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Next Generation ATCA Control Infrastructure for the CMS Phase-2 Upgrades

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A next generation control infrastructure to be used in Advanced TCA (ATCA) blades at CMS experiment is being designed and tested. Several ATCA systems are being prepared for the High-Luminosity LHC (HL-LHC) and will be installed at CMS during technical stops. The next generation control infrastructure will provide all the necessary hardware, firmware and software required in these systems, decreasing development time. It includes an Intelligent Platform Management Controller (IPMC), a Module Management Controller (MMC) and an Embedded Linux Mezzanine (ELM) processing card. The chosen architectures, their testability, integration and the advantages over existing solutions will be discussed.

Summary

Several institutes are presently designing hardware, firmware and software that will be used in CMS for data taking during the High Luminosity LHC (HL-LHC) physics runs, starting in 2025. Most of the architectural choices have been focused in designing Advanced TCA (ATCA) blades and, as part of the PICMG 3.x standard, each blade needs to implement a set of control and management functionalities.

The next generation control infrastructure presented includes three different hardware systems that together implement the PICMG 3.x standard, provide additional features, flexibility and decrease the time necessary to design and test an ATCA blade.

The implemented control infrastructure consists of:

- An Intelligent Platform Management Controller (IPMC) mezzanine: Designed to be the blade management controller, containing a low power Xilinx ZYNQ system-on-chip (SoC) FPGA running RTOS to handle time critical sensitive tasks. Open hardware and firmware allows extensive user customization by taking advantage of several general purpose inputs/inputs (GPIOs) available together with the ZYNQ's Programming Logic (PL). The mezzanine measures 82mm by 30mm and can be easily replaced.
- A Module Management Controller (MMC): Used to control and manage several individual sub modules in an ATCA blade. The blade IPMC will control one or more MMCs using I2C. An Atmel SAM4N Cortex-M4 microprocessor running RTOS handles critical tasks and alarms. A reference design is available to be implemented in a custom hardware layout.
- An Embedded Linux Mezzanine (ELM) processing card: Used as the primary blade on-board computer, featuring a high-end Xilinx ZYNQ SoC running Linux. It provides high speed ethernet access to the blade and all peripherals connected to the ELM. Eight multi-gigabit transceivers are also available for extended connectivity as well as several high performance GPIOs. Compatible Xilinx processing FPGAs (e.g. Virtex-7, Virtex Ultrascale) can exploit the ZYNQ architecture by using AXI chip-to-chip interface for a seamless integration inside the Xilinx ecosystem. The ELM mezzanine measures 84mm by 75mm and has been designed with upgradability in mind.

The talk will cover the architecture choices of the hardware modules, how they are being tested, their performance results, how they fit in the ATCA environment and their advantages over existing solutions.

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