Development and Tests of the Event Filter for the ATLAS Experiment

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on behalf of the ATLAS Event Filter group

- ATLAS TDAQ overview
- EF architecture features
- EF functionality & development plans
- EF functionality & performance tests
- Summary & future prospects

Event Filter in the ATLAS TDAQ System

LHC Collider:

- ★ C.M. Energy 14 TeV
- ★ Luminosity $10^{34} \text{ cm}^{-2}\text{s}^{-1}$
- ★ Collision rate 40 MHz

Level-1 Trigger:

- ★ Hardware-based signature finding algorithms
- ★ Coarse-granularity subdetector objects

Level-2 Trigger:

- ★ Fast steering software
- ★ Full granularity Regions-of-Interest

Event Filter ("Level-3"):

- ★ Access to full-event
- ★ Full-reconstr./analysis offline algorithms

Features of EF Implementation Architecture

set of independent
EF SUB-FARMS, consisting of

set of independent
EF processing NODES,
running

set of independent
Event DataFlow (EFD)
& Processing Tasks (PT)

- ★ Modularity & scalability
- ★ Fault tolerance
- ★ Flexible functionality:
triggering, calibration,
monitoring
- ★ EF provides flexible
data sorting/streaming

Baseline architecture for EF nodes:
1 EFD + 2 PTs per CPU (dual-CPU PCs)

Features of EF Functionality

Modularity & distributed functions:

- difficulty:

- ★ interdependency of components

- advantages:

- ★ flexible balancing of functions in EF Farm for optimal performance
- ★ fault tolerance: EFD transports & owns event, PT has read-access & adds EF result data to event
- ★ virtual interfaces allow separate debugging & using either in TDAQ or pure Offline frameworks

Event Filter Configuration Features

Additional functionality for EF: Online Calibration

Levels of “labelling” events:

- ★ at LVL-1: events streamed to separate “calibration SubFarms”
- ★ at LVL-2:
  - event streamed to separate SubFarm
  - event streamed to “calibration node” or “calibration PT”
- ★ at PT-processing: re-send to another “calibration” PT / node

Implied issues to be concerned:

- ★ optimal topology of EF Farm to balance the performance
- ★ representing/transporting calibration data
- ★ updating calibration data on-the-fly: *(some dedicated mechanism to add ?)*
- ★ configuration and fault tolerance

Additional functionality for EF: Monitoring

Three major possibilities to run monitoring in PT:

▶ PT runs in TDAQ and gets events from TDAQ DataFlow:

- additional representation and streaming of monitoring data
- *implied issues to be concerned:*
optimal topology for balanced performance;
configuration and fault tolerance;

▶ PT runs in TDAQ but gets events from other source:

- *going to adapt/use in June commissioning of ATLAS Tile Calorimeter & cosmic runs*

▶ Running PT as stand-alone programm (no TDAQ):

- simplicity: *avoid full TDAQ infrastructure*

Implied improvement of EF design:

universality of PT-interface for events reading

EF Functionality & Performance Tests

Permanently: small-scale test-beds in CERN & Institutes

- ★ functionality tests & bug-fixing
- ★ code development

May-October 2004: Combined Test Beam @ CERN

- ★ first realistic operations & tests of TDAQ/EF with all major ATLAS subdetector modules together !
- ★ 4 EF nodes used in data taking (dummy PTs / forced event accept)
- ★ 20 EF nodes tested with realistic muon algorithms, also combined with LVL2 !
- ★ reported in many talks/workshops
(S. Gadomski & A. dos Anjos talks @ RT'05)

EF Functionality & Performance Tests

May 2005: Large Scale Tests @ WestGrid/Canada

- ★ 250/840 dual-CPU nodes used – thanks to WestGrid team !
- ★ Debugging as preparation for summer performance measurements
- ★ largest EF farm succeeded to run: 30 SubFarms x 20 nodes
1EFD+4PTs (in dummy mode) per each node, ~ 600x5=3000 processes
- ★ large-scale-specific problems observed & debugged:
  - tuning TDAQ parameters (config. / timeouts)
  - communications of EF components within TDAQ

June-July 2005: Large Scale Tests @ CERN (up to 1000 nodes):

- ★ tools for distribution & management of
TDAQ+Offline software (~ 5 GB) @ large scale
- ★ numerous tests planned running ~hundreds EF nodes
& ~thousands communicating processes
  - TDAQ & EF infrastructure (dummy PTs): communications,
config. parameters, fault tolerance, networking
  - Realistic offline algorithms: configuration,
network/memory/CPU performance
  - Combined LVL2+EF trigger / realistic data

Summary & Future Prospects

- ATLAS Event Filter SW exists in operation-able form and is subject to numerous testing activities
- Event Filter is under active development: design improvement & additional functionalities
- EF follows up the detectors commissioning and cosmic run operations and is going to participate/contribute

We are preparing a robust, flexible and performant Event Filter system for beginning of the ATLAS operations in 2007 -
- much challenging and interesting work remains to be done !

Backup slides

EF Data Structure

Three types of data as result of EF:

★ trigger answer string:

“Accepted” / “Rejected” / “Error”
(more can be added !)

★ EF Result C++ object:

objects reconstructed by
algorithms (fitted tracks, etc.)

★ EF BitPattern:

summary flags from EF Result
for easy classification/sorting

ByteStream conversion service
from Offline SW system to be used
to transform EF Result data into
sequential (ByteStream) format