Chapter XII
Combining Web Services and Grid Services: Practical Approaches and Implications to Resource Discovery

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ABSTRACT
Web technologies have played a significant role in supporting the global sharing of Internet resources and thereby improving communications. On another front, Grids hold the promise to provide global interoperability and interconnectivity at a level considered impossible a few decades ago. In practice, there is not much difference between the existing Grid and Web infrastructures; in fact, a Grid infrastructure could be built by making minor modifications to a Web infrastructure. The implementation of Web-based Grids or a partially-Gridified Web is one of the potential solutions to Grid infrastructure problems. This can be done by sharing Grid services across the Grid infrastructure, effectively using the underlying Web services as vehicles or transporters of these services. The chapter discusses Grid services as another type of Grid resources, examines possible ways to integrate Grid services and Web services, and explores how this will support Grid resource discovery. It is argued that Grids should be developed using the underlying Web infrastructure and Grid services could be integrated with Web services using inheritance techniques to produce Grid-supported Web services. Furthermore, this approach seems to deal effectively with the problems of resource discovery in such partially-Gridified Web environments. An earlier version of this work has been presented in Naseer and Stergioulas (2006a).
INTRODUCTION

Web technologies have played a significant role in supporting the global sharing of Internet resources and thereby improving communications. On a different front, Grids are expected to power up the next generation of Web and hold the promise to provide global interconnectivity and interoperability, regardless of the geographical and heterogeneity constraints, and at such an advanced and ubiquitous level that was considered impossible a few decades ago. Grids enable the sharing, selection, and aggregation of geographically distributed “autonomous” resources dynamically at run time depending on their availability, capability, performance, cost, policies, or rules which govern them and the users’ quality-of-service requirements and reliability. Grids are composed of a global network infrastructure that contains several other networks (local or wide area) and exhibits extensively high synergy among all its units (humans, networks, programs, processes and services, etc.). Cross-communication among the various types of units is needed on a large scale in order to enhance the capabilities and capacities of Grids. Such units or resources are capable of sending and receiving requests/commands and act as independent communicators. This can be made possible by specialized services that are available on the Grids (Grid services).

The trend to use Web-services as wrappers or transporters of Grid services is today becoming more and more popular and is one of the ways to integrate Web services with Grid services. The reason behind this need for integration lies in two crucial facts: (1) Web services alone cannot be directly implemented on a Grid architecture due to constraints such as the requirement for them to have a “stateless appearance” and their persistency, whereas for a service to operate on Grids, it should always have a state and should be transient in nature; (2) Grid services alone cannot be directly implemented on the (successfully deployed) Web infrastructure due to the lack of standardization (standard protocol or standard language). Moreover, Grid technology, being a relatively newly emerged discipline, has neither infrastructural standards nor benchmarks established yet. Therefore, the integration of Grid services with Web services is necessary in order to support a fully- or partially-Gridified Web. The two types of services have to be glued together using some specialized object-oriented techniques. Because Grids, from this perspective can be viewed as the next generation of Web, Grid infrastructure could be built by making minor modifications to the Web infrastructure. The implementation of Web-based Grids or partially-Gridified Web is one of the potential responses to Grid infrastructure needs, which would facilitate the formation of virtual organizations globally. These virtual organizations would then be Grid-like structures residing over the Web.

Grid services provide a means for discovering other Grid resources; the term used for this operation is Resource Discovery. The Grid community has not yet been able to fully resolve the issue of Resource Discovery due to various technical constraints and geographical limitations. However, Grid services can be shared across the Grid infrastructure by using the underlying Web services as vehicles or transporters. Integration of Grid services into Web services can provide an efficient way to pass requests and responses to resource discovery queries, which is a key issue to be addressed. There are two potential ways to address this issue through services integration: (a) by using a Grid-based Web service approach or (b) by using a Web-based Grid service approach. The former supports the development of Web services containing special Grid services’ interfaces or behaviors (inherited or encapsulated) to make them operable on the Grids, that is, it encapsulates or wraps Grid services into Web services as specialized functions; and the latter supports the development of individual Grid services containing the features and functionalities of the Web services that are inherited or extended from...