



Olympe: a NG-Ultra based processing board demonstrator

ESA EDHPC

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DEFENCE AND SPACE

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AIRBUS

Space Electronics key figures & facts



450
France workforce

> 1200 boards /y
> 150 unit /y

150 M€
Revenues
40% export



Space Agencies



Start-up,
medium & big
size companies



Institutions
and Defence
Agencies



Satellite
Operators

Governments, institutional and enterprises from
multiple areas/ fields



1st



Worldwide Leader

> 60 M€ Export
Order Intake in 2022

Spacecraft Electronic Unit Supplier



Elancourt

Toulouse

Our Ambition



Be worldwide Electronics and Sensors / Actuators
reference for Space



Master New Space & Conventional Space solutions
from design and technologies, up to manufacturing
& test processes

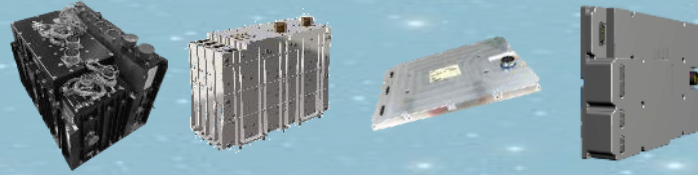


Pioneer and qualify space technologies for future
spacecrafts, launchers & space systems



Be attractive for talents by offering key
competences acquisition and efficient collective
knowledge management

Space Electronics reliable & large unit portfolio



Electric Propulsion



Power Distribution & Regulation



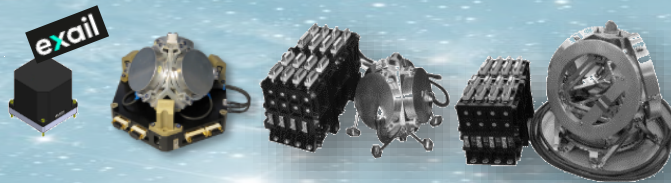
On-board Computers



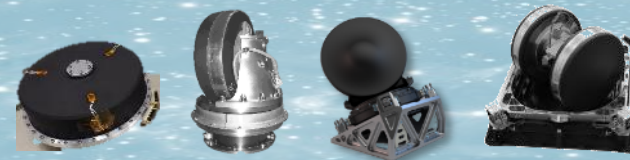
Security



Payload Data Handling



Fiber Optic Gyroscopes



Control Moment Gyroscope

**Power &
Propulsion Units**

**Platform & Payload
Processing Units**

**Sensors &
Actuators**

www.airbus.com/en/products-services/space/equipment

General Support Technology Programme

- From innovation to engineering steps towards future mission adoption

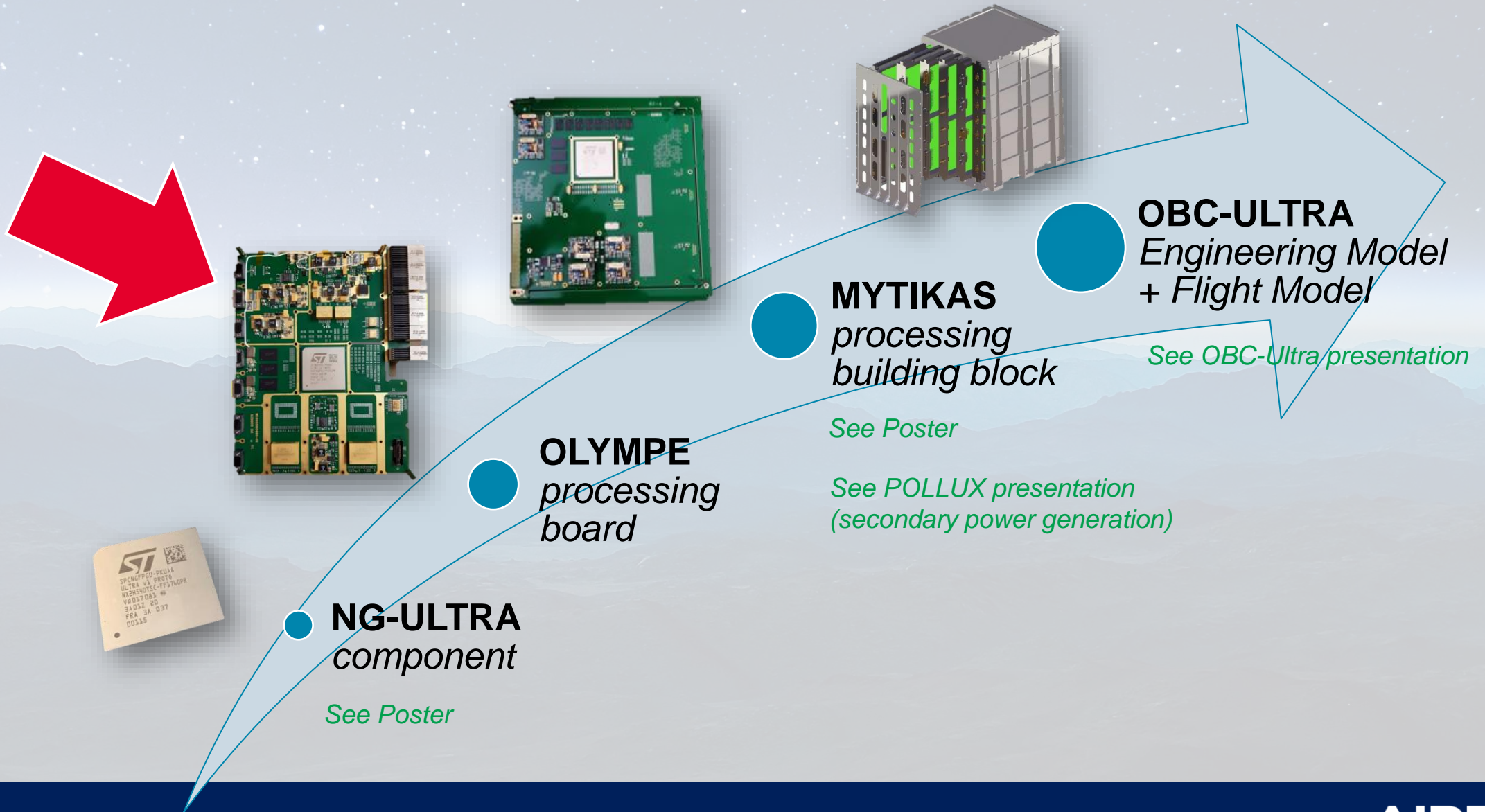
Main objectives

- High-speed links demonstration
- High data rate access to DDR and Flash NAND memories through FPGA
- PS/PL interface performance
- Multi-core application compatibility
- Typical platform application

Perspectives

- OBC-Ultra: NG-Ultra based On-Board Computer
- Mass Memory equipment
- Instrument Control Unit

An 8-year journey from chip to On Board Computer



Demonstrator boards:

➤ Olympe board:

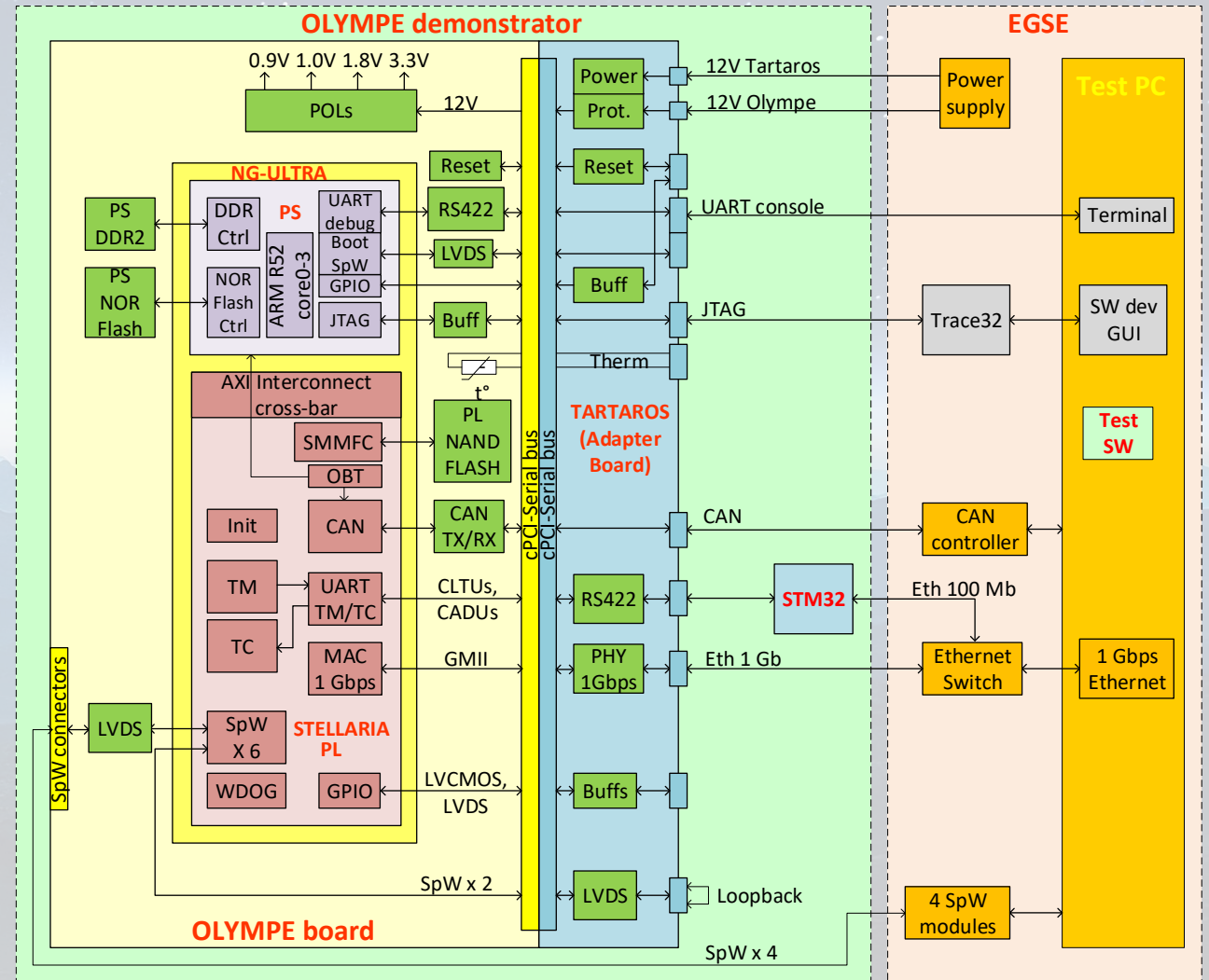
- NG-Ultra-based processing board

➤ Tartaros board:

- Backpane board

EGSE (Electrical Ground Support Equipment):

- PC with STM32-based board
- Send or receive data from the different interfaces following the demo phase
- Displays the data rate



NG-Ultra



Memory:

- 1 GB DDR2
- 16GB Flash NOR: Bootloader, bitstream and ASW storage
- 32 GB Flash NAND: processed data storage

Communication interfaces:

- 6x SPW (100 Mbps)
- cPCI-serial connector

ADHA cPCI-serial connector:

- Power supply
- 2 x CAN (1 Mbps)
- 1 x Ethernet (1 Gbps)



Demonstration principles

- **EGSE sends TCs to the Olympe demonstrator**
- **Olympe initiates a demonstration phase with specific actions:**
 - Data reception from EGSE on multiple links (SPW, Ethernet and CAN)
 - Data processing
 - Internal operation (Flash NAND storage, PS/PL communications)
 - Data sending to EGSE
- **EGSE displays the phase and the Olympe system behaviour all along the demonstration phases:**
 - Link data rate
 - HouseKeeping TM
 - Received images

Demonstration phase

Processing cores status

OLYMPE DEMONSTRATION - NG Ultra v2

AIRBUS

HOME

PHASE 1 : Sending packets

SpaceWire	N°1	N°2	N°3	N°4
Status	Sending	Sending	Sending	Sending

Documentation | Start phase 2

HOUSEKEEPING :

	Received	Transmitted	Default link speed
CAN	33762000	17893860	1 Mbit/second
SpaceWire N°1	337620000	263343600	100 Mbit/second
SpaceWire N°2	347748600	317362800	100 Mbit/second
SpaceWire N°3	540192000	506767620	100 Mbit/second
SpaceWire N°4	759645000	810288000	100 Mbit/second
SpaceWire N°5	945336000	979098000	100 Mbit/second
SpaceWire N°6	1046622000	1131027000	100 Mbit/second
Ethernet	1080384000	-	1 Gbit/second

Images received : 2
No on-going compression on image

Identifier	Remaining bytes to compress	TM packets transmitted
Image N°0	1731315360	1907553000
Image N°1	1731315360	135048000

Core N°0 Waiting
Core N°1 Waiting
Core N°2 Waiting

Cores running at 600MHz

SETTINGS

v1.0.0

Phase description

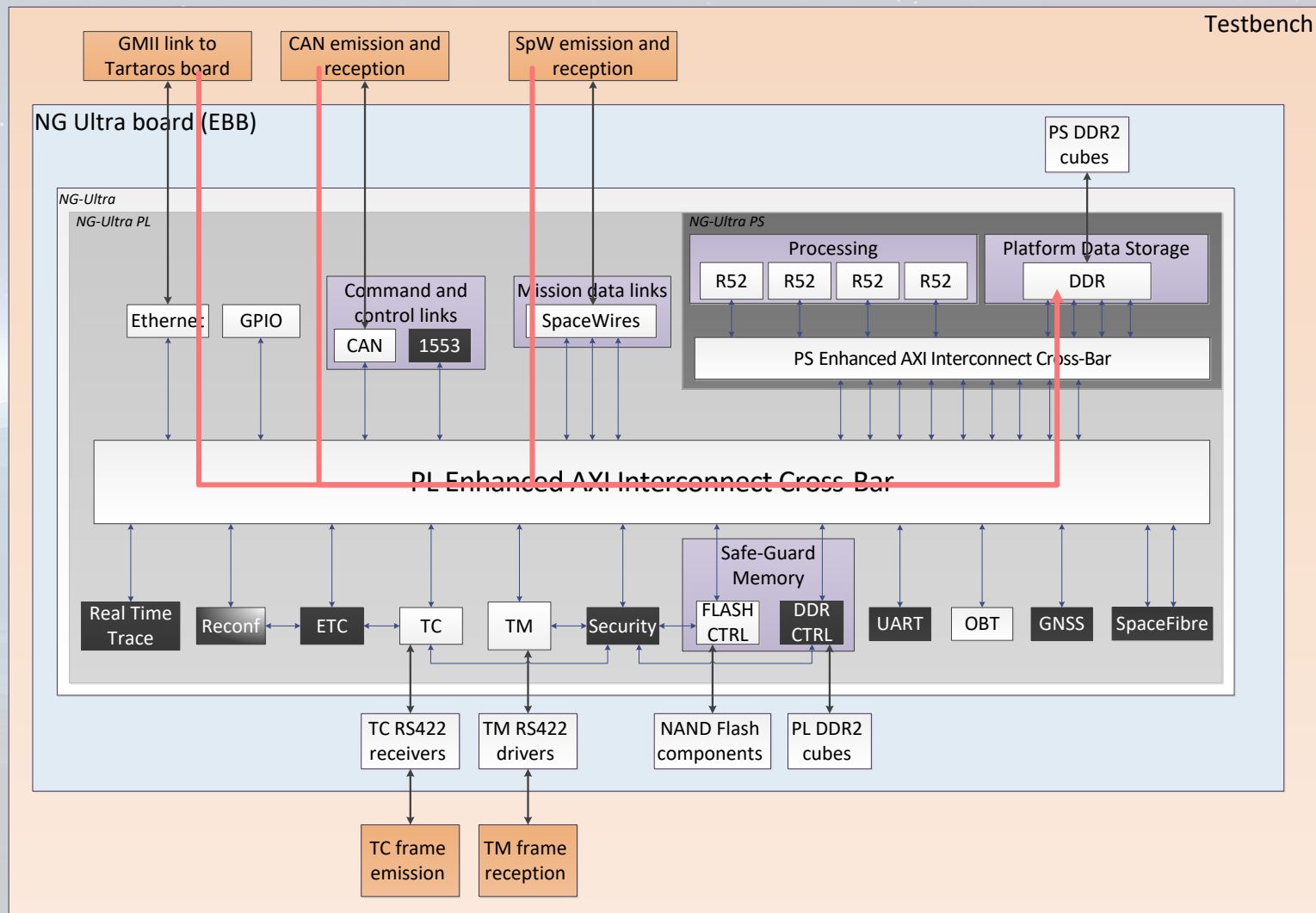
Interface data rate informations

Description

- Data sent to Olympe via:
 - 6 x 100 Mbps SPW links
 - 1 x 1 Gbps Ethernet link
 - 1 x 1 Mbps CAN link
- DDR2 storage

Focus:

- High-speed links
- DDR2 access from FPGA at a high data rate

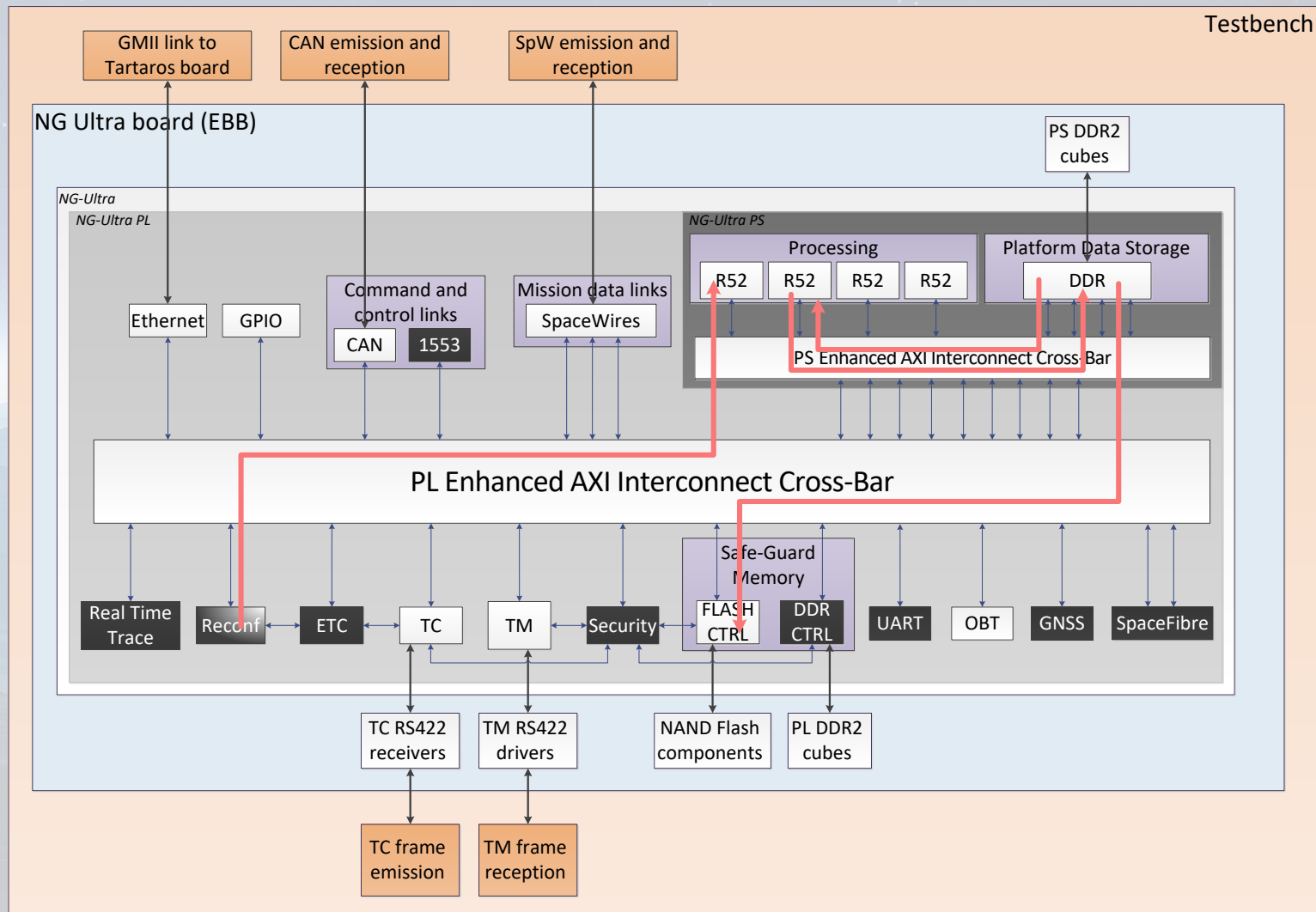


Description

- ASW operations:
 - Reading data in DDR2
 - Processing data
 - Writing back data in DDR2
 - Writing a part of the data in Flash NAND

Focus

- DDR2 access from ASW
- Flash NAND writing from ASW

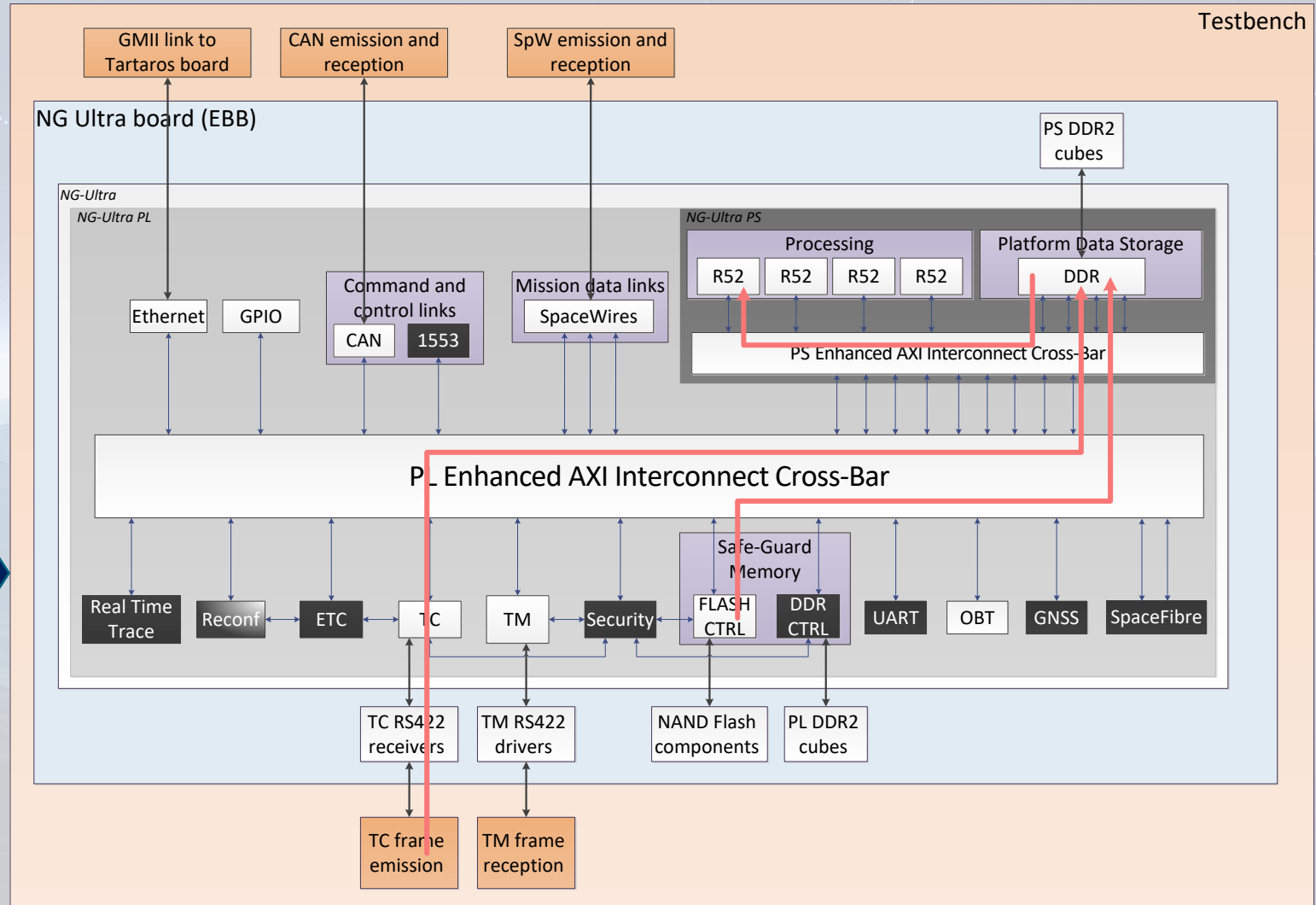


Description

- ASW operations:
 - Flash NAND data retrieving
 - TM sending programming
 - Previously received data

Focus

- Platform application (TM/TC) on one core
- Interface handled on other cores
- Flash NAND reading from ASW

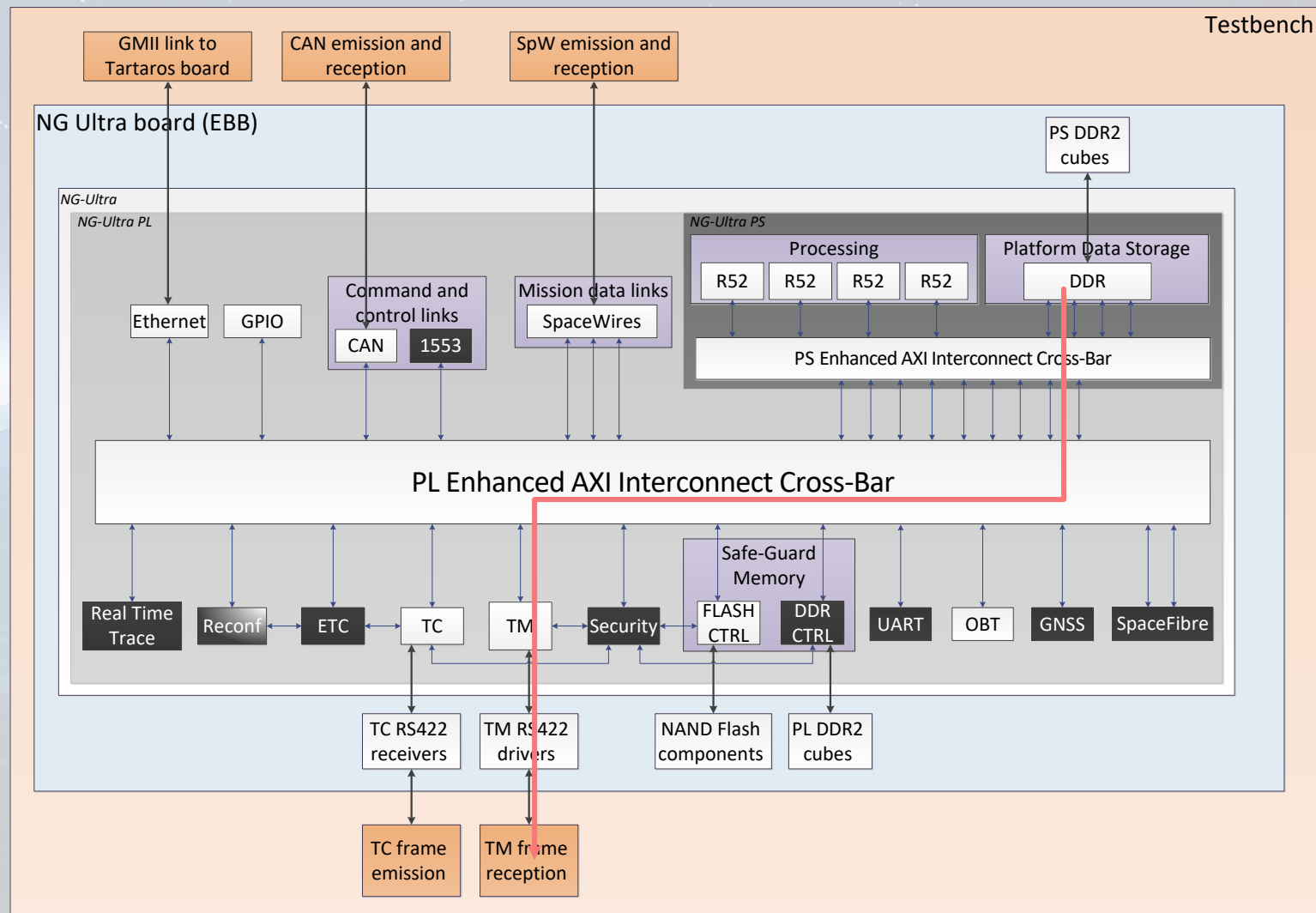


Description

- TM sending data back to EGSE
- Watchdog expiration alarm TM

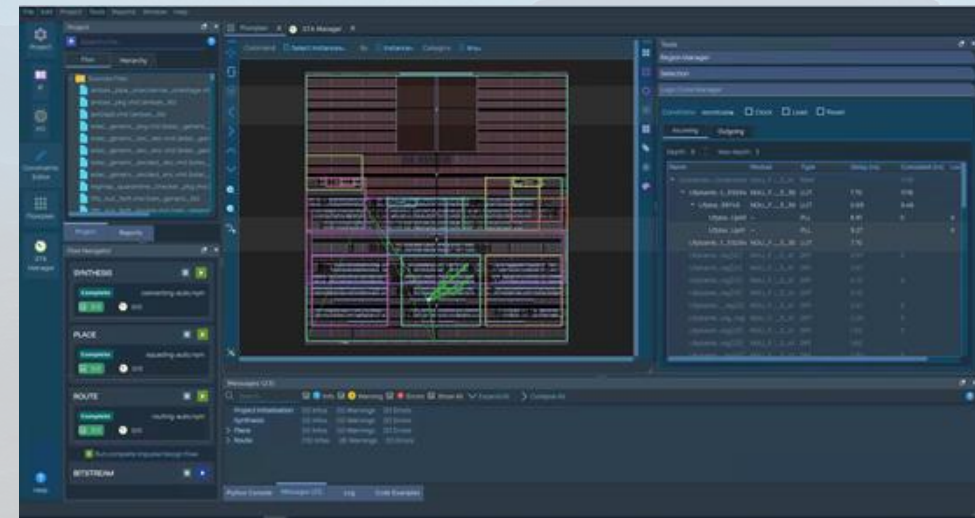
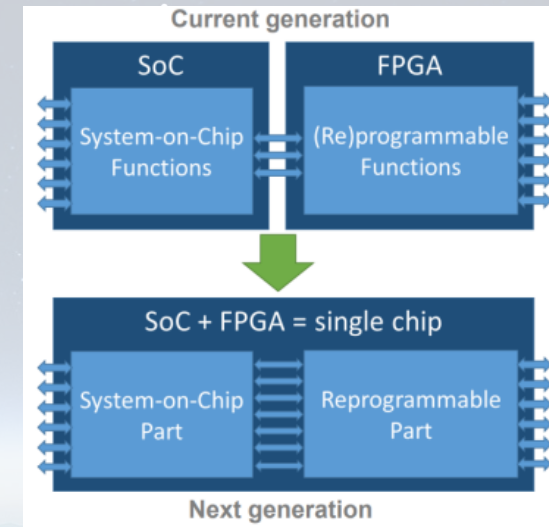
Focus

- High speed communication between PS and PL part
- TM transmission



- **NG-Ultra report**
- **Re-usable block designs**
- **NG-Ultra within an electronic design**

- **SoC + FPGA**
- **HW/SW architecture**
 - Shared DDR access between PL and PS part
 - PL interconnect design
 - Interrupt management
- **Airbus / NanoXplore collaboration**
 - Impulse: NX tool for FPGA design
 - Synthesis, place and route
 - Consolidation
 - Dedicated features
- **Airbus benefits**
 - FPGA fabric design comprehension
 - Filling rate and frequency improvement
 - Specific workflow

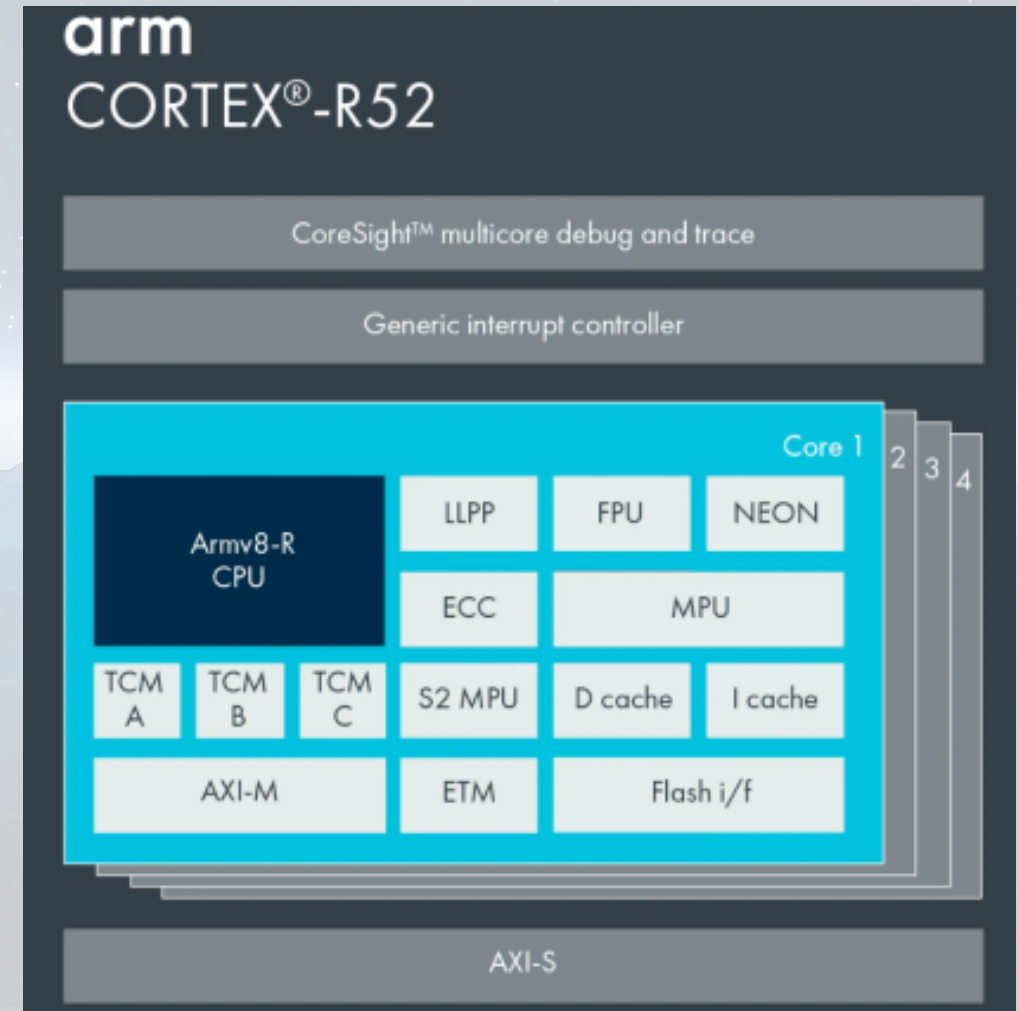


ASW execution environment

- 4 ARM Cortex-R52 cores
- DDR2

Used ARM specific functionalities

- Tightly Coupled Memory (TCM)
- Data and Instruction cache
- Memory Protection Unit (MPU)
- General Interrupt Controller (GIC)
- Coresight debug and trace



Drivers

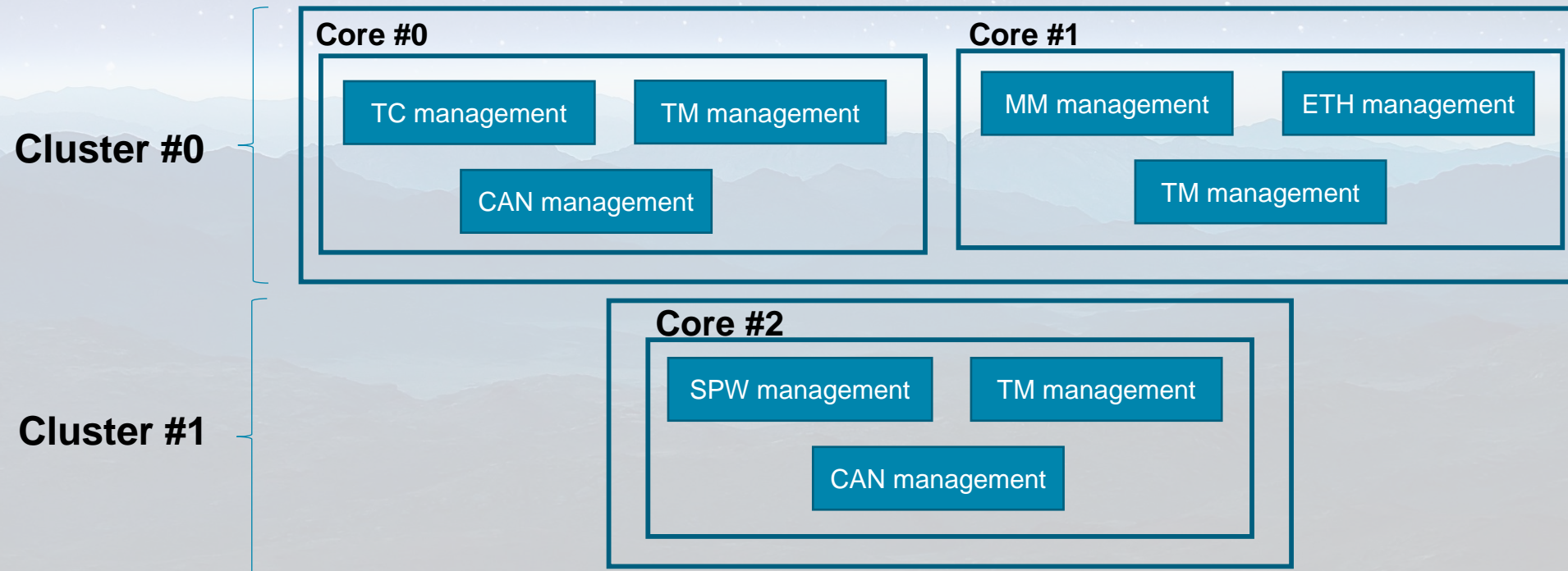
- **NanoXplore SDK**
 - Main elements of the NG-Ultra PS part
 - DDR controller for DDR2 and DDR4 usage
- **Olympe specific drivers**
 - MMFC, OBT, Reconf, Ethernet, Spw, ...

Bootloaders

- **BL0**
 - Load and start BL1 execution
- **BL1**
 - DAHLIA design and development
 - Load and start ASW execution in DDR memory

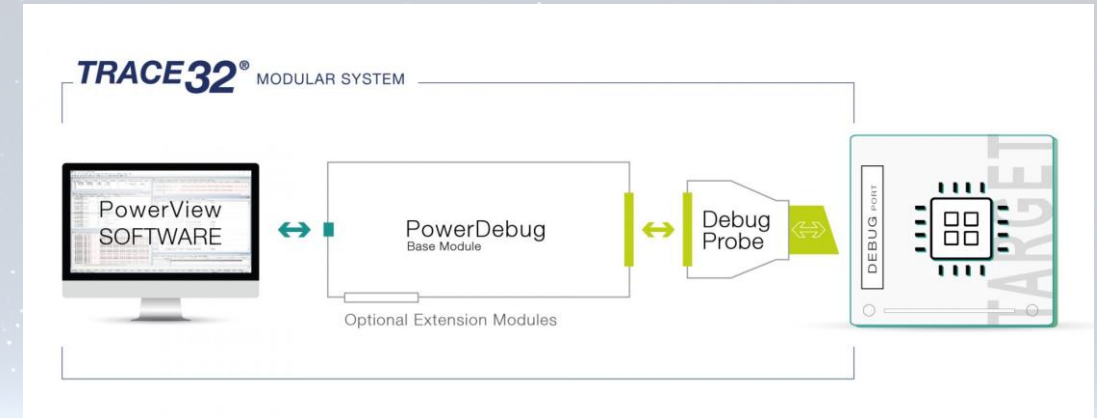
RTEMS

- Open source RTOS
- Multi-tasking and IPC features
- Used on current Airbus equipment units (OBC, MM, ...)
- Support of NG-Ultra multi-core (AMP)



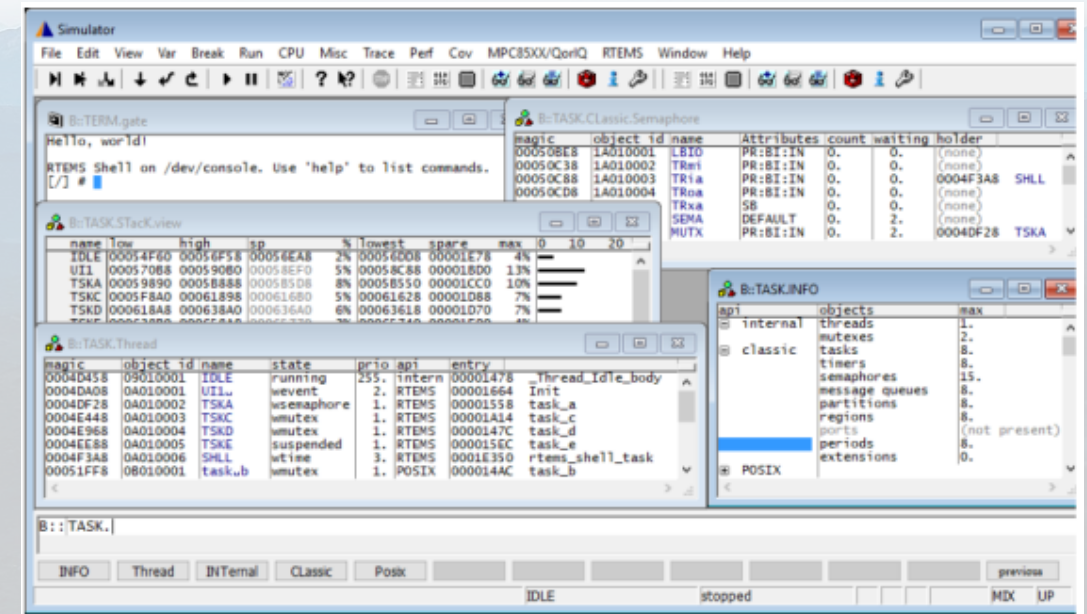
Lauterbach debugging probe

- Relies on ARM Coresight debug and trace features
- Trace32 Software:
 - Basic debug features
 - Scripting language
 - NG-Ultra support
 - RTEMS support
 - Parallel and serial trace



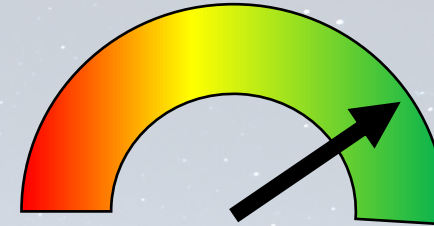
Main tool through different steps:

- FPGA integration
- Drivers integration
- Multi-task ASW debugging
- Multi-core ASW debugging



OSCAR MK4

- Current Airbus OBC generation
- Based on a SCOC3 SoC
- Used in more than 15 LEO satellites

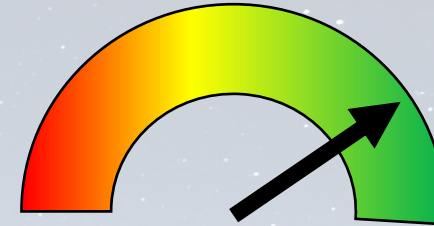


Data-rate link comparison:

Link	OSCAR MK4	OLYMPE	Comments
TC	64 kbps	10 Mbps	
TM	5 Mbps	10 Mbps	Total data rate
SPW	64 Mbps (x7)	64 Mbps (x6)	
CAN	N/A	1 Mbps	Total data rate
Ethernet	N/A	200 Mbps (theoretical)	TFTP protocol
1553	700 kbps	N/A	

Olympe

- **Improved TM/TC data rate**
- **Similar data rate on multiple SPW links**
- **New interfaces implementation:**
 - 1 Mbps CAN
 - 200 Mbps Ethernet
- **PL filling rate: 40 %**
 - Possibility for other IP implementation/integration



- **Harnessing NG-Ultra environment on multiple topics**
 - Electronic design, FPGA and SW part
- **Running a typical application platform on a NG-Ultra based system**
 - TM/TC
 - High-speed link: SPW (x6), Ethernet, CAN
 - Data processing
- **Strategic building blocks for upcoming Airbus product line**
 - OBC-Ultra
 - Mass Memory
 - ICU

Thank you

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