Role of the Resource Broker in the Grid

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ABSTRACT
Today, as Grid Computing is becoming a reality, there is a need for managing and monitoring the available resources worldwide, as well as the need for conveying these resources to the everyday user. This paper describes a resource broker with its main function being to match the available resources to the user's requests. The use of the resource broker provides a uniform interface to access any of the available and appropriate resources using user's credentials. This paper discusses the process of creating the resource broker as well as provides insight into how it connects and relates to the underlying software. The resource broker runs on top of the Globus Toolkit. Therefore, it provides security and current information about the available resources and serves as a link to the diverse systems available in the Grid.

Categories and Subject Descriptors
D.0 [**General**]:
General Terms
Theory, Design
Keywords
The Grid, Resource Broker, Globus Toolkit

1. INTRODUCTION
The Grid represents the middleware that unites simple PCs, various clusters, supercomputers, storage systems, computer-enabled instruments, and other devices into one globally available resource. It enables execution of advanced and resource intensive applications that might require the use of multiple resources from different administrative domains, dynamic resource requirements, complex communication structures, and many others [2]. Although the Grid infrastructure is in a constant stage of development and many of the components have already been developed and deployed, it is still primarily used for research purposes even though several commercial vendors have started to provide grid-based solutions [1]. If the Grid is to succeed and become a commercial infrastructure, the need for finding available remote resources will increase. Solving this problem is the job of the resource broker. The resource broker receives a simple and abstract resource specification and translates it into a more concrete definition in order to find a match for the request. In the process of searching for an available match, multiple resource brokers might be traversed until an available resource has been found. Once a resource is located, the specification is passed on to the local management system for job submission [3].

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2. REQUIREMENTS
Because the Grid is dynamic environment where resources are transient, the user's desire is to automate the search for resources rather than keep track of the previously known ones. That is the idea behind a resource broker. In addition, it is trying to add a new service by adding a layer of transparency in accessing the Grid resources. While using a resource broker, the user should not be concerned with the current status of a particular resource, nor should the user worry about the process of job submission. Traditionally, a user has two basic options when submitting a job to a resource. The most basic one is using command line tools and manually connecting to each particular resource, at first to test for availability of one and then to do the job submission. The more advanced but also more involved option is to use a high level language such as Java. Here the user would be using Java Commodity Kit (CoG Kit) [4] and would have to write a program to automate the job submission. Even though the job submission is automated this time, the user is still in charge of determining which resource to use for job execution. This can, again, be done through command line or it can be determined through a web portal, such as HotPage [5]. The idea of a resource broker is to add a layer of abstraction here by making direct user and resource interaction unnecessary while allowing for job submission to be user-friendly and easily accessible.

3. INCORPORATING RESOURCE BROKER INTO THE GRID

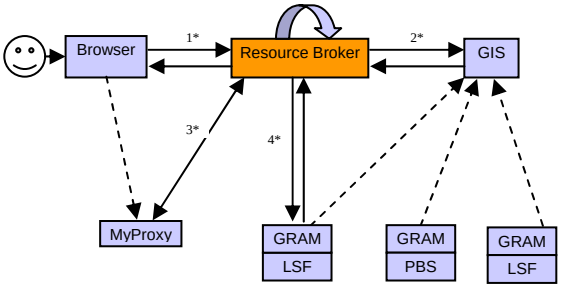

Figure 1. The resource broker is acting as a middle tier between a user and the resources by doing resource matching and job submission for the user.

As can be seen in Figure 1, the resource broker is the part of the Grid that is missing. Communication between different parts of the Grid is standardized and made possible, but the user is still the one to coordinate it. The resource broker adds the part that turns flow of

information from the user to the resource and back into an abstraction that is easy to use. The figure above is showing major steps that take place when a job is submitted, which are discussed in more detail in the next section, except for MyProxy [8] which is a user credential repository that provides the service of keeping the user's credentials and making them available for the resource broker to use in the job submission process. Also, GIS [7] is a service provided by the Grid infrastructure that keeps track of available resources which the resource broker queries in looking for a match to the user's request. Once a resource is decided upon, the job is submitted to GRAM [3] which enables for ubiquitous access and management of jobs on heterogeneous machines.

4. ARCHITECTURE

4.1 User Interface

What follows is a more in-depth look at how a resource broker works and uses Grid services. In developing this product, a path was taken in which the user would access the resource broker through a simple web page by filling out a web form specifying a request in very general terms. An additional feature is available in this resource broker regarding the user's specification of a request. Rather than making a request/response a true-false match, the user is given an option to specify a range of values for which the request is valid. By using this weighted system, there is an option of ranking possible matches according to the user's specification. The resource broker is designed to allow the user to review possible matches to the given request and make a final decision on which resource to use, or the decision can me made by the resource broker.

4.2 Submission Process

Once the request has been received, the resource broker looks for a match by communicating to the GIS [7], which returns requested information in plain text format. This information is converted into XML format for greater portability. Then, the newly created XML is parsed, extracting only fields matching the fields specified by the user in the request. The response is processed until it is determined that a match can or can not be found. Optionally, the user is notified about the result, and in the case of a positive resource selection, the user is prompted with another web form asking one to specify the job for submission. An advantage to using the resource broker is that the instructions given by the user are in the same format as they would be if they were used on the user's local machine, while the translation and adaptation for different architectures the job might be submitted to is handled by the underlying infrastructure. The submission is done using the user's credentials on user's behalf. This is accomplished by using a user proxy, which has been delegated by the user to act on his/her behalf. It has a temporary life time and possibly some other limitations, such as the resources that it is allowed to access and submit a job to [2]. The user acquires this file by invoking the GSI (Grid Security Infrastructure) [2] service and makes it available for the resource broker by depositing it into MyProxy [8] service. As the job completes, the user is notified, and any files are transferred back to the user's machine using GridFTP [7].

4. EXTENSIONS AND OGSA

One of the primary goals in developing this resource broker was simplicity of use. Allowing web access to it is a big step toward that goal because no local software installation is necessary, and it allows for easy access from multiple locations. Considering ease of use a standpoint can be taken of setting the resource broker up to work with an existing grid infrastructure. This being the primary concern of current work, there are efforts to make this resource broker OGSA compliant, thus turning it into a service that can be installed as part of the grid infrastructure. There are further inclinations of changing the web interface by incorporating the resource brokering capability into an existing portal developed by OGCE [6] and in turn creating a portlet.

By making this software easy to use, the goal is not to make it less powerful. In that regard, more work is being done to allow for easy extension that might be desired by an administrative group using this resource broker. A set of API will be provided that can extend or modify current behavior of the brokering job. One thing that the resource broker does not provide is any sort of job scheduling among the resources. Once a request is received and a resource is found on which to execute it, any sort of scheduling is handled by local scheduling software. This is an example where mentioned options for extending this resource broker become useful. The resource broker can be extended with a resource co-allocator, which can be used to schedule jobs among possible resources.

5. CONCLUSIONS

The Grid is a new and upcoming global infrastructure that is still primarily being used for research purposes [1]. The focus of this paper is to introduce a resource broker with its main function being to fill in the gap between a user, finding of a resource, and job submission. Manual operation to achieve the same goal is possible, but they may be somewhat time-consuming and complex. Therefore, this resource broker was developed with the main goal to make the use of resources in the Grid simple and efficient. This paper discusses the flow of information from the user throughout the Grid and back to the user.

6. REFERENCES

[1] Berman, F., Fox, G., Hey, A. (eds) (2003) *Grid Computing: Making the Global Infrastructure a Reality*. West Sussex, England. Wiley

[2] I. Foster, C. Kesselman, G. Tsudik and S. Tuecke. A Security Architecture for Computational Grids.

[3] K. Czajkowski, I. Foster, C. Kesselman, S. Martin, W. Smith, S. Tuecke. A Resource Management Architecture for Metacomputing Systems.

[4] Laszewski, G., Foster, I., Gawor, J., Lane, P., A Java commodity grid kit.

[5] *HotPage, Grid Computing Portal*. Retrieved February 10, 2004, from https://hotpage.paci.org/.

[6] OGCE - Open Grid Computing Environments. Retrieved February 8, 2004, from www.ogce.org.

[7] *The Globus Toolkit.* Retrieved November 15, 2003, from http://www-unix.globus.org/toolkit/.

[8] *MyProxy.* Retrieved Nov. 15, 2004, from http://grid.ncsa.uiuc.edu/myproxy/.