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The Detector Control System for the ALICE Time Projection Chamber Front-end electronics

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The ALICE Time Projection Chamber (TPC) is read out by 4356 Front-End Cards serving roughly 560000 channels. Each channel has to be configured and monitored individually. As one part of the overall controlling of the detector this task is covered by the Detector Control System (DCS).

Since fault tolerance, error correction and system stability in general are major concerns, a system consisting of independently running layers has been designed. The functionality layers are running on a large number of nodes and sub-nodes.

This talk will focus on the concept and architecture of the DCS for the Front-end electronics of the Time-Projection Chamber (TPC) and present results and experiences from system integration tests.

Summary

The Detector Control System in general is divided into three layers, Supervisory Layer, Control Layer and Field Layer. The Supervisory Layer is the top-level with the operator's user-interface. The Control Layer is a communication layer, and the Field Layer is where the different hardware devices are found. All the components in the system work in parallel, feeding the operator with useful information concerning the status of the system, or responding to commands given at the top-level. The DCS for the TPC Front-end electronics is designed to act upon errors as close as possible to the source. Functional blocks are distributed over a larger number of computing nodes and sub-nodes.

The system described is based on so called Front-End-Electronics-Servers (FeeServers). A FeeServer abstracts the underlying Front-end electronics to a certain degree and covers the following tasks:
- Interfacing hardware data sources and publishing data
- Receiving of commands for configuration and controlling the Front-end electronics
- Self-test and Watchdogs (consistency check and setting of parameters)

A dedicated communication software, the InterComLayer, handles the connection between the lower Field Layer and the upper Supervisory Layer. The main tasks are controlling the FeeServers in the Field Layer, sending configuration data to the Front-end electronics and transporting monitoring data to the Supervisory Layer. The InterComLayer implements three interfaces, a Front-End-Electronics client, a Front-End-Device server and a client to the Configuration Database. These interfaces are common abstraction layers within the ALICE experiment.

The FeeServer and other controlling software in the Field Layer runs on the DCS board, an autonomous single-board computer which allows running complex controlling software under the operating system Linux. Further custom hardware devices have been developed covering specific tasks and serving as sub-nodes. The Readout Control Unit (RCU) hosts basic controlling functionality for a set of FECs. Some tasks of the DCS like the Monitoring and Safety Module are carried out by firmware modules of the RCU.
In total the system consits of 216 embedded Linux nodes. Together with standard computers in higher control layers the DCS board and the RCU board form a distributed control system.

The architecture has several advantages:
- Distributed and module-based design with well-defined interfaces increases structure and testability.
- Parallel systems increase bandwidth and reduce workload on each node.

- The system is independent of physical intervention. This is of high importance as the system is unaccessible when it is in operative mode.
- Linux operating systems on the embedded computers provides flexibility and standard tools.
- Software and Firmware that is easily reconfigurable.
- Low-level devices with intelligent error-handling decrease the possibility for permanent failures.

The system is still under development. Several small scale control systems consisting of the DCS board and applicable sub-nodes has already been used as stand alone systems in major tests. The modularity makes it possible to test and review each sub-system on it's own independently of the complete setup. Several integration and beam-tests have been performed with satisfying results. The talk will focus on experiences and results from the major integration test in May 2005.

Author: Mr RICHTER, Matthias (University of Bergen, Dep. of Physics and Technology)

Co-authors: Mr KOFLER, Christian (University of Applied Sciences Worms, Germany); Mr LARSEN, Dag (University of Bergen, Dep. of Physics and Technology); Prof. RÖHRICH, Dieter (University of Bergen, Dep. of Physics and Technology); Mr ALME, Johan (University of Bergen, Dep. of Physics and Technology); Mr RØED, Ketil (Bergen University College, Norway); Prof. ULLALAND, Kjetil (University of Bergen, Dep. of Physics and Technology); Dr KEIDEL, Ralf (University of Applied Sciences Worms, Germany); Mr BABLOK, Sebastian (University of Bergen, Dep. of Physics and Technology); Mr KRAWUTSCHKE, Tobias (University of Applied Sciences Cologne, Germany); Mr ALT, Torsten (University of Heidelberg, Germany); Mr FRANKENFELD, Uli (GSI, Darmstadt); Prof. LINDENSTRUTH, Volker (University of Heidelberg, Germany)

Presenter: Mr RICHTER, Matthias (University of Bergen, Dep. of Physics and Technology)

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