Reinforcing User Data Analysis with Ganga in the LHC Era: Scalability, Monitoring and User-support

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Challenges in a LHC Data Analysis

Data volumes
- LHC experiments produce and store several PetaBytes/year
- e.g. ATLAS recorded \( \sim 700M \) events at \( \sqrt{s} = 7 \) TeV in 2010 so far

CPUs
- Event complexity (large number of channels) and number of users demands: at least 100000 fast CPUs based on computing model

Software
- The experiments have complex software environment and framework

Connectivity
- Data should be available 24/7 at a high bandwidth

Distributed analysis tools must/should be
- Easy to configure and fast to work with
- Reliable and jobs should have 100% success rate at 1st attempt
Data

- Centrally organized data distribution by data management system (DQ2) according to computing model

Experiment software (Athena) distribution kits

- Centrally organized installation on EGEE, OSG and NG

User jobs

- Model: „Job to Data”
- Tools for user job management: Ganga and Panda clients

User Output

- Store on site scratchdisk or transfer on demand to remote site
- Retrieve output with DQ2 command line tools to local computer
Example: ATLAS Data Distribution

≈ 80 Tier1/2/3 sites managed by DQ2 right now
Example: ATLAS Distributed Analysis Layers

Data is centrally being distributed by DQ2 - Jobs go to data
Front-end Client: GANGA

http://cern.ch/ganga

- A user-friendly job definition and management tool.
- Allows simple switching between testing on a local batch system and large-scale data processing on distributed resources (Grid)
- Developed in the context of ATLAS and LHCb similar to open source community-driven project
- Core development is joint between LHCb and ATLAS
- Component architecture readily allows extension
- Mature and stable, with an organized development process - release management shifts and extensive release testing
- Python framework and GPL License
**Distributed Analysis: Ganga**

How to manage the workflows: **Job scheduler/manager: GANGA**
Example job workflow

**User**
- User code
- Input Dataset

**Ganga Client**
1. Environment parsing
2. Dataset Database query
3. User Area tar ball creation

**Grid Worker Node**
4. Job(s) submission
5. Environment setup
6. Inputfile List generation
7. Athena code execution
8. Stage-out output files
9. Output Sandbox retrieval
10. Output files download
11. Output files merging
12. Jobs resubmission
Recently added features I

New job repository
- Job repository is core Ganga component for job bookkeeping and monitoring
- New XML based architecture - more reliable and faster (LHCb start-up time: 1-2s)
- Easily holds several 10k jobs and very fast start-up through lazy loading

Error reporting
- Upload environment to server with single command for user support

Task Monitoring Dashboard
- New ATLAS application monitoring plug-ins
- Job statistics displayed central dashboard webpage

CREAM backend
- Direct submission to CREAM CE

WebGUI monitoring
- New WebGUI based monitoring
Recently added features II

GangaAtlas:
- **GangaTasks**: Automatic job configuration, steering, throttling, resubmission
- Plugin for ATLAS Metadata Interface (AMI) for event based job splitting and luminosity information
- Plugin to Event-Level Database (ELSSI) for event picking
- Many new features for Panda backend
  - Different ROOT based workflows
  - Cross site job brokering
- Job performance and statistics collection for HammerCloud

GangaLHCb:
- See talk from M. Williams in this session

Further interesting plugins:
- GangaSAGA: Plugin for SAGA-API
- GangaJEM: Job level monitoring plugin
Number of Ganga Users

Unique users by week and experiment (2010):

- Total number sessions: 370413, Number unique users: 1319, Number of sites: 130
- Since start of 7 TeV collisions large increase of distributed analysis jobs
User support is very important but time consuming

Central ticketing system for site or grid middleware problem: GGUS

- Site or experiment experts try to solve problems
- Often "one-way" communication

Support mailing list for analysis tools

- Central discussion board for "all" problems
- Discussion of several people
- E.g. in ATLAS and LHCb:
  - Before: only developers as experts - very time consuming
  - Now: experiment shift teams with shift credits
  - Very busy mailing list
  - Hope: user-to-user support similar to open-source projects

- Sites are more stable but still day to day glitches
Infrastructure Tests - Analysis stress tests

ATLAS is/has been testing sites with very high automatic generated analysis load and functional tests: HammerCloud http://hammercloud.cern.ch/

(See presentation by D. van der Ster and Poster by F. Legger)

Now also available for CMS and soon for LHCb

Ingredients and Highlights:

- Ganga is central „engine” for job configuration, submission, performance collection
- User Analysis puts much higher load on SE compared to CPU dominated simulation
- Analysis tools generally stable and reliable
- Some weak spots detected in site infrastructures, especially in input file access mode lots of tuning potential
- From functional tests: usually only a handful of sites have temporary problems
Next steps

- Consolidate current workflows
- Add more MSG based monitoring to more applications and backends
- Extend WebGUI features
- Make GangaTask plugin accessible for all Ganga applications and backend
- More release testing and nightly builds
- Outreach: Development blog
Prospects and Evolutions

- Infrastructure demonstrated to be able to support LHC data processing and analysis
- A reliable and robust service of many components necessary
- Significant operational infrastructure behind it
- Adapt to future technologies:
  - Improve data storage and data access
- Network is much better than initially anticipated
  - Rethink data access models
- Experiments have truly distributed models

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