APPLICATION OT THE ATLAS DAQ AND MONITORING SYSTEM FOR MDT AND RPC COMMISSIONING

E. Pasqualucci, INFN, Roma, Italy
on behalf of the ATLAS muon collaboration and of the ATLAS Readout group

Abstract

The ATLAS DAQ and monitoring software are currently commonly used to test detectors during the commissioning phase. In this paper, their usage in MDT and RPC commissioning is described, both at the surface pre-commissioning and commissioning stations and in the ATLAS pit.

Two main components are heavily used for detector tests. The ROD Crate DAQ software is based on the ATLAS Readout application. Based on the plug-in mechanism, it provides a complete environment to interface any kind of detector or trigger electronics to the ATLAS DAQ system. All the possible flavours of this application are used to test and run the MDT and RPC detectors at the pre-commissioning and commissioning sites. Ad-hoc plug-ins have been developed to implement data readout via VME, both with ROD prototypes and emulating final electronics to read out data with temporary solutions, and to provide trigger distribution and busy management in a multi-crate environment. Data driven event building functionality is also used to combine data from different detector technologies.

Monitoring software provides a framework for on-line analysis during detector test. Monitoring applications have been developed for noise and cosmic tests and for pulse runs. The PERSINT event display has been interfaced to the monitoring system to provide an on-line event display for cosmic runs in the ATLAS pit.

INTRODUCTION

The ATLAS DAQ and monitoring software are currently commonly used to test detectors during the commissioning phase. Two main components are heavily used for detector tests: the ROD Crate DAQ (RCD) software [1] and the online monitoring system [2].

The RCD software is based on the ATLAS Readout application. Based on the plug-in mechanism, it provides a complete environment to interface any kind of detector or trigger electronics to the ATLAS DAQ system.

The Readout application can behave, according to the configuration stored in the online configuration database:

- As a ROD Crate DAQ (RCD) application, configuring and monitoring modules (in general VME or PCI modules), sampling events from them and acquiring events if required. In the final system, it controls all the VME modules used to interface the subsystems to the triggers and configures and monitors the Readout Drivers, i.e. modules dedicated to readout detector front end electronics and format data in a standard frame. This software can also emulate a ROD, producing ROD fragments from payload data.
- As a Readout System (ROS), receiving ROD fragments via optical links from ROD modules or via TCP connections from ROD emulators, interfacing the system to 2nd level trigger and event building system or encapsulating data in ROS fragments and sending them to a Data Driven Event Builder (DDEB);
- As a DDEB, receiving ROS fragments and building ATLAS events.

All these implementations and functionalities are used in the MDT and RPC commissioning, both in standalone installations and in the ATLAS infrastructure [3].

The online monitoring and data analysis is based on the GNAM framework [4], designed to provide an easy interface to the monitoring system. The plug-in mechanism is used to interface user libraries, analyzing sampled event fragments and filling user-defined histograms, to GNAM.

THE COSMIC STAND

A pre-commissioning test stand is dedicated to test MDT and RPC chambers [5] with cosmic rays. Up to three stations, made of MDT chambers sandwiched between two RPC, are slided horizontally into the test stand. Triggers are provided by the coincidence of signals coming from two RPC chambers on the top and bottom of the structure.

The standalone DAQ system is built in a private network, where a boot/file server provide booting and network services and exports disks via NFS to a VME Single Board Computer (SBC), used to control trigger electronics and to read out RPC data, and to a PC running the RCD, used to read out MDT data. A further PC is booted from the server, used to initialize the RPC electronics via a CANBUS interface [6]. A windows PC is used to initialize MDT electronics via JTAG connections [7].

The DAQ system of the cosmic ray stand is described in figure 1. Detectors can run both in standalone and in combined mode, selecting one of the pre-defined DAQ partitions.

In order to keep the system simple, runs are taken in synchronous mode, i.e., after each trigger the system is in busy state until all the RCD finish their data read out.

The trigger signal is distributed as a NIM signal and split to be sent to two TTCvi modules [8] and to a time unit to be latched and sent to a VME I/O register. The former distribute the trigger to the detector electronics, the latter is polled by an instance of the RCD acting as a trigger/busy manager. The latched trigger is used as a veto to the trigger signal itself and is released when all the currently running subsystems finish to read out data.

The other instances of RCD are dedicated to data readout. At configuration time, they open a TCP connection to the trigger/busy RCD. When a trigger is issued, the trigger/busy RCD detects it and a special plug-in of the Readout Application (TCPTriggerModule) distributes it as a small TCP packet to all the open connections. This packet triggers data readout in the subsystems. At the completion of data readout, each subsystem issues a «trigger enable» command, sending a TCP packet to the TCPTriggerModule. When all the enable commands have been received, the trigger/busy manager releases the veto by resetting the latched trigger signal via a pulse generated by the I/O register. This simple system has been proven to work up to about 5 kHz, while the average data acquisition rate at the cosmic stand is about 160 Hz.

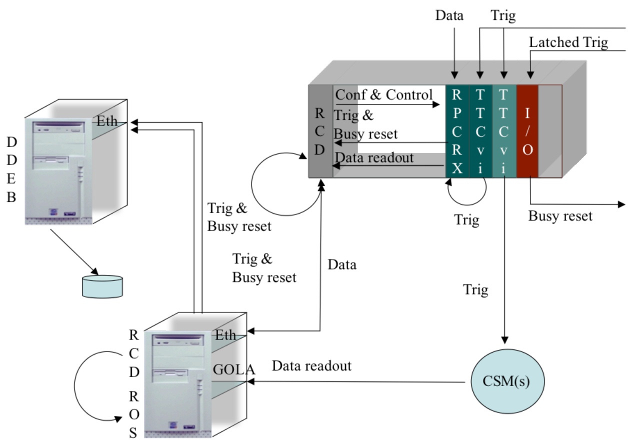

Figure 1. DAQ at the MDT and RPC cosmic test stand.

Both MDT and RPC use the ROD emulation functionality of the RCD.

The RPC RCD runs on a Concurrent Technology SBC running Linux. It reads out data via VME from a data receiver board (RPCRX), collecting information from the on-detector PAD boxes reading out the detector. In the MDT system, a Chamber Service Module (CSM) [9] collects information from on-detector TDC and ADC on each chamber. Each CSM is then connected via an optical link to a GOLA PCI card, interfacing up to four CSM to a PC. In both cases, the RCD, triggered by TCP packets, reads out payload data from the input and builds ROD fragments adding a header and a trailer. Fragments are sent via TCP connections to a ROS (running on the MDT PC) for formatting and then to a Data Driven Event Builder, running on the server, to be built and stored to disk.

The event builder runs in all the partitions, even when no real building is required, in order to produce consistent format in all the configurations.

THE COMMISSIONING SITE

Another standalone system has been installed on the top of the ATLAS pit. This system is dedicated to check chamber status after preparation and transportation to the site, before moving and mounting them in their final position into the pit.

At this site, no gas is available to feed the chambers. Noise and pulse tests are run to test the status of on-chamber electronics and cabling.

In this case, no combined run is required. Nevertheless, the system has been kept as simple as possible and the DAQ structure is identical to the pre-commissioning one. During noise tests, the trigger is generated by a time unit and propagated to the MDT system as in the cosmic setup. The time unit is usually set to produce a trigger rate of about 2 kHz, allowing testing up to 4 MDT chambers in less than 2 minutes.

The RPC subsystem works slightly differently, since pulses are generated by on-detector electronics according to a configuration given by a TTC command. The on-detector electronics generates the triggers accordingly. In this case, the readout is asynchronous, and the RPCRX module generates the busy when its internal memory gets “almost full”. Polling a “data available” flag on the module triggers the RCD readout.

Though the pulse rate is very low, since pulse events are very large and continuously fill up the module memory, only a small number of events are needed to pulse the detector and the test lasts some minutes.

As in the pre-commissioning system, both ROS and DDEB are used in each partition to assure identical data format of the output data.

COMMISSIONING IN THE ATLAS PIT

In the ATLAS pit, a sector of the muon barrel (sector 13) is used as a pilot system to test data taking in the final conditions with cosmic data. The system lives in the ATLAS TDAQ infrastructure, i.e. all the machines are remote booted from standard ATLAS servers and network hardware and services is the standard ATLAS ones.

Figure 2 shows the structure of the DAQ system for sector 13.

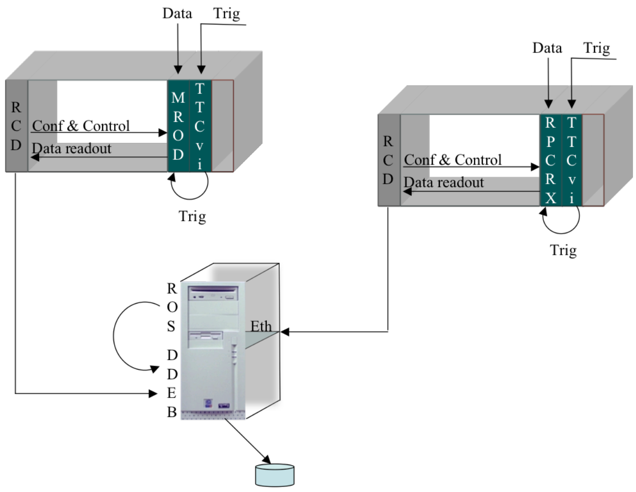

Figure 2. DAQ for sector 13 of muon barrel.

Since the RPC ROD is currently not available, RPC electronics is the same used in the system described above. As a consequence, the RCD is used again in ROD emulation mode and data are sent to a PC running a ROS application.

The readout of the MDT chambers is performed by a prototype of the MDT ROD (MROD) [10]. Though the standard data path is via optical fibres from ROD modules to their ROS, we want to take detector commissioning decoupled from DAQ commissioning. Thus, fragments are read out by the RCD application via VME. Since MROD output data are already formatted as ROD fragments, RCD builds ROS fragments and sends them directly to the DDEB.

Both the RPCRX and the MROD have internal memory for data buffering. The trigger propagation to the RCD is not needed, since the trigger can be blocked by any of the modules' busy signals, generated when module's memory is going to be filled up. Thus, the system is completely asynchronous, since in each crate data readout is driven by data availability.

The two systems can run both in standalone and in combined mode; also here the event builder is used in all the possible configurations to produce data with the final format.

ONLINE MONITORING AND DATA ANALYSIS

The Readout Application automatically instantiates an event sampler. Monitoring applications, based on the ATLAS low-level monitoring framework GNAM [5], can get data at any level of the DAQ system. Event fragments are actually sampled at ROD level for standalone sub-detector monitoring and at event builder level for combined monitoring.

During detector commissioning, all events are sampled and data analysis is performed online, producing root histograms and saving them at the end of run.

Figure 3 shows the system design. Each RCD (or, in general, Readout Application) starts a sampling thread. Sampled events (in this case all of them, as long as possible) are required by a monitoring application and relevant histograms are produced. At the end of the run, histograms are saved to a root file.

A histogram browser displays histograms both offline (reading out the file), and, if required, online through the Online Histogram Service (OHS) [11].

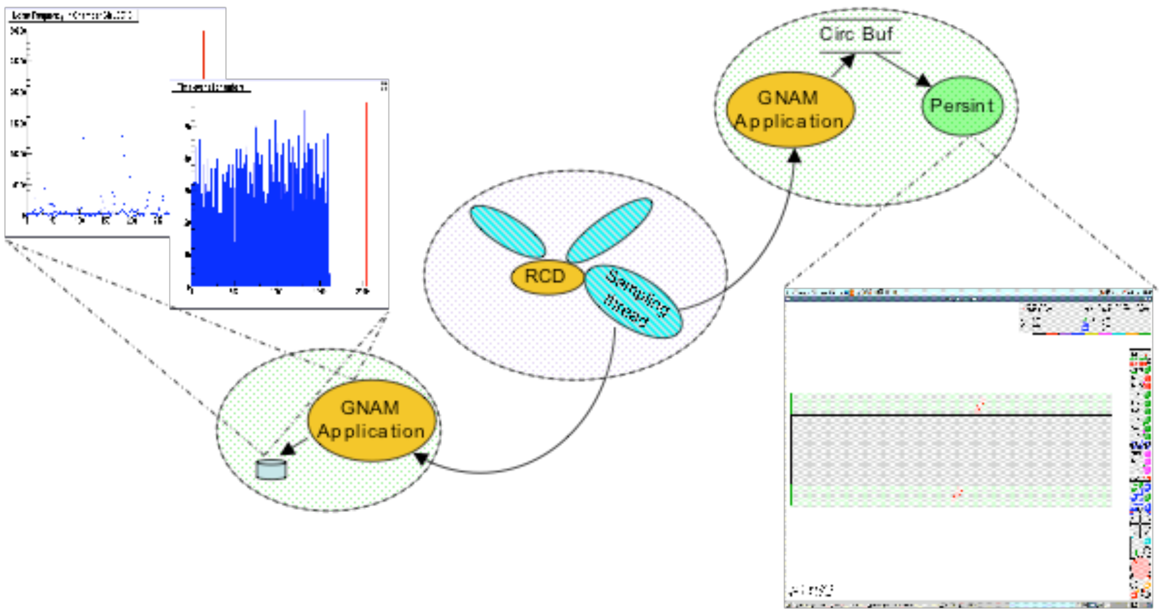

Figure 3. Online monitoring and event display

THE ONLINE EVENT DISPLAY

The Persint event display [12] is a muon specific event display. The original version of Persint reads out ASCII data files with a special format. A plug-in library to GNAM has been developed to transform the fragments sampled by the Readout Application and write out events with Persint compatible format. Persint is then able to receive data generated by any Readout application in the system, re-formatted by a GNAM application and shared via a ring buffer (see figure 3).

Libraries have been built both for standalone runs (getting data from the RCD applications) and for combined run (getting data from the DDEB application).

The muonbox [13] track reconstruction algorithm is integrated with the event display, allowing having a pictorial view of the reconstructed tracks.

Due to the flexibility of this approach, Persint is particularly suitable for detector tests during commissioning and is currently used in conjunction with GNAM monitoring as a fundamental tool to study detector behaviour.

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