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FPGA based data acquisition system for COMPASS experiment

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The COMPASS is a fixed target experiment, situated at the Super Proton Synchrotron (SPS) accelerator in the north area of the CERN laboratory, in Geneva, Switzerland. The experiment was commissioned during 2001, data-taking started in 2002. The data acquisition system of the experiment is based on the DATE soft-ware package, originally developed for the ALICE experiment. In 2011, after the physics program of the COMPASS experiment was ap-proved for the next 6 years, it was decided to build a new data acquisition system, based on modern FPGAs.

The new data acquisition system uses new FPGA based modules in two different configurations: multiplexer and switch. These modules allow whole events to be collected and built purely by hardware and to be received by the readout nodes; therefore no further software event building is required. Deployment of these FPGA modules significantly decreases the amount of components involved in the data acquisition chain, mainly by removal of the event-building network based on Ethernet. Due to removal of the software part of event-building, the performance and reliability of data acquisition system is improved.

The new software architecture consists of Master, SlaveReadout, SlaveControl, graphical user interface, database, Message logger, and Message browser components. All processes are programmed in the C++ language with use of the QT framework and are designed to operate under the Scientific Linux CERN operating system. Communication between processes is based on the Distributed Information Management System (DIM) library which was originally developed for the Delphi experiment at CERN. The database service is based on the MySQL software. Behavior of the Master, the SlaveReadout, and the SlaveControl processes is described by finite state machines. In contrast to the present data acquisition system the new one takes advantage of modern technologies including multithreading.

The aim of this contribution is to analyze the original COMPASS data acquisition system, to present the new one, to compare both architectures, and to discuss their advantages and disadvantages. Furthermore, applications of state-of-the art technologies and modern approaches to the data acquisition software development based on usage of frameworks are presented. The design and results of performance tests and further development steps are also discussed.

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