ATLAS Distributed Data Analysis: performance and challenges

Dr. Farida Fassi
Mohammed V University, Rabat, Morocco

on behalf of the ATLAS collaboration
Large Hadron Collider (LHC)

- LHC is the largest and most powerful particle accelerator ever built.
- Major goal is to provide an experimental verification of different theories within particle physics and high-energy physics with the primary physics targets:
  - Precise measurement of the Higgs boson and search for new Physics
- The LHC is contained in a circular tunnel 27 km in circumference. 1,600 superconducting magnets
- LHC accelerates and collides beams of hadrons (composed of quarks):
  - protons (at 7 TeV)
  - atomic nuclei (PbPb, 2.76 TeV per nucleon)
- The LHC is a Discovery Machine. The LHC will determine the Future course of High Energy Physics
**ATLAS (general purpose detector)**

- Length: 44 m, diameter: 25 m
- Mass: ~7.0 ktons
- Two magnet fields:
  - Solenoid (ID): 2 T
  - Toroid (Muon System): 2-8 Tm

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ATLAS collaboration: human challenge...

- ATLAS experiment:
  - 176 Institutions
  - 38 Countries,
  - 3000 Physicists

- A Brief history:
  - many years from conception to start of operation

- Successful data taking:
  - First collisions at 0.9, 2.36 TeV (2009)
  - First collisions at 7 TeV (2010)
  - First collisions at 8 TeV (2012)
  - Successful start up, first collisions at 13 TeV foreseen 2015
LHC Run-1: Great achievement!

- Higgs boson is a major scientific discovery acknowledged by the 2013 Nobel Prize in physics

Grid computing enables the rapid delivery of physics results
Distributed Data Analysis overview (1/2)

- The ATLAS experiment is recording and simulating several 10's of PetaBytes of data per year.
- Production and Distributed Analysis system (PanDA) is the Workload Management System (WMS) to run jobs on Grid.
- Distributed Data Management (DDM) system distributes data everywhere.
- ATLAS Physicists use PanDA that manages the tasks and jobs to process and analyze these data.
- PanDA is highly sophisticated and automated WMS making distributed resources optimally accessible by all users.
- Grid Computing is essential tool to success of scientific program at LHC.

WLCG is a worldwide collaborative effort on an unprecedented scale in terms of storage and CPU requirements.
PanDA is an unified system for Production and User Analysis capable of operating at LHC data processing scale.

Flexibility in adapting to evolving hardware and network configurations.

Production: central production
- Layer above PanDA to create jobs from ATLAS physics tasks
- Generation, simulation, reprocessing and group production

User Analysis: friendly-user interface; PanDA-clients and Ganga
- User submits “tasks” which are converted to many jobs for parallel execution.
- The tasks are routed to sites based on the availability of relevant data and processing resources.
User Analysis WorkFlow

1. ATLAS specific Front-end interface Ganga, PanDA clients
2. ATLAS specific software Workload Management System (PanDa); Data Management (DDM)
3. Grid middleware WLCG, OSG, ARC
4. Computing & Storage resources
5. User outputs
6. Publication
7.
PanDA performance (1/2)

Completed jobs daily ➔ peaking at ~1.5 Million jobs
PanDA performance (2/2)

- Over 150k of sustained pace of concurrent jobs per day including:
  - data reprocessing, user analysis, MC production

- In 2014 PanDA successfully managed jobs over >100 sites, submitting by >1500 users
Monitoring & site validation

- The monitoring system is critical for the success of all activities on the grid
- It is the key for synchronizing distributed Operations
- End-to-end testing tool for Grid sites
- sites validation before receiving activities
- Stress tests mimicking user analysis are used for automatic exclusion of sites failing the tests from brokerage
- Big improvement of success activities
Distributed Analysis Support Team (DAST)

- DAST provides the first contact point to help thousand of grid users
  - DAST deals with all kind of the distributed analysis-related-issues.
  - an efficient user support is crucial to get physics results fast.

- DAST plays a key role to solve these users-related-issues:
  - Panda-clients and Ganga,
  - ATLAS software, Physics Analysis Tools
  - Site service problems
  - DDM-clients, data access at sites and data replication
  - Monitoring system

- Two expert shifters on duty during working hours; one in the North American time zone and one in the European time zone, covering 16 hours/day.
DAST traffic

- From 1,079 users, we have exchanged 95,654 emails.
- Since Oct. 2008 until 2015 more than 10,000 a year.
- DAST continues to be a very successful first-level contact for ATLAS users with Grid analysis issues.

Emails Received

Peaking at more than 15K received e-mails
To face the Run-2 challenge huge efforts are done during LHC shutdown to improve the ATLAS distributed computing system. The challenge how optimally process and analyse the data and produce timely physics results that end up in a great success as Run-1.
New developments in PanDA

- PanDA was extended with special components:
  - Collecting network metrics from different providers
  - Organized collected data and arrange it in proper format
- Brokerage considers these data to make decision when brokering jobs.
- JEDI (Job Execution and Definition Interface) is the new framework for Distributed Analysis, offering a tremendous improvements:
  - Dynamic job definition optimizing resource scheduling
  - Automated recovery of lost data
  - Advanced task management interface
  - Efficient retrial mechanism for failed jobs
- BigPanDA is the new PanDA monitoring system

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New Distributed Data Management (DDM)

- **Rucio is the new generation** of data management system
  - Rucio is a sophisticated system, equivalent performance as previous DDM in core functionalities
- **The new data lifecycle model**; every dataset has a lifetime set at creation. The lifetime can be infinite (e.g. RAW data)
  - The lifetime can be extended if the dataset is accessed
- **Datasets with expired lifetime can disappear at any time from disk and tape storage system**
- **Rucio manages data replication and reduction within the lifetime range to increase and/or reduce the number of copies based on data popularity**

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Conclusions

- The LHC machine, the ATLAS experiment, the computing facilities behaved brilliantly during Run-1, and we have a major scientific discovery in our pocket; the Higgs Boson
- We are ready for Run-2 challenge
  - Run-2 which will allow to have access to a higher mass regime, sensitive to new Physics
- Computing is crucial factor for the success Physics program of the LHC experiments
backup
PanDA