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ITER Electronics

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ITER and future long duration fusion experiments, similarly to other large-scale physics experiments, demand a high degree of automation and high-availability (HA) for the whole plant infrastructure. Highly available systems operate seamlessly in the case of component failure, ensuring safety of equipment, people, environment and investment. Control and Data Acquisition (C&DA) systems for Fusion diagnostics are considered mission-critical and require high degrees of availability. The biggest challenge is providing robust and fault tolerant control systems able to fulfill requirements for RAMI (Reliability, Availability, Maintainability, Inspectability). Also, diagnostics for high performance measurements may be subject to high levels of particles and radiation beyond the existing in previous facilities, and therefore radiation effects in subsystems have to be deeply considered. Use of Commercial Off The Shelf (COTS) components operating under radiation is a reliability concern but, most often there is no alternative to the use of commercial-grade components and the risk associated to their use has to be managed. Mitigationof radiation effects for reliable operation and irradiation testing on a representative environment is of highest relevance for radiation effects studies in emerging technologies.

Summary

A research program on high-availability control and data acquisition systems is ongoing at IPFN. Such program fosters the development of an Advanced Physics Instrumentation and Computing Architecture fully designed for High-availability. The program follows a multi-tier methodology addressing the different issues at the firmware, software/middleware, and hardware levels. The development of the ITER prototype Fast Plant system controller is integrated in this R&D program. IPFN adopted PICMG's Advanced Telecommunications Computing Architecture (ATCA) industry standard to develop C&DA instrumentation. ATCA was chosen due to its high throughput characteristics and HA features which become of greater importance in steady-state operation scenarios. This contribution presents a Fast Plant System Controller (FPSC) prototype, specialized for data acquisition, based on ATCA. This prototyping activity contributed to the ITER effort on standardization, specifically regarding fast controller characteristics. IPFN system can be setup to perform with the desired degree of availability, by implementing fail-over mechanisms based on the use of redundancy, thus being suitable for advanced C&DA systems in Fusion. Also a complete description of ITER challenges and the tested solutions are presented as well as the integration of the controller into the standard CODAC environment. The most relevant results of real tests will be addressed, focusing in the benefits and limitations of the applied technologies. Details will also be given on several ongoing projects to develop innovative design methodologies for radiation-tolerant, aging-aware, COTS-based, safety critical real-time control and data acquisition systems used in high energy physics experiments.

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