



LHCb MiniDAQ Control System

CHEP 2018

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Outline

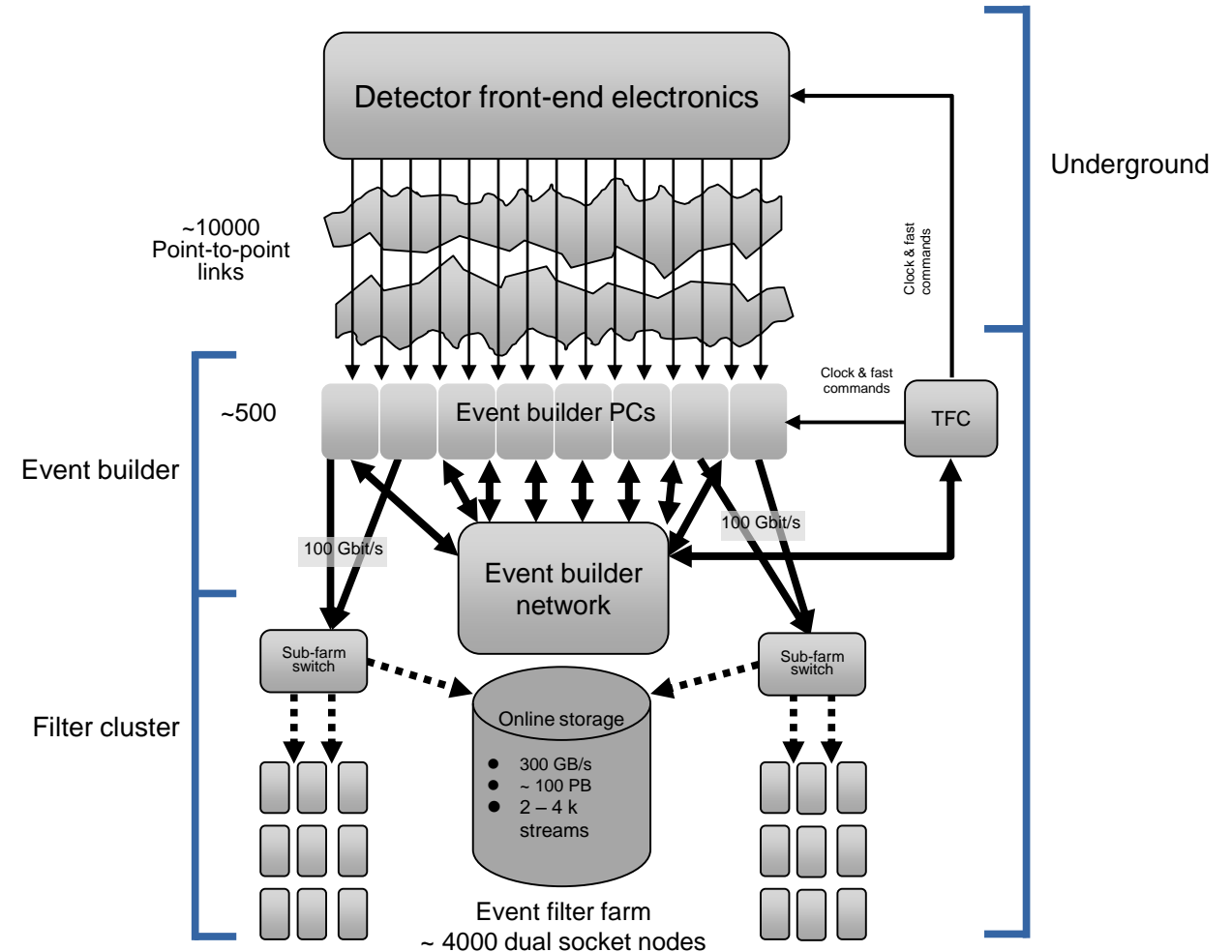
- Motivation
- LHCb Control System
- Experiment Control System (ECS)
- FSM
- MiniDAQ
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- Domains
- Integration
- Features
- Summary

Motivation

LHCb upgrade (starting 2018)

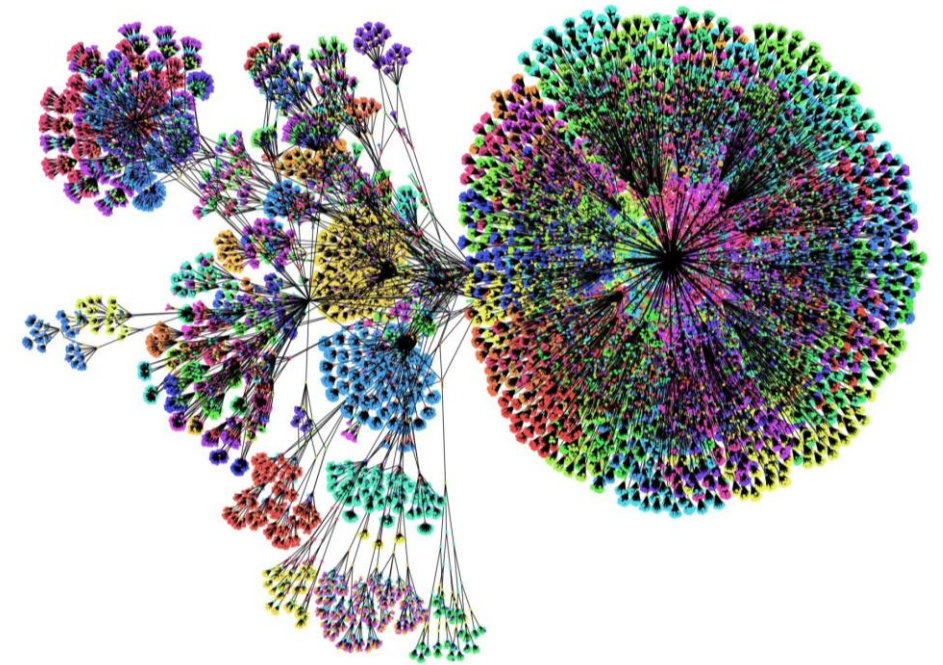
- Bottleneck L0 trigger will be removed
 - Reduced the data from 40MHz to 1.1MHz
- Trigger-less readout
- Full software trigger
- New/upgraded sub-detectors
 - New electronics to cope with the new data rate
- New readout system

→ Upgraded Experiment Control System (ECS)



Current Experiment Control System

- LHCb has designed and implemented a coherent and homogeneous control system
- Controls the complete experiment
 - Run Control, DCS, ...
- Is operated by only 1 person
- Is almost completely automated



LHCb Control System Size
Picture: Courtesy of the CMS DCS Team

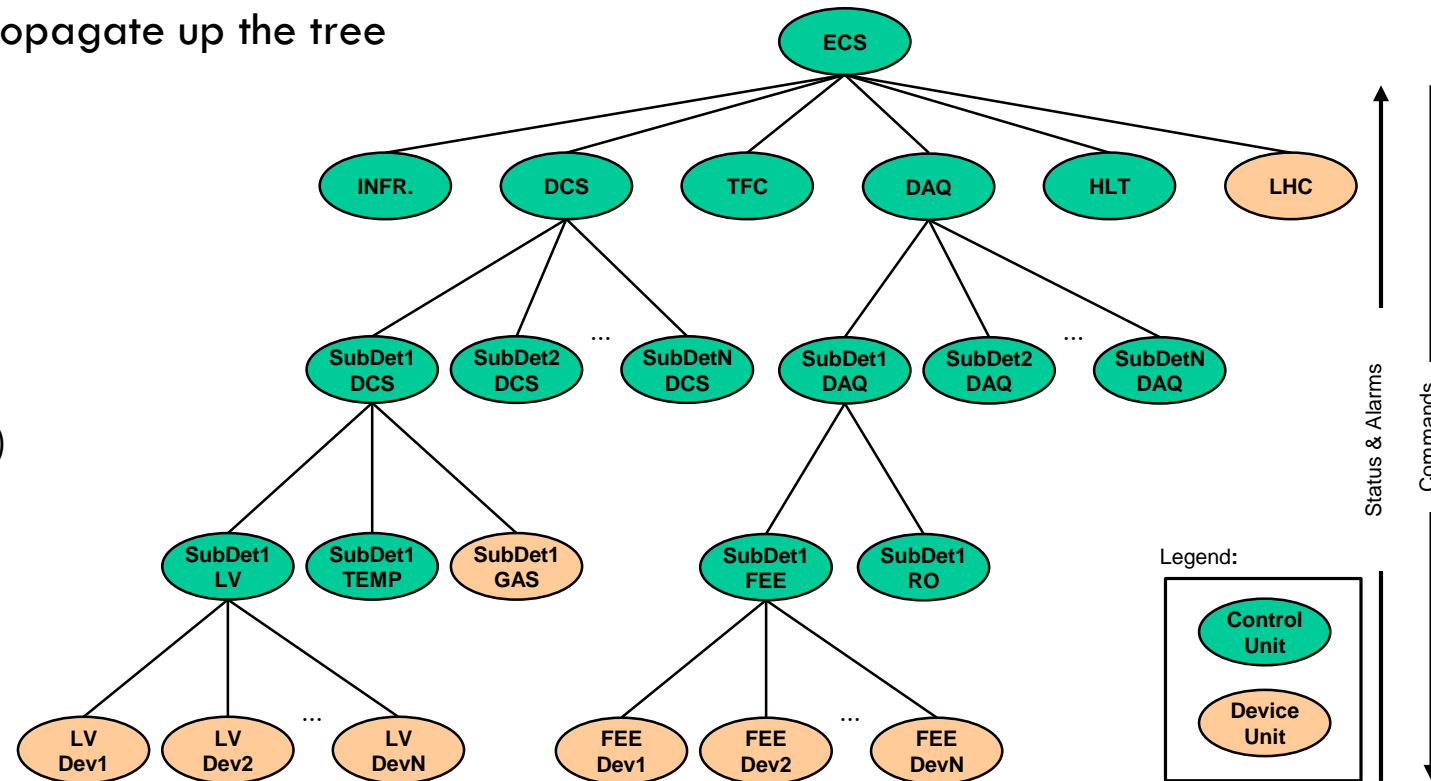
Experiment Control System (ECS)

- Based on WinCC OA 3.15 SCADA
 - Provides the UI, archiving, drivers, alarm-handling, ...
 - Allows for custom developments
 - Panels
 - Scripts/Libraries
 - Managers/Drivers
 - Developments can be packaged and distributed
 - Components
- CERN JCOP Framework
 - Provides a set of WinCC OA components
 - Provides guidelines for component/application developments
 - Common components for common devices
 - Cooling and Ventilation
 - ELMBs
 - Power supplies

ECS

Finite State Machine (FSM)

- LHCb Control System modelled with an FSM tree
- Actions propagate down the tree, states propagate up the tree
- 2 type of Units
 - Control Units
 - Nodes that logically group other nodes
 - State depends on the nodes below
 - Can be partitioned
 - Device Units
 - Nodes that correspond to a real device (HW/SW)
 - State depends on the real state of the device
 - Perform “real” actions



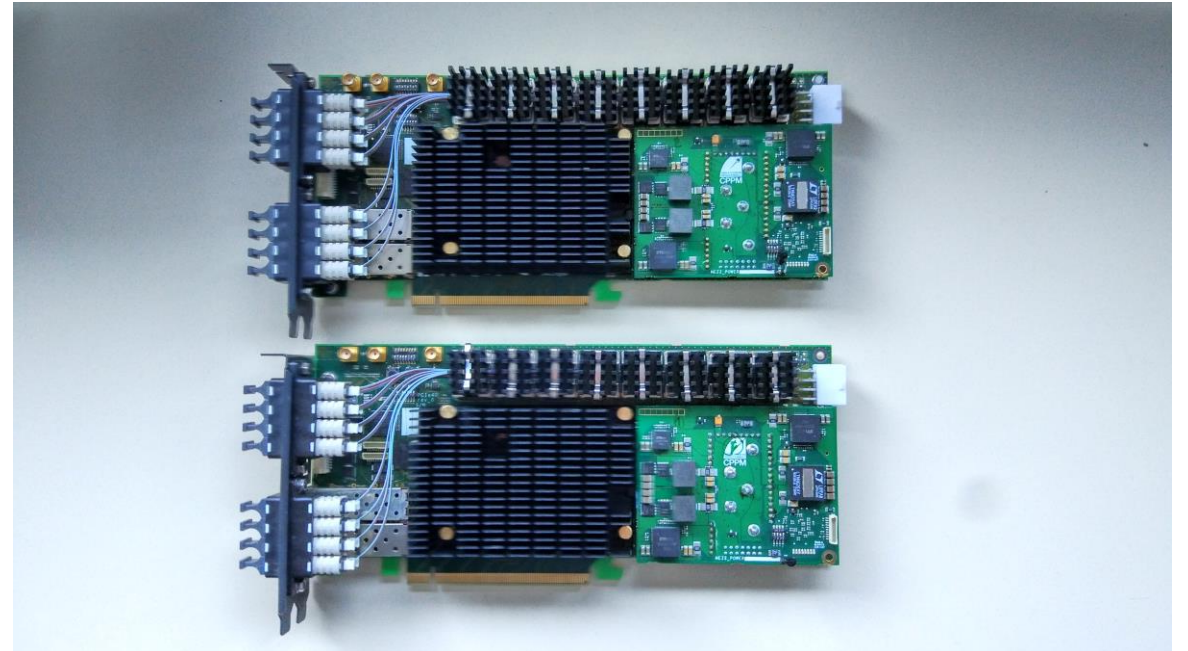
ECS

Run Control

- LHCb is composed of multiple Sub-detectors
- Each Sub-detector can be run independently in a partition
- Each partition is controlled by a Run Control
- Run Control manages the whole FSM hierarchy of a SD
 - makes sure it's ready for data taking
- A global Run Control is used for global operation
 - Controls all the sub-detectors and systems

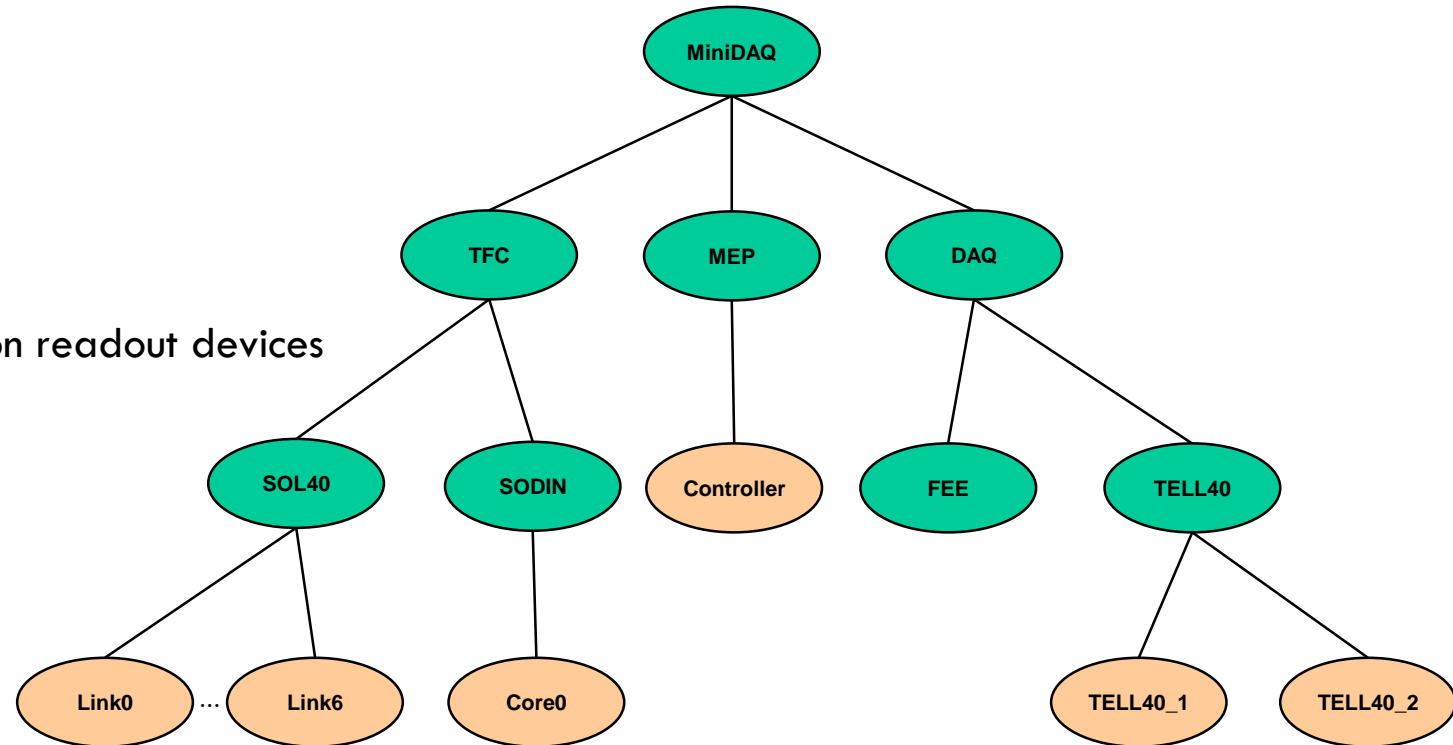
MiniDAQ

- Development server for the upgrade
 - Each SD has 1+ for developments
 - Contains 1 PCIe40 board
 - PCIe board with a programmable FPGA
 - Provides the readout board (TELL40), a readout supervisor (SODIN) and an interface board (SOL40)
 - Stand-alone system
- Basic component of the upgrade
- Needs a Control System



fwMiniDAQ component

- WinCC OA installable component
- Stand-alone Run Control for the MiniDAQ
- Usually installed in a MiniDAQ server
- Provides device units/panels for the common readout devices
 - TELL40s
 - TFC
 - Super ODIN
 - SOL40
- Provides control for several domains
 - DAQ – TELL40s and Front Ends
 - TFC – Supervision and interface boards
 - MEP – Event writing
- Pre-configured Run Control FSM
- Pre-configured with all the necessary instantiated devices for a running system
 - Front-End electronics excluded as they're specific for each SD
- Once installed, little configuration is needed for a running system



fwMiniDAQ

Readout board - TELL40

- Pre-instantiated TELL40 (readout board)
- Full control for the TELL40
 - Configure all the parameters
 - See all data links status
 - Inject data into the memory
 - Memory snooping
 - Hooks for SD specific functionalities

The screenshot displays the fwMiniDAQ control interface for the TELL40 readout board. The interface is divided into several panels:

- Device:** Shows the device name (TELL40_Dev1_1) and its state (RUNNING).
- Data Format:** Configured to Fixed header / Fixed Length with parameters: Data Format (00000004), Data Format Order (00000001), and FE Data Transmission Protocol (Wide Bus, 00000070).
- Header Information:** Shows BXID field size and info field size.
- Others:** Includes SYNC Pattern, Channel size, No of channels, NZS frame size, Active fibers, and Fibers to align.
- Summary:** A table showing the status of various blocks (Dec Blocks).
- Decoding Block 6:** Provides statistics for Valid Frames, Idle Frames, Events Processed, Events Valid, Events Error, SYNC Frames, NZS Frames, First BXID, Current BXID, and Orbit No.
- Errors:** Shows counters for BCID only, Parameters, BCID order, BCID desync, and BCID sync.
- Debug:** Includes Sync OFF, Sync ON, IDLE Frames, and Valid Frames.
- Options:** Configures Loop (No Loop, Auto Write), Write Status, and Frame Pattern.
- Current Configuration:** Shows Loop Status, Write Status, Write on Mem option, Write Address Memory, Write Signal Status, Selected Fiber, and Source.
- Data Table:** A table with columns #1, #2, #3, #4 and rows of hexadecimal data.

fwMiniDAQ

Timing and Fast Control

- Pre-instantiated Super ODIN (timing/trigger control) and 6 SOL40 Links (controls interface)
- Full control for Super ODIN and SOL40
 - Trigger configurations
 - Sub-detector settings

The screenshot displays the fwMiniDAQ control interface, divided into two main windows. The top window, titled 'SOL40_GBTtest/Link1: TOP (MINIDAQ2_2 - MINIDAQ2; #2)', shows the 'Link1' device in a 'RUNNING' state. It includes fields for 'DeviceName' (MINIDAQ2_2:SOL40_GBTtest.Link1), 'Version' (5.01.02), and 'Date' (20171220.00). Below this are sections for 'Command SM' (SOL40 delays) and 'Counters' (BXID, EID, FE Resets).

The bottom window, titled 'SODIN_GBTtest/Core0: TOP (MINIDAQ2_2 - MINIDAQ2; #2)', shows the 'Core0' device in a 'RUNNING' state. It includes fields for 'DeviceName' (MINIDAQ2_2:SODIN_GBTtest.Core0), 'Version' (5.00.00), and 'Date' (20171220.00). This window features a 'Statistics and status' table, 'TFC Enables 1' and 'TFC Enables 2' sections with various checkboxes, and a 'Messages' area at the bottom.

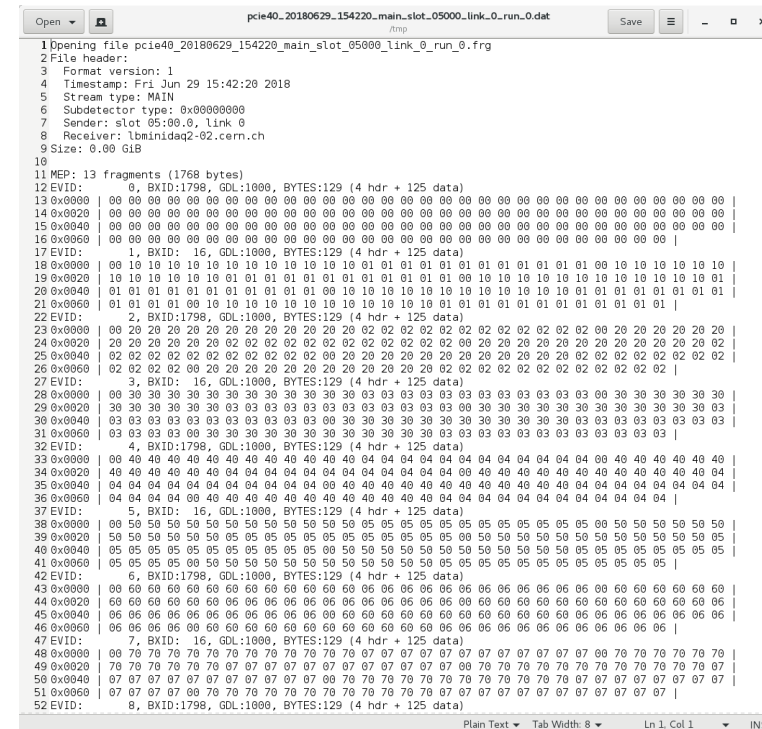
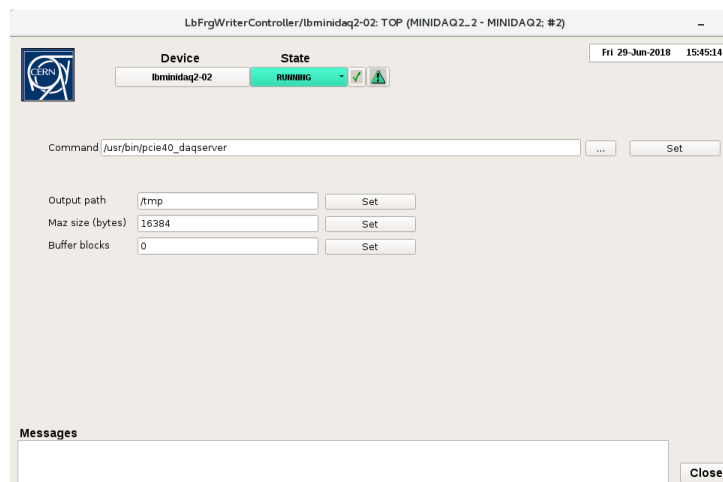
Statistics and status	Periodic Trig. A	Periodic Trig. B
Orbits	1398940	0
Bunch IDs	0x2FA	0
Event ID	1000	2797894
Total Triggers	1001	25.21 kHz
Trigger Rate	0.00 kHz	0
Gated Triggers	1000	0
Gated Trg Rate	0.00 kHz	0
Inst Trg Loss	0.100 %	0
Synch	20	0
Snapshot	99	0
BX VETO	0	0
Header Only	689067525	0
NZS Mode	0	0
FE Reset	2	0
BE Reset	2	0
TFC Reset	2	0
EID Reset	2	0
Throttle	689067526	0

TFC Enables 1	TFC Enables 2
<input type="checkbox"/> Periodic Trg 1	<input checked="" type="checkbox"/> Snapshot
<input type="checkbox"/> Fast Periodic Trg 1	<input checked="" type="checkbox"/> Synch
<input type="checkbox"/> Periodic Trg 2	<input type="checkbox"/> Periodic Synch
<input type="checkbox"/> Fast Periodic Trg 2	<input type="checkbox"/> BX Veto
<input type="checkbox"/> Calibration Trg A	<input checked="" type="checkbox"/> Header Only
<input type="checkbox"/> Calibration Trg B	<input checked="" type="checkbox"/> EVID Cnt
<input type="checkbox"/> Calibration Trg C	<input checked="" type="checkbox"/> MEP Destination
<input type="checkbox"/> Calibration Trg D	<input type="checkbox"/> MEP Dyn Dest
<input type="checkbox"/> Random Generator	<input type="checkbox"/> StepRun
<input type="checkbox"/> Random Trg A	<input checked="" type="checkbox"/> BX Type
<input type="checkbox"/> Random Trg B	<input checked="" type="checkbox"/> Throttle
<input type="checkbox"/> Random Trg C	<input checked="" type="checkbox"/> NZS/TAE throttle
<input type="checkbox"/> Random Trg D	<input checked="" type="checkbox"/> FE Reset throttle
<input type="checkbox"/> TAE	<input checked="" type="checkbox"/> BE Reset throttle
<input type="checkbox"/> NZS Mode	<input checked="" type="checkbox"/> SYNCH throttle
<input type="checkbox"/> NZS Consecutive	<input type="checkbox"/> MEP throttle
<input type="checkbox"/> Lumi Trg	<input type="checkbox"/> FE Reset VETO
<input checked="" type="checkbox"/> Limit Triggers	<input type="checkbox"/> BE Reset VETO
<input type="checkbox"/> External trigger	<input type="checkbox"/> SYNCH VETO
<input type="checkbox"/> L0 trigger	<input type="checkbox"/> External TFC
<input type="checkbox"/> Beamgas trigger	<input type="checkbox"/> Force Trg
<input type="checkbox"/> Ext trg edge select	<input type="checkbox"/> Rate throttle
<input type="checkbox"/> Ext trg edge enb	<input type="checkbox"/> Ext EVID Rst
<input type="checkbox"/> Trg in ChB	<input type="checkbox"/> CntRst with EVID Rst
<input type="checkbox"/> Scan Enb	<input type="checkbox"/> Ext EVID Match

fwMiniDAQ

Event Writer

- 1 Event writer controller
- Start/stop synchronously



fwMiniDAQ

Top panel

- Check the readiness of the system
- Quickly configure your system
- Quickly change your settings

The screenshot displays the fwMiniDAQ control system interface, titled "fwMiniDAQ/FwMiniDAQ_configureMulti.pln (MINIDAQ2.2 - MINIDAQ2: #2)".

Configuration Panels:

- Tell40:** Lists hardware types like MINIDAQ2_2:TELL40_09, MINIDAQ2_2:TELL40_Dev1, MINIDAQ2_2:tell40_17, and MINIDAQ2_2:tell40_8000.
- SODIN:** Lists SODIN configurations like MINIDAQ2_2:SODIN_09, MINIDAQ2_2:SODIN_GBTest, MINIDAQ2_2:sodin_17, and MINIDAQ2_2:sodin_8000.
- SOL40:** Lists SOL40 configurations like MINIDAQ2_2:SOL40_09, MINIDAQ2_2:SOL40_GBTest, MINIDAQ2_2:sol40_17, and MINIDAQ2_2:sol40_8000.
- TOP:** Lists TOP configurations like MINIDAQ2_2:TOP_09, MINIDAQ2_2:TOP_GBTest, MINIDAQ2_2:top_17, and MINIDAQ2_2:top_8000.
- LLI:** Lists LLI configurations like MINIDAQ2_2:LLI_09, MINIDAQ2_2:LLI_GBTest, MINIDAQ2_2:ll_17, and MINIDAQ2_2:ll_8000.
- PRBS:** Lists PRBS configurations like MINIDAQ2_2:P, MINIDAQ2_2:P, MINIDAQ2_2:P, and MINIDAQ2_2:P.
- Writers:** Lists writers like lbminidaq2-02, lbminidaq2-09, and lbminidaq2-17.
- Known GBT Server:** Lists server configurations like lbdaes:8000, lbminidaq2-02, lbminidaq2-08, lbminidaq2-09, lbminidaq2-17, localhost, and pdtcb:195.

Commands (MINIDAQ2.2 - MINIDAQ2: #2): A table showing "Rx Ready Status and Counters" for links 0 through 46. Each link has a status indicator (red or green dot) and a numerical value.

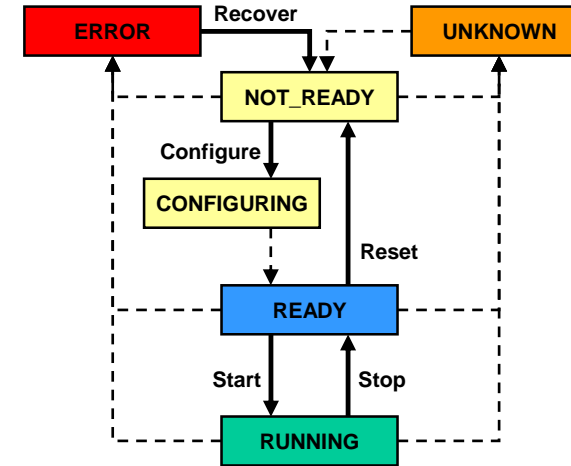
System Status Panel (MINIDAQ: TOP (MINIDAQ2.2 - MINIDAQ2: #2)):

- System State:** MINIDAQ is **RUNNING**.
- Sub-System State:**
 - DAQ: RUNNING
 - MEP: RUNNING
 - TFC: RUNNING
 - MiniDAQ_RunInfo: RUNNING
- System Status:**
 - GBT Server Connection: Reload
 - Registers Subscription: Configure Subscriptions...
 - Ctrl Managers: Restart Ctrl Managers
 - Buttons: Test System, Export System Info
- Reset Logic Regs:**
 - Global:
 - LLI:
 - TELL40:
 - SOL40:
 - SODIN:
- TELL40:**
 - Configure Links... Status...
 - Triggers from TFC: 1'000
 - Events Accepted: OK
- TFC:**
 - SODIN Master: MINIDAQ2_2:SODIN_GBTest
 - TFC Master Links: MINIDAQ2_2:sol40_17.Link0
 - TFC quick control: Click to disable ALL FE
 - Subdetector Type: <Multiple>
- Other Devices:** prbs_8000, LLI..., PRBS..., RXReady...
- Step Run:**
 - Enabled:
 - No of triggers: 10000
 - No of steps: 1, Start step: 0, Current step: 0, End step: 0
 - Buttons: Apply
- Messages:** A text area for system messages.

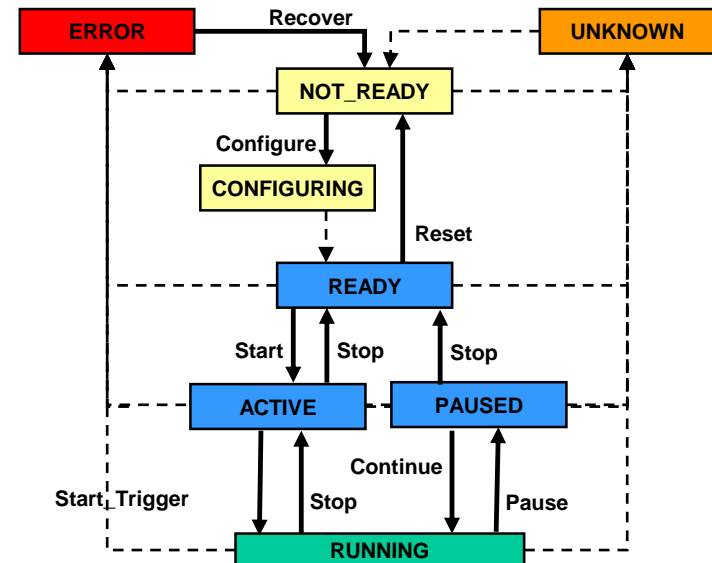
Domains

- Several domains are provided in the component
 - DAQ
 - TFC
- Provide all the required states and transitions
- Provide automation
- The same for all the Sub-Detectors
- Facilitate integration

DAQ Domain



TFC Domain



Integration

- The domains implemented on fwMiniDAQ serve as the base for the final upgrade system
- Templates are distributed to all the Sub-detectors
- Make the system homogeneous and coherent
- DAQ domain will be exactly the same
- TFC domain will remain the same but will be moved to the global Run Control hierarchy
- fwMiniDAQ component probably be split into several independent WinCC OA components
 - fwTell40
 - fwTFC
 - lbDomains

Other Features

- Usage of Recipes
 - Named sets of configuration
 - Applied depending on the requirements at a given time (e.g. PHYSICS, CALIBRATION, ...)
- SCAN runs
 - Runs with a set number of steps, each with a set limit of triggers
 - Between steps, settings are changed on the devices
 - Find the best settings for each application
- Autopilot
 - Base for automatic actions

Summary

- The fwMiniDAQ provides an easily installable and configurable component for the MiniDAQ
- Speeds up testing and development by the Sub-detector teams
 - Can concentrate on the SD specific parts
- Provides several helpful features
 - SCAN runs
 - Recipes
- Serves as base for the future central ECS
- Makes the system homogeneous from early stages of development
- Support and training is easier