DAHLIA, VERY HIGH PERFORMANCE MICROPROCESSOR FOR SPACE APPLICATIONS

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Project website & contact : dahlia-h2020.eu

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1. ABSTRACT

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

DAHLIA is a rad-hard ARM-based System on Chip implemented in 28nm FDSOI technology dedicated to both platform and payload applications.

This chip is designed to boost competitiveness and ensure strategic non dependence of future European Space equipment.

DAHLIA is the European answer to the ARM-based High Performance Spaceflight Computing (HPSC) development commissioned by NASA under the frame of its Game Changing Development Program.

2. CONTEXT & OBJECTIVES

To meet future processing and competition needs, STMicroelectronics, Airbus Defence and Space, Thales Alenia Space, Integrated Systems Development and NanoXplore are developing a novel Very High Performance microprocessor System on Chip (SoC) based on STM European 28nm FDSOI technology with multi-core ARM processors for real-time applications, eFPGA for flexibility and key European IPs, enabling faster and cost-efficient development of products for multiple space application domains, and enabling high integration capability through the functional merging of multiple companion FPGAs & ASICs within a single SoC.

The performance is expected to be 20 to 40 times the performance of the existing SoC for space and more than 2 times the performance of the future quad core LEON4 chip. This performance level, combined with a large set of integrated peripherals including dedicated on-chip functions for GNSS, TM and TC support, will enable key space applications to be executed within the same microprocessor significantly reducing cost and mass and boosting competitiveness of future European space equipment.

With the highest cumulative number of European satellites and electronics equipment successfully operating in orbit, Airbus Defence and Space and Thales Alenia Space have joined efforts to ensure the maximum relevance of the DAHLIA SoC for its future use by the whole European Space community.

3. CONSORTIUM

The industrial organization of the DAHLIA project involves 7 partners from 4 countries constituting the main actors of European Space industry.

- STM *France*, coordinator
- Airbus Defence and Space *Germany & France*
- Thales Alenia Space *Italy & France*
- Integrated Systems Development *Greece*
- NanoXplore *France*

Figure 1. Seven partners from four countries involving the main actors of European Space industry

4. DAHLIA KEY FEATURES

DAHLIA is a quad-core ARM-based System-on-Chip dedicated to future platform and payload applications to be executed in a single chip.

It contains the following main features:

- 4 x ARM Cortex-R52 with Debug & Trace
- SoC Services such as Clock & Reset management, Timers & Watchdog, Temperature & Voltage sensors, Secure Boot
- CCSDS On Board Time
- On-Chip Memories all protected by ECC
- External Memory interface supporting Non Volatile (Flash) and Volatile (DDR) memories with ECC
- Multi-channel DMA controller
- CCSDS TM & TC
- GNSS
- Wide range of communication links: SpW, 1553, UART, CAN, SPI, HSSL…
- Embedded FPGA for flexibility

All functions are connected together through an optimized network interconnect matrix based on the AMBA AXI protocol.

The Figure 2 exposes a block diagram of DAHLIA.

5. TECHNOLOGY

DAHLIA will target the STM 28nm FDSOI (Fully Depleted Silicon On Insulator) technology.

This technology has been selected to bring to DAHLIA both high level of integration capability and a very good tolerance to radiations.

The key features of this European technology are:

- Intrinsic immunity to Latch-up
- Reduced pitch size so good dose tolerance
- Very good immunity to SEU better than classical bulk technologies

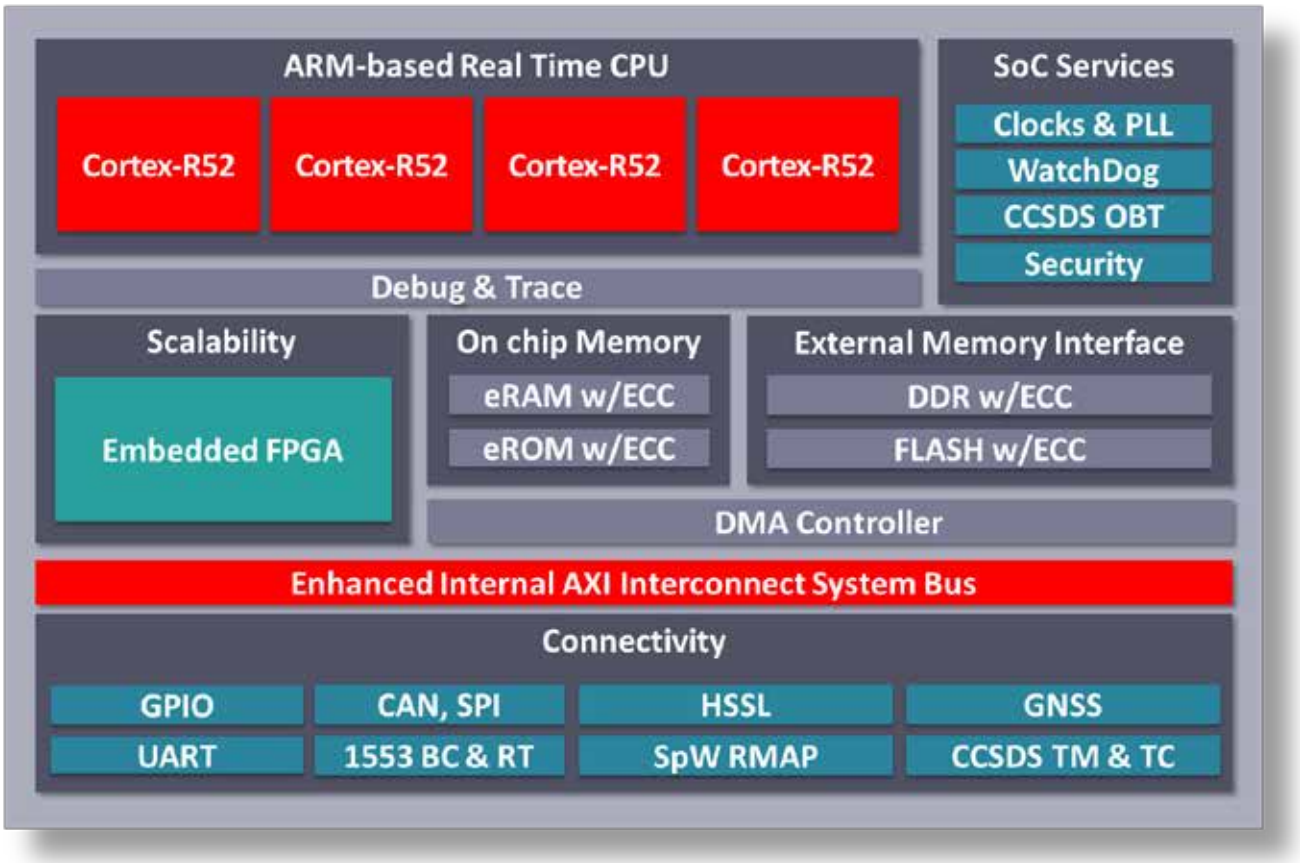

Figure 2. DAHLIA Key Features

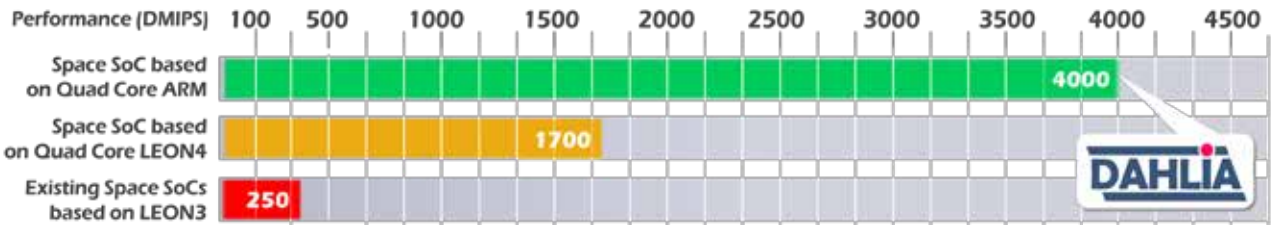

Figure 3. DAHLIA Performances Summary

6. ARM SELECTION

DAHLIA quad-core is based on the ARM Cortex-R52 processing core.

ARM is a European company, based in Cambridge (UK) that proposes different processing IP cores named Cortex for integration into silicon. To summarize the ARM offer, three families of Cortex processing cores are available, named A, R and M. Among the three different families of ARM Cortex processors available, we have selected for DAHLIA the Cortex-R52.

The Cortex-R Series offers performance for real-time applications. These processors have been developed for deeply embedded real-time applications with interesting features dedicated to safety such as ECC (Error Correcting Code) on the internal busses, or the possibility to work in a Lock-Step configuration.

Within the Cortex-R family, the Cortex-R52 represents ARM's most advanced processor for safety. Its design is dedicated for safety applications including automotive, industrial and healthcare, and its safety features represents direct advantages in space environment. Last but not least, it simplifies integration of software in complex safety systems, including optimized features for Time and Space Partitioning (TSP).

The Cortex-R52 core embeds many safety features dedicated to random errors that are of interest for Space applications:

- ECC protected memory within the core
- Software BIST libraries
- Error management
- Level 2 MPU
- New privilege level
- …

Moreover, this ARM core is based on the ARMv8-R architecture which offers the following key features:

- Introduction of a new privilege level
- Simplified isolation of tasks and possibility of sandboxes creation protected from other SW
- Fast real-time switch between tasks and sandboxes
- Simplified integration of complex SW from multiple sources

As a summary, the Cortex-R52 simplifies real-time SW isolation of tasks and is optimized for TSP, which is one of the main trends to improve integration in our future Space equipment.

Considering the Cortex-R52 performance and the frequency achievable on the 28 nm technology, we can estimate the overall DAHLIA performance beyond 4000 DMIPS. This is summarized in Figure 3.

7. CONCLUSION

DAHLIA project covers the development of a rad-hard high performance quad-core ARM SoC in 28nm FDSOI technology, with eFPGA for flexibility and key IPs.

It is developed through an H2020 project by a European consortium involving the main actors of the Space industry.

DAHLIA key points can be summarized as a powerful combination of innovative technology adapted for Space, optimized to support time and space partitioning for centralized avionics and designed to face the new challenges of Space such as mega-constellations

It will enable faster and cost-efficient development of products for multiple space applications.

Beyond Space applications, DAHLIA will enable the convergence with terrestrial applications benefiting from the strong ARM ecosystem.

DAHLIA brings to reality what was still a dream few years ago, addressing the new expectations and new mind-set of Space industry.

More information on DAHLIA project, consortium and publications are available on dahlia-h2020.eu website, including also the project contact point.