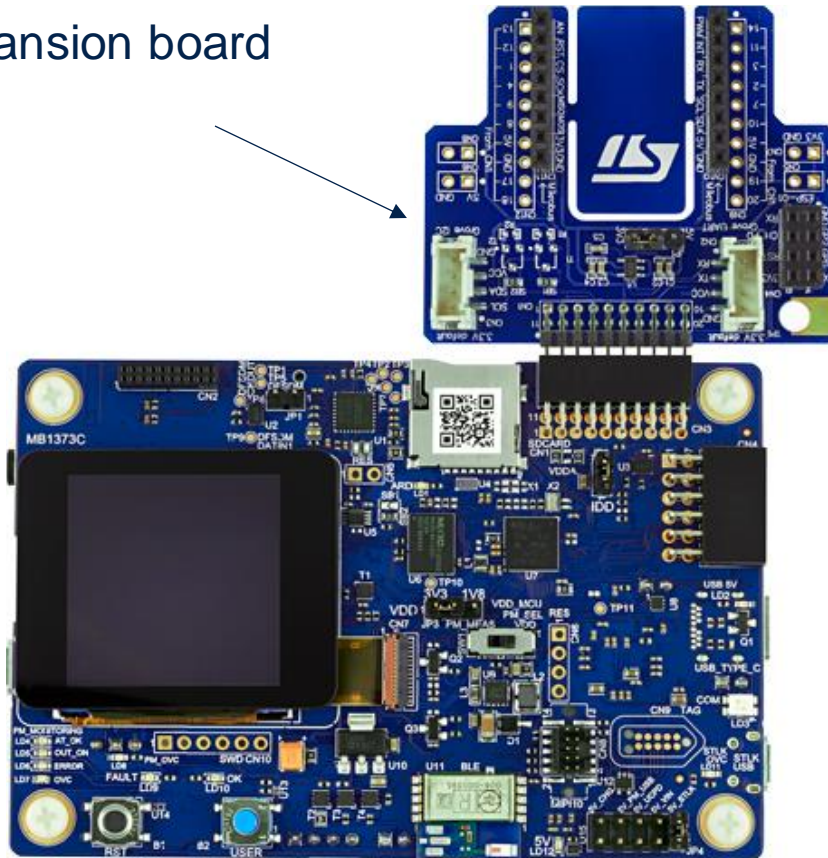
Key Features

- STM32L562 MCU with AES and PKA
- 240 x 240 pixel-TFT color Display
- state-of-the-art Energy Meter
- 3D accelerometer and 3D gyroscope
- Bluetooth® V4.1 low energy module
- Audio Codec and Headphone amplifier
- Digital microphone
- USB Type-C™ Sink device FS
- 512Mbit Octal Flash memory extension
- ST-Link V3
- STMod+ connector with fan-out expansion board for Wi-Fi®, Grove and mikroBUS™ compatible connectors

State-of-the-art on-board power consumption measurement
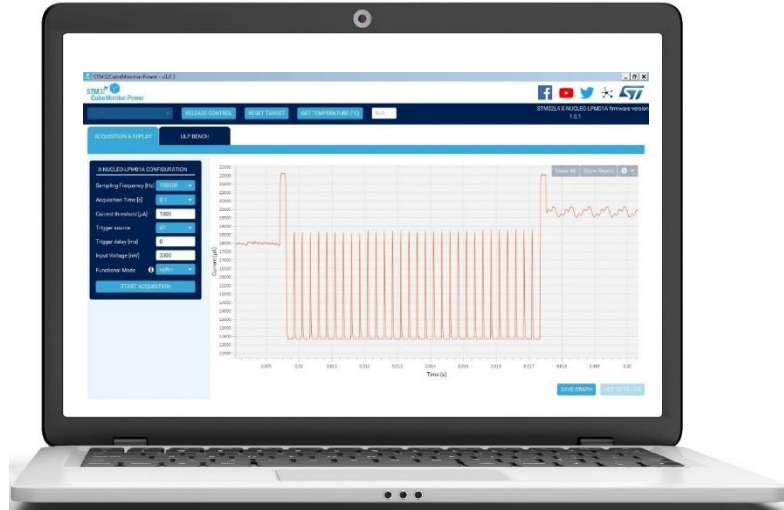
STM32L562E-DK

On-board Energy Meter
300 nA to 150 mA measurement range

STM32 CubeProgrammer
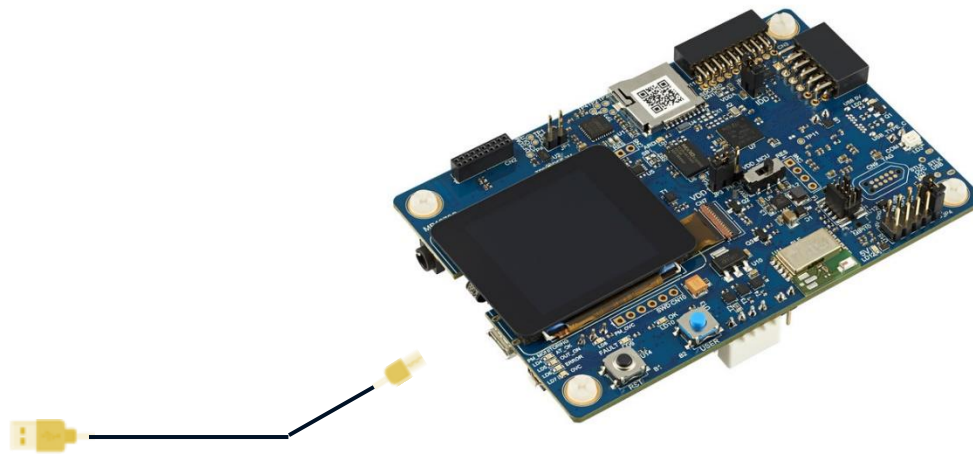
Protect your code and control the number of products manufactured

Customer premises

Untrusted environment

FW

Encrypted FW

Encrypted FW transfer

STM32L5 SFI

Store encryption key and production counter into HSM

Authenticate target STM32 Generate installation license

ST Hardware Secure Module (HSM)

HSM

HSM **physical** transfer

HSM
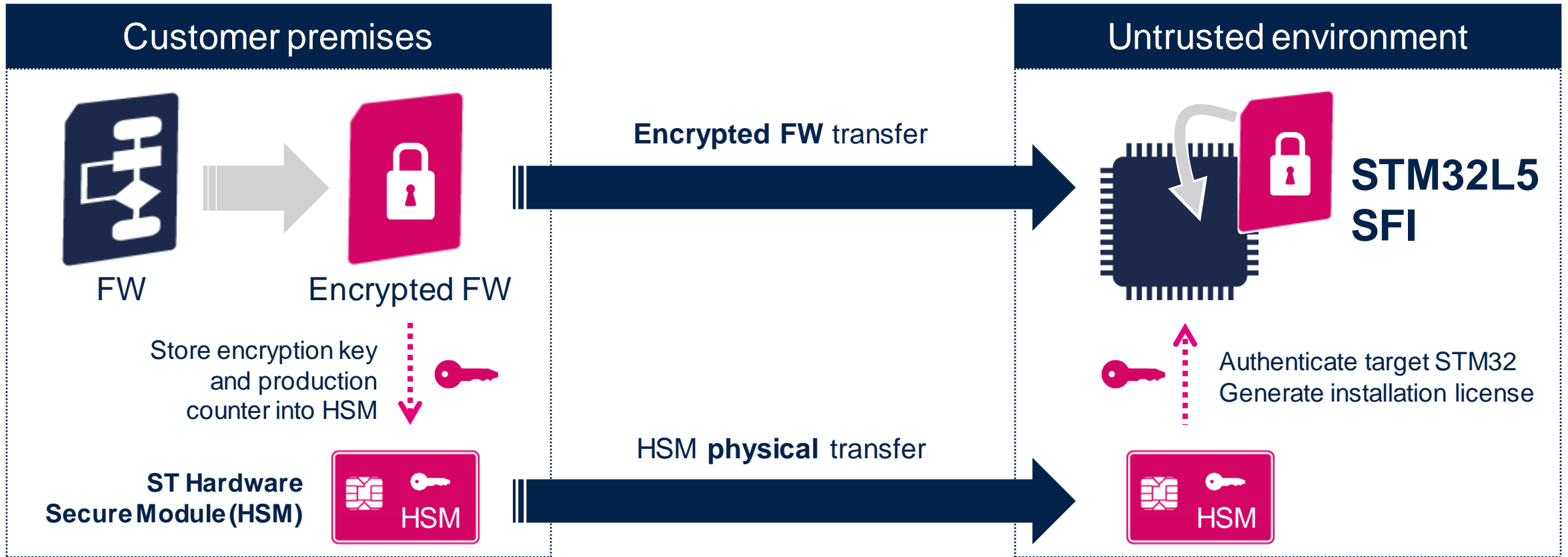
Number of products controlled

27

STM32L5 helps designers to answer IoT challenges

- More security

- Lower power consumption

- Integration, performance, ecosystem
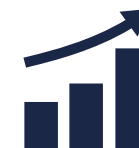
Releasing your creativity

 /STM32

 @ST_World

 community.st.com

 www.st.com/STM32L5

 STM32L5 Online Training

 wiki.st.com/stm32mcu

 github.com/STMicroelectronics

 STM32L5 blog articles

STM32

Thank you

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