ATLAS CONDITIONS DATABASE AND CALIBRATION STREAM

Monica Verducci CERN/CNAF-INFN
(On behalf of the ATLAS Collaboration)
Siena 5\textsuperscript{th} October 2006
10\textsuperscript{th} IPRD06
Summary

- Introduction of ATLAS @ LHC
- Trigger System
- Streams
- Non-Event Data Storage
- Conditions DataBase Structure
- Access, Implementation and Test in the Commissioning
ATLAS @LHC

Collisions proton-proton
Energy: 7 TeV/beam
Luminosity: $10^{34}$ cm$^{-2}$ s$^{-1}$
(2007: $0.5 \times 10^{33}$ cm$^{-2}$ s$^{-1}$;
2008/09: $2 \times 10^{33}$ cm$^{-2}$ s$^{-1}$)
Inelastic Total Cross Section
$pp \quad \sigma_{\text{tot}(pp)} = 70 \text{ mb}$

Bunch-crossing frequency: 40 MHz
~ 20 collisions p-p per bunch crossing

$10^9$ events/s => 1GHz
1 event ~ 1MB (~PB/s)

Hierarchical trigger system
~MB/sec
~PB/year raw data
The ATLAS Trigger

Reduction of the event via 3 Levels of Trigger into 4 different output streams (200Hz, 320 MB/s):

- Primary stream (5 streams based on trigger info: e, µ, jet)
- Calibration and Alignment Stream (10%)
- Express Line Stream (Rapid processing of events also included in the Primary Stream 30 MB/s, 10%)
- Pathological events (events not accepted by EF)
ATLAS Computing Strategy

- **Tier-0 at CERN**: online (RAW) and first reconstruction (RECO/ESD Event summary data). Store Calibration data. RECO+RAW goes to Tier-1’s.
- **Tier-1**: store RECO/ESD provide services for simulation, reconstruction calibration and skimming (AOD Analysis Object Data). AODs go to Tier2.
- **Tier-2**: AOD for physics analysis, ESD and a small amount of RAW event format for calibration, calibration centers.
- **Tier-3**: User Analysis.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ATLAS</td>
<td>200</td>
<td>1.6</td>
<td>0.5</td>
<td>100</td>
<td>2</td>
</tr>
</tbody>
</table>

40 Mhz (1000 TB/s)
Calibration and Alignment Stream

Production of NON-EVENT DATA in different steps, used for the event reconstruction

- Input Raw Data can come from the event stream or be processed by the sub-detector read-out system. RODs level (not read-out by the standard DAQ path, not physics events: pulse signal)
- At the event filter level (standard physics events: $Z \rightarrow ee$, muon sample, etc.)
- After the event filter but before the “prompt reconstruction”
- Offline after the “prompt reconstruction” ($Z \rightarrow ee$, $Z+\text{jet}$, $\ell \ell$)
- Calibration Stream (technical detector stream)
  - An Inner Detector Alignment Stream (100 Hz reco tracks info 4kB)
  - A LAr electromagnetic calorimeter stream (50Hz of inclusive electrons pt > 20 GeV up to 50kB)
  - A muon calibration stream (Level1 trigger region ~10kHz for 6kB)
  - Isolated hadron (5Hz for 400 kB)

- Express Stream (processed promptly, i.e. within < 8 hours)
  - contain all calibration samples needed to extract calibration constants before the 1st-pass reconstruction of the rest of the data: $Z \rightarrow ll$, pre-scaled $W \rightarrow l\nu$, tt, etc.
  - Inclusive high-pt electrons and muons (20Hz with full event read-out 1.6MB)

- These streams sum to a total data rate of about 32MB/s, dominated by the inclusive high pt leptons (13% EF bandwidth= 20Hz of 1.6MB events). RAW Data -> 450 TB/year. More streams are now subsumed into the express stream
ATLAS DataBase:
Configuration DB

- Configuration Database
  - Data needed at the start of the run to configure
    - Sub-Detector hardware and software
    - Data defining the configuration of the TDAQ/DCS/subdetector hardware and software to be used for the following run
    - Different configurations can be available (cosmics, physics, calibration, …)
    - Configuration data can evolve into conditions
ATLAS DataBase: Conditions DB

- **Conditions Database**
  - Non-event detector data that could
    - Vary with time
    - May exist in different versions
    - Data coming from both offline and online
  
- **Used for**
  - Diagnostic by detector experts
  - **Calibrations and Alignment**
  - Event Reconstruction and analysis
  - Conditions data
  - Geometry, DCS, alignment, calibration
Condition Database II

- The CondDB is accessed by the offline reconstruction framework (ATHENA).
- The interface is provided by COOL (COnditions Objects for LHC), implemented using CORAL:
  - LCG RelationalAccessLayer software which allows database applications to be written independently of the underlying database technology.
  - COOL databases can be stored in Oracle, in MySQL or in SQLite.
  - Database schema optimized for IOV retrieval & look-up.
COOL Implementation

- COOL:
  - Heavily influenced by Lisbon MySQL implementation and feedback from ATLAS use in CTB and elsewhere
  - Tight integration with other LCG software components (SEAL, POOL)
  - Both Oracle, MySQL and SQLite implementations
  - Within ATLAS, the master conditions database at CERN will be stored using Oracle, as will all Tier-1 replicas.
  - COOL provides a C++ API, and an underlying database schema to support the data model.
    - Once a COOL database has been created and populated, it is possible for users to interact with the database directly, using lower-level database tools
COOL implements an interval of validity database
- objects stored or referenced in COOL have an associated start and end time between which they are valid.
- times are specified either as run/event, or as absolute timestamps in agreement with the meta-data stored.

COOL data are stored in folders (tables)
- Database = set of folders
- Within each folder, several objects of the same type are stored, each with their own interval of validity range

COOL folders can be
- **SingleVersion**: only one object can be valid at any given time value
  - DCS data, where the folder simply records the values as they change with time
- **MultiVersion**: several objects can be valid for the same time, distinguished by different tags
  - calibration data, where several valid calibration sets may exist for the same range of runs (different processing pass or calibration algorithm)
Access to COOL from Athena is done via the Athena IOVDbSvc (provides an interface between conditions data objects in the Athena transient detector store (TDS) and the conditions database itself).

1. When reading event data, the IOVDbSvc ensures that the correct conditions data objects are always loaded into the Athena Transient Detector Store (TDS) for the event currently being analysed.

2. When writing conditions data, the user puts the data into the TDS and then calls various support services to have it output and registered in the conditions database.
Tests & Applications: Commissioning

- During 2006-2007 the ATLAS collaboration will be deeply involved in the detector and software commissioning
- First Data will be collected and stored into the Databases
- Tests of all the chain, transfer of data (streaming), access to the data in reconstruction job
- First “real data”, test of reconstruction using the calibration and alignment parameters from Database.
Csc 2006

- CSC06, computing system commissioning has started
- Detector alignment and calibration procedures in the main data flow (detector misalignment in the simulation)
- Condition database
- Detector inefficiency
- Study of latency
What data samples in 2007

\[ \sqrt{s} = 900 \text{ GeV}, \quad L = 10^{29} \text{ cm}^{-2} \text{ s}^{-1} \]

Interaction rate \( \sim 10\text{kHz} \)

- **Jets** \( p_T > 15 \text{ GeV} \) (b-jets: \( \sim 1.5\% \))
- **Jets** \( p_T > 50 \text{ GeV} \)
- **Jets** \( p_T > 70 \text{ GeV} \)
- \( \Upsilon \rightarrow \mu \mu \)
- \( W \rightarrow e\nu, \mu\nu \)
- \( J/\psi \rightarrow \mu \mu \)
- \( Z \rightarrow ee, \mu\mu \)

30% data taking efficiency included (machine plus detector)
Trigger and analysis efficiencies included

+ 1 million minimum-bias/day

- Start to commission triggers and detectors with collision data (minimum bias, jets, ..) in real LHC environment
- Maybe first physics measurements (minimum-bias, underlying event, QCD jets, ..) ?
- Observe a few \( W \rightarrow l\nu, \Upsilon \rightarrow \mu \mu, J/\psi \rightarrow \mu \mu \) ?
Conclusions

- The ATLAS Computing TDR (2005) defined the strategy and architecture of the databases and data streaming.
- Every sub-Detector community has started to implement and test the database schema, storage way and access.
- The ATHENA framework will be ready to check all the chain for the CSC and using the commissioning data.
- Next year will be crucial and will be the last opportunity to test all before data taking.
ATLAS EVENT FORMAT

The physics event store holds a number of derived event representations, from RAW to analysis formats.

- **RAW Data**: Output by Event Filter for reconstruction (1.6MB/event, 200Hz) to Tier0 in files of 2GB
- **ESD (Event Summary Data)**: POOL Root Files obtained by the reconstruction (0.5 MB/event)
- **AOD (Analysis Object Data)**: derived by ESD but reduced representation suitable for the analysis (100kB/event)
- **TAG (Tag Data)**: event level metadata, used for analysis queries (1kB/event)
- **DPD (Derived Physics Data)**: ntuple-style for end-user analysis and histogramming
Databases are organized collections of data
• Organized according to a certain data model
• The data model defines not only the structure but also which operations can be performed
Access Schema (ATHENA)

Begin Run or Event - Read scenario

1) Begin Run or Begin Event
2) delete obj
3) callback
4) retrieve CondObjColl
5) update address
6) get payload
7) set IOV
8) createObj
8') createObj
8") read obj

IOVSvc

IOVDbSvc

DetectorStore Service

Transient Detector Store

CondObjColl

CondObj

AthenaPoolConvSvc

Converter

POOL File/DB