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Taking advantage of the intercommunication features of IPMCs in ATCA CDAQ systems

António P. Rodrigues[a,*], Bruno Santos[a], Paulo F. Carvalho[a], Miguel Correia[a], Jorge Sousa[a], Carlos M.B. Correia[b], Bruno Gonçalves[a]

[a] Instituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico, Universidade de Lisboa, 1049-001 Lisboa, Portugal
[b] LibPhysUC, Departamento de Física da Universidade de Coimbra, 3004-516 Coimbra, Portugal

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ABSTRACT

The PCI Industrial Computer Manufacturers Group (PICMG) 3.x AdvancedTCA Base Specification and Intelligent Platform Management Interface (IPMI) standards specify a modular system for Control and Data Acquisition (CDAQ) where the boards can communicate through the Intelligent Platform Management Bus-0 (IPMB-0).

CDAQ systems applied to large physics experiments like ITER, are designed, among other features, for High-Availability (HA). A CDAQ system based on the PICMG 3.x AdvancedTCA Base Specification and IPMI standards grants these features. One of the key functions of the HA is the hot swapping possibility of the CDAQ system elements which is granted by those standards. An Advanced Telecommunications Computers Architecture (ATCA) CDAQ system can be designed implementing the Peripheral Component Interconnect Express (PCIe) standard communication protocol in their fabric lines. Despite the fact that this protocol has its own rules for hot swapping, defined as hot-plug, ATCA and PCIe standards are not entirely compatible in what concerns this aspect.

Instituto de Plasmas e Fusão Nuclear (IPFN) has developed and implemented a CDAQ system using the ATCA and PCIe standards.

This paper describes the software architecture and functions implemented in the microcontroller of the Intelligent Platform Management Controller (IPMC) of the ATCA boards in order to render those standards compatible in what concerns hot-swap and hot-plug processes as an example of the possibilities that can be achieved taking advantage of the intercommunication features of IPMCs through the Intelligent Platform Management Bus-0 (IPMB-0).

1. Introduction

The modular systems Advanced Telecommunications Computers Architecture (ATCA) [1,2] and the Peripheral Component Interconnect Express (PCIe) [3,4] have defined processes, in their standard specifications, that allow the insertion or removal of their boards/cards without the need to execute the power down or restart procedures. In both systems there are physical elements that enable the operator to signaling the system that he wants to insert/remove a system module. Using these elements the operator can inform the system control software that he wants to start a module insertion/removal process in the system. In the case of an ATCA system, this is a synchronized and sequential process between the operator and the software that runs in the Intelligent Platform Management Controller (IPMC) of the module and in the Shelf Manager Controller (ShMC) of the ATCA crate [2]. On the other hand, in the case of the PCIe system, this is as well a synchronized and sequential process but between the operator and the software that runs in the PCIe Host computer [4]. If the protocol established in each standard is followed during the insertion/removal process then it is possible to keep the overall system in a correct and coherent operation without the need of system power down or even of system restart. However, these processes, defined as hot-swap in the ATCA systems, and as hot-plug in the PCIe system, are different mechanisms not totally compatible in what concerns the execution of the hot insertion/removal functions of their modules.

Furthermore, an ATCA Control and Data Acquisition (CDAQ) system can be designed implementing the PCIe standard in its fabric interface [5]. This generates compatability issues in the board insertion/removal procedures in an ATCA crate with PCIe implementation. In the ATCA systems there are no signals between boards dedicated to the

* Corresponding author.
E-mail addresses: pinto@ipfn.tecnico.ulisboa.pt, pinto@ipfn.ist.utl.pt (A.P. Rodrigues).

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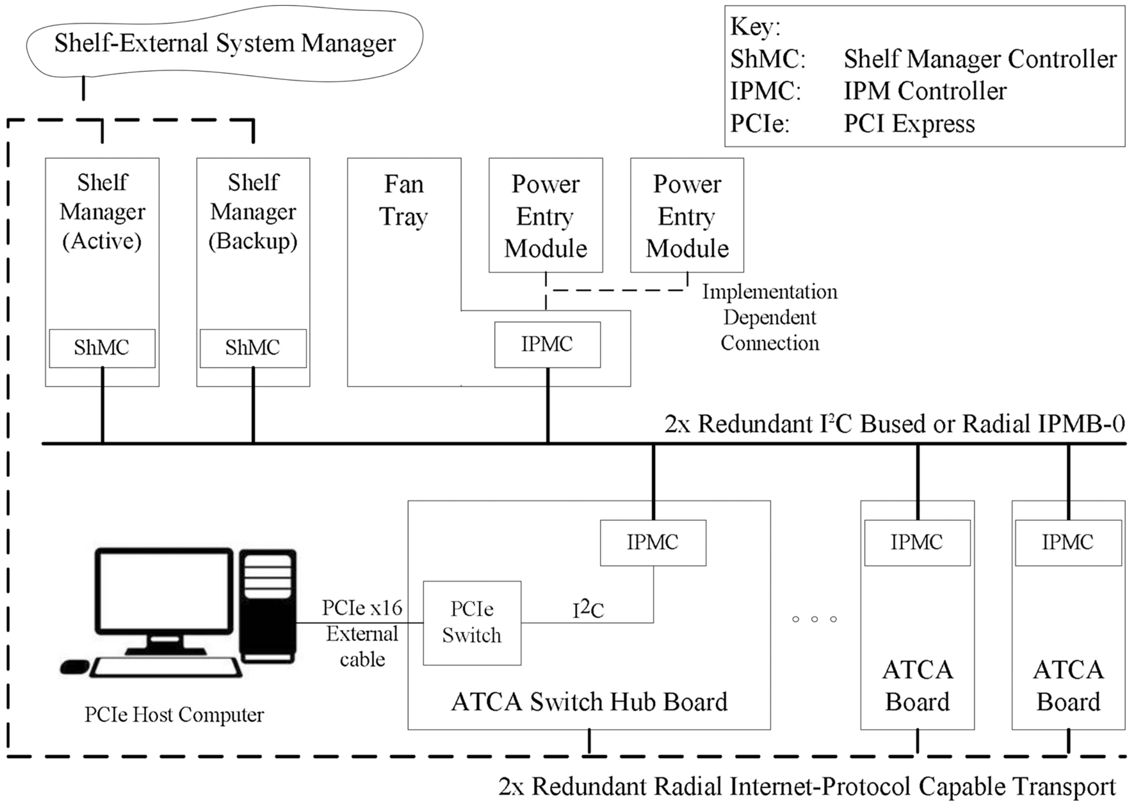

Fig. 1. ATCA-PCIe System Architecture.

transmission events related with the insertion/removal of boards. This is a serious issue when the operator intends to insert/remove a board and it is necessary to inform the PCIe Host in order that this takes the necessary actions to prevent the PCIe system control software from crashing.

ATCA systems are designed aiming at a High-Availability (HA) and for that the hot insertion/removal processes are absolutely crucial in order to achieve a high level of availability.

Instituto de Plasmas e Fusão Nuclear (IPFN) has developed and implemented a CDAQ system [6–15] applied to large physics experiments like the ITER [16] using the ATCA and PCIe standards (Fig. 1).

The compatibility of the two referred processes requires intervention in the software at two levels: the first one, at the PCIe Host level in linux drivers, PCIe Host interrupt routines and user applications [18–20]; the second one, at the ATCA crate level, in the IPMC controllers software of the ATCA endpoint boards and in the IPMC controller software of the ATCA hub board.

This paper describes the IPMC microcontroller's software architecture implemented in the ATCA boards in order to render those standards compatible in what concerns hot-swap and hot-plug processes. The result was achieved using the Inter-Integrated Circuit (I^2C) bus, defined as Intelligent Platform Management Bus-0 (IPMB-0). This bus is used to transmit Platform Event Messages of the Intelligent Platform Management Interface (IPMI) standard [1,2,17] between the ATCA node boards (which are PCIe endpoints) and the ATCA hub board that contains the PCIe switch [21].

2. PCIe hot-plug elements

The PCIe standard [3] defines several physical elements in a PCIe system to perform the PCIe cards hot insertion/removal [4] of the system maintaining the PCIe Host operating system running in normal operation.

The basic physical elements defined for each slot are the following:

- Attention Button (AB), a push button existing in the card or in the PCIe slot that is used by the operator to start a hot-plug process;
- Manually-operated Retention Latch (MRL), a mechanical handle used to lock or unlock a PCIe card;
- MRL sensor, follows the status (locked or unlocked) of the MRL. The status register associated with this sensor can be read or interrupts the operative system and if the status is locked means that the MRL is closed and if it is unlocked means that the MRL is opened;
- Presence sensor, detects the presence or absence of a card in the slot;
- Power Controller hardware, that is used by the hot-plug software to control the power status in the slot;
- Power Indicator (PI) led, indicates if the slot is powered ON or OFF and so if the card can be removed or not;
- Attention Button Indicator (ABI) led, indicates if the AB was pressed.
- Attention Indicator, used to get the operators attention if the slot is malfunctioning or is being identified.

These elements are associated with signals and registers in the PCIe switch that reflects the elements status. The registers can be configured to generate interrupts or send Message Signal Interrupt (MSI) messages to the Host CPU and this way the PCIe hot-plug software can manage the hot-plug process started and monitored by the operator.

3. ATCA board hot-swap description

The AdvancedTCA Base Specification [1,2] of the PCI Industrial Computer Manufacturers Group (PICMG) defines the board handle (mechanically connected to the handle switch) and the blue led as the physical elements used by the operator to carry out hot-swap operations with the ATCA boards. The board handle is used by the operator to start a hot insertion/removal operation. This handle, that can be opened or closed, actuates mechanically on the handle switch, making the handle switch reflect the status of opened or closed of the board handle. The switch status is monitored by the respective board IPMC (Fig. 1).