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Pilot run of the new DAQ of the COMPASS experiment

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This contribution focuses on the deployment and first results of the new data acquisition system (DAQ) of the COMPASS experiment utilizing FPGA-based event builder. The new DAQ system is developed under name RCCARS (run control, configuration, and readout system).

COMPASS is a high energy physics experiment situated at the SPS particle accelerator at CERN laboratory in Geneva, Switzerland. After two years of preparations and commissioning, the physics data taking started in 2002. The original DAQ consisted of several layers and was based on software event building paradigm. The detector frontend electronics continuously preprocess and digitize data in approximately 300000 channels, the data are readout when trigger signal arrives and are concentrated into 250 custom VME modules. These modules were connected to the event building network using 90 Slinks. The network consisted of two types of servers: readout buffers and event builders. Readout buffers served for data reception and buffering which allowed to distribute the load over the entire SPS accelerator cycle. The collected event fragments were transferred over the switched gigabit Ethernet to the event builders that assembled full events. Full events were written into the local disk space and afterwards send to the central CERN storage facility CASTOR. The system was controlled by adapted ALICE DATE package which implemented run control, event sampling, monitoring, run keeping, and configuration functionality.

Since 2002, number of channels increased from 190000 to approximately 300000, trigger rate increase from 5 kHz to 30 kHz; the average event size remained roughly 35 kB. In order to handle the increased data rates and mainly cope with aging of the system, it has been decided to develop a new DAQ system during technical shutdown of CERN accelerator in 2013-2014. Custom FPGA based data handling cards (DHC) are responsible for building of events in the new system, thus replacing the event building network. The cards have been designed in Compact AMC form factor and they feature 16 high speed serial links, 4GB of DDR3 memory, Gigabit Ethernet connection, and COMPASS Trigger Control System receiver. There are two different versions of firmware: multiplexer and switch. The multiplexer card combines data from 15 incoming Slinks send them into one outgoing, whereas the switch combines data from up to 8 multiplexers and distributes the full events to the readout engine servers equipped by spillbuffer PCI-Express cards that receive the data. DHC cards memory allows to store date of one spill and to distribute the load over the accelerator cycle period. Readout engine servers are also used for monitoring of data consistency and data quality checks.

As the DHC cards perform data flow control and event building, the software serves for configuration, run control, and monitoring. For these purposes, we have developed special software package. The main part of the software is implemented in the C++ language with the Qt framework; JavaScript, PHP, TCL, Python languages are used for support tasks. MySQL database has been selected as storage of system configuration and logs. Communication between processes in the system is implemented using the DIM library. Several types of processes are present in the system. The master is the most important process; it exchanges information and commands between user interface and slave processes. Slaves monitor and configure the DHC cards, process data, and provide interface for data access. User interface can run either in control or in viewer mode. However, only one instance of user interface may be present in the control mode. Message logger collects messages from all processes involved in the RCCARS and stores them in the database. Message browser is a graphical tool which allows to display and to filter these logs. The RCCARS is configured trough the web interface.

The RCCARS has been deployed for the pilot run starting from the September 2014. In the paper, we present performance and stability results of the new DAQ architecture, we compare it with the original system in more details.

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