DAHLIA / NG-Ultra

ESCCON, 12th March 2019

Jean-Luc Poupat

AIRBUS DEFENCE AND SPACE

What do we all dream about ?

High performance processing solution

With high flexibility for future applications

Allowing multitasks for integration

Suitable for Space

Developed with a european team spirit

DAHLIA

What do we all dream about ?

High performance processing solution

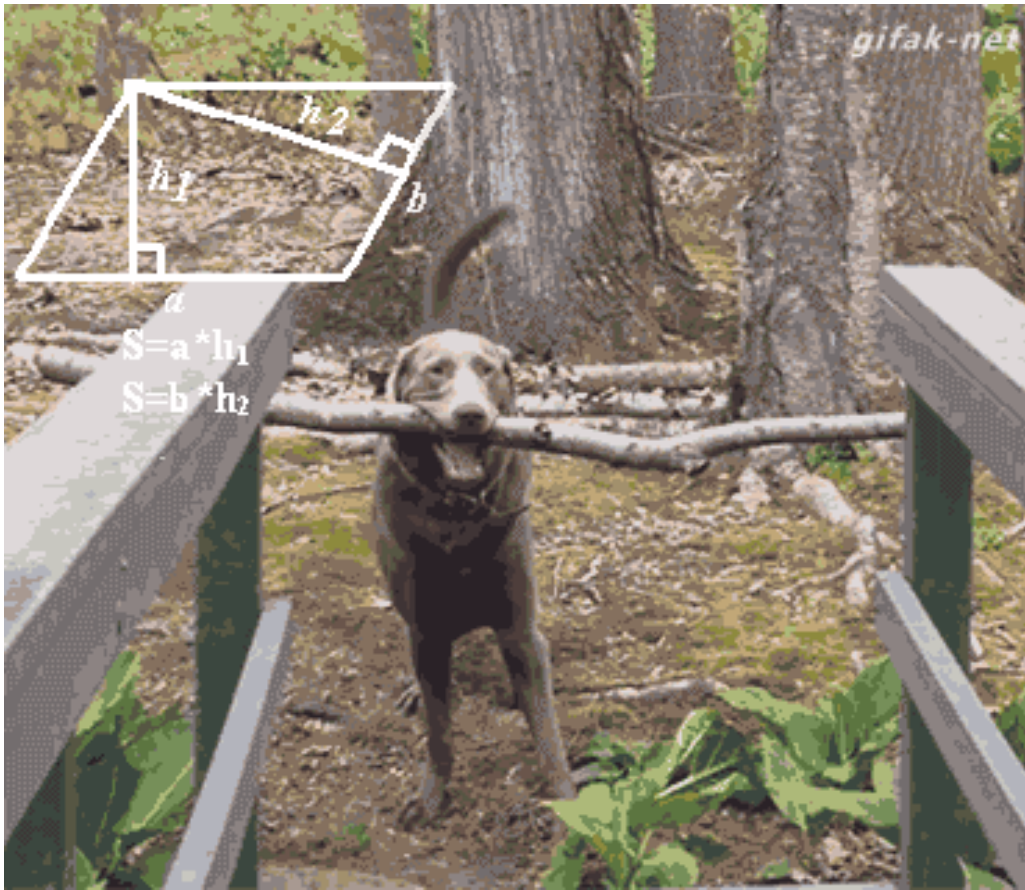With high flexibility for future applications

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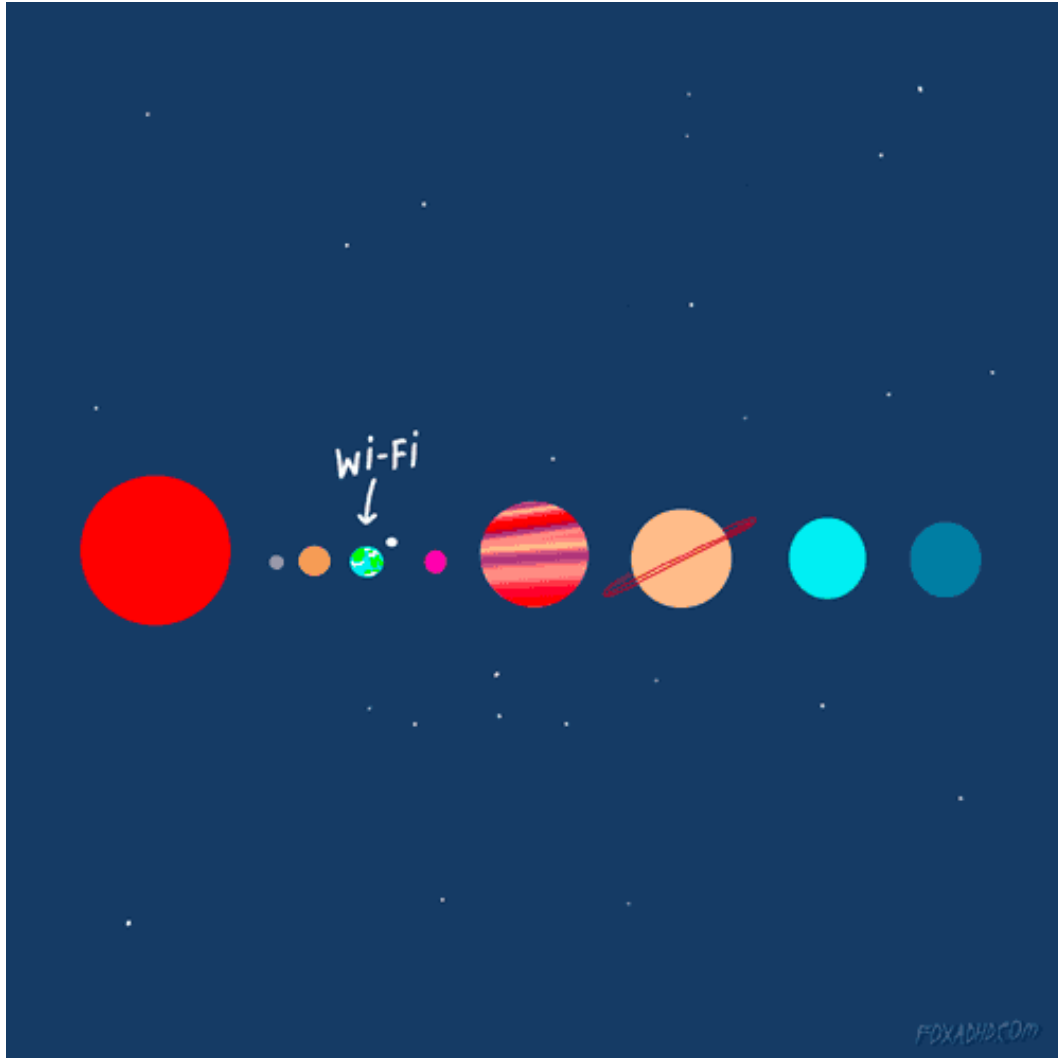**DAHLIA**

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And of course at reasonable price

Introduction
Key Features
ARM Technology
Software
Use Cases
Conclusion

Context & Objectives

DAHLIA is an answer to the H2020 topic
"*COMPET-1-2016: Critical Space Technologies for European Strategic Non-Dependence*"

DAHLIA is an **ARM-based SoC** implemented in **28nm FDSOI** technology with **eFPGA** designed to boost competitiveness and ensure **strategic non-dependence** of future European Space equipment.

DAHLIA is associated to the **NG-Ultra** development and vice-versa.

DAHLIA context

DAHLIA development has been initiated by **CNES**, **Airbus DS** and **TAS** targeting 3 main objectives:

- a large improvement of **performances** to cope with evolutions of needs in the mid/long term

- a dynamic **ecosystem** closer to Ground applications in order to enhance possible synergies

- a competitive **computing solution** allowing much more integration/miniaturization

H2020 Organization
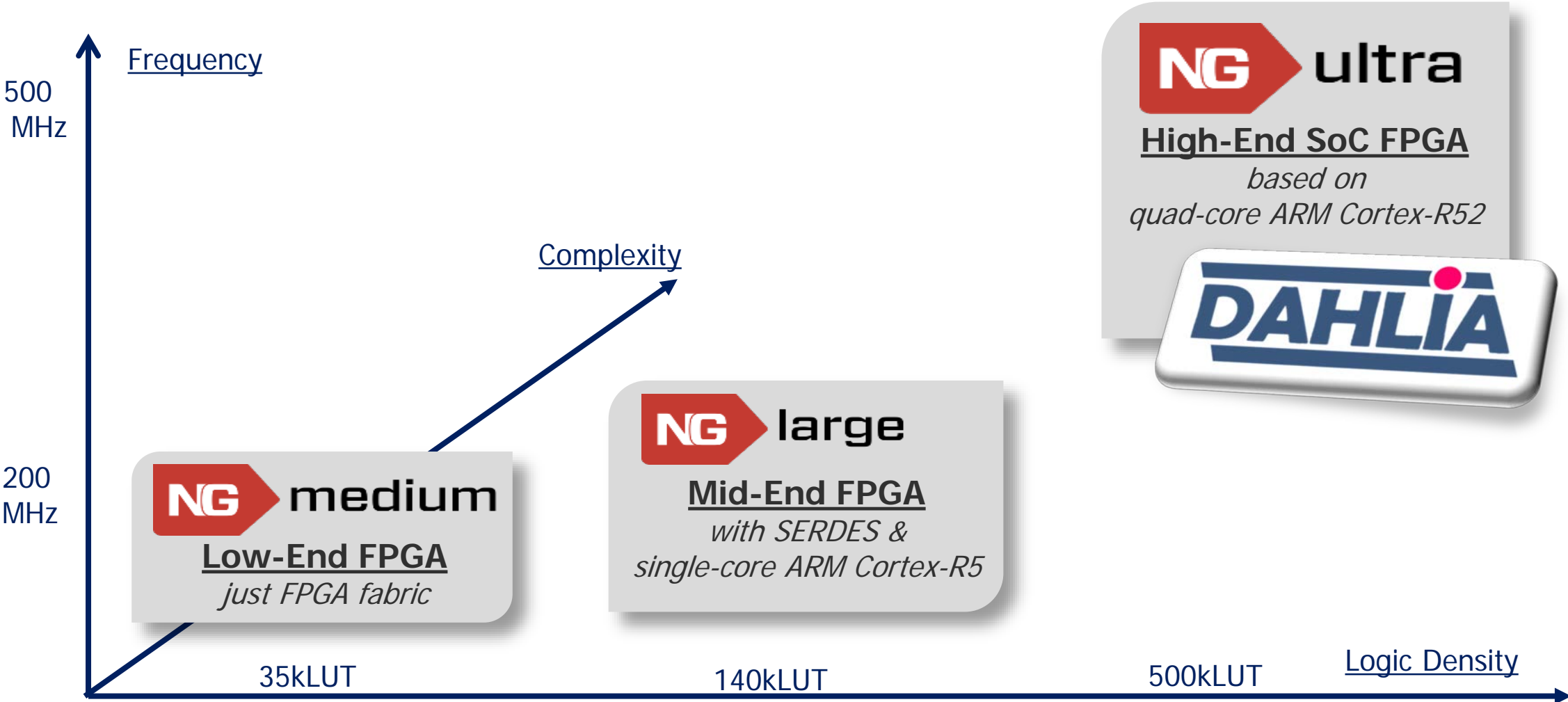
7 partners from **4 countries**

ESA and **CNES** are also part of an Advisory Group

Development Plan

- Kick-Off in 2017

- Development in 2017-2018-2019

- SoC FPGA first prototyping Q1 2019

- DAHLIA prototypes available Q1/Q2 2020
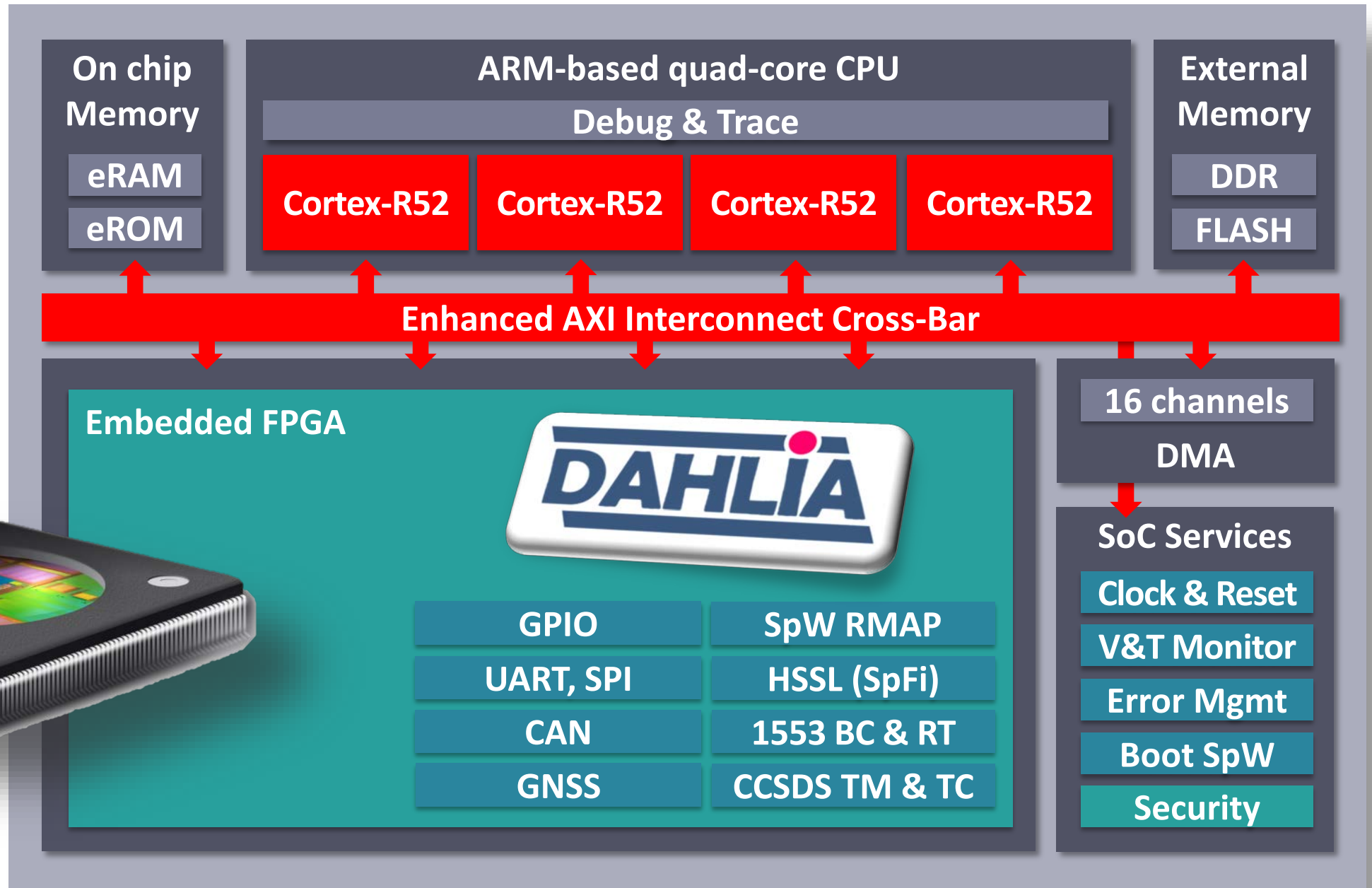
Clarification on DAHLIA & NanoXplore FPGA Roadmap

Frequency

500 MHz

NG ultra
High-End SoC FPGA
based on
quad-core ARM Cortex-R52

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Complexity

200 MHz

NG large
Mid-End FPGA
with SERDES &
single-core ARM Cortex-R5

NG medium
Low-End FPGA
just FPGA fabric

35kLUT   140kLUT   500kLUT   **Logic Density**

DAHLIA

Features

On chip Memory
- eRAM
- eROM

ARM-based quad-core CPU

Debug & Trace

| Cortex-R52 | Cortex-R52 | Cortex-R52 | Cortex-R52 |

External Memory
- DDR
- FLASH

Enhanced AXI Interconnect Cross-Bar

Embedded FPGA

DAHLIA

GPIO	SpW RMAP
UART, SPI	HSSL (SpFi)
CAN	1553 BC & RT
GNSS	CCSDS TM & TC

16 channels

DMA

SoC Services
- Clock & Reset
- V&T Monitor
- Error Mgmt
- Boot SpW
- Security

DAHLIA

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SoC Services
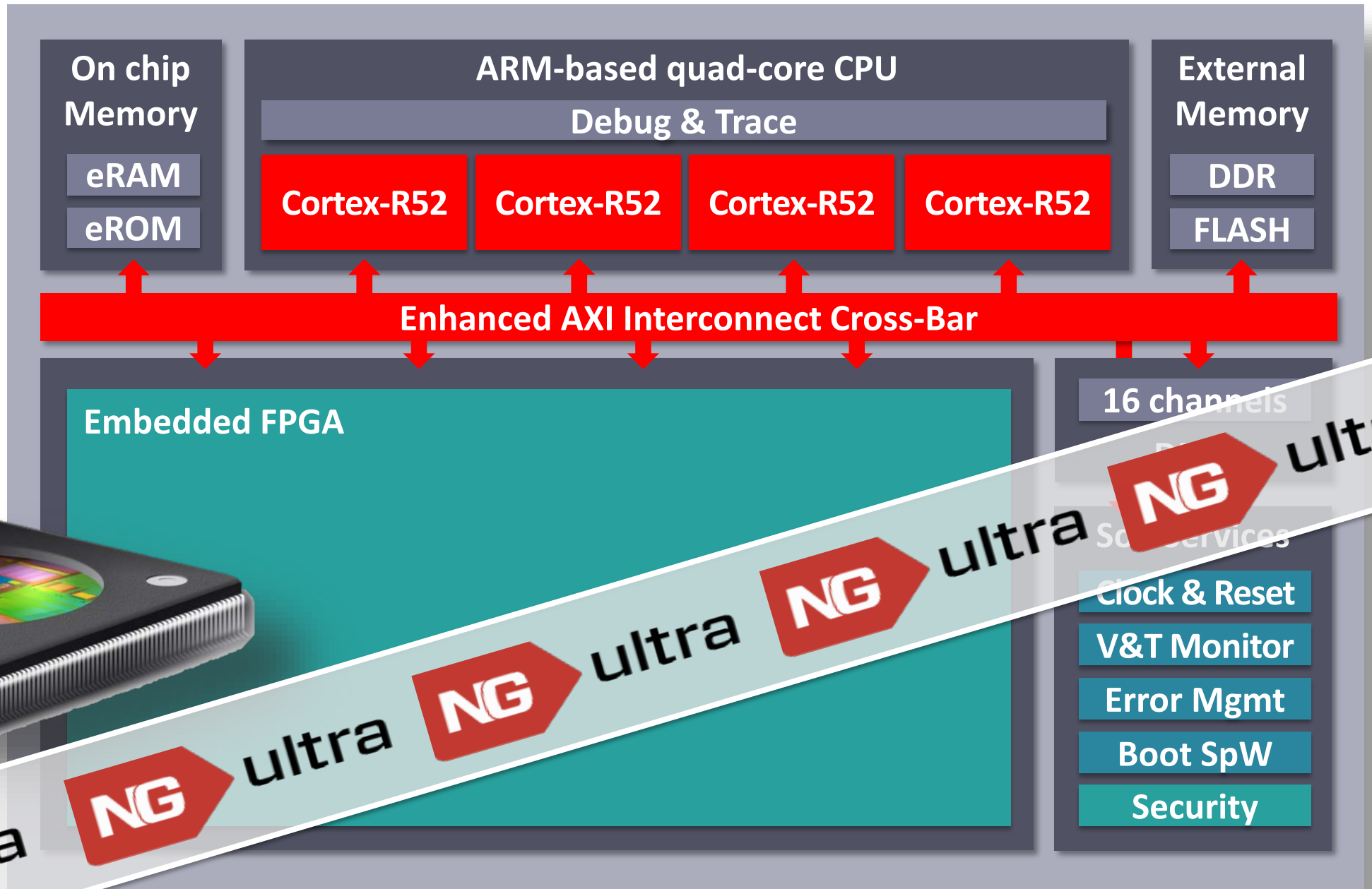- Clock & Reset
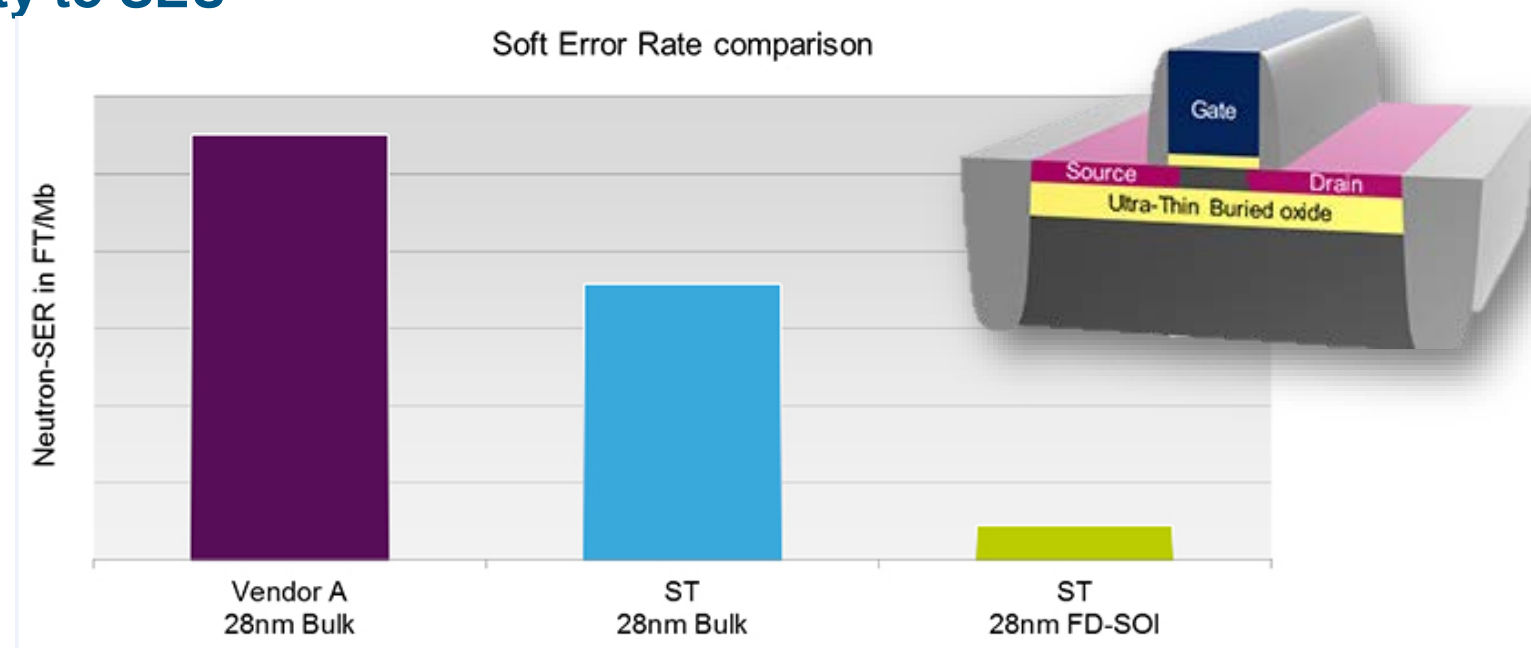- V&T Monitor
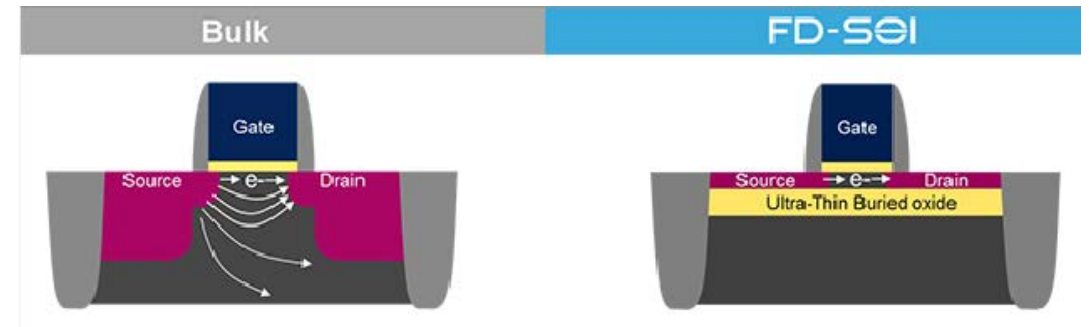- Error Mgmt
- Boot SpW
- Security

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STM 28nm FDSOI Technology

- Intrinsically **immune to Latch-up**
- Reduced pitch size providing **good dose tolerance**
- **Very good immunity to SEU**
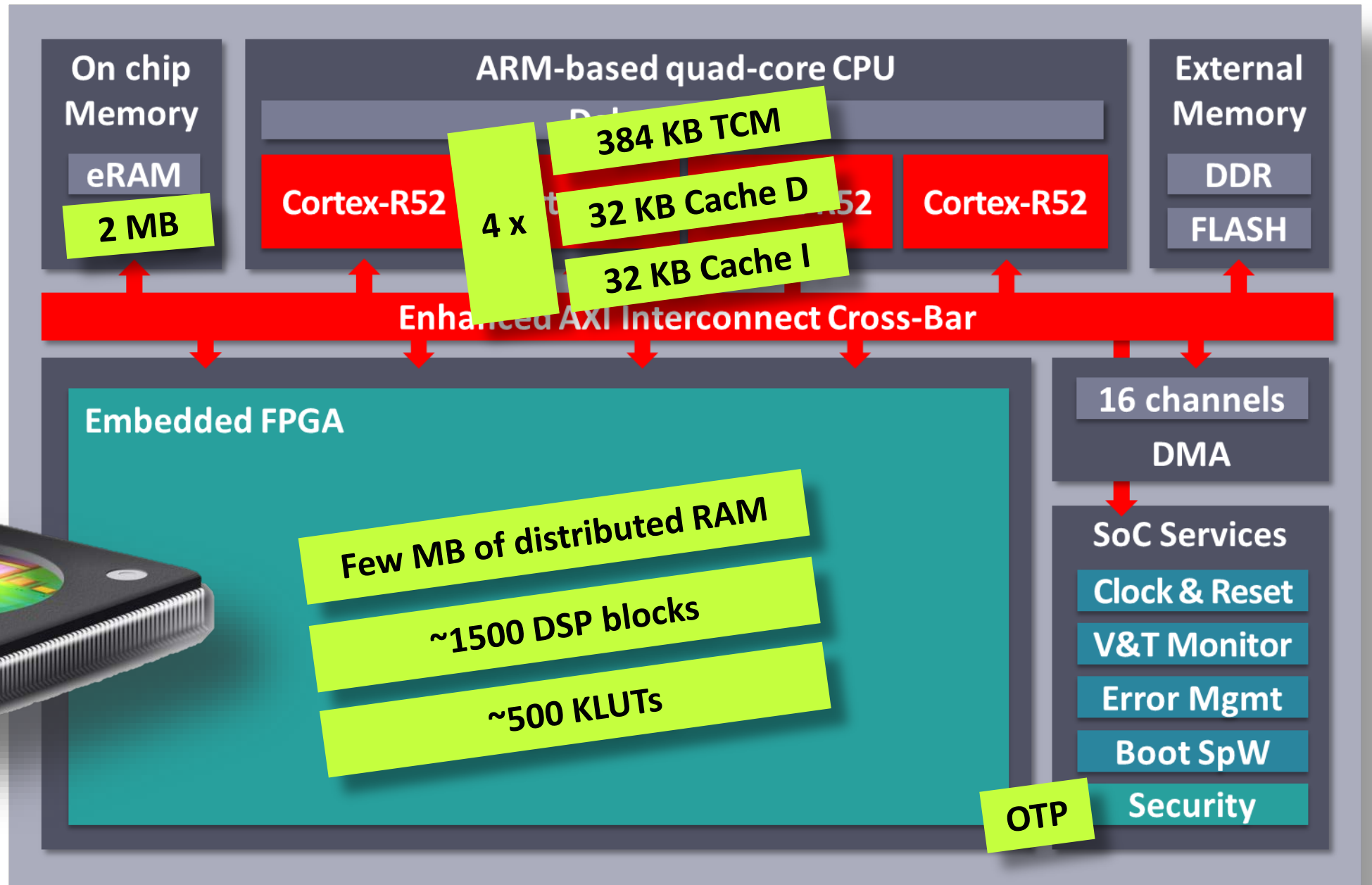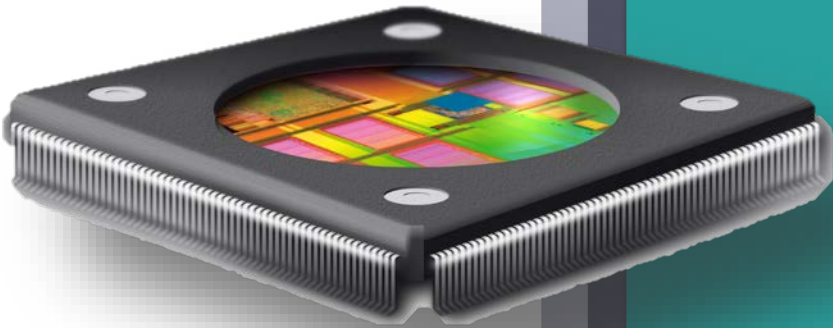

Soft Error Rate comparison

- 28nm FDSOI is combined with **RHBD solutions** such as Hardened DFF, ECC on memories or Embedded Configuration Memory Integrity Check (CMIC) for the embedded FPGA
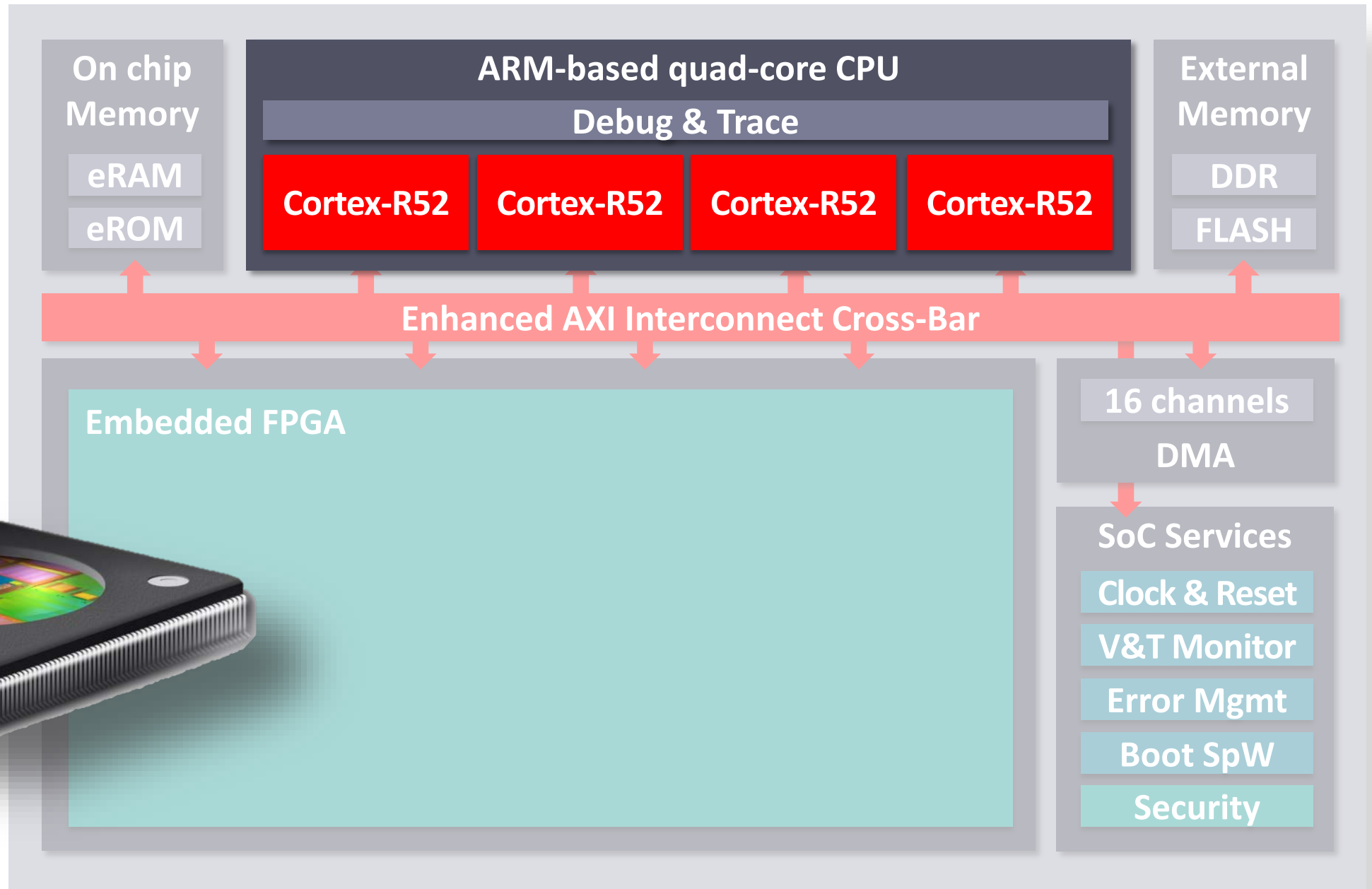
28 nm → Moore's Law is (as usual) still on our side

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Memories & Sizes

Some sizes to be consolidated during detailed design step

On chip Memory

eRAM

2 MB

ARM-based quad-core CPU

384 KB TCM

Cortex-R52

4 x

32 KB Cache D

Cortex-R52

Cortex-R52

32 KB Cache I

Enhanced AXI Interconnect Cross-Bar

External Memory

DDR

FLASH

Embedded FPGA

Few MB of distributed RAM

~1500 DSP blocks

~500 KLUTs

16 channels

DMA

SoC Services

Clock & Reset

V&T Monitor

Error Mgmt

Boot SpW

OTP

Security

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Features

On chip Memory
- eRAM
- eROM

ARM-based quad-core CPU

Debug & Trace

| Cortex-R52 | Cortex-R52 | Cortex-R52 | Cortex-R52 |

External Memory
- DDR
- FLASH

Enhanced AXI Interconnect Cross-Bar

Embedded FPGA

16 channels

DMA

SoC Services
- Clock & Reset
- V&T Monitor
- Error Mgmt
- Boot SpW
- Security

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Why looking at ARM ?

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ARM technology selection

Cortex-A

Highest performance

Optimized for rich

operating systems

Cortex-R

Fast response

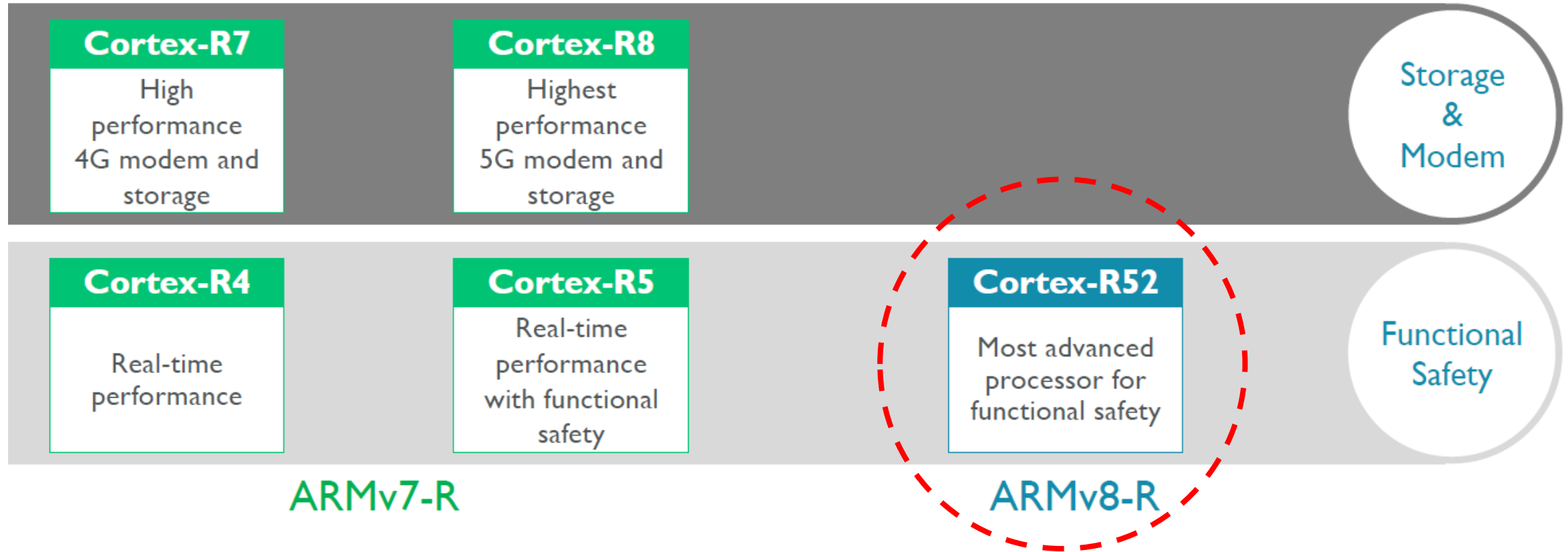Optimized for high-

performance, hard real-

time applications

Cortex-M

Smallest/lowest power

Optimized for discrete

processing and

microcontroller

ARM Cortex-R family

Cortex-R7	Cortex-R8		Storage & Modem
High performance 4G modem and storage	Highest performance 5G modem and storage		

Cortex-R4	Cortex-R5	Cortex-R52	Functional Safety
Real-time performance	Real-time performance with functional safety	Most advanced processor for functional safety	

ARMv7-R   ARMv8-R

Cortex-R52

High performance processing

- 2.2 DMIPS/MHz @ 600 MHz
- FPU Single and Double Precision
- Advanced SIMD co-processing NEON

Improved MPU

- 14x faster context switch than Cortex-R5
- Hard real-time determinism

Safety features dedicated to **random errors**

- ECC protected memory
- Software BIST libraries
- Level 2 MPU with new privilege level

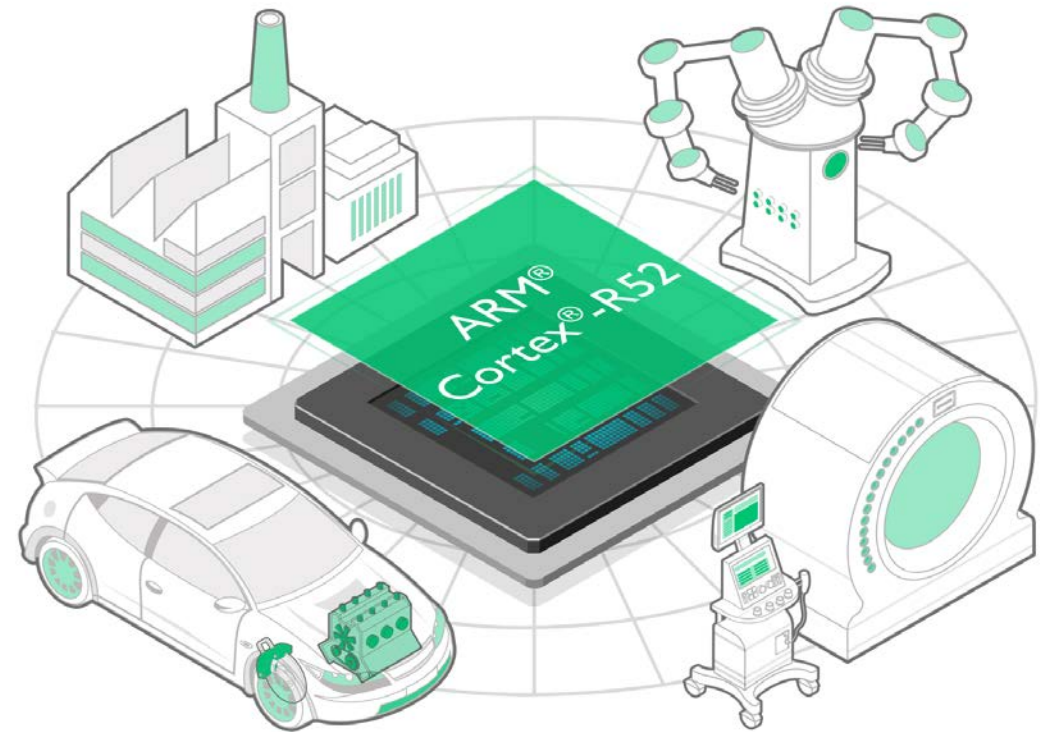Fully integrated **Generic Interrupt Controller** supporting complex priority-based interrupt handling
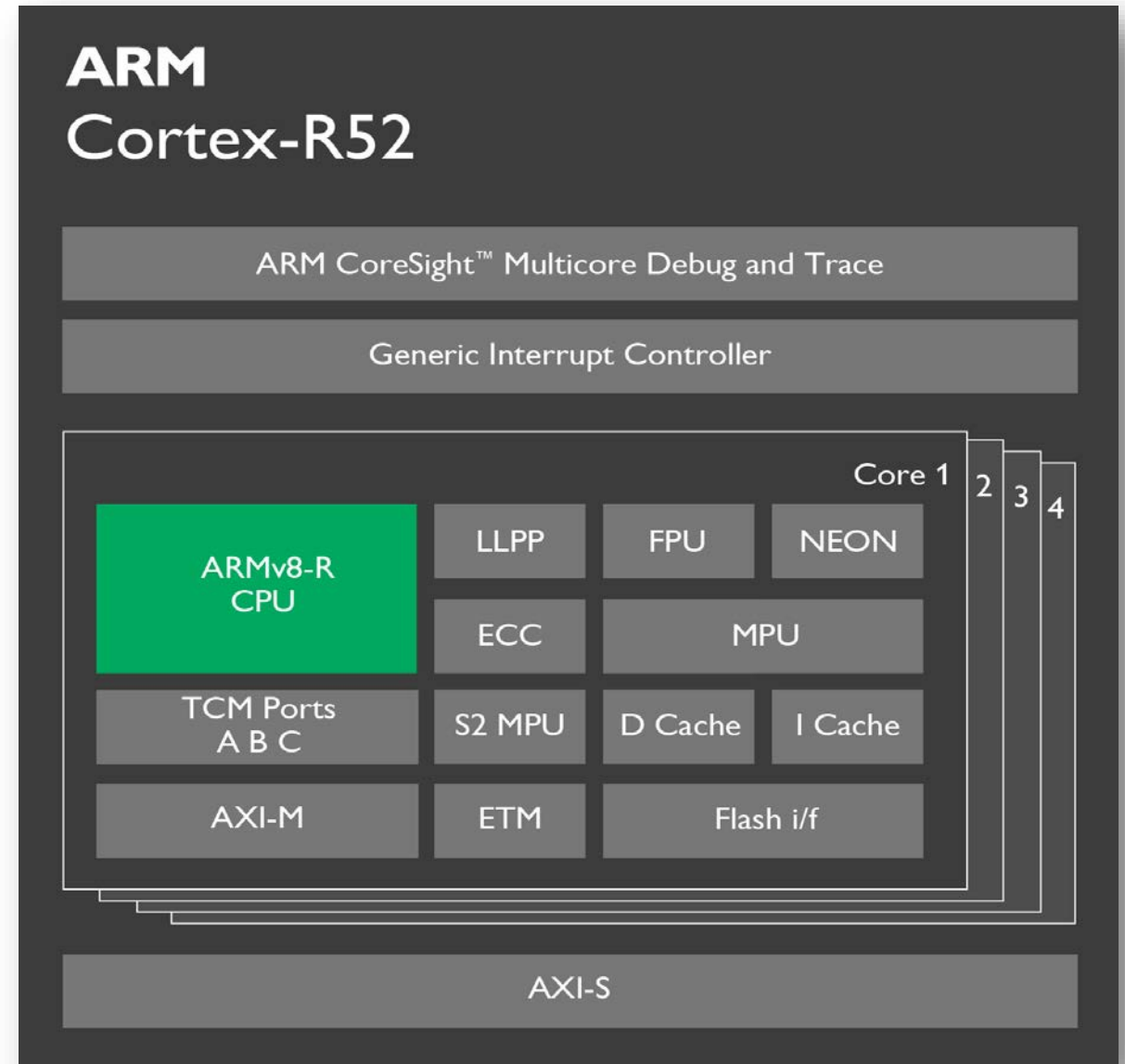
Cortex-R52

- ARM's **most advanced** processor for **safety**

- Simplifies **integration of software** in complex safety systems

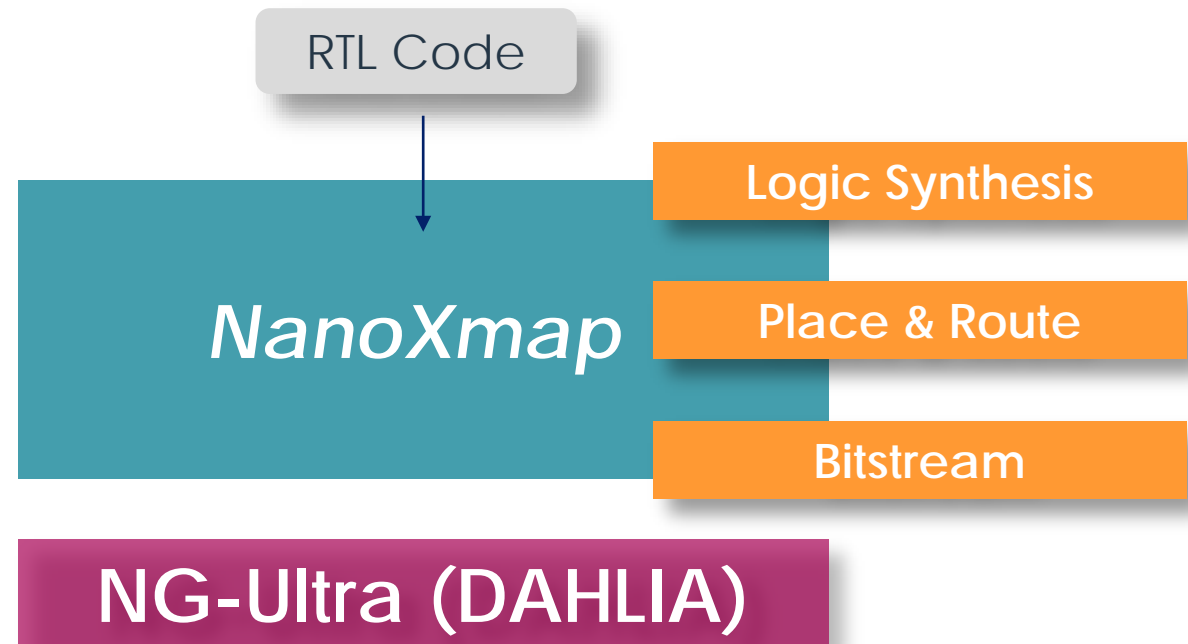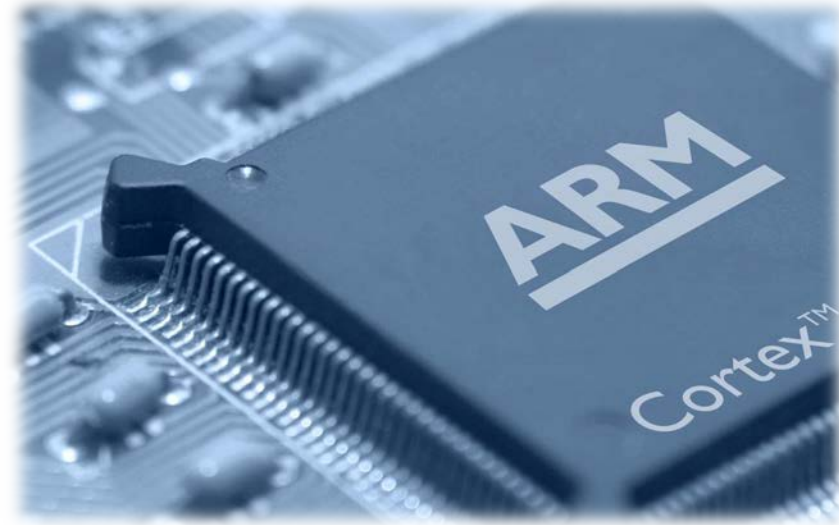- Optimized for **Time and Space Partitioning**

NG-Ultra Ecosystem

Around the Processing
- ARM ecosystem
- SW Development tools
- Hypervisor
- Simulator
- …

Around the FPGA
- NanoXmap tools cover from RTL synthesis, P&R up to bitstream generation
- …

RTL Code

NanoXmap

Logic Synthesis

Place & Route

Bitstream

NG-Ultra (DAHLIA)

DAHLIA

Example of Use Cases

- **Platform OBC & Integrated Avionics**

- **Payload OBC**

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Example of Use Cases

- **Platform OBC & Integrated Avionics**

DAHLIA / NG-Ultra will make possible several levels of avionics integration

At spacecraft level, four HW+SW functional groups can be identified :
- Platform core avionics
- Mission data storage and payload interconnection
- Instrument management and data processing (ICU)
- Spacecraft housekeeping and commanding discrete I/O acquisitions (RTUs)

Integration levels vs SAVOIR
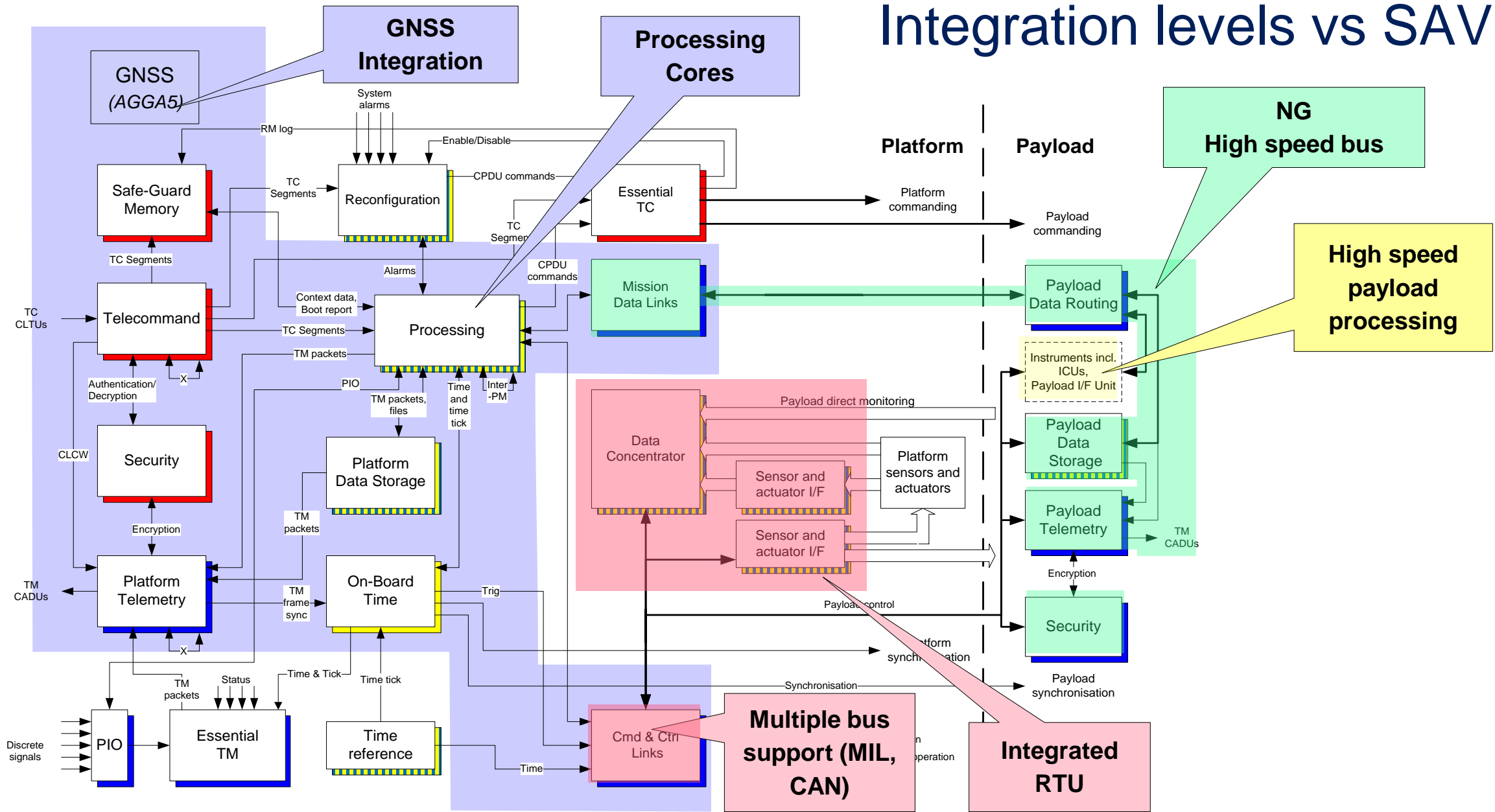
Example of Use Cases

- **Payload OBC**

Payload OBC typically requires:
- High performance computation capability for execution of mission/instrument control and/or specific algorithms
- High data rate communication link for acquisition of specific sensor data and/or payload data
- Low data rate for command and control function
- Efficient HW implementation of very customized specific functions and interfaces

DAHLIA covers all of these requirements

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Conclusion

DAHLIA H2020 & NG-Ultra will offer to European Space Community a unique **rad-hard** high performance quad-core **ARM** SoC in 28nm FDSOI technology, with **huge eFPGA** for flexibility.

It will enable development of products for multiple platform and payload Space applications, enabling the convergence with terrestrial applications benefiting from the strong **ARM ecosystem**.

Success/adoption of the **DAHLIA / NG-Ultra** will predominantly depend on the quality of the **tools** that will be available for any development with such component.
Indeed **HW/SW** is the keypoint for such new component.

DAHLIA / NG-Ultra is a key for future **European Strategic Non-Dependence** & for **all of us**

dahlia-h2020.eu

More details on DAHLIA are available on the project website

Thank you

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