EDG integration and validation in the framework of ATLAS Data Challenges.

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Abstract

The ATLAS experiment is designed to study the products of high-energy proton-proton collisions at the Large Hadron Collider (LHC), currently under construction at CERN, near Geneva (Switzerland). It is operated by a worldwide collaboration and is expected to produce over one petabyte of data per year. To cope with this vast amount of data to process and the large number of geographically scattered users, a distributed computing model is evolving, relying on the development of a generalized network of computing resources, the Grid.

We report on the use and validation of the European DataGrid (EDG) middleware throughout the first phase of the Data Challenges of the ATLAS experiment, held over last year.

The ATLAS experiment [1], due to start in 2007, will study the products of interactions between two high-energy proton beams produced by the Large Hadron Collider (LHC) at CERN, near Geneva (Switzerland). It involves two thousands of physicists, from 150 institutes over the world, and will require analysis and processing of data volumes of several petabytes per year.

As no single computing centre can handle this volume of data and users, the collaboration opted for the parallel development of regional computing resources, put together on a global computing network called the Grid or Data Grid. This global network is not yet in place, although several regional networks exist, forming a local Grid project.

Among the projects aiming to develop such a computing grid, the European DataGrid project [2] (EDG), initiated by the CERN in collaboration with institutes across Europe, is being tested by several HEP experiments including this one.

The ATLAS Data Challenges [3] are set to validate the data processing software developed by the collaboration within the distributed computing model mentioned above, to prepare for the data taking scheduled to start in 2007.

A natural extension of these Data Challenges is to port the data processing software into a grid environment and intensively test the grid middleware associated to a given project.

The work related in this paper is the validation of the EDG middleware in the

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framework of the Data Challenges, and the integration of the ATLAS software used during Data Challenges in the Grid project.

The layout is the following: we start by describing the European DataGrid project and associated middleware, then detail the Data Challenges. We follow up with the integration of both and the description of one of the tests performed over last year. Finally, we will make some remarks about the coming LHC Computing Grid [4] (LCG) project that will take over EDG and conclude.

1 The European Data-Grid project.

1.1 Overview.

The European DataGrid project is a 3 year project funded by the European Union and initiated by CERN and associated European Institutes. The goal is to build a prototype Data Grid fulfilling the needs of participating collaborations, including non-HEP (like Earth Observatory and Bio-medical research).

Each collaboration is associated to a Virtual Organization (VO), a structure that grants access to supporting sites’ resources to its registered members. The map in Figure 1 illustrates the sites supporting the ATLAS VO.

Resources are located on individual sites. These sites are usually small size computing farms, containing one Computing Element (CE) that hosts the batch server and the experiments run-time environments, at least one Worker Node and one Storage Element (SE) to store the data. Larger sites can host dedicated servers like a Resource Broker (RB, key server for job and resource management across the Grid), a Replica Catalogue (RC, for data management) or a Mass Storage Server (tape).

GRIDPP [5] is the UK contribution to the Grid project, involved in both middleware development and support to the EDG project.

Figure 1: Map of EDG sites (detail).

1.2 Grid Setup.

Users log into the Grid by activating their GLOBUS certificate. To ensure that their job will go to the right processing place, they use a job description file to list the components of the job and the running requirements. They submit this list to a Resource Broker that builds a ranked list of Computing Elements matching the job requirements. The Replica Catalogue is used in this evaluation when the job is bound to a registered data file. The Resource Broker sends the job and its associated files (Input Sandbox) to the first CE on its list for remote, local processing.

Output data produced locally can be registered for future use into the Replica Catalogue, or replicated on another Storage Element. Finally, when the submitted job is finished, the CE sends back to
the RB the logfiles and requested output files (Output Sandbox). The User checks the job status and retrieves its output by querying the RB.

2 The ATLAS Data Challenges.

2.1 Overview.

The Data Challenges (DC) are testing the ATLAS offline software within the proposed distributed computing model, by generating and processing simulated data on sites all over the world. Some of these sites belong to a regional Grid project, some do not. The main issues in such heterogenous environment are data management, software deployment and timely production.

2.2 Details of the phase 1.

The phase 1 of Data Challenges, started in mid-2002, describes the complete chain of simulated data production reproduced in Figure 2.

![Figure 2: DC data processing flow.](image)

The data produced is used to optimise detector settings (event filters) for future data taking operation. It amounts to 60 Tbytes shared between production sites. The whole production took approximately 155 KSI95 days.

3 Testing the EDG.

A joint group ATLAS-EDG made of representatives of EDG and producers from the Data Challenges formed last year to evaluate the EDG middleware, then adapt the Data Challenge software for further testing of EDG. A first series of tests was held in end 2002, for which the ATLAS run-time environment was updated to the standard ATLAS distribution used in the Data Challenges. The test consisted in the submission of long, computing intensive simulation jobs by three operators, to evaluate the robustness and the response of involved components (CE, SE, RB, RC). Input and Output data files were registered in the Replica Catalogue and replicated on different sites. The test was done initially for EDG 1.2 and repeated for EDG 1.4 [6]. Success rates were unfortunately rather small.

The most recent tests were small-scale production, to demonstrate the reliability of the prototype Grid in the preparation for the next step, production Grid, that will be achieved by the LCG project. They both take place at the Reconstruction level (see Figure 2), are not CPU intensive but require large (~ 1.3 Gb) input files.

The presentation illustrates the Reconstruction test performed in UK.

We used the job description file and the Resource Broker to select a handful of sites in the UK, to ease the data replication from and to RAL.

Running ATLAS reconstruction requires 500 Mb of memory and an open Outbound IP to access an external database. Furthermore, the run-time environment was not updated to the right reconstruction release, so we had to use standalone pre-built boxed sets as executables.
After validating the candidate sites by running a single job on a common input file, we started the mass data replication from RAL datastore to the Storage Elements, using RAL’s dedicated interface and globus-url-copy for the replication. Once completed, the job submission followed. As this prototype Grid suffers from a unsteadiness from the Resource Broker, we had to share the 300 jobs between two servers and submit them by batches of no more than 15 jobs at a time. Output data was left on the Storage Elements, and replicated afterwards into RAL datastore. Results of the tests are described on Table 1.

<table>
<thead>
<tr>
<th>Site</th>
<th>RAL-PRO</th>
<th>CAMB</th>
<th>IC</th>
<th>BH</th>
</tr>
</thead>
<tbody>
<tr>
<td>N Alloc</td>
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<td>180</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>N Succ.</td>
<td>57</td>
<td>170</td>
<td>40</td>
<td>17</td>
</tr>
<tr>
<td>N aver.</td>
<td>12</td>
<td>16</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>N max</td>
<td>20</td>
<td>16</td>
<td>8</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 1: Results of the test by site.

RAL-PRO is RAL’s EDG farm, CAMB is for Cambridge, IC for Imperial College, London, BH for Birmingham. N Alloc is the number of allocated jobs, N Succ is the total number of successful jobs. N aver. is the average number of jobs running at the site, giving an idea of the site occupancy and N max is the number of Worker Nodes.

An overall success level larger than 90% is achieved, which is encouraging for the next step of this Grid project, moving from prototype to production testbed. From the HEP point of view, this will be ensured by the LCG project (LHC Computing Grid), merging EDG and VDT (US Grid) projects to turn them into a production grid spanning over US and Europe. This project has started to be deployed during this summer and shall be running soon.

4 Conclusion.

We have successfully managed to run a small part of ATLAS data challenges on the prototype European DataGrid. As the coming production grid takes over, a more significant part of the production will be done on the Grid, aiming towards a completely distributed data processing by the start of data taking in 2007.

References


