Distributed analysis functional testing using GangaRobot in the ATLAS experiment

Federica Legger for the ATLAS collaboration

Geschwister-Scholl-Platz 1, 80539 München, Germany
E-mail: federica.legger@cern.ch

Abstract. Automated distributed analysis tests are necessary to ensure smooth operations of the ATLAS grid resources. The HammerCloud framework allows for easy definition, submission and monitoring of grid test applications. Both functional and stress test applications can be defined in HammerCloud. Stress tests are large-scale tests meant to verify the behaviour of sites under heavy load. Functional tests are light user applications running at each site with high frequency, to ensure that the site functionalities are available at all times. Success or failure rates of these tests jobs are individually monitored. Test definitions and results are stored in a database and made available to users and site administrators through a web interface. In this work we present the recent developments of the GangaRobot framework. GangaRobot monitors the outcome of functional tests, creates a blacklist of sites failing the tests, and exports the results to the ATLAS Site Status Board (SSB) and to the Service Availability Monitor (SAM), providing on the one hand a fast way to identify systematic or temporary site failures, and on the other hand allowing for an effective distribution of the work load on the available resources.

1. Introduction

Due to the large amount of storage space and processing power needed to analyse LHC data, the ATLAS computing model is based on the use of grid resources [1]. Grid sites with various hardware and software configurations are therefore required to run arbitrary user applications, on the other hand analysists rely on site availability to get their physics results.

To meet the user demand of a stable and reliable system, and to help site administrators spot failures, HammerCloud, a tool allowing the automated testing of distributed analysis resources, has been developed [2]. Specifically, the HammerCloud framework creates and submits several real ATLAS user applications to the various sites using the distributed analysis framework GANGA, a front-end for easy grid job definition and management [3].

Within HammerCloud, two types of tests can be defined: stress and functional tests. Stress tests are meant to test the site behaviour under heavy load, and are tailored to stress specific components of the infrastructure. Stress tests are normally large-scale tests running on one or more sites on demand. Functional tests are automated tests run on each site at high frequency. They consist of a standard user application with a short execution time (normally some minutes) to ensure that the site is available and able to execute user analysis jobs. Functional tests are monitored by the GangaRobot framework. The results are used to blacklist the sites failing the tests, and exported to the ATLAS Site Status Board (SSB) and to the Service Availability Monitor (SAM). After a brief introduction to distributed analysis in ATLAS in section 2, the GangaRobot framework will be described in section 3.
2. Distributed analysis
A typical user analysis in the ATLAS experiment can be of the following type:

- Athena analysis on both Monte Carlo and collision data, using various types of input: AODs, DPDs, ESD [4];
- TAG-based analysis, which requires direct access to data using a metadata index;
- calibration and alignment studies, requiring access to the conditions database;
- private Monte Carlo production;
- ROOT analysis.

In the ATLAS distributed analysis environment, the typical analysis workflow is depicted in Fig. 1. The user has the choice between two frontends to prepare and submit applications to the grid: the aforementioned GANGA and pathena [5]. The frontend submits the analysis job to the backends, which are workload management systems. GANGA allows the user to submit applications to PanDA (Production and Distributed Analysis system) [6], the gLite WMS (Workload Management System) [7], and the ARC (Advance Resource Connector) [8]. pathena is a PanDA client. The backends are then responsible for sending the user job to various computing grids, namely the Open Science Grid (OSG) [9], the EGEE grid [10], and NorduGrid [11]. The management of distributed data is accomplished by the Don Quixote 2 (DQ2) service [12].

3. GangaRobot
GangaRobot is a tool designed to perform regular tests of all grid sites by running arbitrary user applications with varied configurations at predefined time intervals. First, an operator defines a functional test template using the HammerCloud administrator web interface. Test templates contain information about the specific Athena version to be used, a list of input datasets, a bundled package with the analysis code, the list of sites to be tested, and the data access method to be used at the site (direct I/O, FileStager, copy-to-scratch). Functional test templates using a predefined data access are (see Fig. 2):

- sample user analysis code to be executed on Monte Carlo data, using default data access method or Filestager,
- A D3PD\(^1\) production code running on collision data, testing Frontier/SQUID access.

\(^1\) Flat ntuple format currently used in ATLAS data analysis.
Test templates are stored in the HammerCloud database. If the test template is flagged as active in the database, a functional test is automatically created. HammerCloud uses GANGA to submit the test jobs to the sites defined in the job test template. The job status is also monitored by GANGA, and the result of each job is stored in the HammerCloud database. GangaRobot publishes the test results on its website, and on grid monitoring services such as the ATLAS Site Status Board (SSB) [13] and the Service Availability Monitor (SAM) [14].

Each functional test runs for 24 hours. After that, if the template is still active, a new test is created. Functional tests are configured to have only one job running at each site at any time. A typical job processes only 100 events from the input dataset, in order to keep the execution time short. As a result, jobs are submitted with high frequency and site performances can be recorded in short time intervals. Functional tests are meant to test the sites’ abilities to accept and process user analysis jobs without overloading the sites with test jobs that would consume resources unnecessarily. Currently there are 8 concurrently running functional tests in GangaRobot. Each test runs for 24 hours and in that time submits approximately 2000 jobs to the worldwide sites. Test status can be checked on the HammerCloud web page (see Fig. 3(a)). Detailed information on the properties and metrics of the running tests, as well as access to the test log files, are also available on the HammerCloud website (see Fig. 3(b)).

The complete HammerCloud/GangaRobot workflow is shown in Fig. 4.

Functional tests are used to evaluate site performances. The site efficiency is defined as the number of jobs who successfully completed in the last 24 hours divided by the number of total jobs (successful and failed). Only tests using Monte Carlo data are used to calculate the efficiency. An overview of site efficiencies is shown on the GangaRobot web page (see Fig. 5). Efficiencies are recalculated every hour. EGEE sites with efficiencies less than 80% are automatically placed in a ‘blacklist’, i.e. this information is used by GANGA to prevent user analysis jobs from being sent to problematic sites. An automatic blacklisting scheme for PanDA sites is currently under development.

GangaRobot also exports functional test results to the ATLAS SSB and to the SAM monitoring system, providing information to evaluate site ranking and availability as a function of time (see Fig. 6). In general, most EGEE sites have an availability larger than 90%, also including scheduled downtimes. Remarkably only a handful of sites have availabilities smaller than 80%. Problems at a site are normally of transient nature.

4. Summary and conclusion
Despite the complexity of the grid infrastructure and very different use-cases, end-users expect their analysis code to execute smoothly in a distributed analysis environment. To ensure this, HammerCloud, a framework to validate distributed analysis resources, has been developed. It
Figure 3. The HammerCloud website: view with currently running functional tests (a) and detailed view for each running test (b).

allows for rapid definition, execution, and monitoring of tests aimed to check the capability of grid sites to accept and successfully execute user analysis jobs.

GangaRobot uses the HammerCloud framework to run automatic functional tests, i.e. light sample user applications submitted at high frequency (5-10 per hour) to monitor site availability. Such tests are used to help site administrators to quickly spot site failures, and to prevent user analysis jobs from being sent to problematic sites. The front-end client GANGA uses GangaRobot information to automatically blacklist sites failing more than 20% of the functional tests submitted during the previous 24 hours. GangaRobot results are published on the HammerCloud/GangaRobot web site and on grid information services such as the ATLAS SSB and SAM. Functional test results show that site availability is generally very high (around 90%), and that site failures are usually temporary and solved in a short time.

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| Country | Cities | Site Efficiency Code | Test Sites |
|---------|--------|----------------------|------------|
| CA      | Panda  | ANALYSISF_U, ANALYSISTRUNKF_U, ANALYSISAUSTRALIA | CA_PANDA   |
| DE      | Panda  | ANALYSICYT, ANALISYFREEBURG, ANALISYFZ | DE_PANDA   |
| ES      | Panda  | ANALYSISJCIC, ANALYSISPIC, ANALYSISIFAE, ANALYSISUAM | ES_PANDA   |
| FR      | Panda  | ANALYSISBEIJING, ANALISYCPPM, ANALISYGRIF-IRFU, ANALISYGRIF-LAL, ANALISYGRIF-LPNHE | FR_PANDA   |
| IT      | Panda  | ANALISYNFIN-NAPOLI, ANALISYNFIN-ROMA | IT_PANDA   |
| NL      | Panda  | ANALISYSTEP, ANALISYJINR, ANALISYHEP, ANALISYTR-ID-UUARK,IM | NL_PANDA   |
| TO      | Panda  | ANALISYCE, ANALISYCAI, ANALISYIT | TO_PANDA   |
| TW      | Panda  | ANALISTAIWAN, ANALISTW-FIT | TW_PANDA   |
| UK      | Panda  | ANALISYGLASGOW, ANALISYLANCS, ANALISYOMUL | UK_PANDA   |
| US      | Panda  | ANALISYBNL-ATLAS, ANALISYNET2, ANALISYSLAC, ANALISYSLAC, ANALISYSLAC, ANALISYSLAC | US_PANDA   |

Tests used -- LCG: UA 15.6.9 DQ2Local and Filestage - Panda: UA 15.6.9 Default data access and Filestage

Click to see: Test efficiency in the last 24 hours, Ganga blacklist for WMS (efficiency <80% in the last 24 hours)

**Figure 5.** The GangaRobot web page: an overview of site efficiencies in the last 24 hours.

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Figure 6. EGEE site availability ranking (a) and availability as a function of time (b), as provided by the SAM system based on functional test results.