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SWATCH: Common software for controlling and monitoring the upgraded CMS Level-1 trigger

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The Large Hadron Collider at CERN restarted in 2015 with a higher centre-of-mass energy of 13 TeV. The instantaneous luminosity is expected to increase significantly in the coming years. An upgraded Level-1 trigger system is being deployed in the CMS experiment in order to maintain the same efficiencies for searches and precision measurements as those achieved in the previous run. This system must be controlled and monitored coherently through software, with high operational efficiency.

The legacy system is composed of approximately 4000 data processor boards, of several custom application-specific designs. These boards have been controlled and monitored by a medium-sized distributed system of over 40 computers and 200 processes. The legacy trigger was organised into several subsystems; each subsystem received data from different detector systems (calorimeters, barrel/endcap muon detectors), or with differing granularity. Only a small fraction of the control and monitoring software was common between the different subsystems; the configuration data was stored in a database, with a different schema for each subsystem. This large proportion of subsystem-specific software resulted in high long-term maintenance costs, and a high risk of losing critical knowledge through the turnover of software developers in the Level-1 trigger project.

The upgraded system is composed of a set of general purpose boards, that follow the MicroTCA specification, and transmit data over optical links, resulting in a more homogeneous system. This system will contain the order of 100 boards connected by 3000 optical links, which must be controlled and monitored coherently. The associated software is based on generic C++ classes corresponding to the firmware blocks that are shared across different cards, regardless of the role that the card plays in the system. A common database schema will also be used to describe the hardware composition and configuration data. Whilst providing a generic description of the upgrade hardware, its monitoring data, and control interface, this software framework (SWATCH) must also have the flexibility to allow each subsystem to specify different configuration sequences and monitoring data depending on its role. By increasing the proportion of common software, the upgrade system's software will require less manpower for development and maintenance. By defining a generic hardware description of significantly finer granularity, the SWATCH framework will be able to provide a more uniform graphical interface across the different subsystems compared with the legacy system, simplifying the training of the shift crew, on-call experts, and other operation personnel.

We present here, the design of the control software for the upgrade Level-1 Trigger, and experience from using this software to commission the upgraded system.

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