



**Industrial
Summit 2020**
Shenzhen, China | 2 December
POWERING YOUR INNOVATION



STM32G4 mainstream series mixed signal MCU

PENG Zunian

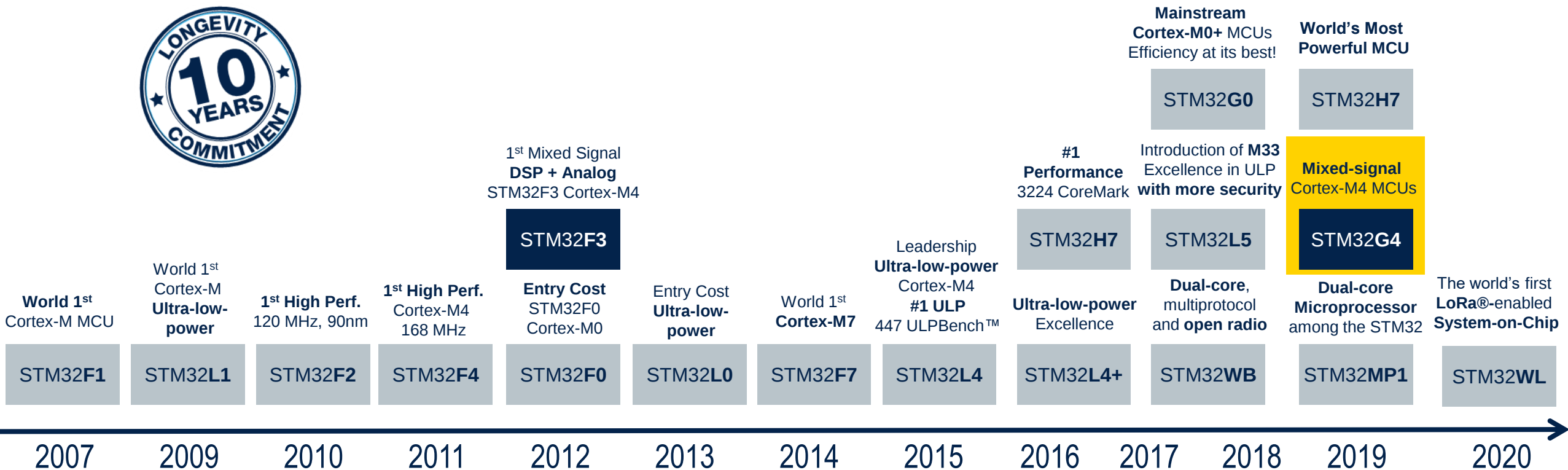
Microcontroller Digital Group

AP Region, STMicroelectronics



Continuing the STM32 success story

Leader in Arm® Cortex® 32-bit MCU & MPU



General Purpose Microcontrollers* Ranking

(Omdia CLT, Mar 9th 2020)

STM32 WW Leadership

From 2% market share in 2007 to 20% in 2018-19 by Internal Growth

Rank	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	Renesas	Renesas	Renesas +	Renesas	Renesas	Renesas	Renesas	Renesas	Renesas	Microchip	Microchip	Microchip	Microchip
2	Panasonic	Panasonic	Panasonic	Atmel	Atmel	Atmel	Microchip	Microchip	Microchip +	Renesas	Renesas		
3	Microchip	NEC	Microchip	Microchip	Microchip	Microchip	Atmel	Atmel				Renesas	Renesas
4	Toshiba	Microchip	NEC	Samsung	TI	TI	TI		NXP	TI	TI	TI	TI
5	NEC	Toshiba	Toshiba	Toshiba	Toshiba			TI	Atmel	NXP	NXP	NXP	NXP +
6	Freescale	Freescale	Atmel	TI	Freescale	Fujitsu	Freescale	Freescale	TI	Cypress	Cypress	Infineon	Infineon +
7	Atmel	Atmel	Samsung	Freescale	Cypress	Freescale	Cypress	NXP +	Cypress	Infineon	Infineon	Cypress	Cypress
8	Fujitsu	Fujitsu	Freescale	Fujitsu	Fujitsu	Toshiba	Spansion	Spansion	Infineon	Silicon Lab	Silicon Lab	Toshiba	Nuvoton
9	Samsung	Samsung	TI	Panasonic		Cypress +	NXP	Cypress	Silicon Lab	Toshiba	Nuvoton	Silicon Lab	Toshiba
10	TI	TI	Fujitsu		Samsung	NXP	Toshiba	Infineon	Toshiba	Nuvoton	Toshiba	Nuvoton	Silicon Lab
10+				NXP	NXP	Samsung	Infineon	Toshiba	Nuvoton	Cobham	Cobham		Marvell

Share ~2% ~20% (>120Mu/month)

>60,000 Customers

STM32 rolling longevity commitment

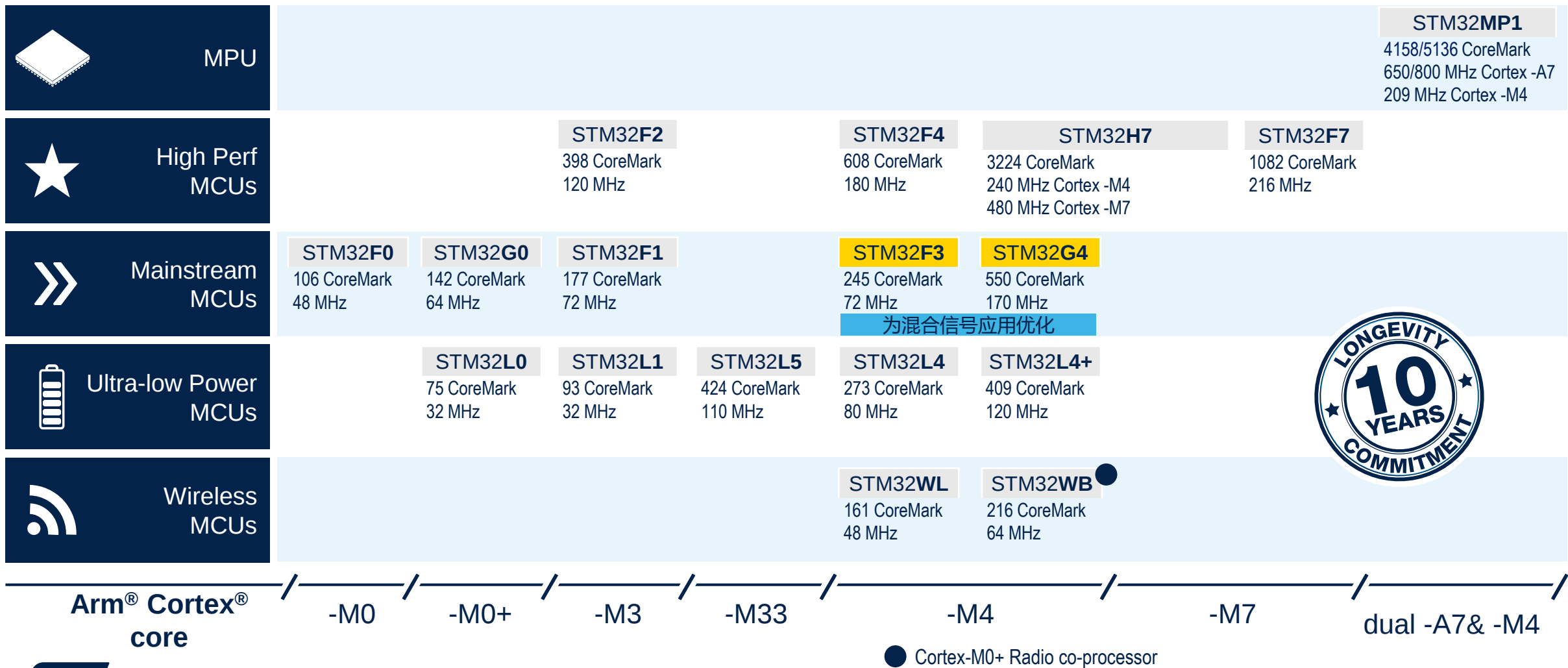


starting January
1st 2020
→ Until 2030

• STM32F1	(Launched in 2007)	23 years of commitment
• STM32L1	(Launched in 2009)	21 years of commitment
• STM32F2	(Launched in 2010)	20 years of commitment
• STM32F4	(Launched in 2011)	19 years of commitment
• STM32F0	(Launched in 2012)	18 years of commitment
• STM32F3	(Launched in 2012)	18 years of commitment
• STM32L0	(Launched in 2013)	17 years of commitment
• STM32F7	(Launched in 2014)	16 years of commitment
• STM32L4	(Launched in 2015)	15 years of commitment
• STM32L4+	(Launched in 2016)	14 years of commitment
• STM32H7	(Launched in 2016)	14 years of commitment
• STM32WB	(Launched in 2018)	12 years of commitment
• STM32G0	(Launched in 2018)	12 years of commitment
• STM32L5	(Launched in 2018)	12 years of commitment
• STM32MP1	(Launched in 2019)	11 years of commitment
• STM32G4	(Launched in 2019)	11 years of commitment
• STM32WL	(Launched in 2020)	10 years of commitment



STM32G4 series continuity of the STM32F3



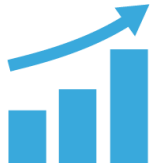
STM32G4 series

Ideal for applications requiring an MCU that offers advanced and rich analog peripherals



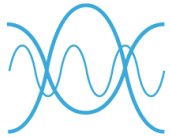
- Control applications (Motor Control...)
- Industrial equipment
- Instrumentation and Measurement
- Digital Power
- Digital SMPS (switch mode power supply)
- PFC (power factor correction)
- Solar inverter

STM32G4 series – key messages



Performance

- Arm® Cortex®-M4 at 170 MHz
- 213 DMIPS and 550 CoreMark® results
- Better dynamic power consumption (163µA/MHz)
- ART Accelerator™ (dynamic cache)
- Mathematical accelerators
- CCM-SRAM Routine Booster (static cache)



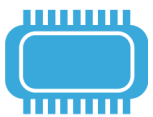
Rich Integrated Analog and Digital

- Op-Amps (Built-in gain), DACs, Comparators
- 12-bit ADCs 4Msps with hardware oversampling
- CAN-FD (flexible data rate – 8 Msps bit rate)
- High resolution timer (184 ps)
- USB type-C Power Delivery 3.0
- 1% RC accuracy [-5°..90°C], 2% full T° range



Safety and security focus

- Dual Bank Flash with ECC (error code correction)
 - Securable Memory Area
 - Hardware encryption AES-256
 - SIL, Class-B
 - SRAM with Parity bit
- } Secure Live Upgrade
- } Functional safety design packages

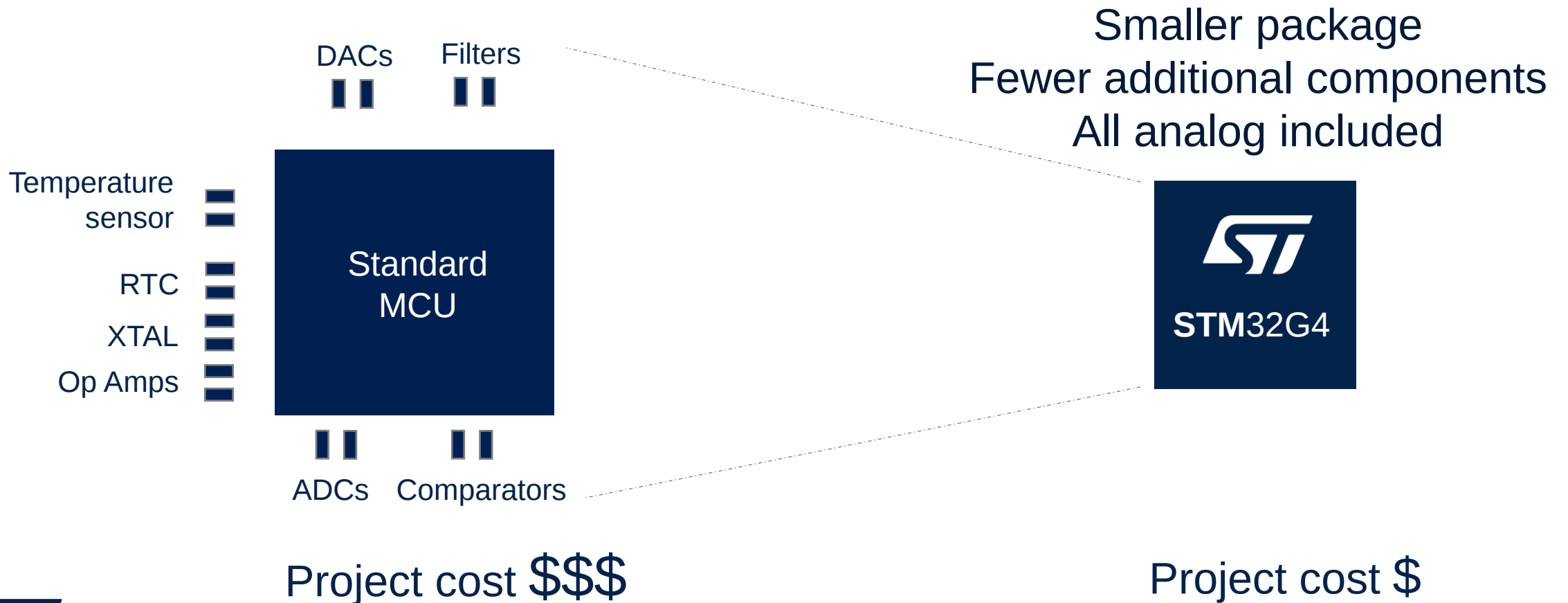


Complete portfolio

- Complements existing STM32F3 Series portfolio
- From -40°C up to 85 or 125°C devices
- From 32- up to 128-pin
- From 32 KB to 512 KB Flash

Reducing PCB size and BOM cost

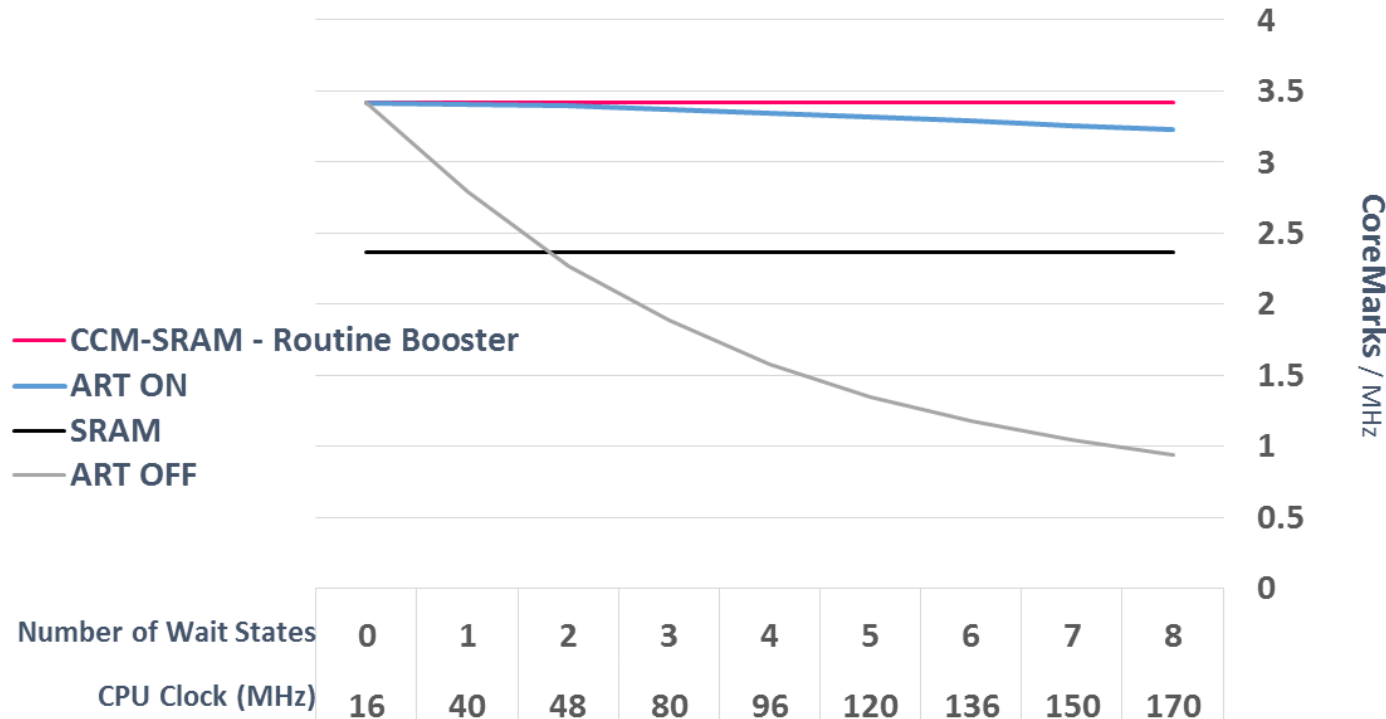
System-on-Chip – All-in-one solution



Greater performance

Pure 170 MHz CPU performance (Arm® Cortex®-M4) with three accelerators

Code execution performance



Arm Cortex-M4 with **FPU**

Up to 170 MHz CPU frequency

Up to 213 DMIPS and 550 CoreMark® results

3 different HW accelerators:

- **ART accelerator** (~dynamic cache) → Full code acceleration (average)
- **Routine Booster CCM-SRAM** (~static cache) → determinism preserved
- **Mathematical** (Cordic + FMAC)



Mathematical accelerators

Function acceleration and CPU offload



1. CORDIC (Trigo)

- Very helpful for Field Oriented Motor Control method (FOC)
 - Accuracy up to 20bit
- Vector rotation (polar to rectangular): Sin, Cos
 - Vector translation (rectangular to polar): Atan2, Modulus
 - Sinh, Cosh, Exp
 - Atan, Atanh
 - Square root
 - Ln
- Significantly increase efficiency of mathematic processing (e.g, Sin and Cos are more than 5x faster than ARM math lib)
- ➔ In motor control application, increase 12% control looping efficiency.



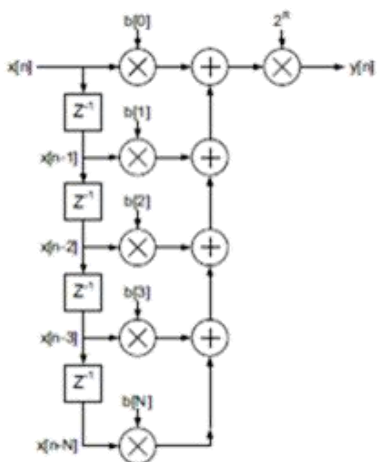
Mathematical accelerators

Function acceleration and CPU offload

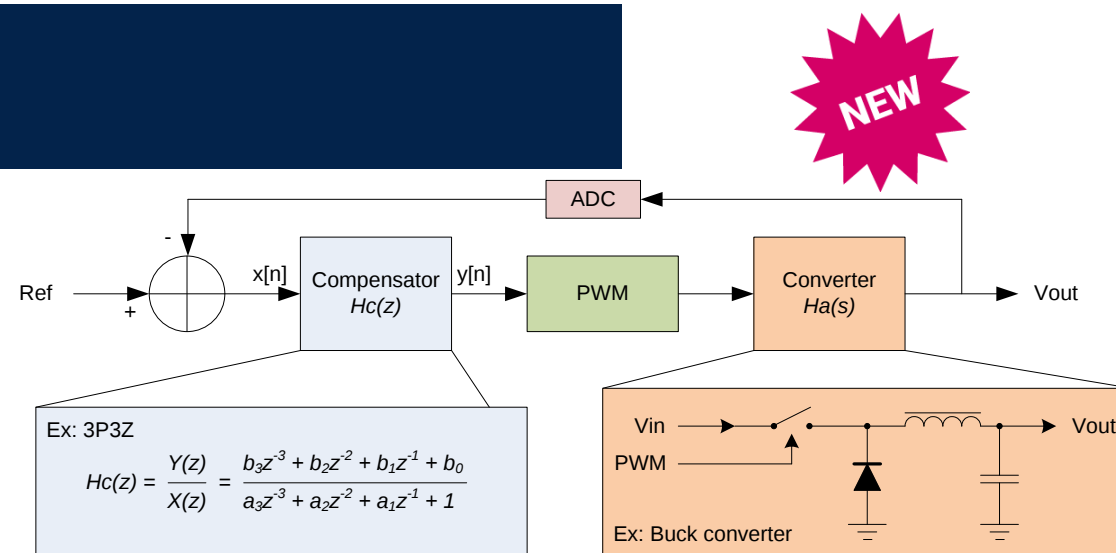
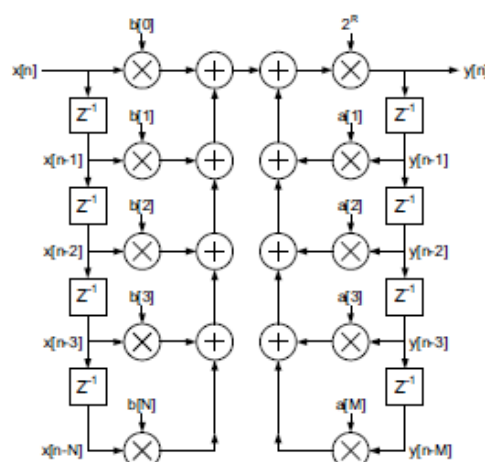
2. Filter Math ACcelerator (FMAC)

- Can be used to create
 - FIR, IIR
 - Compensator (Digital power3p3z)

FIR filter



IIR filter

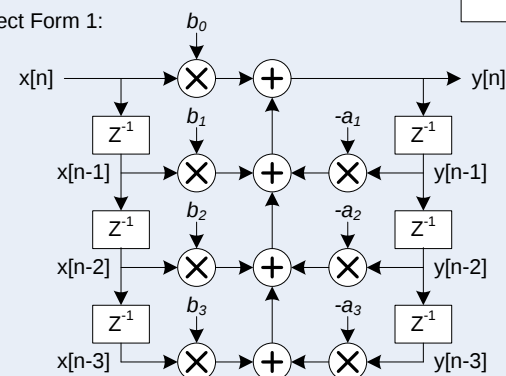


Ex: 3P3Z

$$H_c(z) = \frac{Y(z)}{X(z)} = \frac{b_3z^3 + b_2z^2 + b_1z^1 + b_0}{a_3z^3 + a_2z^2 + a_1z^1 + 1}$$

$$y[n] = b_0x[n] + b_1x[n-1] + b_2x[n-2] + b_3x[n-3] - a_1y[n-1] - a_2y[n-2] - a_3y[n-3]$$

Direct Form 1:



FMAC configuration:

X1_BUF_SIZE ≥ 5, X2_BUF_SIZE = 7, Y_BUF_SIZE ≥ 4

Preload X2_BUF : [b0,b1,b2,b3,a1,a2,a3]

Run IIR filter with parameters: P = 4, Q = 3

Repeat:

Write x[n] to WDATA

Poll YEMPTY flag low or wait for interrupt (~8 clock cycles)

Read y[n] from RDATA

Rich, advanced analog

Mixed-signal SoC for wide variety of applications

ADC (up to 5)	Values
Topology	SAR 12-bit + HW oversampling → 16-bit
Sampling rate	Up to 4 Msps
Input	Single-ended and differential
Offset and Gain compensation	Auto calibration to reduce gain and offset

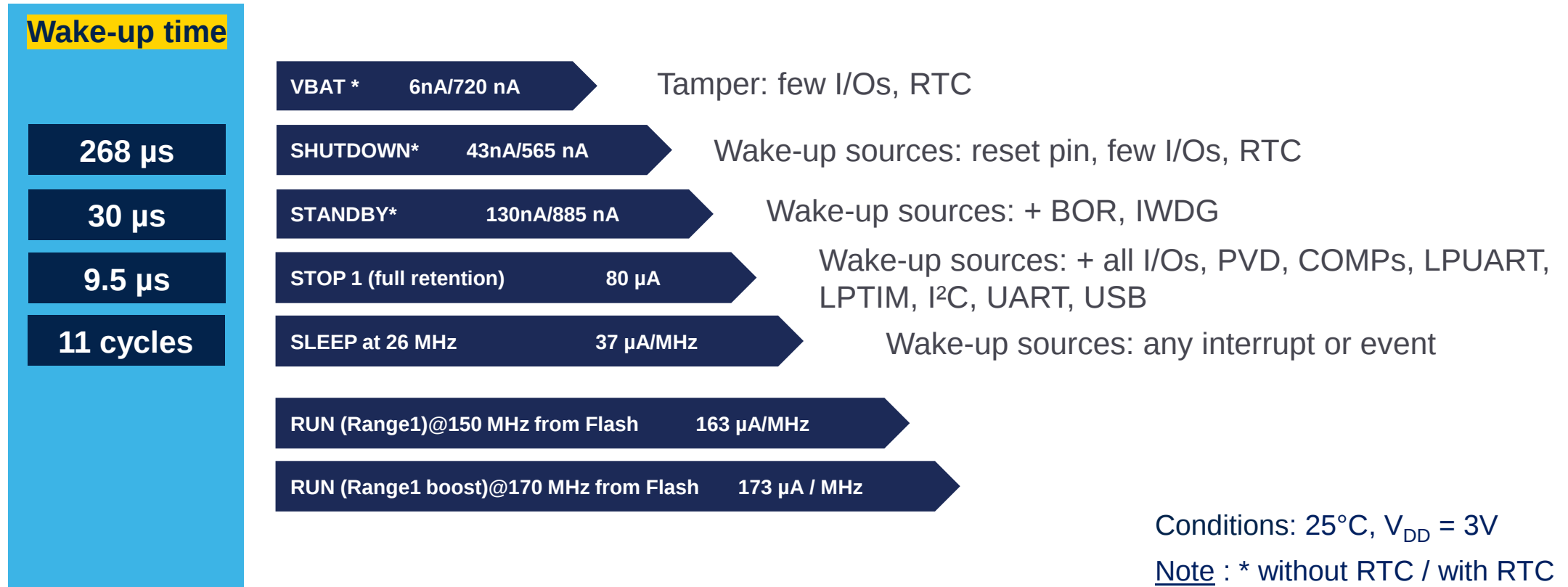
DAC (up to 7)	Values
Sampling rate	15 Msps (internal) 1Msps (from buffered output)
Settling time	16ns

Op-Amp (up to 6)	Values
GBW	13 MHz
Slew rate	45 V/μs
Offset	3mV over full T° range 1.5mV @ 25°C
PGA Gain (accuracy)	2, 4, 8, 16, -1, -3, -7, -15 (1%) 32, 64, -31, -63 (2%)

Comparator (up to 7)	Values
Power supply	1.62 .. 3.6V
Propagation delay	16.7ns
Offset	-6 .. +2 mV
Hysteresis	8 steps: 0, 9, 18, 27, 36, 45, 54, 63 mV

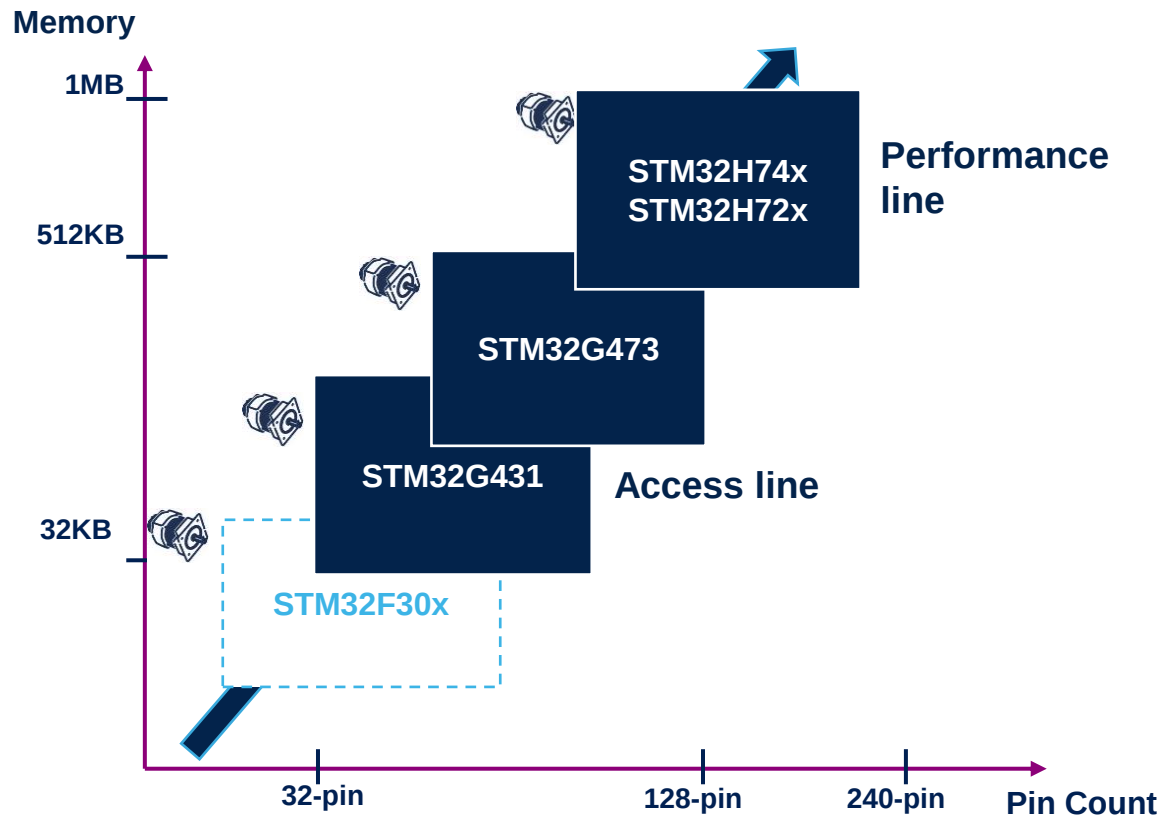
Dynamic efficiency modes

When Mainstream MCU Series meets low-power requirements

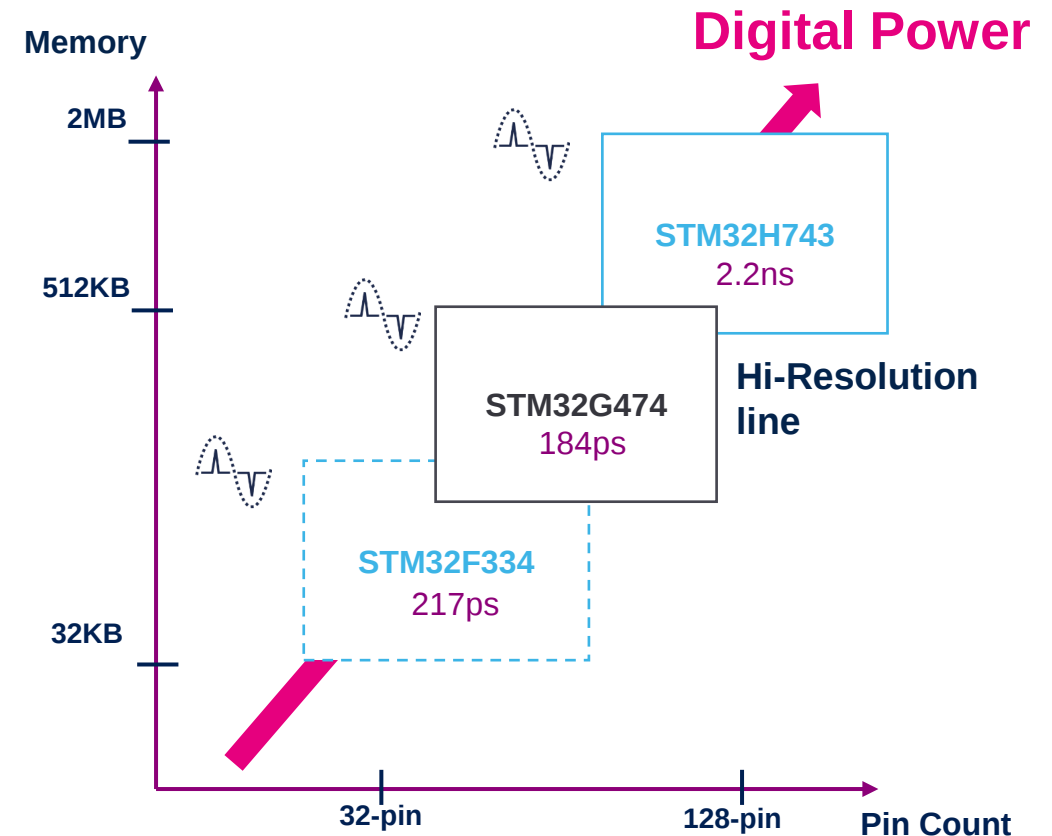


STM32G4 products lines

Motor control



Digital energy



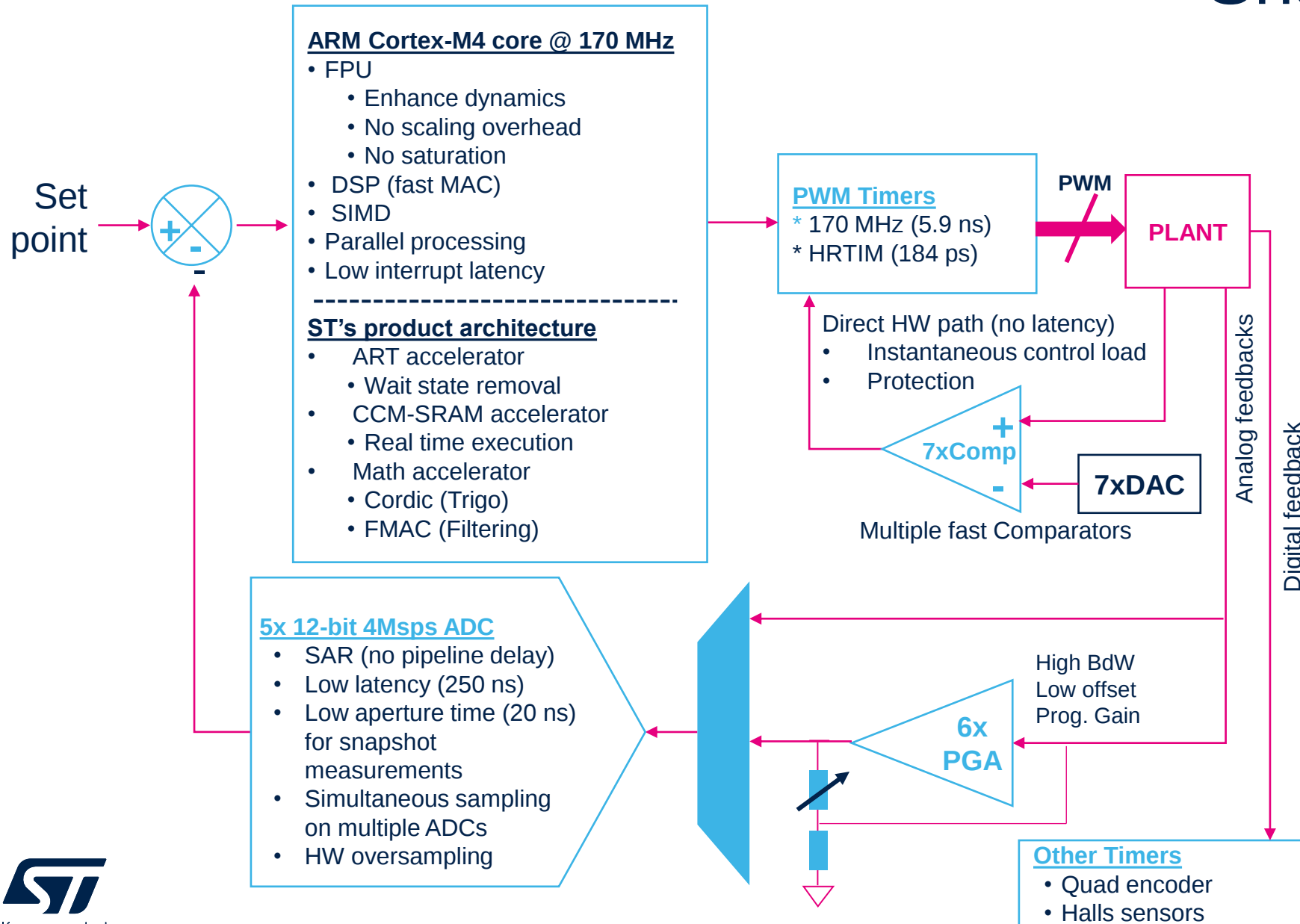


Extensive & innovative peripheral set

No compromise on what matters

Unit parameters	STM32G474 Hi-Resolution line	STM32G473 Performance line	STM32G431 Access line
Core, frequency	Arm Cortex-M4, 170 MHz		
Flash (max)	512 Kbytes (2x256KB dual bank)		128 Kbytes single bank
RAM (up to)	96 Kbytes		22 Kbytes
CCM-SRAM (code-SRAM)	32 Kbytes		10 Kbytes
12-bit ADC SAR	5x 12-bit 4 MSPS		2x 12-bit 4 MSPS
Comparator	7		4
Opamp with 4 built-in gain values with 1% accuracy	6		3
12-bit DAC	7		4
Motor Control timer	3x (170 MHz)		2x (170 MHz)
CAN-FD	3x		1x
12 channel Hi-resolution Timer	1x	-	-
Power supply	1.72 to 3.6 V		

Shaped for control

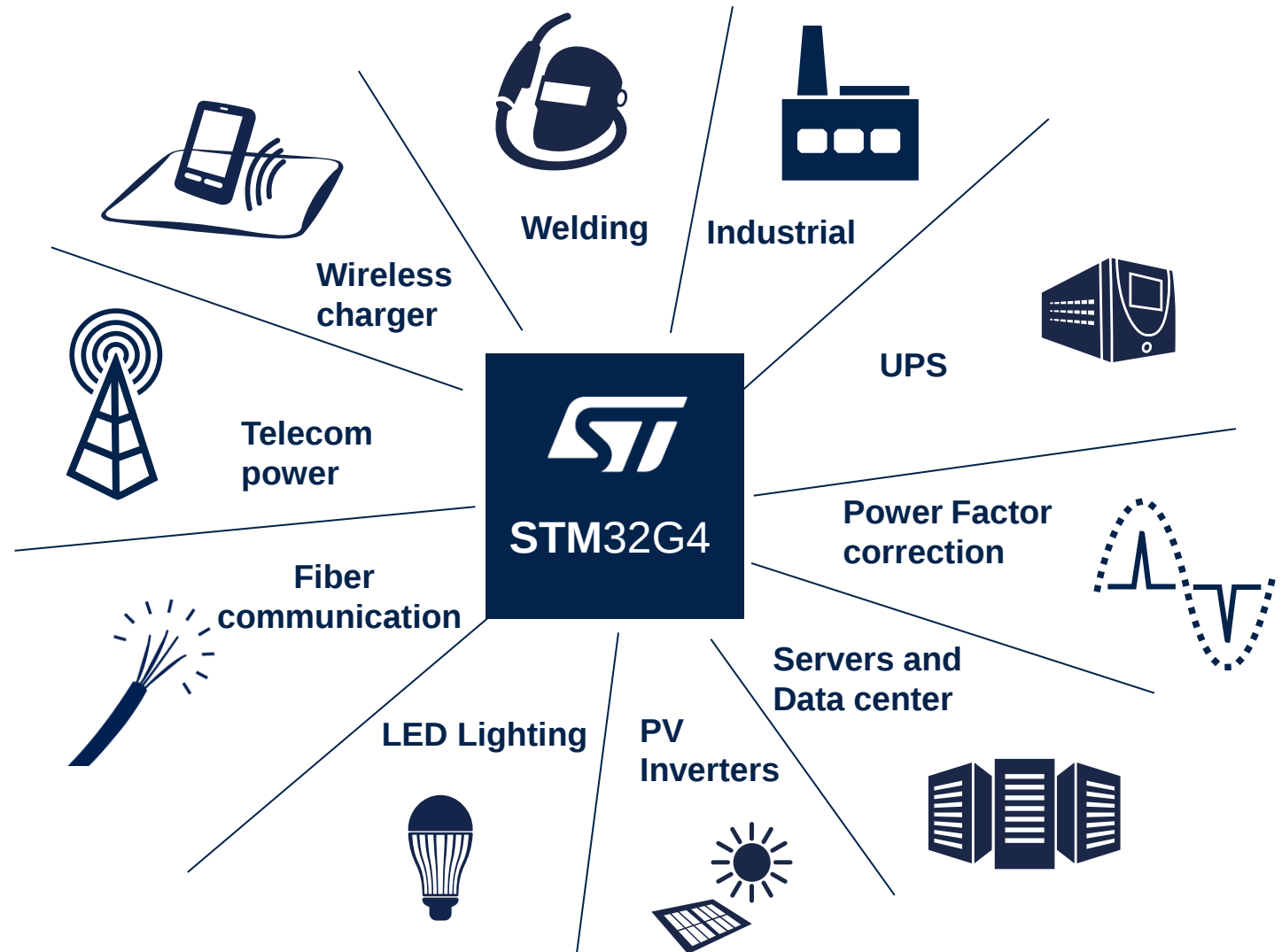
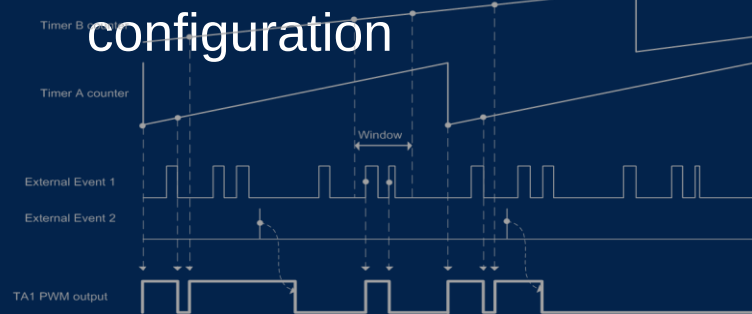


Easy use of the Analog and Digital resources thanks to high peripherals interconnect and flexible bus matrix

Ease digital power conversion

Enhance your digital power solutions using the

- **STM32G474** full features High Resolution Timer (HRTIM)
 - ✓ 184ps resolution
 - ✓ High flexible PWM configuration



HRTimer – not only high resolution...

High resolution PWM

- 12 channels with 184ps resolution on frequency and duty cycle
- 184ps is equivalent to 5.4GHz timer clock

Flexible PWM generation

- 7x independent time base to create various shape of PWM
- 6x complementary pair PWM outputs
- Up to 32 set/reset transition per PWM period thx to the built-in crossbar
- Master/Slave configuration for multi phase converter

Multiple Event handler

- 6x Digital and Analog fault input
- 10x Events cycle to cycle current control or PWM restart (constant Ton/Toff)
- Blanking, windowing and digital filter

12 independent channels

- Any topology supported from 1x 12 PWM (triple interleaved LLC (servers application) up to 12x1 PWM (multiple independent buck converters (lighting))

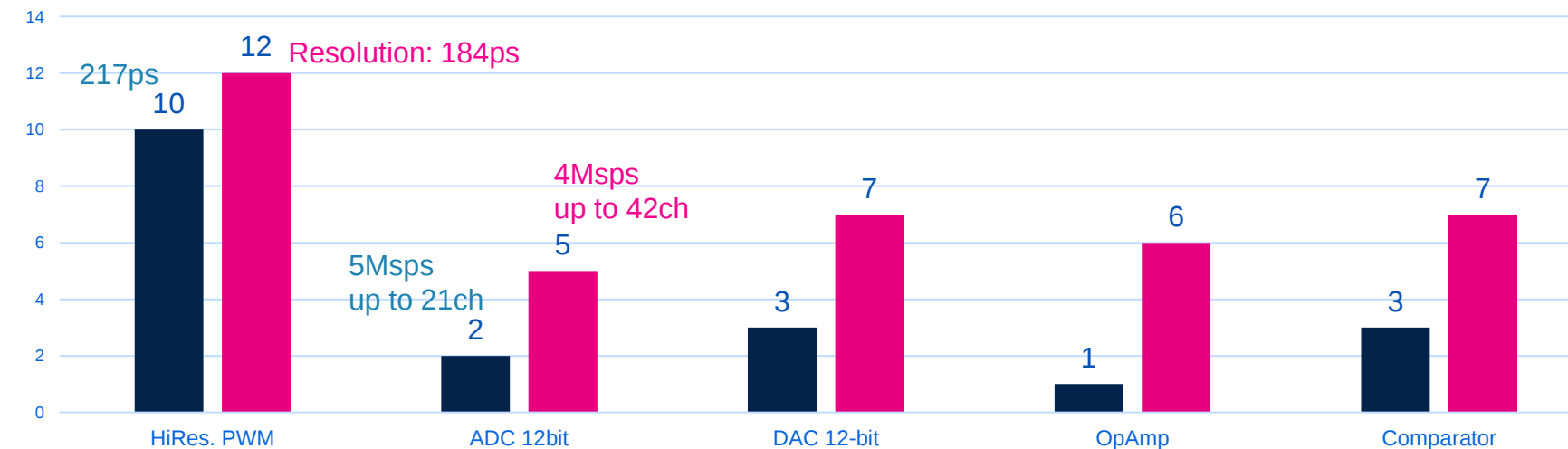
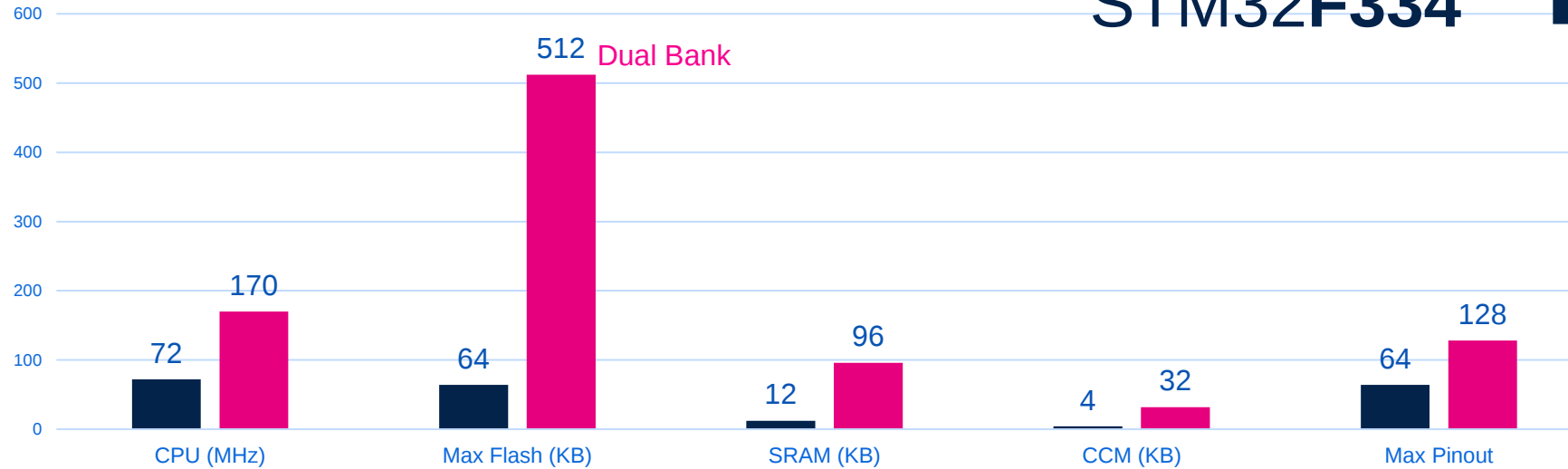


Product upgrading for digital power design

STM32F334



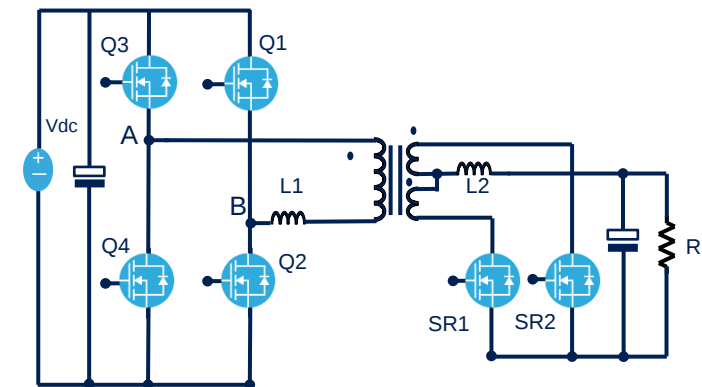
STM32G474



■ STM32F334 ■ STM32G4

New supported topology example

- Tri-phase interleave HB LLC (3 x 4 PWM)
- Dual-phase interleave FB LLC (2x 6 PWM)
- Dual-phase FB PS /LLC with SR (2x 6 PWM)



• FB PS /LLC with SR 拓扑



life.augmented

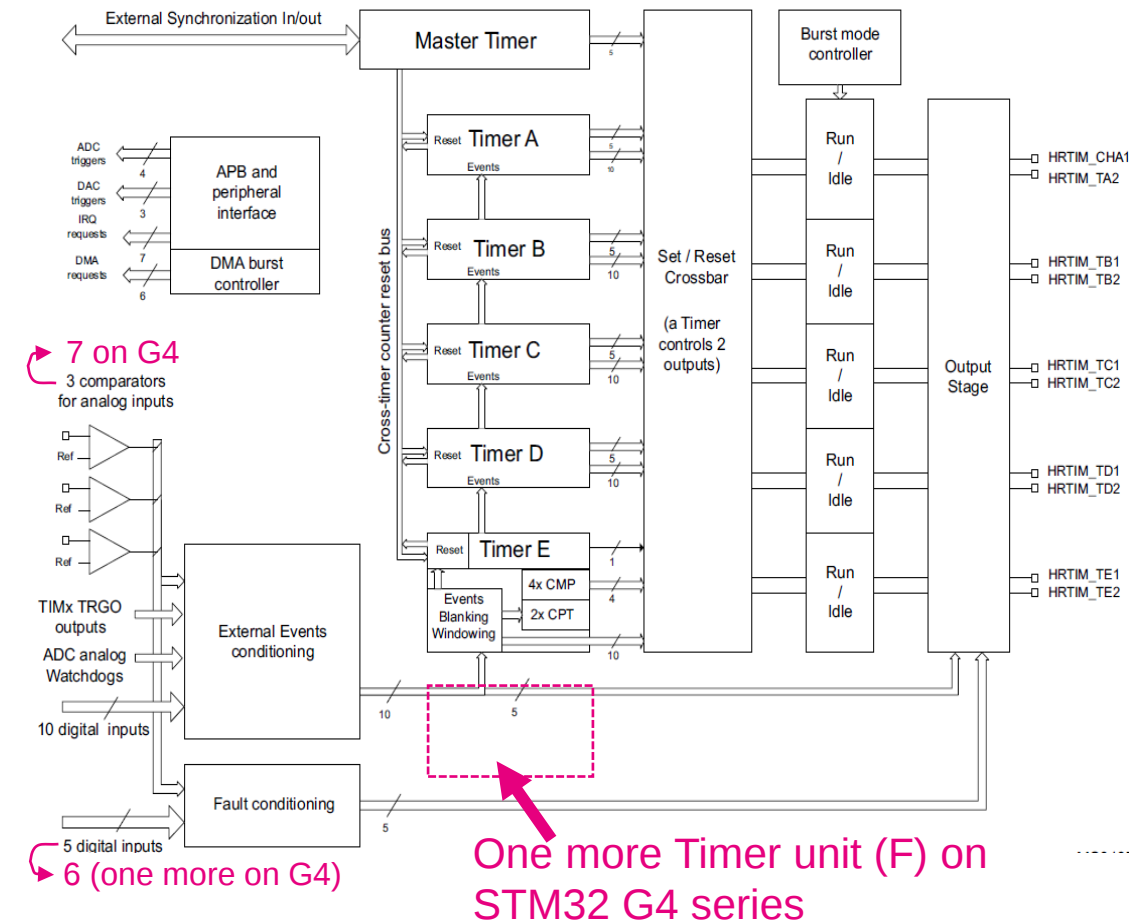
HRTIMER Overview

STM32F334



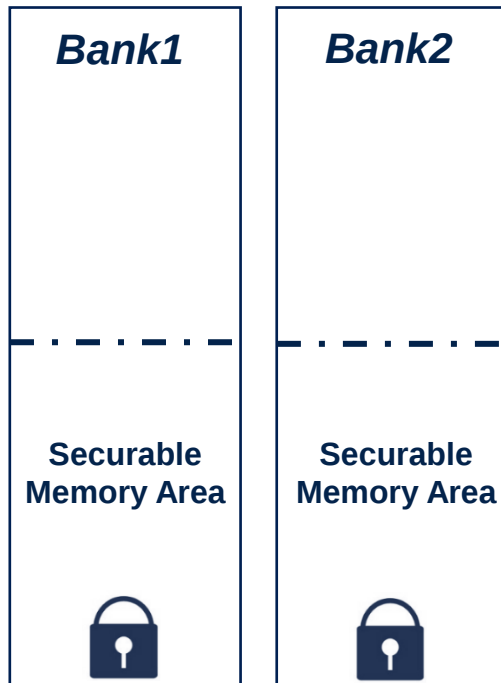
STM32G474

- Modular architecture: one master and 6 timer sub-units that can be cross-synchronized
- Digital@170MHz followed by analog DLL
- High-resolution
 - 184 ps on all Outputs
- Self-compensated
 - No Temp/Vdd drift
- Up to 12 PWMs outputs
- Multiple faults/events In
- Minimizes SW overhead
- Complex event handling
 - Blanking / windowing / timeout



Integrated security features, ready for tomorrow's needs

User Flash

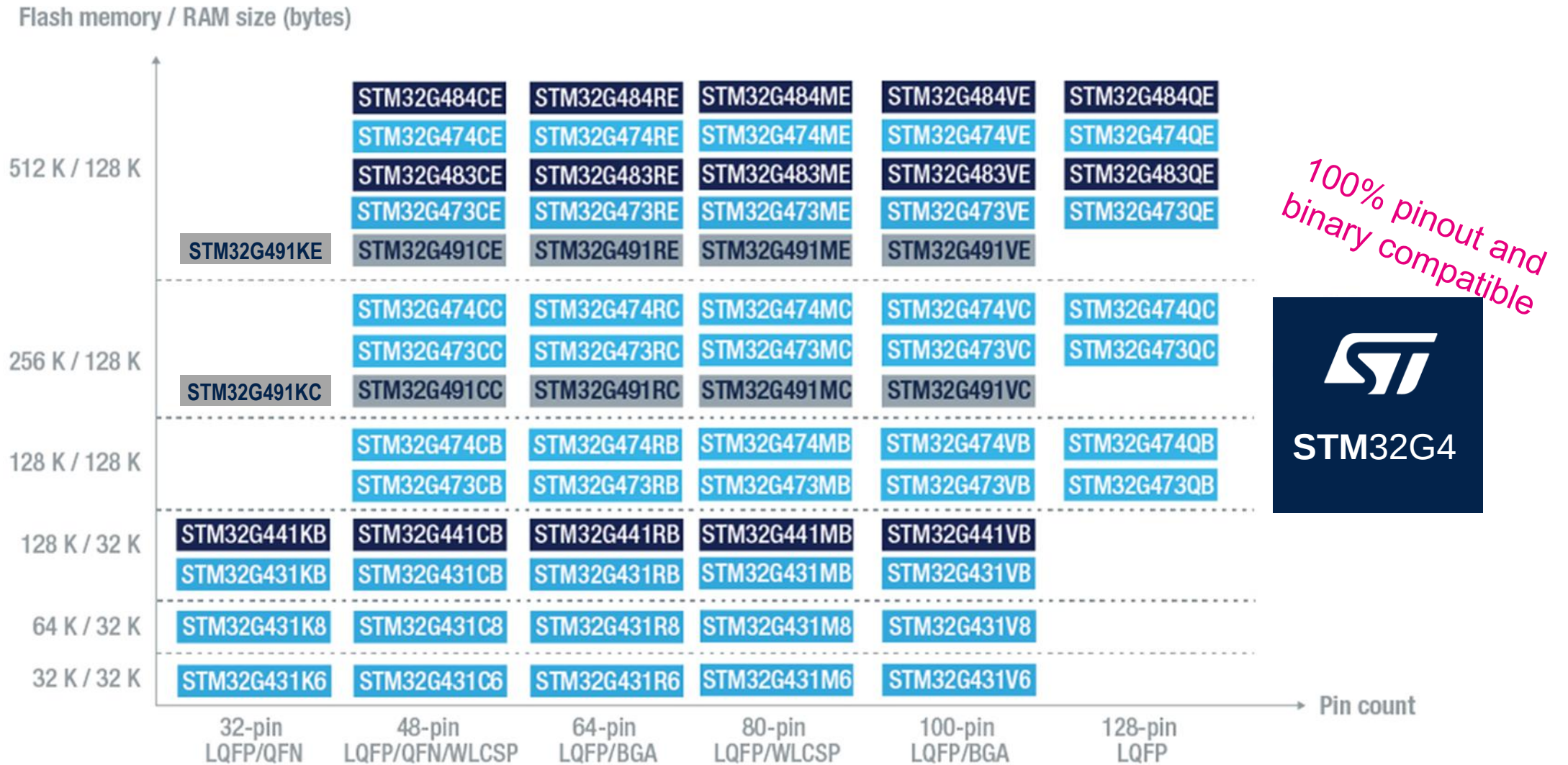


Securable Memory Area:

- Configurable size
- Can be secured once exiting
 - No more access nor debug possible
- Good fit to store critical data
 - Critical routines
 - Keys

	Securable user memory	AES TRNG	PCROP	MPU	Readout protection	CRC	Write Protection
Secure firmware install (SFI)	●	●			●		
Secure Firmware upgrade (SFU)	●	●			●		●
Mutual Distrustful			●				
Firmware IP protection			●				
Secret key storage	●				●		
Secured communication		●				●	
Authentication	●	●			●		
Task cloisoning				●			

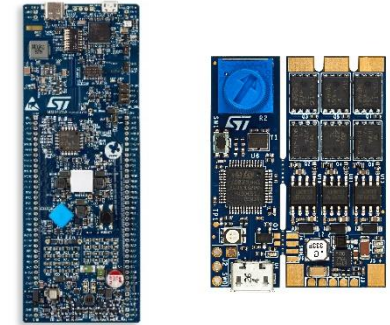
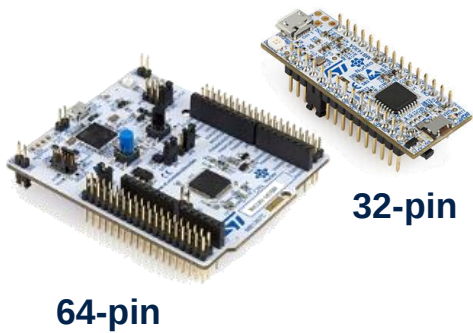
STM32G4 portfolio



Legend: Crypto AES-256 Available in H1 2021

STM32G4 hardware solutions

Accelerate evaluation, prototyping and design



STM32 Nucleo

Flexible prototyping

- NUCLEO-G431RB
- NUCLEO-G474RE
- NUCLEO-G431KB*

Evaluation boards

Full feature STM32G4 evaluation

- STM32G484E-EVAL
- STM32G474E-EVAL
- STM32G474E-EVAL1

Motor Control Pack

Full feature for Motor Control and Analog

- P-NUCLEO-IHM03

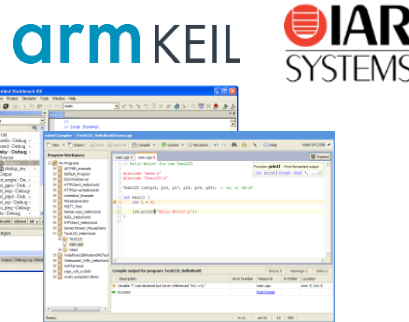
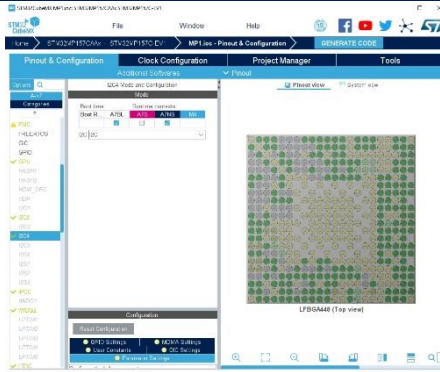
Discovery kits

Key feature prototyping

- B-G474E-DPOW1
- B-G431B-ESC1

STM32G4 software tools

Complete support of Arm Cortex-M ecosystem



All-in-one STM32 programming tool
Multi-mode, user-friendly



STM32CubeMX

STM32CubeMX

- Configure and generate Code
- Conflicts solver

IDEs Compile and Debug

灵活的方案

- Partners IDE, like IAR and Keil
- Free IDE based on Eclipse, like STM32CubeIDE

STM32 Programming Tool

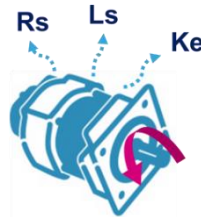
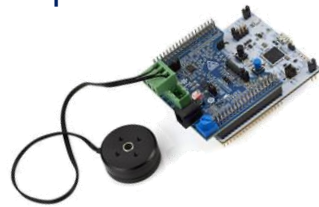
STM32CubeProgrammer

- Flash and/or system memory
- GUI or command line interface

Dedicated ecosystems

Motor Control

- **Complete ecosystem** (HW boards, SW Development Kit (SDK), docs and trainings)
 - X-CUBE-MCSDK (v5.4)
 - Motor Control FW library based on STM32Cube HAL and LL
 - Motor control workbench: Graphical configurator of the motor control library linked with STM32CubeMx
 - P-NUCLEO-IHM03: Motor Control Nucleo pack
 - NUCLEO-G431RB Nucleo-64
 - X-NUCLEO-IHM16M1 motor driver expansion board
 - Low Voltage motor
- **State of the art algorithms** (FOC, 6-step, sensorless...)
- **Motor Profiler**: Plug and spin your motor within less than one minute



Digital Power

- **Complete ecosystem** (HW boards, FW examples, SW tools, docs and trainings)
- **Dedicated HRTIM Cook Book - AN4539**: How to operate the Hi-Resolution timer in different topology
- **Digital Power training** (PSU and PFC) – based on STM32 G4 series – done in collaboration with Biricha (from Q4 2019)



Releasing your creativity





Thank you