Fusion Engineering and Design 128 (2018) 117–121

Contents lists available at ScienceDirect

Fusion Engineering and Design

journal homepage: www.elsevier.com/locate/fusengdes

Control and data acquisition software upgrade for JET gamma-ray diagnostics

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ARTICLE INFO

Keywords:
Control
Data acquisition
Software
MARTe
JET
Nuclear fusion

ABSTRACT

The Joint European Torus (JET), the largest magnetic confinement plasma physics experiment in operation, has a large amount of key diagnostics for physics exploration and machine operation, which include several Gamma-Ray Diagnostics. The Gamma-Ray Spectrometer (GRS), Gamma Camera (GC) and Gamma-Ray Spectrometer Upgrade (GSU) diagnostics have similar Control and Data Acquisition Systems (CDAQ) based on the Advanced Telecommunication Computing Architecture standard, featuring Field Programmable Gate Arrays for data processing and management.

During past JET-EP2 enhancements, the GRS and GC diagnostics were successfully installed and commissioned. However, the installed CDAQ software that interfaces these diagnostics to JET Control and Data Acquisition System is different, requiring higher maintenance costs.

Benefiting from the Gamma Camera Upgrade (GCU) and new GSU installation and commissioning, the upgrading of the software and controller hardware used in the GRS and GC was evaluated, aiming at software standardization between all three diagnostics for easier maintenance.

This paper describes the software standardization process between the diagnostics towards the usage of the same CDAQ software as well as the same Operating System (OS) for the controllers, which allows the operator to minimize the maintenance time, avoiding the need for system specific expertise. The rationale behind the choice of MARTe framework as CDAQ software and Scientific Linux as OS will also be presented.

1. Introduction

The Joint European Torus (JET) gamma-ray diagnostics are in the scope of the diagnostic package of the JET deuterium-tritium (DT) campaign in preparation for ITER [1,2]. This includes the Gamma-Ray Spectrometer (GRS), Gamma Camera Upgrade (GCU) and Gamma-Ray Spectrometer Upgrade (GSU) projects.

The GRS (KM6S spectrometer) and GSU (KM6T spectrometer) projects aim at performing high-resolution gamma-ray spectroscopy at very high count rate while the GCU (KN3G camera) project is expected to improve the spectroscopic properties of the existing gamma-ray/hard X-ray camera, in terms of energy resolution and high count rate capability, for DT campaign [3–8].

The GRS and the old version of GCU, the Gamma Camera (GC), were

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[1] See the author list of "Overview of the JET results in support to ITER" by X. Litaudon et al. to be published in Nuclear Fusion Special issue: overview and summary reports from the 26th Fusion Energy Conference (Kyoto, Japan, 17–22 October 2016).

https://doi.org/10.1016/j.fusengdes.2018.01.064
Received 8 June 2017; Received in revised form 22 January 2018; Accepted 26 January 2018
Available online 06 February 2018
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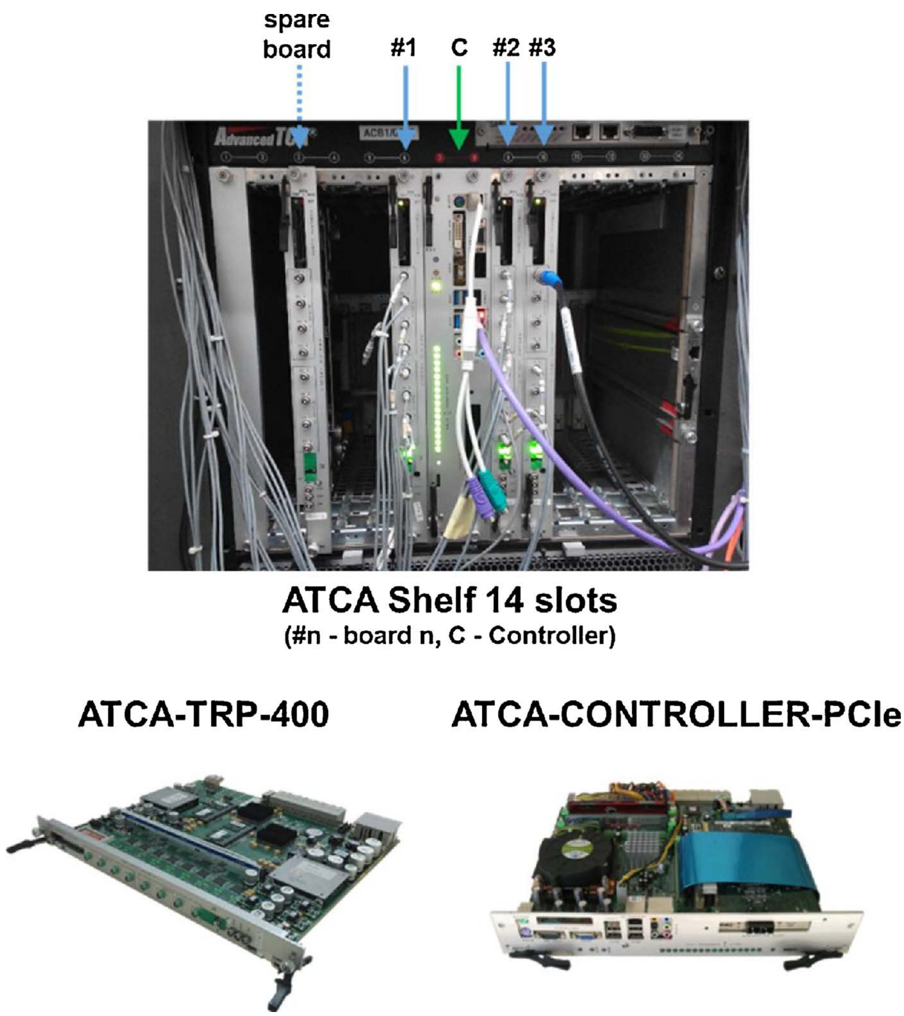

Fig. 1. Hardware environment.

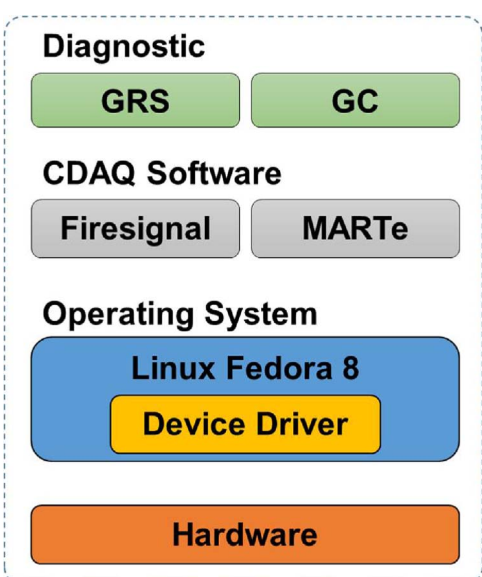

Fig. 2. Existing Software Architecture.

successfully installed and commissioned during past JET-EP2 enhancements. These systems are based on the Advanced Telecommunications Computing Architecture (ATCA) standard [9], which was selected for ITER fast controllers requiring demanding tasks (diagnostics, I&C and Interlock) like plasma control system [10,11].

The ATCA Control and Data Acquisition (CDAQ) system includes high frequency and reconfigurable digitizer modules (ATCA-TRP-400) [12] with embedded Field Programmable Gate Array (FPGA) devices, connected to the host controller (ATCA-CONTROLLER-PCIe) [13] using the Peripheral Component Interconnect Express (PCIe) interface [14].

Both diagnostics have similar hardware, however, due to historical reasons, the installed CDAQ software that interfaces to JET COntrol and Data Acquisition System (CODAS) is different. While the GRS was implemented using FireSignal [15,16], the GC uses the Multi-threaded Application Real-Time executor (MARTe) framework [17,18]. Thus, the usage of different CDAQ software systems may lead to maintenance problems in the future.

The recent upgrade in the JET gamma-ray diagnostics comprised the new GSU installation and commissioning, and the GC upgrade. This contributes to the study of a new solution, aiming at the usage of an updated host hardware (Motherboard, CPU, Memory and Hard-Drive), Operating System (OS) and CDAQ software.

This paper presents the implemented solution based on the new hardware and software environment common to all diagnostics, which contributes to reduce the system specific expertise and minimize maintenance time. A brief overview of the hardware environment is provided in Section 2. The CDAQ software architecture and its uniformization across diagnostics is described in Section 3. Section 4 presents the MARTe Integration with JET CODAS and Section 5 details the configuration mirroring between diagnostics. The paper ends with Section 6 devoted to the conclusions.

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