# Grid Meta-Broker Architecture: Towards an Interoperable Grid Resource Brokering Service

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**Abstract.** Grid computing has gone through some generations and as a result only a few widely used middleware architectures remain. Using the tools of these middlewares different resource brokers have been developed to automate job submission over different grids. As grid resources were grouped to Virtual Organizations, users seem to become isolated by these groups. Enhancing interoperability among these VOs and grids will be the main issue of future generation grids. This paper describes a meta-brokering architecture that shows how to enable the interoperability of various grids through their own resource brokers.

**Keywords:** Grid Computing, Meta-Broker, Resource Broker, Grid Portal.

## 1 Introduction

The Grid was originally proposed as a global computational infrastructure to solve grand-challenge, computational intensive problems that cannot be handled within reasonable time even with state of the art supercomputers and computer clusters [1]. Grids can be realized relatively easily by building a uniform middleware layer, on top of the hardware and software resources, the programming concept of such distributed systems is not obvious.

Executing a job in a grid environment requires special skills like how to find out the actual state of the grid, how to reach the resources, etc. As the number of the users is growing and grid services are starting to become commercial, resource brokers are needed to free the users from the cumbersome work of job handling. Though most of the existing grid middlewares give the opportunity to choose the environment for the user's task to run, originally they are lacking such a tool that automates the discovery and selection. Brokers meant to solve this problem. To enhance the manageability of grid resources and users Virtual Organizations were founded. This kind of grouping started an isolation process in grid development,

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too. As resource management is a key component of grid middlewares, many solutions have been developed [2]. Interoperability among these "islands" will play an important role in grid research. This paper introduces a meta-brokering approach to reach different grids through a common interface. Grids are typically accessed through portals that serve as both grid application developer and executor environments. This graphical interface helps the users to utilize grids, therefore it is important to provide a portal for user-oriented grid services.

## 2 Related Work

In the past decade several projects targeted to build an efficient resource broker. A proper solution should follow the standards of grid communities [8], the requirements of user groups and the results of the latest grid middleware research.

Focusing on interoperability, the Grid Interoperability Project [4] has some results on resource brokering between Unicore [6] and Globus [7] Grids. The goal of their work was to create a semantic matching of the resource descriptions. Their ontological mappings specialize only in these two middlewares. The Gridbus Grid Service Broker [5] is designed for computational and data-grid applications and supports all Globus middlewares and Unicore in experimental phase. Both solutions aim at accessing resources from different grids, but their architecture stays on the level of direct resource brokering.

## 3 Abstract Architecture

Utilizing the existing, widely used and reliable resource brokers and managing interoperability among them could be new point of view in resource management. The following figure (Fig. 1.) introduces an abstract architecture of a Meta-Broker that enables the users to access resources of different grids through their own brokers.

Designing such an interoperable Meta-Broker, the following guidelines are essential: As standards play an important role of today's grid development, the interfaces must provide standard access. The architecture must be "plug-in based" - the components should be easily extended by all means. The properties of the underlying components are also important; we need to be aware of the recent Grid Resource Brokers. The most efficient and widely used ones should be selected in order to make this solution usable.

There are 4 major parts of this architecture. The Translator component is responsible for translating the user requests to the language of the appropriate broker that the Meta-Broker wants to invoke. It should "speak" the languages of the interconnected brokers. The Information Collector stores the properties of the reachable brokers and historical data of the previous submissions. This information shows whether the chosen broker is available, or how reliable it is. This database can be extended with the information of the resources reachable by the utilized brokers. This can also limit or broaden the usability of the appropriate broker. The Matchmaker selects the proper broker for a user request.

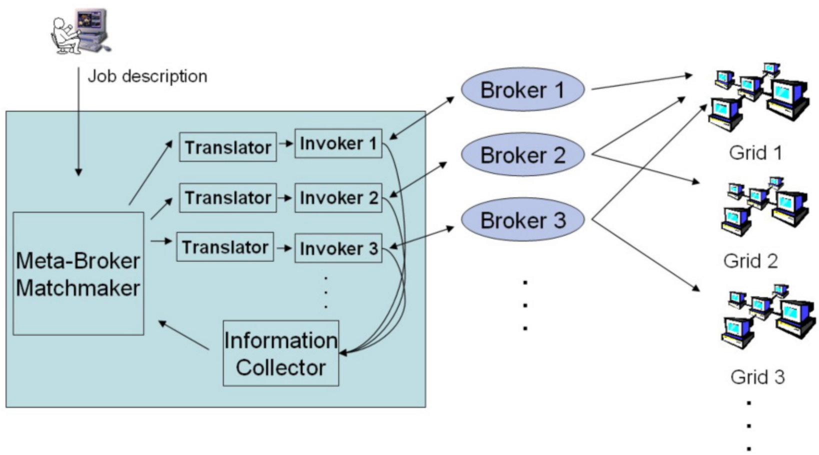


**Fig. 1.** Grid Meta-Broker Architecture

The job description contains the user request; this should be an exact specification of the user's job, including quality of service requirements and certificate information about the user of the job - this can be used as a filter during matchmaking. The Information Collector provides the broker information needed for the Meta-Broker to decide where to submit the job. The resource broker properties and historical information stored in this component help the Matchmaker to select the proper environment for the actual job defined by its job description. The Invokers are broker-specific components. They communicate with the interconnected brokers, invoke them with job requests and collect the results. Data handling is also an important task of this component. After the user uploaded the job and input files to the Meta-Broker, the Invoker should take care of transferring them to the selected broker's environment. After submission it should stage back the output files, and upgrade the historical data stored in the Information Collector with the appropriate broker's log.

The user's job description is independent from the execution environment, and the Meta-Broker does not need to know how to access resources of different grids. The interconnected brokers' tasks are to perform the actual job submissions; to find the best resource within their scopes, i.e. the VOs they have access to. The Meta-Broker only needs to communicate with them. In this sense meta-brokering stands for brokering over resource brokers instead of resources.

Grid portals give a user friendly access to grid resources and other grid services. Using a Web-based portal, the user can submit a job easily, regardless of location. The P-GRADE Portal [3] is a workflow-oriented, multi-grid portal that provides all the functions needed for job submission. P-GRADE portal is already connected to different grids and brokers. Integrating the Meta-Broker to this portal will be the next step supporting interoperability in grids.

## 4 Conclusions

The introduced meta-brokering approach opens a new way for interoperability support. The design and the abstract architecture of the Grid Meta-Broker follow the latest results and standards in grid computing. This architecture enables a higher level brokering called meta-brokering by utilizing resource brokers for different middlewares. This service can act as a bridge among the separated "islands" of the current grids, therefore it enables more beneficial resource utilization and collaboration.

Our future work aims at examining and summarizing the prevalent resource brokers and developing the components of the Meta-Broker architecture according to the properties of these brokers.

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