STM32WL, 세계 최초의 **LoRa** 원-칩 솔루션
STM32 Discovery Day Online Track 2020

John LEE

Agenda

Overview of LPWA Technology & Market

STM32WL World 1st LoRa SoC

Demo (Node – GTW – Server)

LPWAN: The IoT missing link

How to connect remote objects?

Pipelines ?

Fields & Farms ?

Underground ?
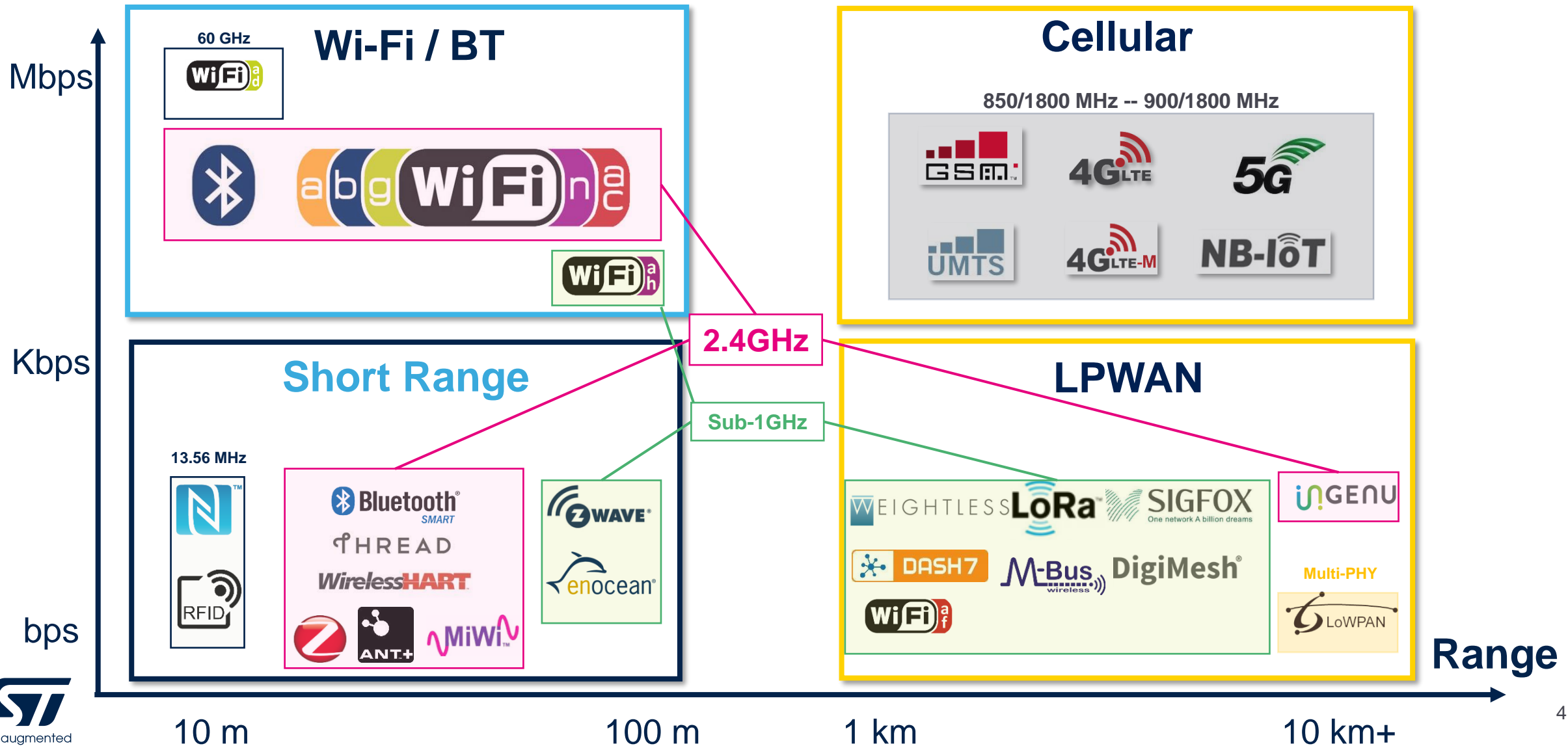
WiFi, BLE etc.

Cellular

LPWAN

Gateway

Base Station

3

Technological subsets overview

LPWAN - Uses cases VS Data rate

Use cases will help to identify the most appropriate technology

System-On-Chip made for versatility

**A long-range wireless microcontroller:
One die, many IoT possibilities**

World First!

Single Silicon Die

STM32L4 + LoRa® (G)FSK (G)MSK BPSK = STM32**WL**
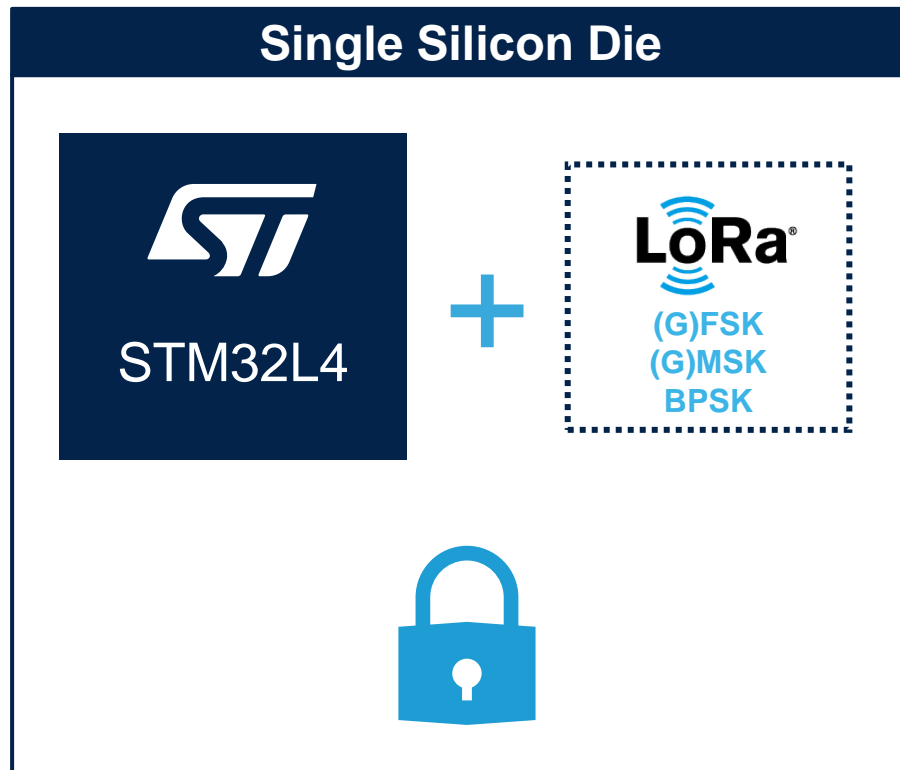
Make the choice of STM32WL series

The 7 key points that will make the difference

LoRa™
(G)FSK
(G)MSK
BPSK

Multi-modulation

$

**Massive integration
Cost saving**

Open platform

Ultra-low-power

STM32 security

256KB
3.6 V   73-pin
1.8 V   48-pin
64KB Flash

A large offer is coming

LONGEVITY
10 YEARS
COMMITMENT

No matter what!

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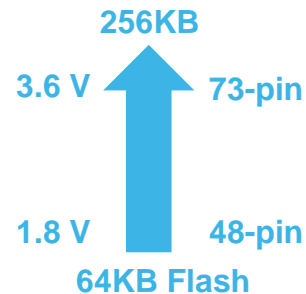
Deep integration
Wide purposes

4 Modulations - Many protocols

*Coming soon

STM32WL - A rich feature set

- Arm® Cortex®-M4 DSP up to 48 MHz

- Up to 256 KB Flash and 64 KB SRAM

- Sub-GHz Radio – Multi-modulations
  - LoRa, (G)FSK, (G)MSK, BPSK
  - 2 embedded power amplifiers:
    1 output up to +15 dBm / 1 output up to +22 dBm
  - LoRa RX sensitivity: -148 dBm (SF12, BW=10.4kHz)
  - RX: 4.82 mA and TX: 15mA (at 10dBm) / 87mA (at 20dBm) [3.3V]
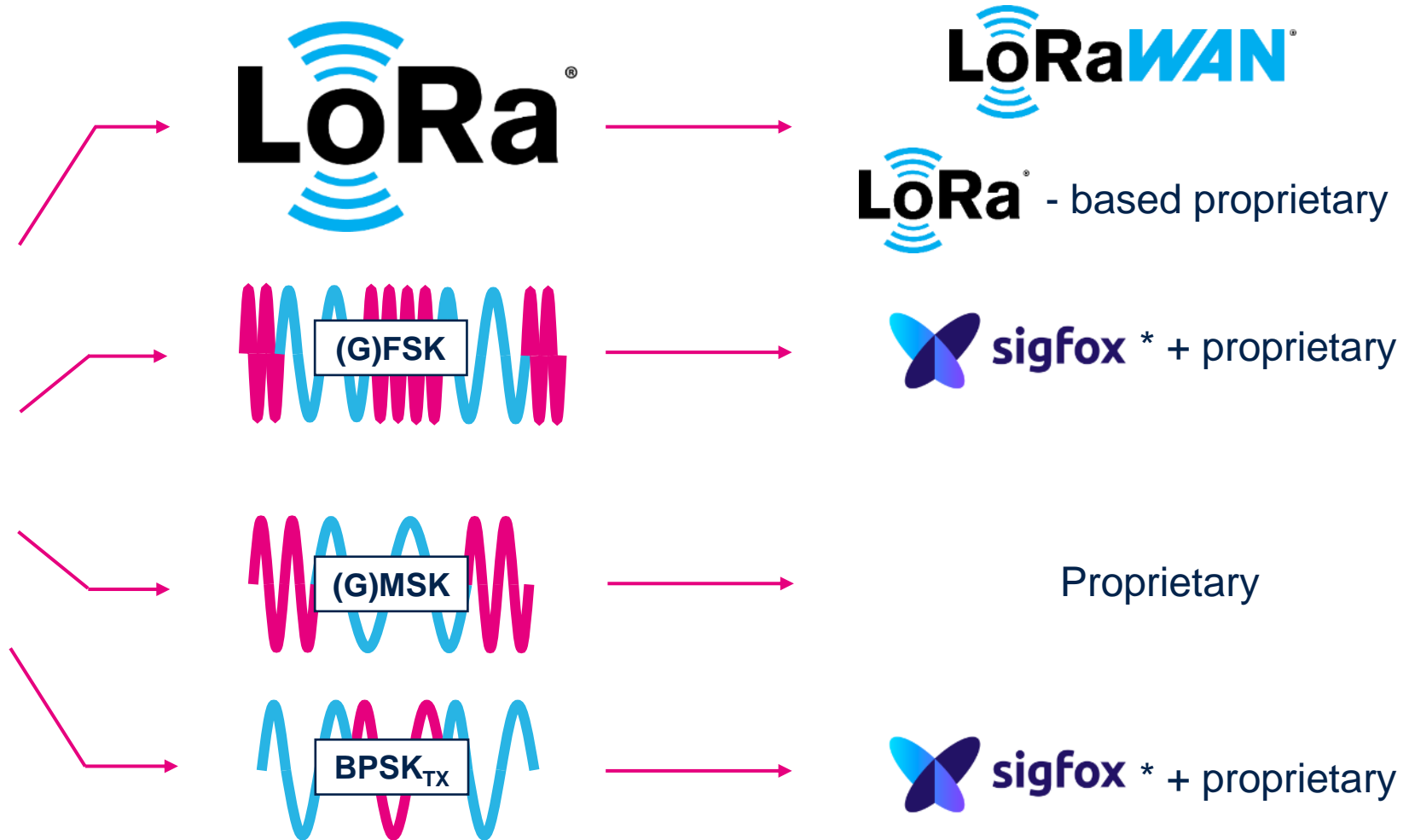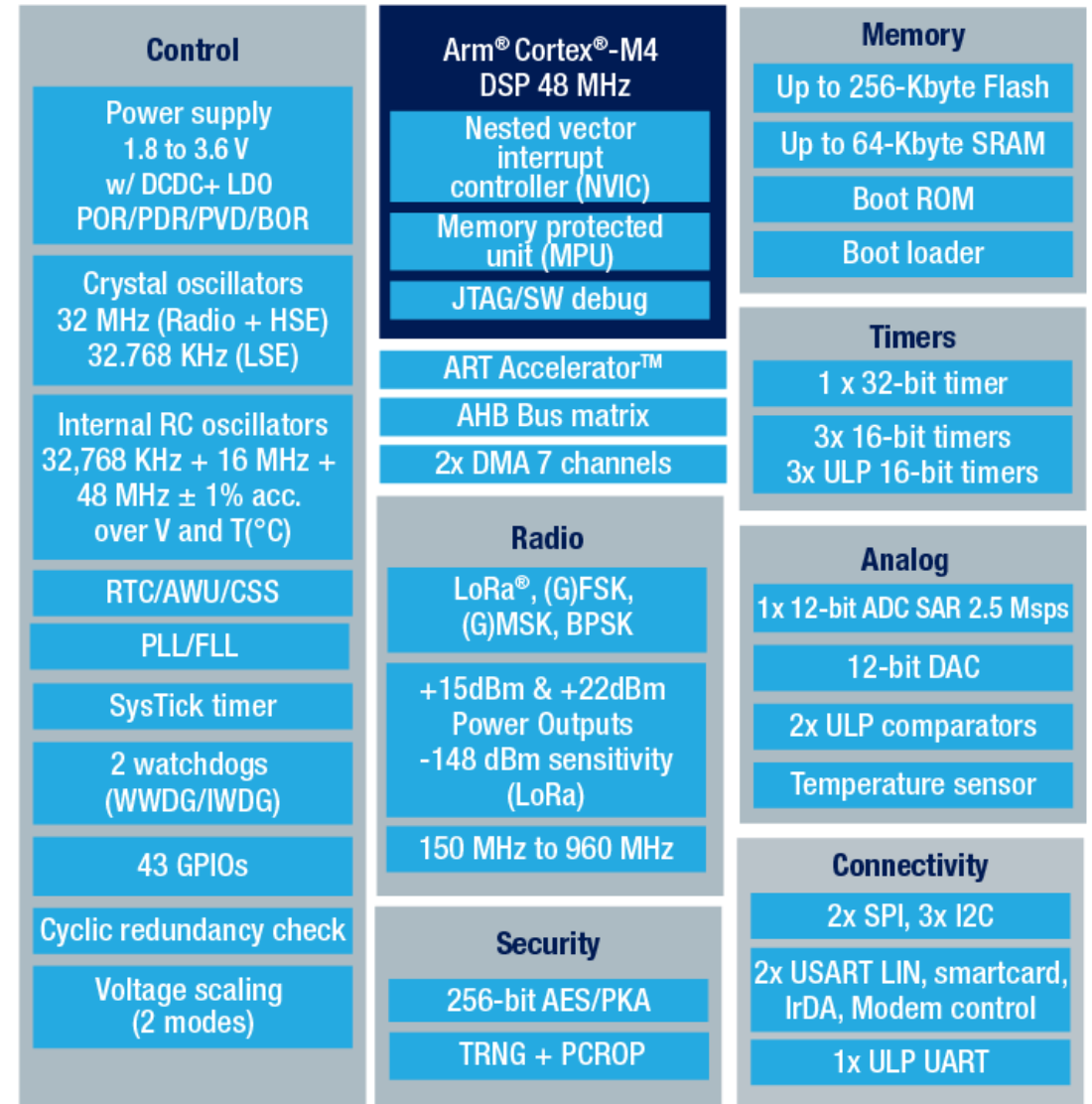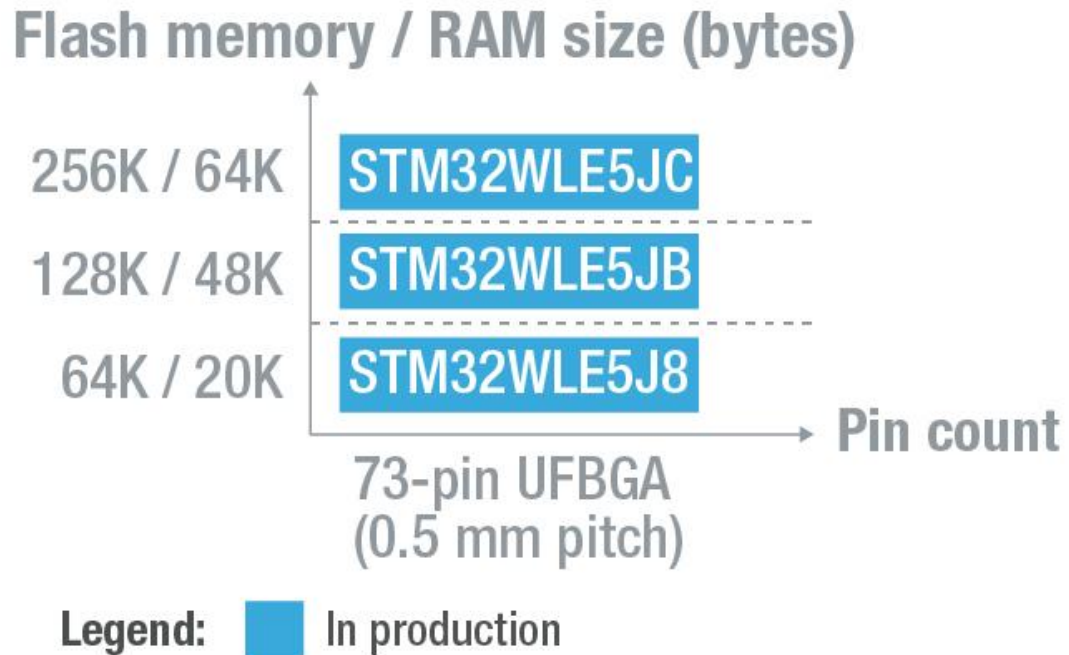
- Peripherals
  - 3xI²C, 2xUSART, 1xLP-UART, 2xSPI

- 7x timers + 2x ULP Comparators

- 1.8 to 3.6V voltage range (DC/DC, LDO)

- -40 to up to +105°C temperature range

- Power consumption
  - < 71µA/MHz Active mode (3V - RF OFF)
  - 1 µA Stop2 mode with RAM retention
  - 390 nA Standby mode with RTC
  - 31 nA Shutdown mode

Control
Power supply 1.8 to 3.6 V w/ DCDC+ LDO POR/PDR/PVD/BOR
Crystal oscillators 32 MHz (Radio + HSE) 32.768 KHz (LSE)
Internal RC oscillators 32,768 KHz + 16 MHz + 48 MHz ± 1% acc. over V and T(°C)
RTC/AWU/CSS
PLL/FLL
SysTick timer
2 watchdogs (WWDG/IWDG)
43 GPIOs
Cyclic redundancy check
Voltage scaling (2 modes)

Arm® Cortex®-M4 DSP 48 MHz
Nested vector interrupt controller (NVIC)
Memory protected unit (MPU)
JTAG/SW debug
ART Accelerator™
AHB Bus matrix
2x DMA 7 channels

Radio
LoRa®, (G)FSK, (G)MSK, BPSK
+15dBm & +22dBm Power Outputs -148 dBm sensitivity (LoRa)
150 MHz to 960 MHz

Security
256-bit AES/PKA
TRNG + PCROP

Memory
Up to 256-Kbyte Flash
Up to 64-Kbyte SRAM
Boot ROM
Boot loader

Timers
1 x 32-bit timer
3x 16-bit timers 3x ULP 16-bit timers

Analog
1x 12-bit ADC SAR 2.5 Msps
12-bit DAC
2x ULP comparators
Temperature sensor

Connectivity
2x SPI, 3x I2C
2x USART LIN, smartcard, IrDA, Modem control
1x ULP UART

STM32WL Sub-1 GHz - Portfolio

Flash memory / RAM size (bytes)

256K / 64K	STM32WLE5JC
128K / 48K	STM32WLE5JB
64K / 20K	STM32WLE5J8

Pin count

73-pin UFBGA
(0.5 mm pitch)

Legend: ■ In production

STM32WLE5

**Up to 43 GPIOs for full flexibility
+
Tiny package footprint**

Best Ssuited for many LPWAN markets

- Worldwide compatibility **150 MHz to 960 MHz** Linear Range
- Multi-protocol capable
- ST Longevity commitment: **10 years lifetime**

Utilities

- Up to **105 °C** MCU capable
- **Only 5 µs wakeup time** for best latencies
- Only 4.82 mA as LoRa RX consumption for battery optimization

Industrial IoT

- Up to +22 dBm output power for wide coverage
- **-148 dBm** sensitivity with LoRa: **Robust RF Link**
- **Reduced BOM cost**

Smart Cities & Buildings

- Link Budget > **160 dB** = Very long ranges
- Excellent battery lifetime: Only 15 mA for LoRa TX consumption @ 10 dBm
- **PCROP**, **ECC**, TRNG, **PKA**, for best design robustness

Smart Ag

STM32WLE5

- **Unique-IDs** for enhanced traceability
- Down to 390 nA mode with RTC and 32KB of RAM for extended Battery lifetime
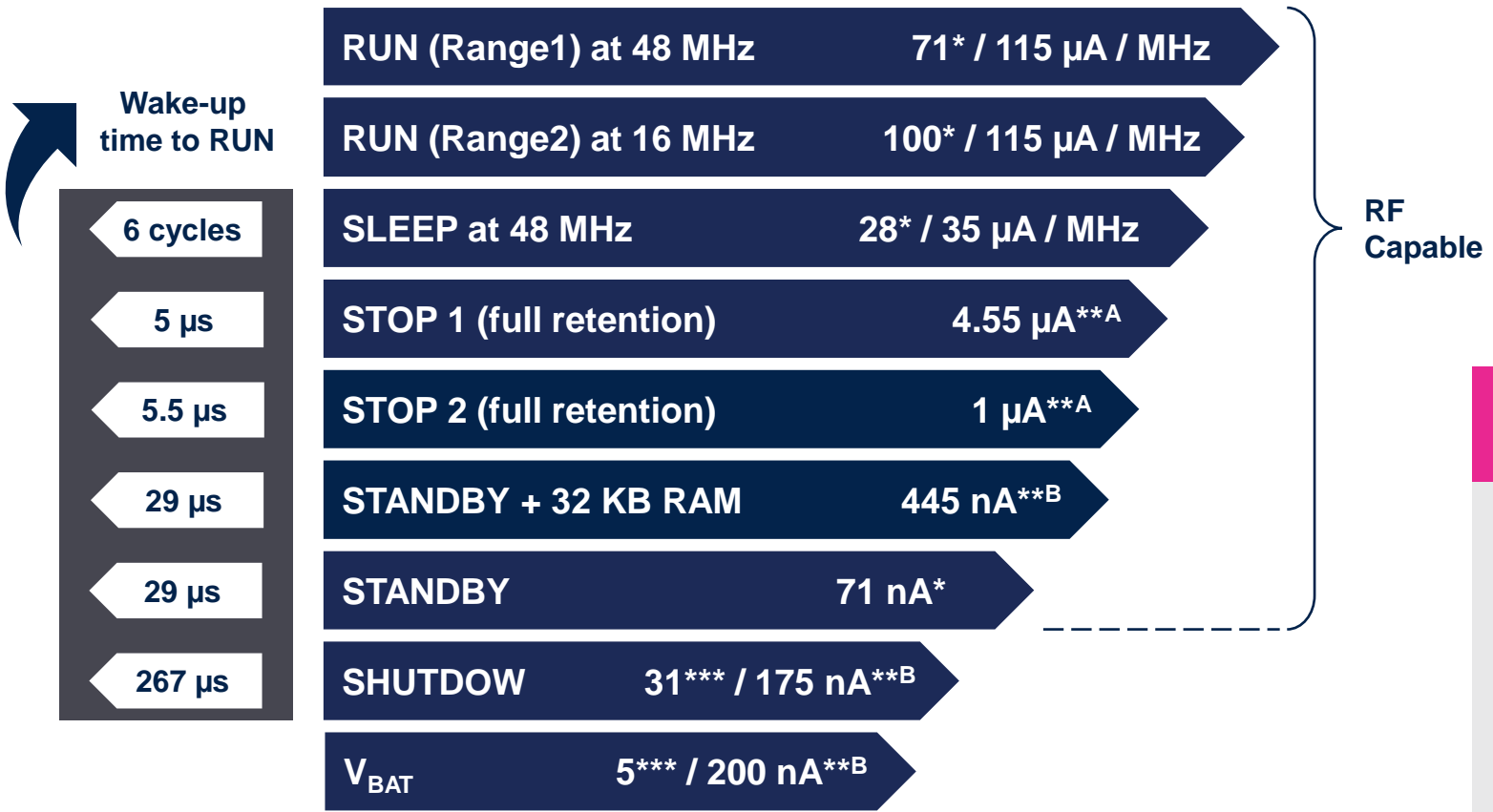- Small form factor with **UFBGA 5x5 package**

Logistics

- Down to 71 µA/MHz in Run mode for efficient action
- < 1 µA Stop mode with full RAM for **battery life** optimization
- 12-bit ADC & DAC for mixed applicative use cases

Smart Home

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Flexible power scheme

Flexible power scheme FlexPowerControl

Typ with LDO @ V_{DD} = 3 V @ 25 °C

Wake-up time to RUN

	Mode	Value	
6 cycles	RUN (Range1) at 48 MHz	71* / 115 µA / MHz	RF Capable
5 µs	RUN (Range2) at 16 MHz	100* / 115 µA / MHz	
5.5 µs	SLEEP at 48 MHz	28* / 35 µA / MHz	
29 µs	STOP 1 (full retention)	4.55 µA**A	
29 µs	STOP 2 (full retention)	1 µA**A	
267 µs	STANDBY + 32 KB RAM	445 nA**B	
	STANDBY	71 nA*	
	SHUTDOW	31*** / 175 nA**B	
	V_{BAT}	5*** / 200 nA**B	

* Typical values with SMPS, RF OFF
**A RTC clocked by LSI / **B RTC clocked by LSE
*** All OFF

Benchmark Scores

- High Efficiency
  - → CoreMark score = 162[1]
- Ultra Low-Power Platform
  - → ULPBbench score ≈ 204[1]

[1] Pending certification

Flexible power scheme
Matching your application needs

LPWANs made easy through ultra-low-power tradeoffs

Power mode	Arm® Cortex®-M4	Peripherals	RAM Retention	RF
Run	✓	✓	Yes	✓
Sleep	X	✓	Yes	✓
Stop 0	X	✓	Yes	✓
Stop 1	X	✓	Yes	✓
Stop 2	X	Subset	Yes	✓
Standby	X	X	Yes	✓
Shutdown	X	X	X	X

Seamless toolbox
(I²C, SPI, USART, ADC/DAC, Timers, Comparators etc.)

RF available
In all power modes

Back-up registers are **always** available

Efficient power management
STOP modes comparison

Flexible peripherals power mapping

	STOP0	STOP1	STOP2
Consumption (without Real Time Clock)	Typ, 25 °C, 3 V, LDO		
	400 µA	4.55 µA	1 µA
Wakeup time to 48 MHz — Flash	2.2 µs	5 µs	5.5 µs
Wakeup time to 48 MHz — RAM	2.2 µs	5.1 µs	5.5 µs
Wakeup clock	≤ 48 MHz		
Regulator	Main or Low-Power regulator		Low-power regulator
Peripherals	All	All	CSS, RTC, 3 Tamper Pins, 1x LPUART, 1x I²C, VREFBUF, 2x COMP, 1x LPTIM, Dual-WDG, CRC, EXTI

No impact on wakeup time from embedded DCDC

Ultra-low power & IoT ready for worldwide applications

Best LoRa-enabled IP on the market

Transmission		
Parameter	Settings	Value
TX	+10 dBm 868/915 MHz	15 mA DCDC
TX	+20 dBm 868/915 MHz	87 mA DCDC

Worldwide Compatibility

Reception		
Parameter	Settings	Value
LoRa Sensitivity	BW_L = 10.4 kHz SF = 12	-148 dBm
2-FSK Sensitivity	BR_F = 0.6 kb/s FDA = 0.8 kHz BW_F = 4 kHz	-125 dBm
RX	FSK 4.8kb/s buck 100mA max	4.47 mA DCDC 8.18 mA LDO
RX	LoRa® 125 kHz	4.82 mA DCDC 8.9 mA LDO

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Flexible power implementation

Tailor STM32WL to your IoT needs

STM32WL

LDO

DC-DC

CORE + RF IP

REG PA

LP PA

HP PA

Power Management Config.

2 Power Outputs

Up to +15 dBm

Up to +22 dBm
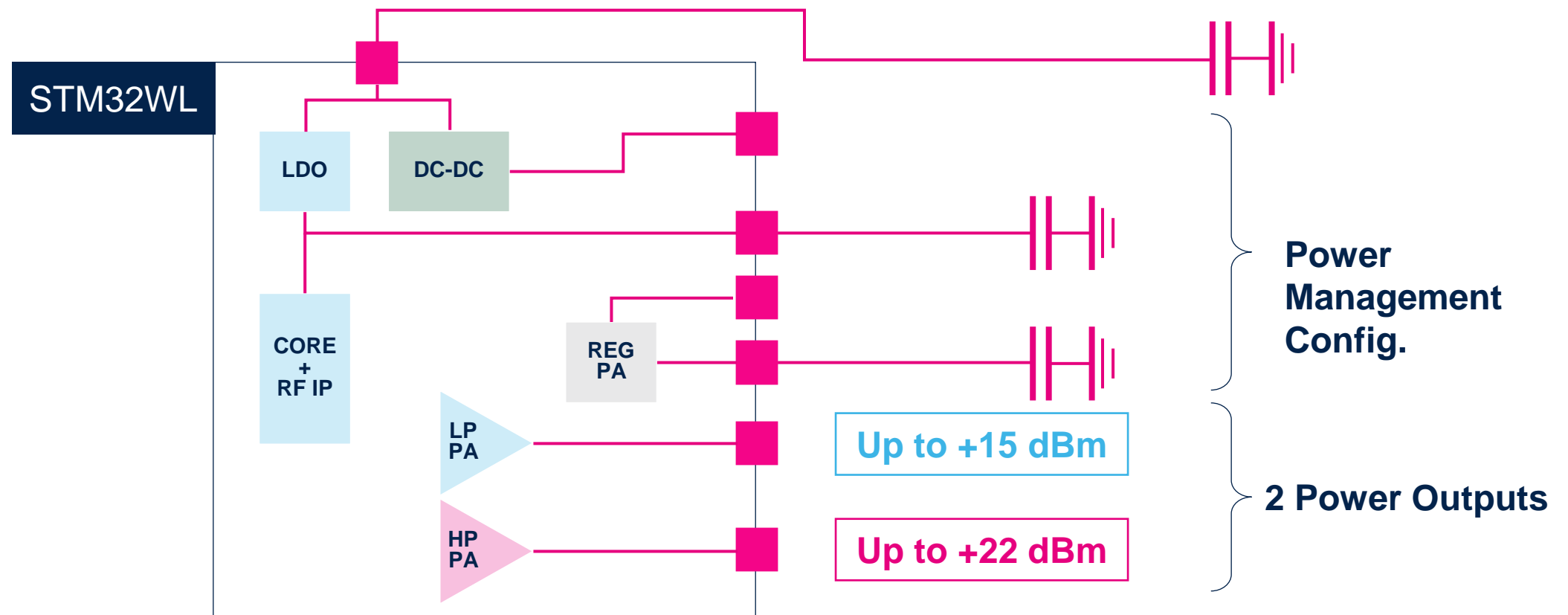
Advanced features and ecosystem

STM32WL - Safety and security

Secure you application with embedded safety & security

Safety

- Back-up clock circuitry
- Supply monitoring
- Dual watchdog
- Flash memory with ECC (address status register)
- SRAM Parity check
- Cyclic Redundancy Check
- Brown-out reset in all modes
- Clock Security System
- Backup byte registers

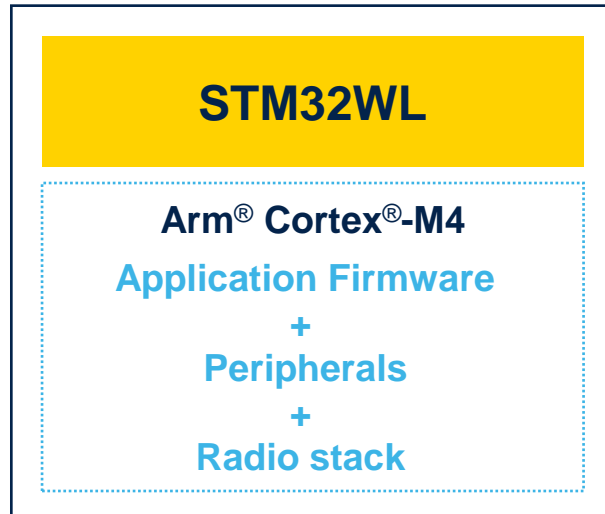**Device integrity**   **Data Integrity**

STM32**WL**

Security

- Anti-Tamper detection
- Boot Lock
- Read & Write protection
- Memory Protection Unit (MPU)
- Software IP Protection
- True Random Number Generator
- Private Key Accelerator
- Unique IDs (64- and 96-bit)

Anti intrusion Traceability   **Privileges Permission Management**   **Firmware IP Protection**   **Data encryption**

Open chips, takeaway stacks

STM32WL

Arm® Cortex®-M4

**Application Firmware
+
Peripherals
+
Radio stack**

- **Open Platform**
- **Open stack**

LoRaWAN®

Certified LoRaWAN stack

Please contact your nearest ST
Sales Office for more information

22

A higher level of integration

MCU + Radio 2-in-1 solution

STM32WL

Arm® Cortex®-M4

Application Firmware
+
Peripherals
+
Radio stack

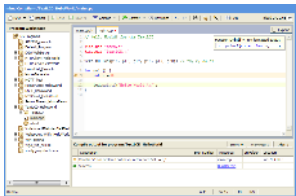**VS**

Standalone MCU

Standalone transceiver
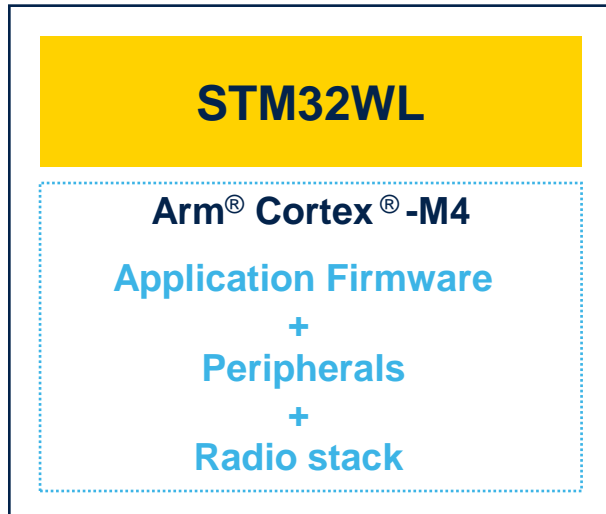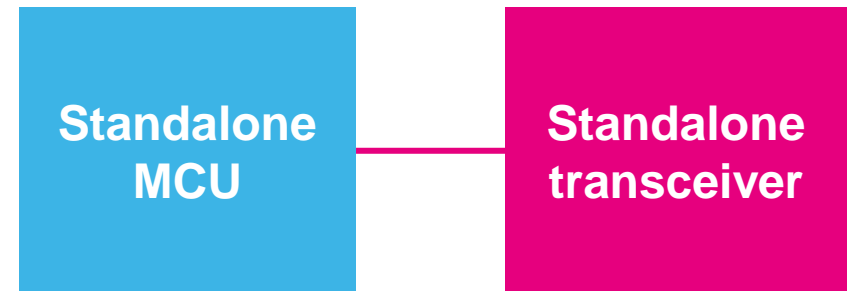
- SoC solution **(1 single die)**
- **All-in-1** solution - cost saving
- Simplified development helps speeding up time to market

- **2 standalone chips, or dice (SiP)**
- Bigger final PCB (increased cost)
- Wired communication more exposed

STM32WL – Introductory ecosystem

Fully integrated into the rich and market-proven STM32 ecosystem

STM32 Nucleo-64	Dev tools	Stacks
Flexible prototyping	STM32CubeMX for pinout and clock configuration STM32CubeProg Partners IDE	LoRaWAN Sigfox[1] [1] Coming soon

Please contact your nearest ST
Sales Office for more information

Save on your application cost

Integrated functionalities helps you drop the BOM down

Optimization of the silicon cost

- Deep integration factor
- Less external components
- Single 32 MHz crystal for CPU & embedded radio
- 32 kHz master clock output available

Optimization of the ecosystem cost

- LoRaWAN stack: free of charge
- STM32CubeMX: free of charge
- STM32CubeProg: free of charge
- System-on-chip avoids to use a second radio

STM32 rolling longevity commitment

Longevity commitment is renewed every year

Starting in 2020

- **STM32F1** (launched in **2007**) — **22 years** of commitment
- **STM32L1** (launched in **2009**) — **20 years** of commitment
- **STM32F2** (launched in **2010**) — **19 years** of commitment
- …
- **STM32WB** (launched in **2018**) — **11 years** of commitment
- **STM32G0** (launched in **2018**) — **11 years** of commitment
- **STM32G4** (launched in **2019**) — **10 years** of commitment
- **STM32WL** (launched in **2020)** — **10 years** of commitment

STM32 MCU "Wireless" Series

High Perf MCUs

STM32F2
398 CoreMark
120 MHz

STM32F4
608 CoreMark
180 MHz

STM32H7
3224 CoreMark
240 MHz Cortex -M4
480 MHz Cortex -M7

STM32F7
1082 CoreMark
216 MHz

Mainstream MCUs

STM32F0
106 CoreMark
48 MHz

STM32G0
142 CoreMark
64 MHz

STM32F1
177 CoreMark
72 MHz

STM32F3
245 CoreMark
72 MHz

STM32G4
550 CoreMark
170 MHz

Ultra-low Power MCUs

STM32L0
75 CoreMark
32 MHz

STM32L1
93 CoreMark
32 MHz

STM32L5
424 CoreMark
110 MHz

STM32L4
273 CoreMark
80 MHz

STM32L4+
409 CoreMark
120 MHz

LONGEVITY
10 YEARS
COMMITMENT

Wireless MCUs

NEW

STM32WL
161 CoreMark
48 MHz

STM32WB
216 CoreMark
64 MHz

Arm® Cortex® core —— -M0 —— -M0+ —— -M3 —— -M33 —— -M4 —— -M7

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

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