ABSTRACT

Currently, the grid computing community is undergoing a paradigm shift from the traditional resource-centric model to a service-oriented one. The Open Grid Services Architecture (OGSA) from the Global Grid Forum proposes that Web service-like abstractions be used to encapsulate shared grid resources for service-oriented grid computing. An important management component of such an infrastructure which is essential for its success in enterprise environments, is the metering and accounting for grid service usage. This paper explores the problem space and presents an architecture that addresses this need. We start by defining taxonomy of grid services from the perspective of usage metering, charging and business models. We discuss how service usage can be measured, aggregated and communicated in a uniform way. Finally, we report on a prototype design and implementation. Market economics-driven issues such as pricing are not discussed in this paper.

Keywords: accounting; business models; charging; distributed systems; e-commerce; e-services; grid services; Internet technologies; large scale computers; metering; OGSA; resource-oriented services; service composition; transactional services; Web services

INTRODUCTION

In recent years, grid computing has emerged as a discipline encompassing various distributed systems technologies for large-scale resource sharing in virtual organizations (Foster, Kesselman, & Tuecke, 2001). Several special-purpose grids have been built, primarily for running scientific applications. Recently, grid computing has attracted the attention of industry as well. With a view of making grid computing widely usable for enterprise computing, an Open Grid Services Architecture has been proposed (Foster, Kesselman, Nick, & Tuecke, 2002). This architecture envisions the marriage of grid computing with web services technologies, thus introducing the notion of grid services that offer programmatic remote access to shared resources or software. The Grid Service Specification (Tuecke, Czajkowski, Foster, Frey, Graham, Kesselman, et al., 2003)
specifies a set of conventions regarding the interfaces and expected behaviour of these grid services.

In commercial grids, service providers need to charge their users based upon some measure of their usage. Thus, service metering and accounting are essential functions of a service-oriented grid infrastructure such as OGSI (Tuecke et al., 2003). Lack of support for such complementary and service provider-specific components has been a key inhibitor to the success of Web services on which the OGSA is based (Langdon, 2003). Current work on accounting for the Grid has focused mainly on shared hardware resources (such as CPU time and disk space), and economics of trading or bartering such resources (Buyya, Abramson, & Giddy, 2001; Kenyon & Cheliotis, 2002). The metering, accounting and pricing considerations can be quite different however in the services world, for various reasons. First, the software function of a service often is as important as the resources that it encapsulates, and may even dominate the pricing. Secondly, complex services may be created by composing simpler ones — this composition must be reflected in their accounting and pricing. Also, unlike traditional grid usage where a user’s job directly consumes grid resources, we can now have remote users sending requests to grid services, indirectly consuming the service provider’s resources. This limits the user’s ability to observe server-side resource usage, making such metrics less acceptable for charging purposes. It is apparent that enabling service provider support for management components such as metering and accounting is non-trivial. It requires foresight about both how to decompose an automation problem and how to deliver it (Langdon, 2003).

This paper presents an architecture that deals with various aspects of metering and accounting in a service-oriented grid infrastructure. We anchor our discussion by defining some background concepts and terminology in the “Basic Concepts and Terminology” section. The “Metering and Accounting for Grid Services” section presents in detail the proposed metering and accounting architecture. The “System Design and Implementation” section describes our prototype implementation and the “Discussion” section informally evaluates the proposed architecture. The “Related Work” section discusses prior art and presents related work and finally, we conclude the paper and present our thoughts on future work.

BASIC CONCEPTS AND TERMINOLOGY

Monitoring, Metering and Accounting

This subsection describes the typical modules of a runtime accounting infrastructure and briefly discusses their function. Next is a discussion on the metrics that are required to capture service usage. Finally it presents our understanding of accounting terms such as pricing, charging, and so on.

Typical Accounting Infrastructure

Figure 1 depicts the modules of a runtime infrastructure for commercial e-services, and shows the information that must flow to enable accounting of service usage. The service provider’s resources are usually instrumented to collect data for usage metering, as well as other purposes like quality of service management and load balancing. The Monitoring module collects the raw data and provides usage-related metrics to the Metering module. Metering is responsible for computing service usage metrics, using the monitored resource usage data if appropriate. An Accounting module aggregates the service usage by specific users (or accounts), while the Billing module applies service provider-defined pricing schemes to the aggregated usage data, and generates bills for the users.

Usage Metrics

The Metering module which expresses the usage of a service must choose the appropriate metrics (“units”) for this purpose. A us-
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