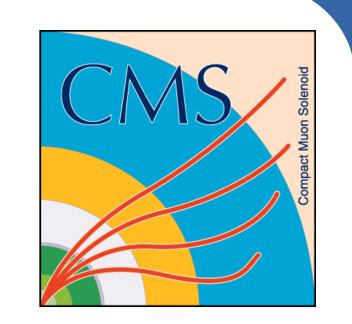


SWATCH: Common Software for Controlling and Monitoring the Upgraded CMS Level-1 Trigger



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The SWATCH Framework 🦠

The increased homogeneity of the upgraded CMS Level-1 trigger hardware [1] deployed during the long shutdown of the LHC, prompted the creation of a common framework to exploit the commonalities between the new trigger processors. The SWATCH (SoftWare for Automating the conTrol of Common Hardware) framework provides a set of interfaces for controlling and monitoring the hardware of the trigger system while remaining independent of the driver software, thus reducing code and effort duplication for the subsystems.

The Upgraded CMS Level-1 Trigger

5 Distinct Board Designs

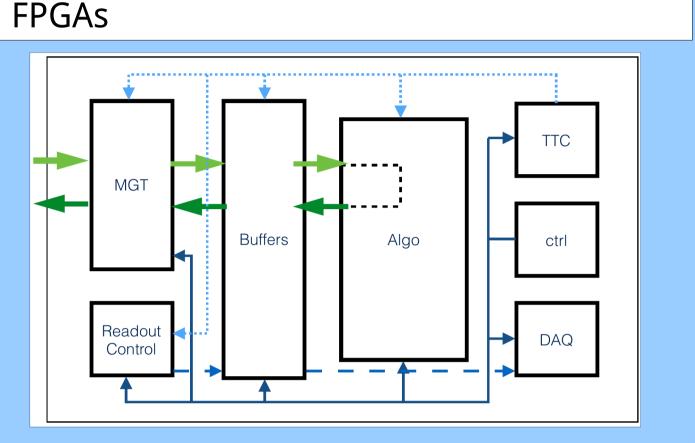
9 trigger subsystems

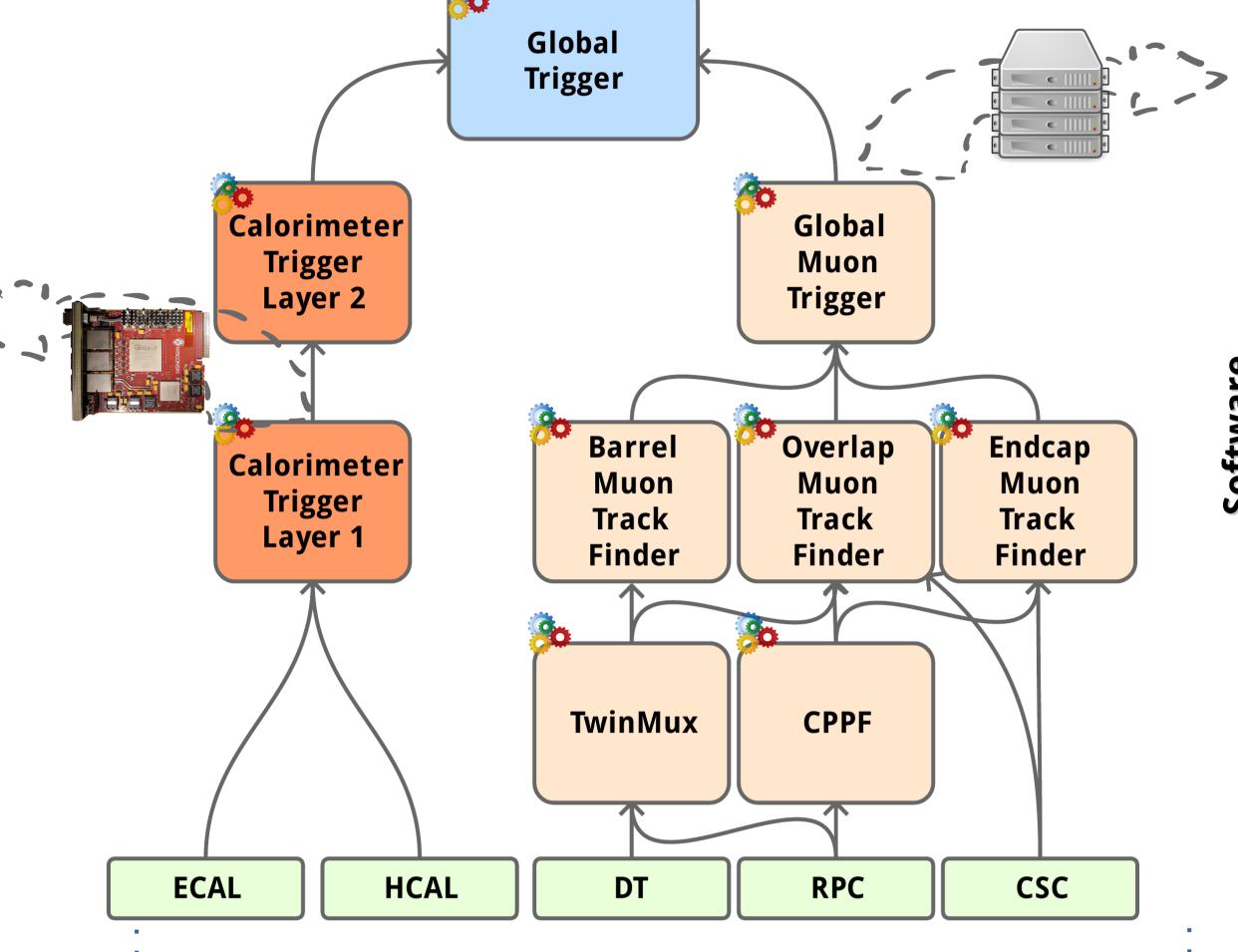
Hardware

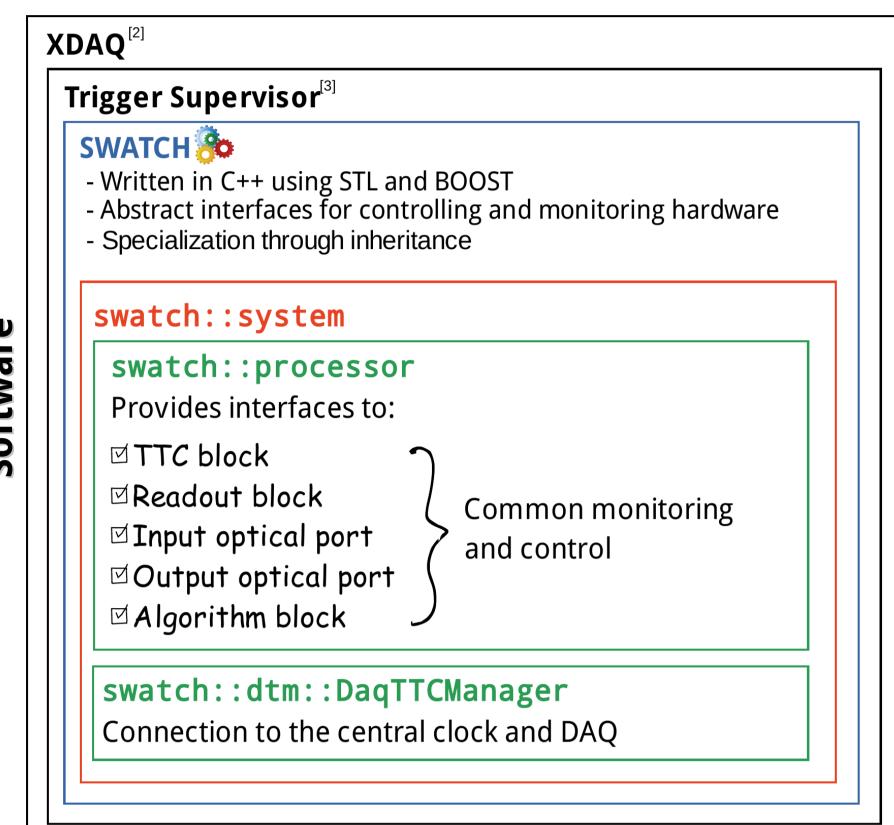
- Different algorithms and scales
- O(100) boards & O(3000) links

Common Processor Model

- AMCs following the uTCA specification Trigger data Tx/Rx via high-speed serial
- optical links • Processing logic implemented on Virtex-7

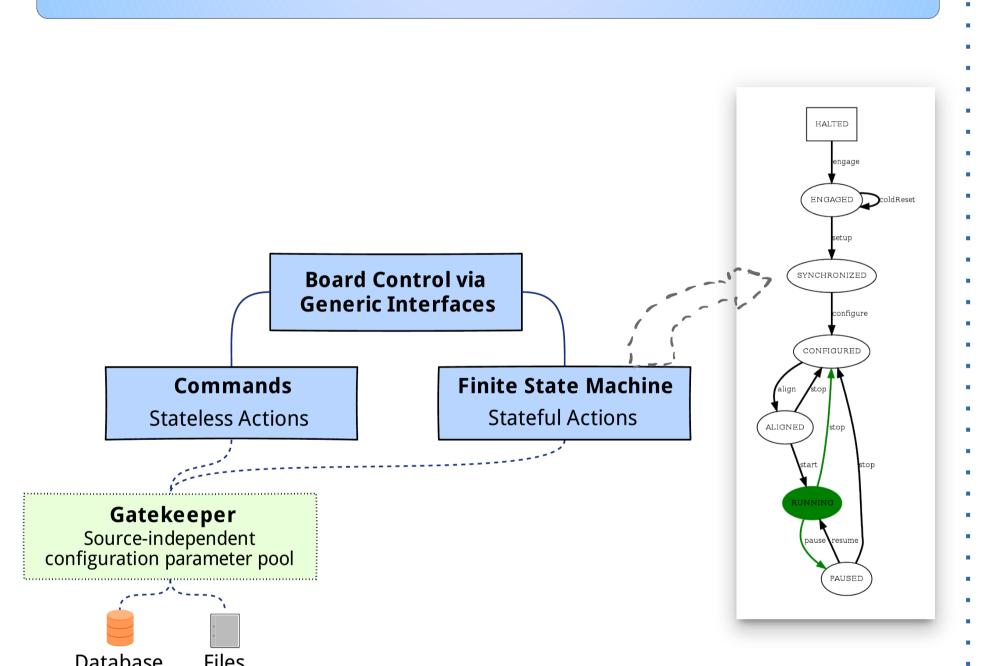






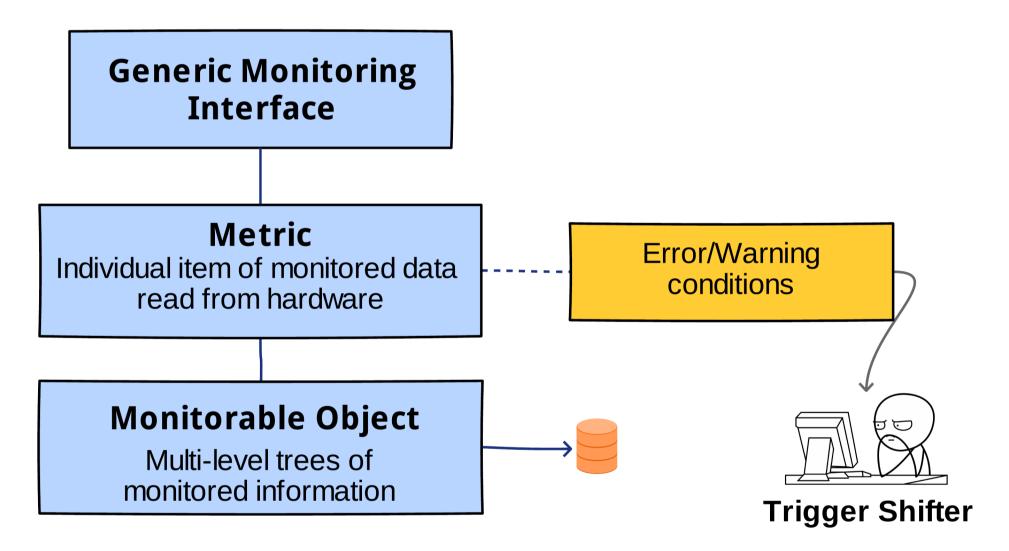
Configuration

- Subsystem-agnostic hardware description
- Factory pattern to create subsystem-specific classes
- Centrally defined Run Control Finite State Machine
- Command Sequences to be executed during transitions customized by subsystems



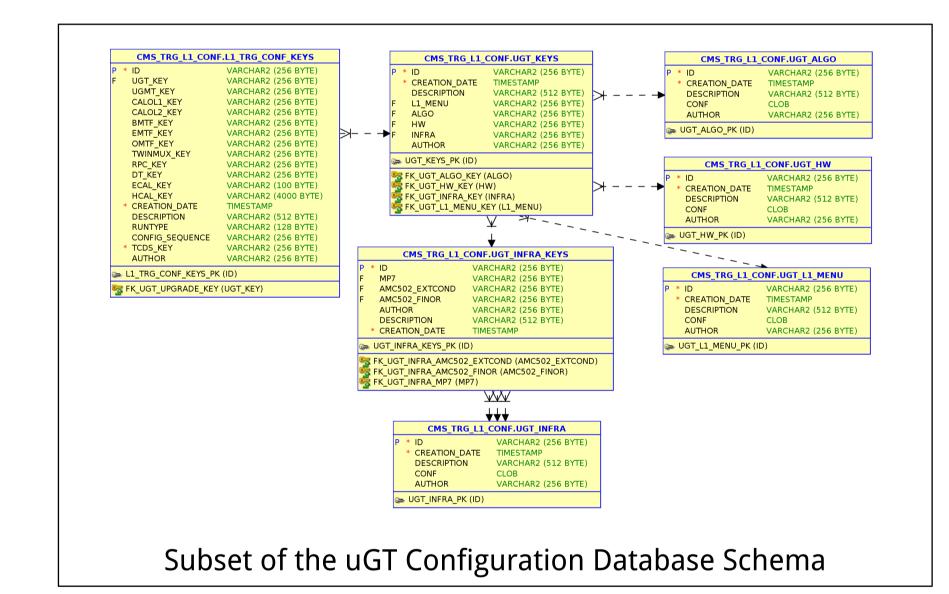
Monitoring

- All common components represented as monitorable objects
 - Optical I/O ports
 - TTC block
 - Readout block
- History stored in Oracle database
- Common visualization tools under development



Database

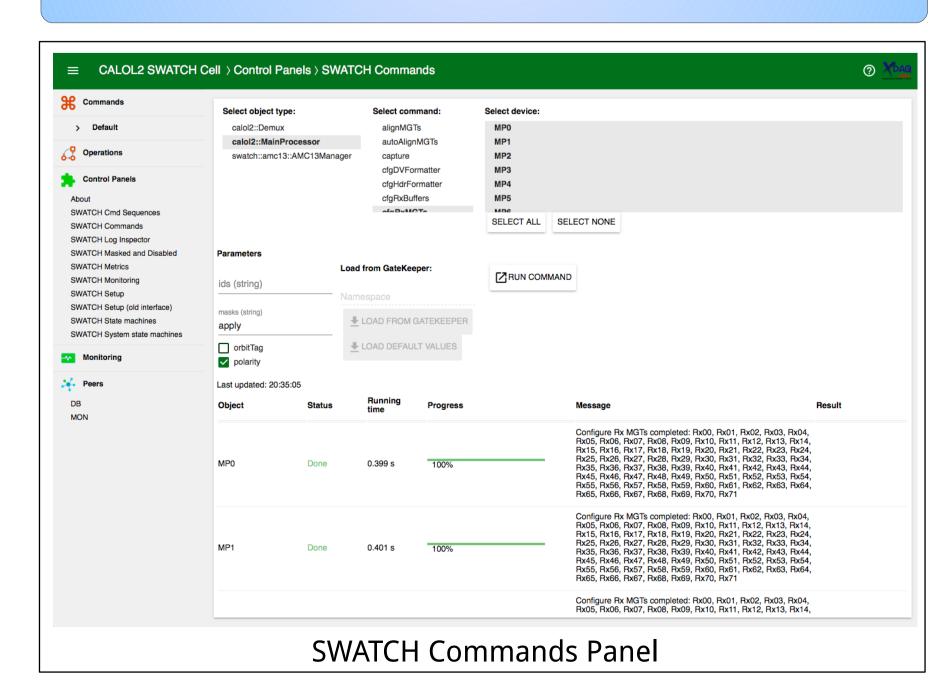
- Common schema for all subsystems
- Distinct XML-based "modules"
- Hardware : System description Infra : Alignment points etc.
- : LUTs, physics-related thresholds Algo
- Run Settings : Masks, monitoring settings



Commissioning & Operations

SWATCH Cell

- "Baseline" SWATCH system
- Common control/monitoring panels
- Uniform interface for operation personnel
- HTML5 Polymer^[4] GUIs
- Integration with central run control



CALOL2 SWATCH Cell > Control Panels > SWATCH Monitoring

Input Port Details **SWATCH Monitoring Panel**

Subsystem integration

- SWATCH-independent low-level drivers
- Bridge via "plugin" libraries
- Common hardware between subsystems
- One SWATCH "plugin" per component
- Code validation using "dummy" hardware Framework tested by a comprehensive nightly
- build test suite
- Parallel and centralized software deployment
- Fast detection and treatment of potential problems

SWATCH had a great impact in the successful commissioning of the Upgraded CMS Level-1 Trigger

- Replaced a long-running and stable trigger system
- Despite the short transition time
- Significant gains from SWATCH hardware-agnostic approach
- Less code overhead
- Developers focus on subsystem-specific issues
- High operational efficiency
- Minimal trigger downtime during data taking

References:

- [1] The CMS collaboration, "CMS Technical Design Report for the Level-1 Trigger Upgrade," CERN, Geneva, Tech. Rep. CERN-LHCC-2013-011, CMS-TDR-12, Jun 2013, http://cds.cern.ch/record/1556311 [2] XDAQ; https://svnweb.cern.ch/trac/cmsos
- [4] Polymer project; https://www.polymer-project.org/
- [3] I. Magrans de Abril, C. E. Wulz, and J. Varela, "Concept of the CMS trigger supervisor," IEEE Trans. Nucl. Sci., vol. 53, pp. 474–483, 2006