A GLOBALLY DISTRIBUTED GRID MONITORING SYSTEM

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ABSTRACT

A grid environment involves large scale sharing of resources that are distributed from a geographical or an administrative perspective. There is a need for systems that enable continuous discovery and monitoring of the components of a grid. In this work, we discuss the development and deployment of a monitoring system that has been designed as a prototype for the D∅/SAM-Grid. We have developed a system that uses a layered architecture for information generation and processing, utilizes the various grid middleware tools, and implements Integration and Enquiry Protocols using existing Discovery Protocols to provide a user with a coherent view of all current activity in this grid - in the form of a web portal interface. The prototype system has been deployed for monitoring of 11 sites geographically distributed in 5 countries across 3 continents. This work focuses on the D∅/SAM-Grid, and is based on the SAM system developed at Fermilab.

KEYWORD: GRID, D∅/SAM-GRID, PROTOCOLS

INTRODUCTION

Humans continuously keep developing new methodologies to solve the complex science and engineering problems. The requirements of these new scientific methods, however, tend to supersede capabilities of the contemporary underlying technology. High-energy physics is one such scientific domain; it has immensely helped in exploring the phenomena that range from the smallest particles of nature to the largest galaxies in the universe. Some of the greatest breakthroughs in high-energy physics rely on experiments that generate huge amounts of data. The analysis of this data can be facilitated by computing technologies like high-performance computing, simulations, data analysis and distributed computation – which require availability of enormous computing power. However, with the current pace of advancements in high-energy physics experiments, the available computing power may need to be harnessed much more effectively. A *solution* to this task of finding solutions to complex scientific problems is *grid computing*. The global scientific community is paying a lot of attention to this enabling technology. With global computing grids being setup all over the world by international collaboration, there is a need for the ubiquitous monitoring of this distributed computing power.

1.1 The Grid

2.1 'The Grid' as a term in computing world, was formulated in the last decade. It referred to an envisioned advanced distributed computing paradigm with capabilities to ultimately assist in solving complex science and engineering problems beyond the scope of existing computing infrastructures [BLUEPRINT]. The concept has evolved considerably over these years. The growing popularity has also resulted in various kinds of 'grids', common ones being known as Data grids, Computational grids, Bio grids, Clus

The D∅/SAM-Grid

The SAM system (an acronym for Sequential Access to data via Metadata) has been developed at Fermilab [SAM-1] to handle the data management of the Run II experiments of high-energy physics. In this context, sequential refers to the layout of physics events stored within files, which in turn are stored sequentially on tapes within a Mass Storage System (MSS). SAM provides transparent delivering of files and managing of caches of data. This system is the sole data management system being used by the D∅ experiment at Fermilab, and other experiments like CDF at Fermilab have also started using this system.

Based on the success and popularity of SAM, a larger architecture has been conceived that enables the existing system to fully evolve into a grid known as the D∅/SAM-Grid. This architecture incorporates grid level job submission and management, and grid information services [SAM-1].

ter grids, Science grids, among many others [FOSTERARTICLE]. Effort is in progress to converge the concepts related to the architecture, protocols, and applications of these grids to formulate a *single* paradigm – the Grid.

Heterogeneous Distributed Grid Computing Architecture

In this chapter the hardware and architecture of the SUNY IT and BITS Grid will be examined. In addition, the middleware components will be discussed. Each section provides background into the development and design of the heterogeneous Grid.

Hardware and Networking Background

The SUNY IT heterogeneous Grid is represented in the figures 3-1 and 3-2 below. This section gives both an overview of the heterogeneous Grid being studied and details to the SUNY IT Grid that was implemented. The technologies used to create the Grid network were the Globus Toolkit and the Condor job-scheduling tool developed by the University of Wisconsin. MPICH2 is an application developed at the Argonne National Laboratory in conjunction with the University of Chicago. It was also installed on all the machines to provide for the distributed job processing used in our investigation.

Corning Community College and State University College at Geneseo were also integrated into the SUNY IT heterogeneous Grid architecture through their BITS (Bunch of Integrated Technology Stuff) network to provide an additional resource that was diverse.

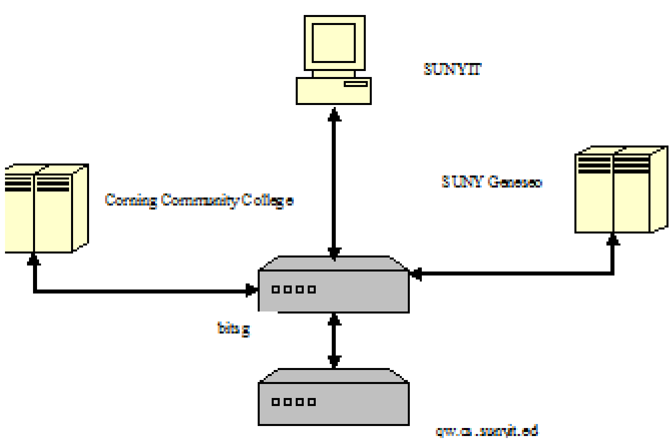


Fig:1 BITS Architecture

current prototype system

A geographical map serves as an anchor to the execution sites as shown in Figure 5.1, there is also a hyperlink to monitor the submission sites on the grid. The monitoring system can be launched to monitor a particular site by clicking on the available hyperlink on the map. The information from the execution sites at a particular monitoring site is retrieved from the information servers deployed at the monitoring site itself. These information servers utilize the D∅/SAM-Grid's grid sensors (information providers) that are also deployed at the monitoring site. These grid sensors are responsible for generating the information required by the monitoring system, and also serve as an interface with the SAM system. The information about the submission sites and the currently available resources on the grid is retrieved from the Condor/Condor-G interfaces. The system attempts at providing the user with monitoring site level monitoring, the grid-job submission level monitoring, and the progress of execution of the job at the execution site – among other important information pertinent to the entire grid.

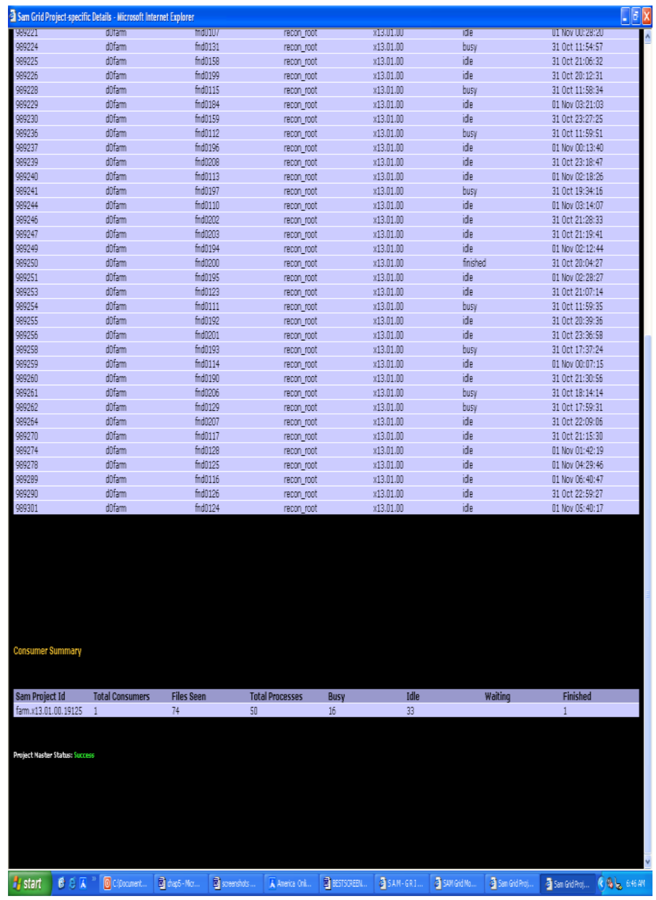
The execution sites in this prototype are actually SAM-Stations, each of these providing information about its SAM entities like projects, disks, and groups. The grid jobs in this prototype are synonymous with the sam-analysis projects of SAM.

The map shown in figure 5.1 shows 11 monitoring sites in 3 different continents on earth: North America, Europe and Asia, along with a link that is an anchor to all the submission sites. The system does not display the submission sites on the map, since their geographical distribution can not always be determined in advance.

Implementation

The implementation of the System directly relies on GNU/Linux, Linux Apache/PHP, Shell-Awk scripts; and indirectly relies on C++, Python, XML, Condor, Globus-MDS, and OpenLDAP among other technologies.

In order to test the interoperability of the Condor and Globus Toolkit, it was necessary to run tests leading up to this focus. The tests were run to validate the installation and set up of the Grid. For example, the WS-GRAM/bin/true and false test to validate the operability of the web service GRAM were successful. Since 0 and 1 were returned from the Globus Toolkit, it was confirmed that the command line invocation of the web service GRAM worked. Further, the counter-service example which was built into the container was and comes with the Globus Toolkit proved to be correct. This was determined based on previous release test that was documented on the Globus Alliance Web page. Some examples that were given by the Globus Alliance to test the functionality were modified to learn the particular Resource Specification Language (RSL) and to test the functionality of the Grid. For example, the Globus Alliance used an example that used only one Grid transfer. The test was modified that would use multiple transfers to test the dynamic functionality of the Grid. Several different nodes could transfer files amongst each other with a single RSL script. The Condor jobs used to test the functionality were a combination of developed code and a script found used in another test found on the Web.



Progress summary of a *production* SAM-project

CONCLUSIONS

DØ/SAM-Grid is being built on the SAM data-handling system and is expected to be one of the important grids used by major high-energy physics experiments. We have developed a prototype grid monitoring system that performs extensive monitoring of this grid, under certain assumptions like:

- All resources of the grid are SAM-Stations.
- All jobs in the grid are sam-analysis type of jobs (SAM projects).

Under these assumptions, the prototype monitoring system has been deployed and tested by monitoring 11 sites in 5 countries distributed across 3 continents, and has delivered the desired level of performance, with as much de-centralized control of information as possible. Robustness is a major feature of the system, with the performance unaffected by unavailable or unreachable parts of the grid. The system utilizes a layered architecture for information processing, with the sources of information distributed across the grid; and also integrates information generated using different grid middleware realms.

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