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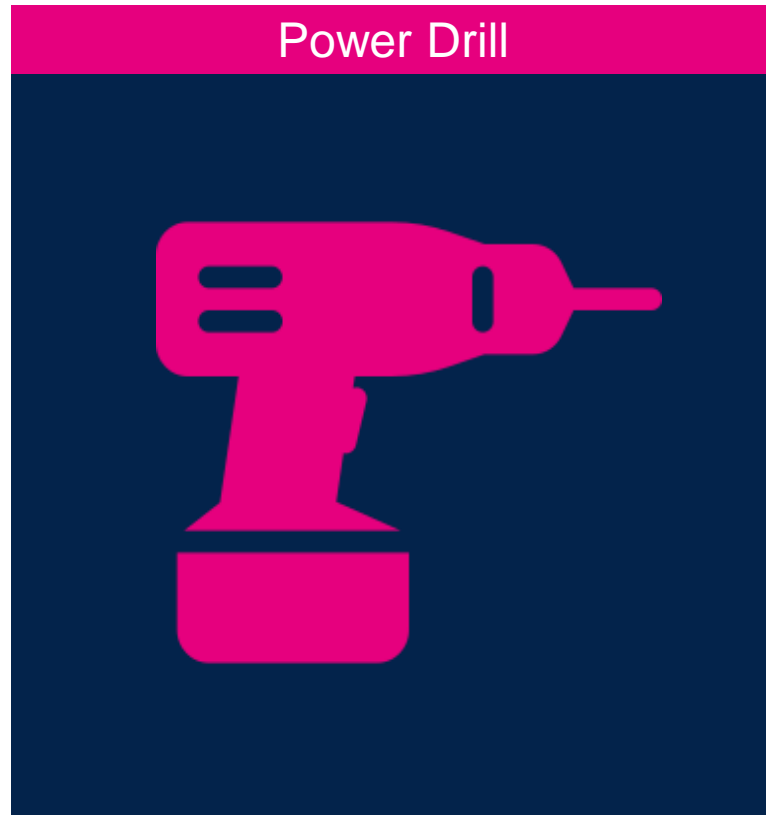
# IoT and wireless solutions

# IoT and Wireless connectivity are deeply linked

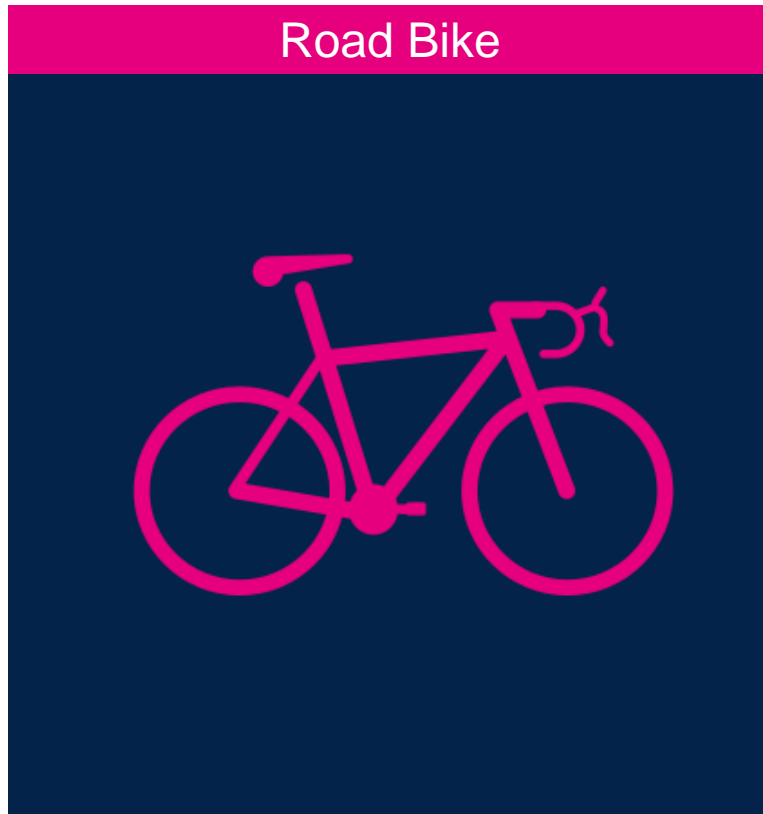


# Some applications

# Power Tools



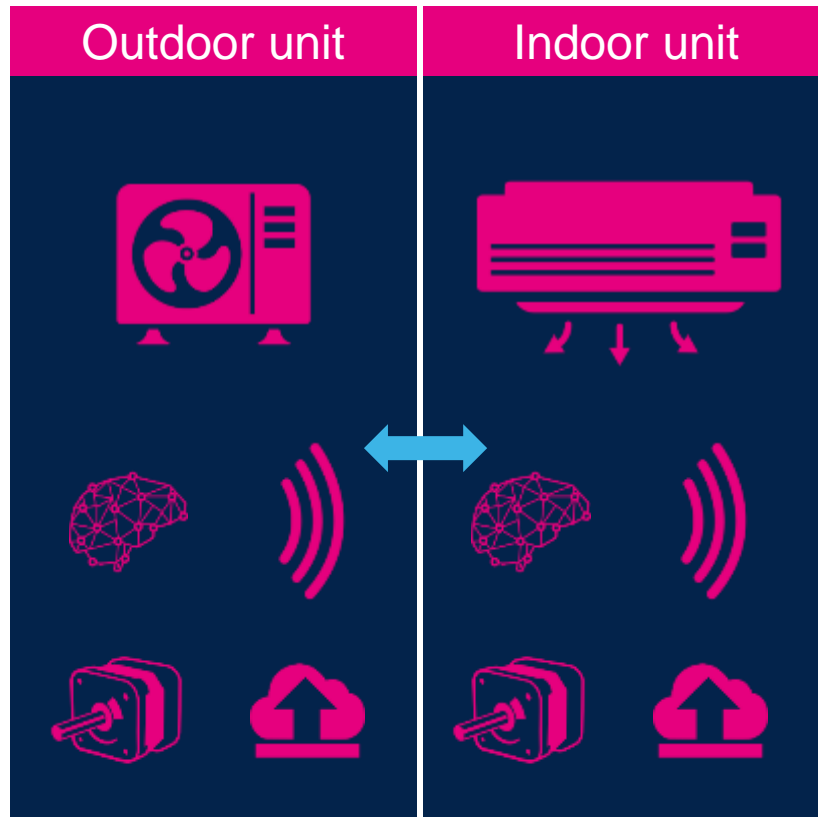
- Several major evolutions over the year
- 2<sup>nd</sup> wave was the switch from Cord to Cordless
  - 3<sup>rd</sup> wave is the addition of wireless connectivity allowing multiple use cases
    - Location awareness
    - Authentication
    - Battery/system monitoring
    - Datalogging



10 years ago, there was no electronic in Road bike

- Today electronic gear shift system is gradually introduced on all ranges (currently high-end and mid-range) allowing
  - Better user experience
  - Data acquisition
- Other technologies like cellular are coming up to understand user behavior

# Appliances



Many applications are going wireless, such as air conditioning units!

- Connectivity used for user
  - Remote control
- Connectivity used for B2B services
  - Predictive maintenance
  - Software updates



# Asset tracking

IoT tracking		Luxury goods 	Personal devices 	Pet tracking 	People tracking 	Social distancing 
Outdoor real-time monitoring		Containers 	Fleet management 	Livestock monitoring 	Tractor 	Mobility sharing 
Indoor localization & Warehouse logistics		RTLS* 	Mobile assets 	Pallet 	Smart parcels 	Employee Safety 
Good guarantee		Cold chain 	Food tracing 	Medical 	*RTLS = Real Time Localization System	
Disposable		Letters 	Packages 	Parcels 		

# Asset tracking – Needs per applications

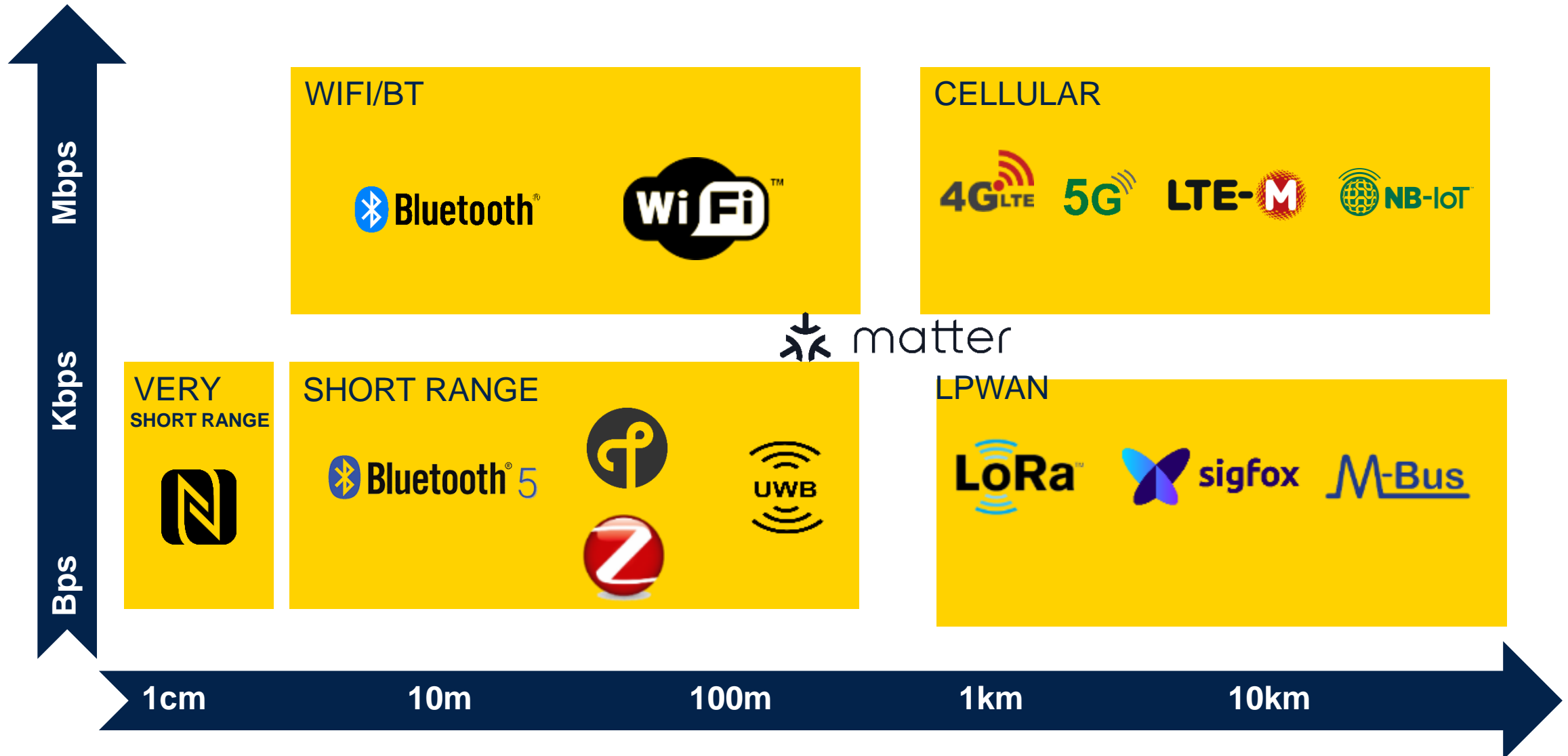
		Processing & security	Sensing	Connectivity	Power management	
<b>IoT tracking</b> Personal devices, pet, child and held people, social distance		Dedicated MCU Dedicated secure chip	HI-G ToF Temperature	NFC Bluetooth UWB Zigbee WiFi LoRa NB-IoT LTE-M Sigfox GNSS	Shield Battery Lightning bolt Leaf	Real-time tracker     Complexity (# of sensors, connectivity)     Logger
<b>Outdoor real-time monitoring</b> Containers, livestock monitoring, Mobility sharing, fleet management, pet, tractor		Dedicated MCU Dedicated secure chip	HI-G ToF Temperature	NFC Bluetooth UHF UWB Zigbee LoRa NB-IoT LTE-M Sigfox GNSS	Shield Battery Lightning bolt	
<b>Indoor localization &amp; Industrial logistics</b> Pallets, racks, Real Time Localization, Smart Parcels, Employ safety		Dedicated MCU Embedded security	HI-G ToF Temperature	NFC Bluetooth UHF UWB Zigbee LoRa NB-IoT LTE-M Sigfox WiFi	Battery	
<b>Good guarantee</b> Cold chain, food tracing, medical		Dedicated MCU Embedded security	HI-G ToF Temperature	NFC Bluetooth UHF UWB Zigbee LoRa NB-IoT LTE-M Sigfox WiFi	Battery	
<b>Disposable</b> Letters, packages, parcels		Sensor with processing Embedded security	ToF Temperature	NFC Bluetooth UHF UWB Zigbee LoRa NB-IoT LTE-M Sigfox	Leaf	



# Wireless technologies

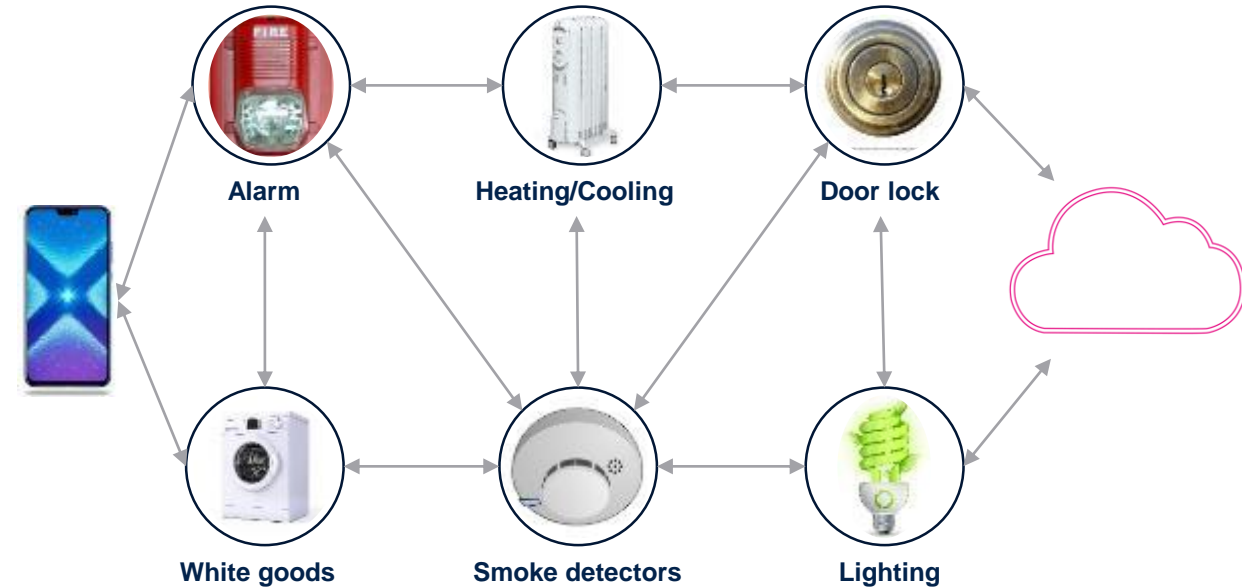
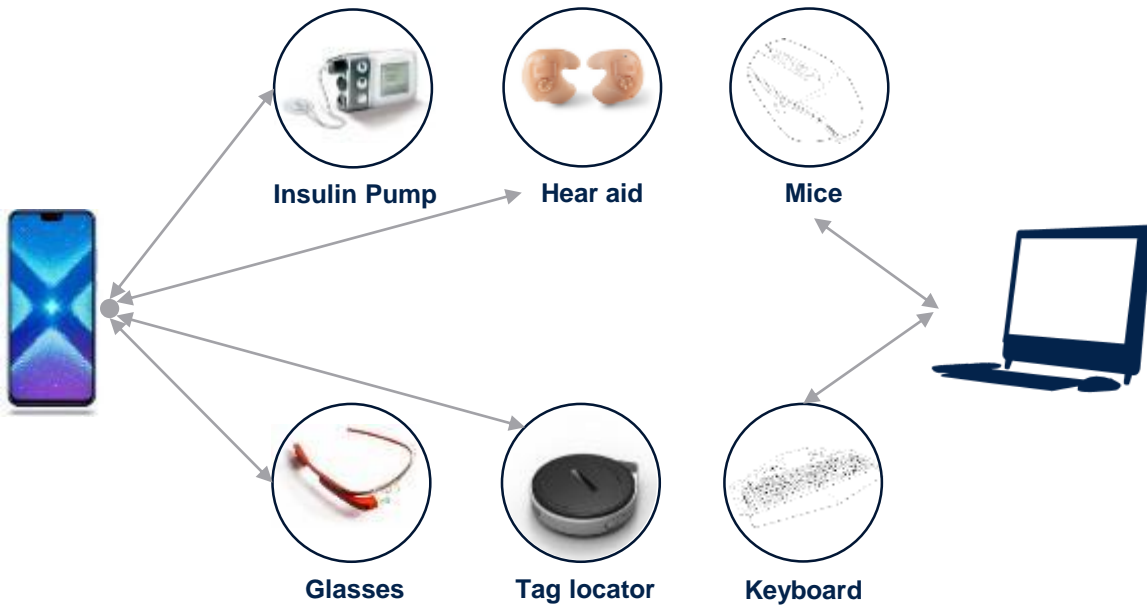


# Communication Technologies - Overview



# 2,4GHz / BLE – ZigBee – Thread - Matter

# Targeted application



**P2Point or P2Multi Comm. devices**  
 Connected to Smartphone/Laptop ...  
 Mostly battery powered



Proprietary  
 protocol  Proprietary

**Mesh Comm. devices**

Home automation, Industry 4.0, Consumer  
 Power plugged and/or battery powered





# Bluetooth LE standard evolution

Bluetooth LE version number/Name	4.2	5.0	5.1 : Madrid	5.2 : Milan	5.3 : Sydney	Denver
Data rate	1Msps	2Msps	2Msps	2Msps	2Msps	Higher Data throughput
Range	Up to 30m	Up to 30m (1/2Msps) Long Range (x4) (125/250Kbps)	5.0 like	5.0 like	5.0 like	5.0 like
Advertising	27bytes	Extended mode	Advertising channel index	5.0 like	Periodic Advertising Enh	-
Mesh (BT SIG profile)	SIG profile	Mesh v1.0	5.0 like	5.0 like	MeshEnh (V1.1 Q2'22)	Mesh enhancement (HCI)
Audio	Not supported	Proprietary	Proprietary	Isochronous channel	Connection subrating	
Direction finding	Not supported	Not supported	AOA / AOD	5.1 like	5.1 like	HADM
Other			GATT caching	LE Power Control Enhanced Attribute Protocol	LE Enhanced Connection Update LE Channel Classification	Wake-Up Radios
Security						Signature-Based Authentication and Pairing
Schedule	Broadly deployed	Deployed	January 2019	Dec 2019	June 2021	(TBC)



# 802.15.4 Standard evolution on 2.4GHz






802.15.4 main communication protocol over the year to address IoT

Protocol	2012	2015	2016	2017	2022	2023
Zigbee	Light Link Green Power	Zigbee Pro (2011 PHY MAC) (2015 PHY MAC for Sub-GHz operation)	Zigbee 3.0 with Interoperability, Security layers Backward compatible Application layers integrated (2011 PHY MAC)	Zigbee PRO with Thread and Zigbee 3.0 compatibility Multi-band IoT mesh network Smart energy 1.4 (2011 PHY MAC) <b>(2015 PHY MAC</b> for Sub-GHz operation)	Zigbee R23 ( <b>not released</b> ) Zigbee Direct ( <b>not released</b> ) SuZi (SubGHz solution) ( <b>not released</b> )	
Thread	--	Thread V1.0 <b>Specification</b> (based on 6LowPan)	Open-Thread V1.0 <b>Reference implementation</b> (based on 6LowPan)	Still Open-Thread V1.0	<b>OpenThread 1.2 (not released)</b> Commercial building Bluetooth bridge <b>OpenThread 1.3 (not released)</b>	SubGHz support
MATTER					V1.0 supporting <ul style="list-style-type: none"> <li>• OpenThread</li> <li>• WiFi</li> <li>• IP over BLE</li> </ul>	



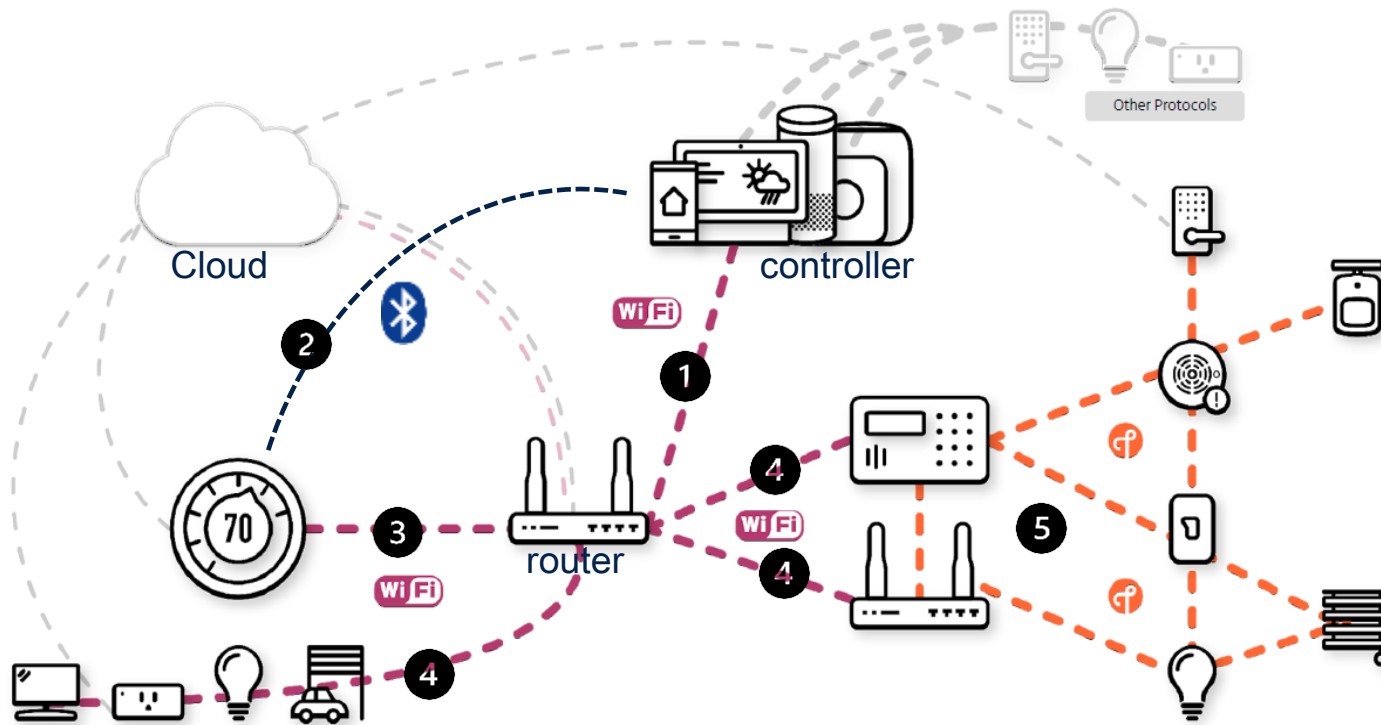
# Wi-Fi Standard evolution

Wifi  
Low-power

Wi-Fi Alliance Naming	802.11	Frequency Band	Theoretical maximal data rate	Range	Congestion	Channel width	MIMO
a or 1	a	5 GHz	54 Mbps	20m	Low	20 MHz	No
b or 2	b	2,4 GHz	11 Mbps	35m	High	20 MHz	Yes
g or 3	g	2,4 GHz	54 Mbps	38m	High	20 MHz	Yes
	n	2,4 GHz	72 - 288 Mbps	70m	High	20 MHz	Yes (max 4x4)
	n	5 GHz	150 - 600 Mbps	35 m	Low	20, 40 MHz	Yes (max 4x4)
	ac	5 GHz	433 - 2600 Mbps	35m	Low	20, 40, 80, 160 MHz	Yes (max 8x8)
	ax	2.4 and 5GHz now 1 – 7GHz next	Up to 600Mbps	100 – 200m	Low	20MHz/40MHz @ 2.4GHz, 80MHz, 80+80MHz & 160MHz @ 5GHz	Yes (max 8x8)
	ad	2.4 and 5GHz now 1 – 7GHz next	Up to 6750 Mbps	10 m	Low	2 160 MHz	No

# Technologies engaged in MATTER V1

- WiFi & Thread for transport
- Bluetooth LE for commissioning



- 1 Controller connects to WiFi router
- 2 Controller commission device via BT
- 3 Device joins WiFi network
- 4 Additional Matter device connected to WiFi
- 5 Thread devices connect to other IP networks through Border Router



# Sub-1GHz



# Multiple standards



IPv6-based Low-power  
Wireless Personal Area Networks

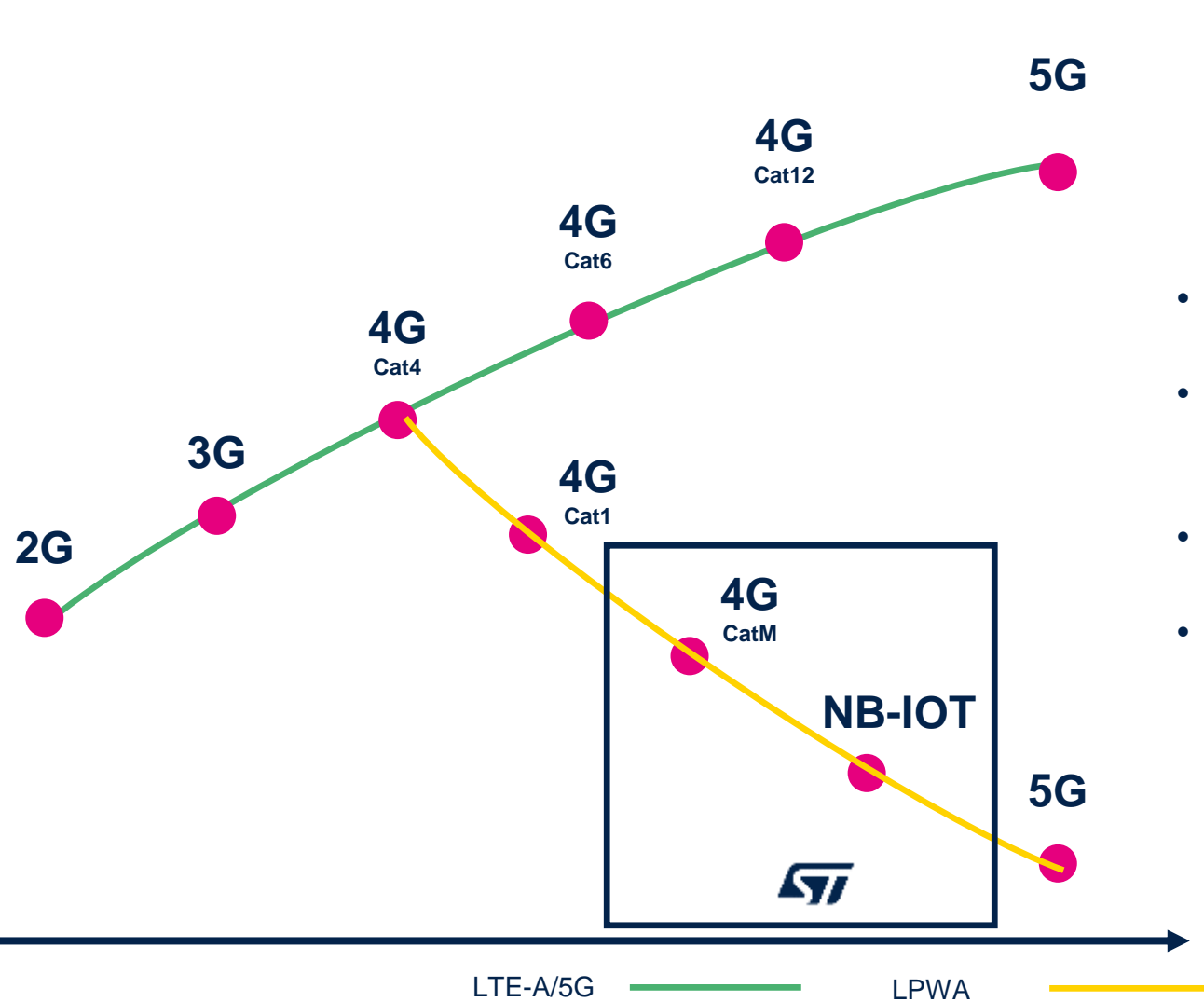
# Cellular



# Cellular Technologies

High Bandwidth  
High cost  
High Power Consumption  
Low Latency

Low Bandwidth  
Low cost  
Low Power Consumption  
High Latency



- Cat-M & NB-IoT are future-proof
- Viewed as 5G technologies (inc. in the 5G spec)
- Can efficiently co-exist with 5G
- Already fulfill all 5G massive MTC requirements



- Cat-M is an extension<sup>1</sup> of the 4G-LTE
  - Up 300kbps(DL), low-latency, Accurate device positioning
- Fast and easy deployment (4G-LTE)
- Fast and easy adoption
- Security: SIM based
- 3-5y battery lifetime thanks to:



- eDRX: extended Discontinuous RX mode
- PSM: Power Save Mode

- Key applications



1 : Cat-M just requires a SW upgrade of existing 4G-LTE network  
 2 : Stands for Voice over LTE

# Cat-M vs NB-IoT

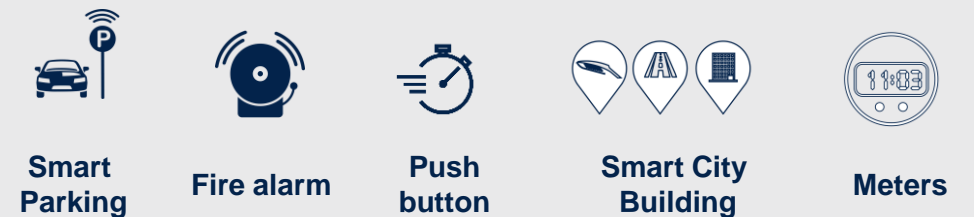


- NB-IoT is an extension of the 4G-LTE which requires infrastructure upgrade<sup>1</sup>
  - Up 20/60kbps(DL/UL), narrow-band signal
  - No Roaming for now
- Fast adoption
- Security: SIM based
- 10y battery lifetime thanks to:



- eDRX: extended Discontinuous RX mode
- PSM: Power Save Mode

- Key applications



1 : Some carrier already offers NB-IoT network infrastructure while other need to invest

**UWB**



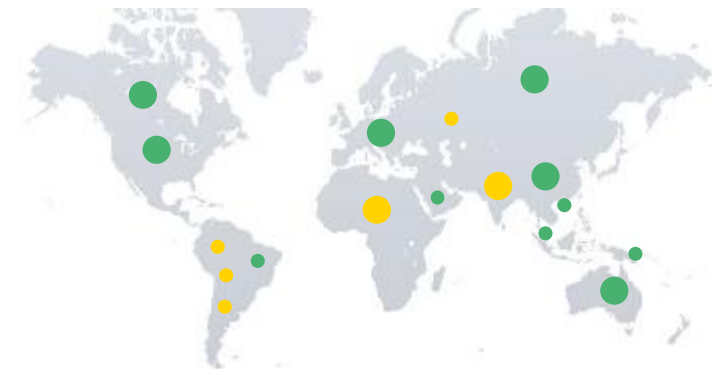
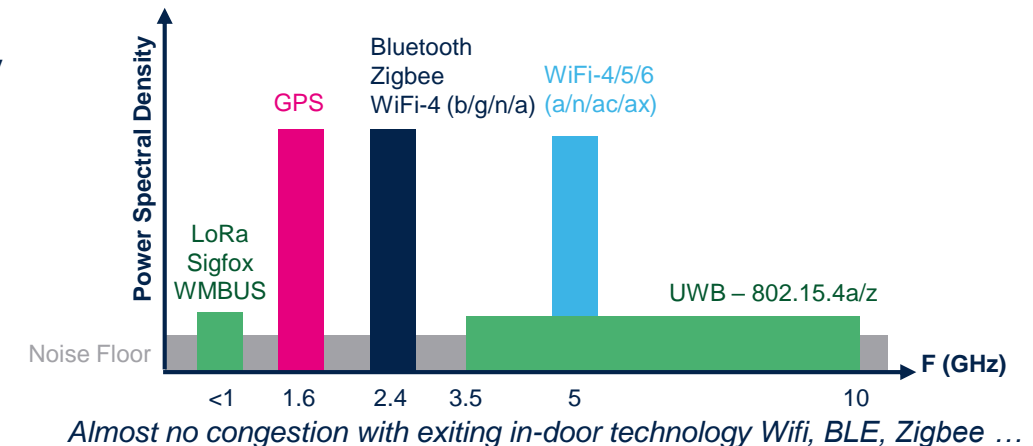
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# What is UWB ?

- UWB consist in sending very short pulse of signal to minimize signal rebound effect
  - Ultra Accurate: centimeter accuracy
  - Ultra Fast: lower latency than GPS and other positioning technology
  - Ultra Secure and Robust: Great immunity to noise and multipath

## • About the PHY:

- IEEE 802.15.4a:
  - Frequency range: 3.5 GHz to 9.48 GHz
  - Bandwidth: 499.2 MHz to 1355MHz
- IEEE 802.15.4z:
  - Security extension feature (under definition)



● UWB approved by local regulatory government (FCC, ETSI ...)

● UWB Not approved yet but will most probably stick to closest regulatory committee

# Alliances and Consortium

## omlox

- The world first **Open Locating Standard** for the industry
- Key vendors in industrial sensing, automation and software solutions
- Carriers, ISVs and Hardware providers
- Open UWB Infrastructure
- Interoperable, Indoor-Outdoor, Realtime
- Multi-Positioning Technology



## fira

- Provide Seamless user experiences, develop compelling uses cases and ensure interoperability:
  - Test Specifications for UWB PHY/MAC based on IEEE 802.15.4 standards
  - Technical and Test Specifications for UWB Services (complementary to digital key for car access)
  - Develop and operate Certification programs for UWB PHY/MAC and Services
- Organize **interoperability test** events
- Commitment to collaboration with other technologies (NFC, Wifi, BLE) and Consortium (CCC)



## CARCONNECTIVITY consortium

- A cross industry organization advancing global technologies for smartphone-to-car connectivity solutions
  - **Digital Key**: a new open standard to allow smart devices, to act as a vehicle key
  - Car data: create an ecosystem to link the ever-expanding set of vehicle data to authorized data usage
  - MirrorLink®: an open standard for connecting apps between the smartphone and the car.





# ST Solutions



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# STM32 MCUs and MPUs portfolio



**STM32MP1**  
 4158 CoreMark  
 Up to 800 MHz Cortex-A7  
 209 MHz Cortex-M4

MPU

High Perf MCUs

Mainstream MCUs

Ultra-low Power MCUs

Wireless MCUs

			<b>STM32F2</b> Up to 398 CoreMark 120 MHz Cortex-M3	<b>STM32F4</b> Up to 608 CoreMark 180 MHz Cortex-M4	<b>STM32F7</b> 1082 CoreMark 216 MHz Cortex-M7	<b>STM32H7</b> Up to 3224 CoreMark Up to 550 MHz Cortex-M7 240 MHz Cortex-M4
	<b>STM32F0</b> 106 CoreMark 48 MHz Cortex-M0	<b>STM32G0</b> 142 CoreMark 64 MHz Cortex-M0+	<b>STM32F1</b> 177 CoreMark 72 MHz Cortex-M3			
			<b>STM32F3</b> 245 CoreMark 72 MHz Cortex-M4	<b>STM32G4</b> 569 CoreMark 170 MHz Cortex-M4		
	<b>STM32L0</b> 75 CoreMark 32 MHz Cortex-M0+	<b>STM32L1</b> 93 CoreMark 32 MHz Cortex-M3	<b>STM32L4</b> 273 CoreMark 80 MHz Cortex-M4	<b>STM32L4+</b> 409 CoreMark 120 MHz Cortex-M4	<b>STM32L5</b> 443 CoreMark 110 MHz Cortex-M33	<b>STM32U5</b> 651 CoreMark 160 MHz Cortex-M33
			<b>STM32WL</b> 162 CoreMark 48 MHz Cortex-M4 48 MHz Cortex-M0+	<b>STM32WB</b> 216 CoreMark 64 MHz Cortex-M4 32 MHz Cortex-M0+ ●		

*Mixed-signal MCUs*

■ Latest product generation

● Radio co-processor only

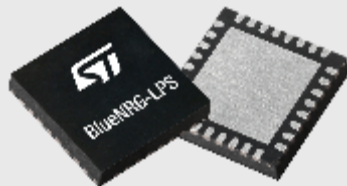


# Meet our 2.4GHz families!

## STM32WB & BNRG

Bringing the most comprehensive portfolio for Bluetooth and other 2.4GHz protocols !

- From **192KB to 1MB** Flash
- **Single** or **Dual-core** products
- Compliant with **5.3 standard**
- Multiple **stack variants** available
- From **32pins to 129pins**
- **Matter** and **LE Audio** coming soon



 **Bluetooth® 5**



**OPENTHREAD**  
released by Google

 **zigbee**

 **matter**

 **Proprietary**

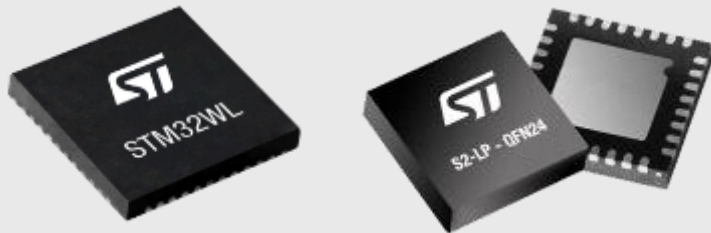


# Meet our Sub-1GHz families!

## STM32WL & SPIRIT

Ultimate portfolio to tackle Sub-1GHz markets !

- **SoC or Transceiver** solutions to address all topologies
- Wide **choice of protocols** supported
- **Excellent** Radio performance
- Ultra **low-power** consumption
- **Mature** ecosystem
- **New members** to be added soon





# 2.4GHz Families

## Additional details

Comprehensive portfolio for Bluetooth and other 2.4GHz protocols



### BLE 5.3 Support

- Long Range
- Advertising extensions
- Direction Finding

### Versatile

- Multiple protocols supported
- Concurrency between protocols
- Lightweight or fully featured stacks

### State of the art solution

- Suitable for 2-layer PCB
- SoC and Modules
- Enhanced security
- Complete ecosystem





# Sub-1GHz families Additional details

Ultimate portfolio to tackle Sub-1GHz markets !



## Extreme versatility

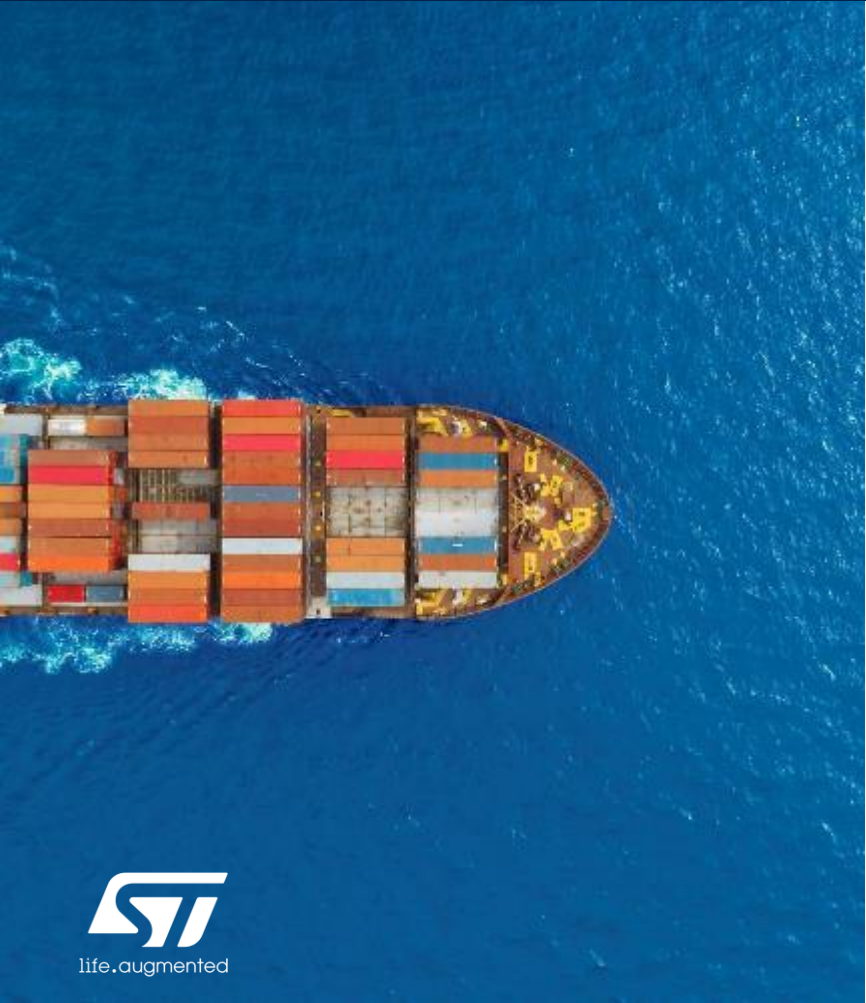
- LoRa (both LoRaWAN and proprietary based LoRa protocols)
- SigFox
- WiSun
- KNX
- Wireless Mbus, Zeta, Mioty support
- (G)FSK, (G)MSK, BPSK, OOK for proprietary protocols

## Tailored to address any location and constraint

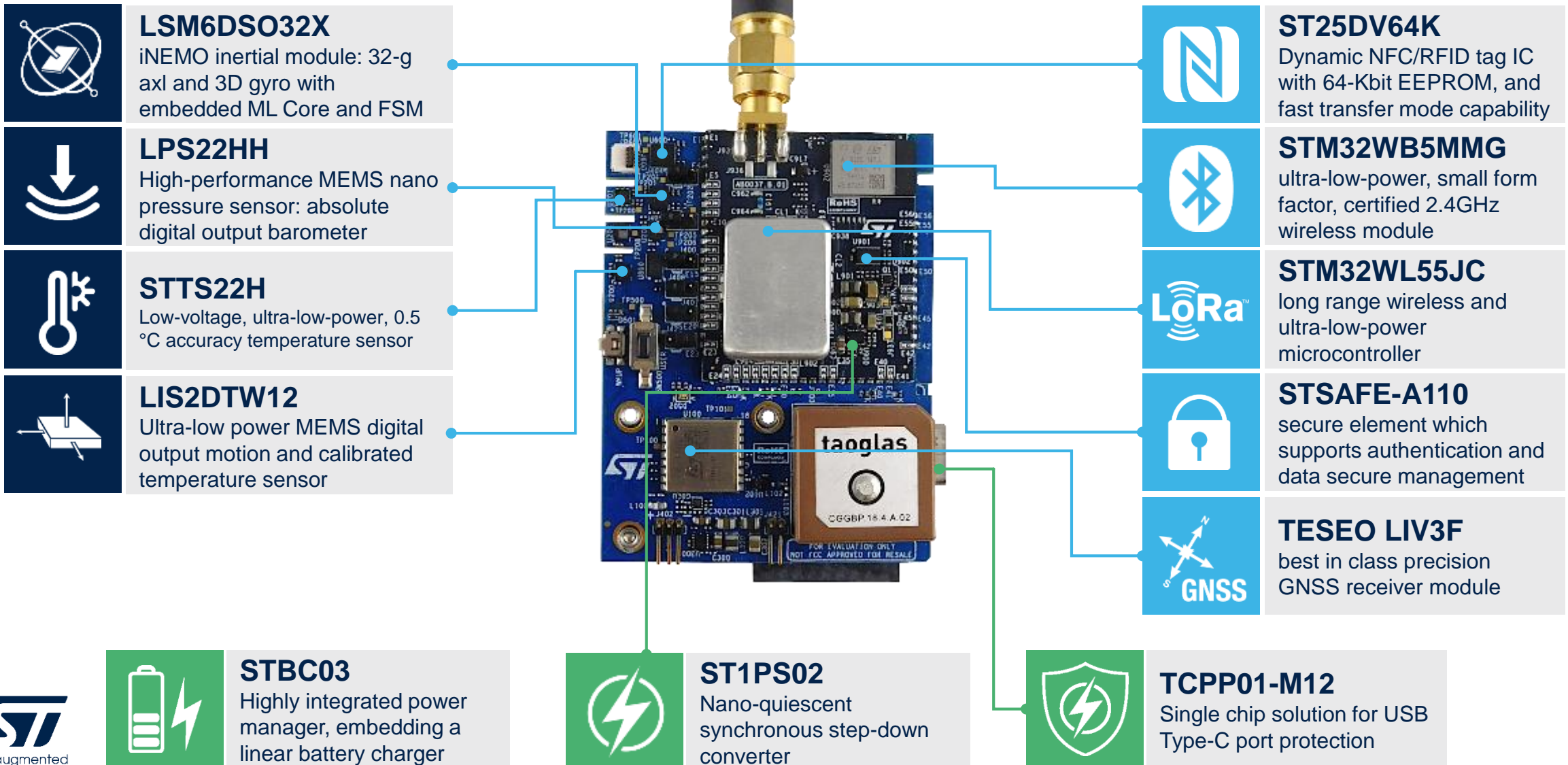
- Worldwide compatibility
- Up to +22 dBm output power for wide coverage
- Up to 105 °C capable for harsh environments

## State of the art solution

- SoC and Modules
- Enhanced security (On STM32WL)



# Reference designs



**LSM6DSO32X**  
iNEMO inertial module: 32-g axl and 3D gyro with embedded ML Core and FSM

**LPS22HH**  
High-performance MEMS nano pressure sensor: absolute digital output barometer

**STTS22H**  
Low-voltage, ultra-low-power, 0.5 °C accuracy temperature sensor

**LIS2DTW12**  
Ultra-low power MEMS digital output motion and calibrated temperature sensor

**ST25DV64K**  
Dynamic NFC/RFID tag IC with 64-Kbit EEPROM, and fast transfer mode capability

**STM32WB5MMG**  
ultra-low-power, small form factor, certified 2.4GHz wireless module

**STM32WL55JC**  
long range wireless and ultra-low-power microcontroller

**STSAFE-A110**  
secure element which supports authentication and data secure management

**TESEO LIV3F**  
best in class precision GNSS receiver module

**STBC03**  
Highly integrated power manager, embedding a linear battery charger

**ST1PS02**  
Nano-quiescent synchronous step-down converter

**TCPPO1-M12**  
Single chip solution for USB Type-C port protection

# Inside the STM32Cube ecosystem

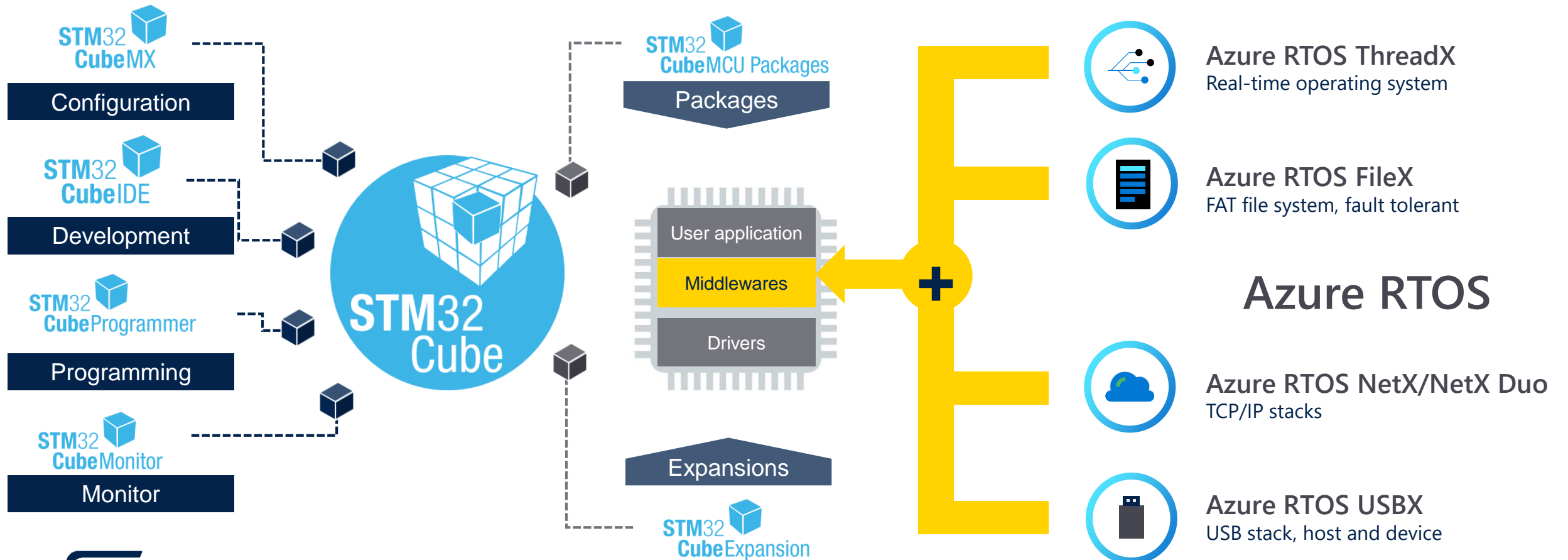
Software Tools



Embedded Software



Complemented with Microsoft Azure RTOS





# Our technology starts with You

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