A Framework for Automated Negotiation of Service Level Agreements in Services Grids

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Abstract. An important aspect of managing service-oriented grid environments is negotiation of service level agreements. In this paper we propose a framework in which we adopt the three-layer architecture of agent-based negotiation to the problem of service level agreement negotiation in services grids. We report on the first experience with an implementation of the framework in the context of the WS-Agreement specification provided by the Global Grid Forum and present lessons learnt when using this framework in a simple practical scenario.

1 Introduction

Grid computing has emerged as a new paradigm for next-generation distributed computing. It supports a notion of virtual organizations that can share resources for solving large problems in science, engineering, and business.

Service-orientation in grid computing focuses on virtualization of grid resources such as computational resources, storage resources, networks, programs, databases and so forth, and representing them by means of an extensible set of services that may be accessed, shared and composed in various ways [12]. The Open Grid Services Architecture (OGSA) [13] has taken up this approach and introduced the concept of grid services. At the same time integration and management of distributed applications by means of services is the objective of Web Services [36]. In an attempt to take advantage of progress in these two areas, the Globus Alliance [16] in conjunction with industry support has further developed the existing Web Service standards and the OGSA specification, and proposed the WS-Resource Framework (WSRF) [3]. WSRF supports creation, addressing, inspection, and lifetime management of resources as stateful services. It defines the semantics of WS-Resources and summarizes how interoperability between components from different sources can be enhanced using a service-oriented resource view [5]. Rather than shared usage of computer resources in computational grid infrastructures, services grids use grid paradigms in the context of services providing service-oriented applications on demand.
One of the most important aspects of service-oriented computing environments is that their administration and management is driven by individual organizational goals and application requirements. In order to support cross-enterprise dynamic composition and enactment of services, a number of fundamental issues regarding management of service quality and regulation of service behavior must be addressed. Some of these issues are: (a) How can the behavior of services be adjusted dynamically and who does that? (b) If services are created dynamically based on requirements of the consumer, how do participants find a mutually acceptable configuration? (c) How can these agreed service configurations be stored?

The key concept in addressing these issues is service level agreement (SLA). Similarly to commercial situations where “best effort” service guarantees are not sufficient, the agreement documents that specify what the user receives from the offered resources and its relevant performance guarantees are required in the form of SLA. SLAs capture the mutual responsibilities of the provider of a service and its client with respect to functional and non-functional parameters. For example, an agreement may define bounds on service response time and availability, or other service level objectives that describe the required quality of a service. Hence the main motivation for creating SLAs between providers and consumers is to get a reasonable certainty of the provided service behavior.

In a distributed cross-enterprise services grid numerous services interact with each other simultaneously, taking the roles of a provider and a consumer at the same time. The conditions of each of these relationships need to be represented in a SLA document. Keeping track of creating such SLAs, monitoring and evaluating service performance against them, and triggering appropriate actions in cases of SLA violation and exceptions are tasks of overwhelming importance. They include analysis of which part of SLA is violated and which party is responsible for it, what consequences arise from the violation for the overall system, and what the monetary and legal impacts are for the participants. Currently these tasks are performed by humans and require substantial manual effort, hindering broader adoption of services grids across enterprises as manual connection and contract negotiation are too costly on a large scale. Therefore, automation support for these tasks, especially for negotiating SLAs, is required. This automation must include automated creation of SLAs (e.g. as the result of negotiation), and other tasks during SLA lifecycle including their fulfillment and termination. In this context a flexible and precise SLA language, appropriate SLA templates, and a standardized SLA terminology are needed.

In this paper we propose a framework for automated negotiation of service level agreements in services grids, with the focus on the agreement creation phase. The framework adopts the three layer architecture of agent-based negotiation [21] to grid service agreements, involving decomposition of the negotiation into the negotiation objects, negotiation protocols and decision making models that are represented as different services. In addition to presentation of the theoretical framework, we also demonstrate its adaptability in a practical scenario and report on our first experiences in implementing it in the context of the Web Service Agreement specification (WS-Agreement) [1].

The paper is structured as follows. In the next section we briefly summarize related work concerning service level agreements in service-oriented environments. In Section 3 the concept of service-based representation of agreements is introduced.