Contribution ID: **6** Type: **Oral**

Phase-2 CMS DAQ – Growing from prototype boards to demonstrator systems

Wednesday 2 October 2024 14:20 (20 minutes)

The LHC-synchronous part of the Phase-2 CMS DAQ and timing systems will be built around two custom ATCA boards, interfacing the subdetector back-ends to the central trigger-DAQ systems. The DAQ and Timing Hub provides a 10 Gb/s connection to the central timing system, and up to 400 Gb/s of DAQ bandwidth. This board can be combined with one/multiple DAQ800 boards to increase the data bandwidth.

With the prototyping phase completed, we now present our first experience with partial- and full-chain systems, demonstrating the core of the Phase-2 CMS DAQ, timing, and trigger control systems.

Summary (500 words)

The LHC-synchronous part of the Phase-2 CMS DAQ and timing systems will be built around a pair of custom ATCA boards, interfacing the subdetector back-end electronics to the central trigger-DAQ systems. The DAQ and Timing Hub (DTH400) forms the main back-end interface, and one DTH400 will be located in each of the ATCA crates housing the back-end electronics. The DTH400 provides a 10 Gb/s bidirectional connection to the central timing and trigger control system, and up to 400 Gb/s physics data bandwidth to the central DAQ system. Physics data are aggregated from up to 24 custom-protocol back-end links, and output on up to four 100 GbE standard Ethernet ports. For subsystems requiring more throughput, the DTH400 can be combined with one or multiple DAQ800 boards. Each DAQ800 board provides twice the DAQ bandwidth of the DTH400, on twice the input and output link count. The DAQ800 only implements the data aggregation functionality and receives its timing and trigger information from the DTH400 in the back-end crate.

During the prototyping process, the recent increases in component lead times and obsolescence hampered the convergence of the final design. For example: the on-board controller used for the DTH400 and DAQ800 boards, which, for reasons of space and functional factorisation, is placed on a Rear Transition Module (RTM), had to be changed due to lack of availability. This required a redesign of the RTM and the corresponding boot and configuration firmware and software. At the same time, this did demonstrate the flexibility of the RTM-based design.

The limited amount of prototype boards available so far necessitated a piece-wise development approach, where small parts of the overall system were implemented and tested one at a time, repurposing the boards for different tasks in each and every step. Now, with more

boards becoming available, several larger-scale systems are being assembled.

These systems can be grouped along two scaling axes': the timing system scaleshorizontally' to the synchronisation of multiple crates, with a configurable switch grouping crates into independent runs, whereas the DAQ system scales 'vertically' along the data aggregation and event reconstruction/selection path. The possibility to operate multiple crates in-sync also opens up the path towards integration of the Level-1 trigger system in its final architecture, spanning several crates housing multiple board types, interconnected with optical links of different lengths and latencies.

This paper focuses on our first experience with these demonstrator systems, showcasing the core of the Phase-2 CMS DAQ, timing, and trigger control systems. For context, it summarises how the prototyping of individual functionalities was led to converge for this system-level integration and development.

Author: HEGEMAN, Jeroen (CERN)

Presenter: HEGEMAN, Jeroen (CERN)

Session Classification: Module, PCB and Component Design

Track Classification: Module, PCB and Component Design