Outline:
The ATLAS Trigger system and DAQ
The Online Monitoring Framework
First experience with real data
The ATLAS Trigger System

Level 1
- Hardware based
- Coarse granularity calorimeter and muons
- Identifies Region of Interest (RoI)

High Level Trigger (HLT)
- Level 2 and Event Filter PC farm
- Algorithms reconstruct physical quantities
- Monitored physics reconstructed variables
- Trigger chains organized in “physics slices”

Level 2 (L2)
- Full detector granularity in RoIs
- Special fast algorithms

Event Filter (EF)
- Full event available
- Full detector granularity
- Offline-quality algorithms

In 2009:
27 Racks for L2 and EF
~800 nodes (8 cores/node)
1/3 of full system

Event Size ~1.5 MB

Highly Distributed System
Monitoring during TDAQ Commissioning (now and first weeks of collisions)

Increase data taking efficiency
prevent/understand conditions that stop data taking
Maximize: ATLAS Recording time/LHC beam time

Increase physics efficiency
Recorded data good for physics?
Maximize: ATLAS events good for physics/ATLAS recorded events

Display, Monitor and Analyze:
• Operational Data from TDAQ components
• Event content and histograms produced
Gathering the histograms

Sums all the histogram produced by HLT farms

A single application → 2500 histograms (now, will probably increase)
A single HLT rack : 250 applications
Total number of histos per rack: 600k
23 HLT racks in 2009 (1/3 of final size)

- Need gatherer optimization (CPU, Memory, bandwidth)
Graphical Applications

Online Histogram Presenter:
Interactive presenter displaying histograms stored in IS/OH:

• Large number of histograms to display
• Possible to interact with histograms (zoom, fit, log/lin scale, etc...)
• Minimize network traffic via a subscription mechanism: process is informed when the histogram is published or updated
• Sophisticated cache mechanism
• Manage reference histograms
• Configurable with XML

“visual check” by Atlas Control Room shifters (main shifter tool)
Histograms are organized in Physical Slices (electron/gamma, muon, jets,...)
OHP

- Supports hierarchy of tabs which contains predefined set of histograms
- Reference histograms can be displayed as well
- Sub-systems have several tabs with most important histos which have to be watched

Shifter Oriented Tool

Trigger chains of common interest regrouped in slices

40k Histos Received
Operational Monitoring Display

- Displays quantities in IS in time series, bar charts, tables or distributions
- Calculate basic statistics (sum, thresholds, averages, ...)
- Publishes back in OHP
- Configurable via Drag’n Drop approach → RunTime
- Mostly used to monitor L2 and EF farms

Two possible display levels:
Expert and User
Trigger Rates: one of the most useful quantities to monitor.
Sudden increase/decrease → Variation in ATLAS detector (TDAQ)

Trigger Rate Presenter:
A package that calculates, displays, archives and publishes the trigger rates

Main driving ideas:
• Client-Server architecture → Modularity
• Scalability
• Shifter user-oriented
Servers perform CPU intensive rate calculation

Clients:
- GUI showing timetrends and values in tables
- Archiver tool (in Root file)
- Web factory for html pages
Data Quality Monitoring Framework

Automatic checks on produced histograms
Many predefined algorithms for checks (e.g. non empty histograms, mean and RMS values, fitted parameters, KS test wrt reference histograms)
→ Also user defined checks

Output: A Data Quality flag:
- available in realtime to the shifter
- recorded in the Conditions DB
Data Quality Display

- General ATLAS tool → Trigger specific “tab”
- Results of checks build Data Quality Flags for Trigger
  - One flag per Trigger slice
- Configuration based on XML files
- Different configuration for different Run conditions (Cosmics, Beam, Single Beam, Early Beam)
- Color code indicates the status of each slice: ok, warning, bad, undefined, disabled
- DQMF duplicated in Tier0 and specific farms for quick offline monitoring
# ATLAS Remote Monitoring

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Web Monitoring Interface

- Periodically generates HTML pages with monitoring information.
  - Information **shown is fixed** and coded in the plugin
  
  → **non-expert oriented tool**

- 3 plug-ins are currently used at P1:
  - Run Status
  - Data Quality
  - Trigger Rates (from TRP)
  
  - Referenced from the ATLAS Operation page:
    - [http://pcatdwww.cern.ch/atlas-point1/operation.php](http://pcatdwww.cern.ch/atlas-point1/operation.php)
Remote Monitoring Partition

Monitoring at Point 1 (ATCN)

- DQM Framework
- Archiving Service
- Visualization Tools

Event Analysis Frameworks

Web Service

Remote Monitoring (CERN GPN)

Visualization Tools

Information Service (Mirror)

Web Browser

Information Service (IS/OH)

Data Flow/LVL1/HLT

Mirror partition replicates outside closed network most important data. Monitoring tools read the “mirrored” partition outside ATLAS
Performances with early data

ATLAS recorded real cosmics data in 2008 and 2009 (cf talk xyz)
TDAQ system in commissioning phase → Need a working Trigger Monitoring
• More than 150 event monitoring tasks per run
• 4 millions histogram updates per minute
• 100k histograms saved at the end of run

Will probably increase by a factor 3 with final system
Conclusions

• Online Monitoring Infrastructure for Trigger is deployed and works reasonably well.

Many tools for the trigger shifter are available

→ Trigger monitoring information is well covered

Further experience with real (collisions) data:

• Tuning of some part of this system (e.g. reference histograms for DQM)

• Optimize the interaction Shifter ↔ Trigger Monitoring tools
BackUp
The ATLAS Detector at LHC

Being assembled around Large Hadron Collider @ CERN
p–p collisions with $\sqrt{s} = 14$ TeV

44 m long, 22 m high, 7000 tons
140 Mchannels, 1 MB/event

Muon spectrometer
(CSC, TGC, MDT, RPC)

Calorimeters
(LArg, Tile)

1D (Pixel, SCT, TRT)

40 MHz collisions
100 kHz 1st level trigger
$O(100)$ stored events/s

The ATLAS Detector at LHC
The ATLAS Trigger System

Level-1 Trigger:
Provided by Calorimeters (EM and HAD) and Muon Spectrometer (RPC and TGC).
Coarse grained granularity.
Selects Regions of Interests (RoI) and identifies Bunch Crossing (BC)

Level-2 Trigger:
Access data in selected RoI.
Fine grained granularity.
Combination with other subdetectors, (e.g. ID Tracker)

Event Filter:
Access full event with full granularity
CAF is a pool of reserved (ATLAS trigger) PCs (8 multicore) in the lxbatch system
Access to several castor pools with dedicated disk servers (also RAW data)
Run users' jobs.

2 weeks of cosmics data taking June-July

As soon as data will start to flow → less idle time on CAF
Offline Trigger Monitoring-CAF

Different usages:
• Run HLT Trigger on Level-1 selected data (in particular express stream)
  • → Test new trigger keys before online deployment
  • Classify HLT errors (Run on Debug stream)
  • Run Trigger offline monitoring on RAW data
  • Rerun the trigger selection on the CAF
  • Produce “trigger ntuple”
  • Estimate trigger rates for new trigger menus (occasional and lower priority)

Ideal place to rerun the Trigger reconstruction on selected events.
Trigger Checks: Decision and Reconstructed variables
Can run TrigHLTMonitoring (Tier0) analysis with some additional checks switched on (avoid duplication of code)
Can run also “private” user's code or Trigger Offline shifter jobs.
The provider publishes an histogram on the OHS server, OHP is notified about the notification with timestamp $T_n$. OHP requests the histogram $H$ from the OHS server. If the histogram is not in the cache, it is requested from the OHS server. If the histogram is requested by a plugin, the OHP core retrieves it from the OHS server. After retrieving the histogram, the OHP core forwards the histogram to the plugin.
OHP
Monitoring Tools in ATLAS TDAQ

Reelaborate inserting L2 and IS
Remote Monitoring approach

- TDAQ Monitoring Working Group proposed and evaluated the following solution:
  - Run mirroring copy of the basic configuration and monitoring infrastructure services **outside** P1
  - Remote users can run the standard ATLAS Control Room X sessions on some dedicated machines **outside** P1
Data Quality Monitoring Framework

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Output: A Data Quality flag written in the Conditions DB