Interoperability Among Heterogeneous Services: The Case of Integration of P2P Services with Web Services

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ABSTRACT

Service-oriented computing (SOC) has been marked as the technology trend that caters for interoperability among the components of a distributed system. However, the emergence of various incompatible instantiations of the SOC paradigm, e.g. Web or peer-to-peer services (P2P), and the divergences encountered within each of these instantiations state clearly that interoperability is still an open issue, mainly due to its multidimensional nature. In this paper we address the interoperability problem by first presenting its multiple dimensions and then by describing a conceptual model called generic service model (GeSMO), which can be used as a basis for the development of languages, tools and mechanisms that support interoperability. We then illustrate how GeSMO has been utilized for the provision of a P2P service description language and a P2P invocation mechanism which leverages interoperability between heterogeneous P2P services and between P2P services and Web services.

Keywords: generic service model; grid services; heterogeneous services; peer-to-peer (P2P) services; P2P service description; P2P service invocation; service-oriented computing; Web services

INTRODUCTION

The software community has been confronted with the issue of interoperability between software components during the last couple of decades. Various approaches such as object and component based approaches tackle this problem in various ways. However, they have not yet managed to provide a widespread solution that enables the interoperation of diverse components developed by different providers, in multi-vendor platforms (Medvidovic, 1999). Service oriented computing (SOC) emerged as
an evolutionary step of object and component based approaches, with the promise to support the loose coupling of system parts thus providing agility, flexibility and cost savings via reusability and interoperability. However, the existence of many heterogeneous types of services and the vast amount of existing and emerging standards still constitutes a major obstacle towards interoperability, as it will become apparent in the following.

The most well-known instantiations of the service-oriented computing paradigm are Web services (Christensen, 2001) and Grid services (Czajkowski, 2004). However, other types of services such as Peer-to-Peer (P2P) services, see for example the JXTA services (Gong, 2001), are currently gaining momentum. All these types of services are usually built on top of XML standards (Bray, 2004) and other proven communication protocols such as HTTP (Fielding, 1999) and TCP/IP (Tanenbaum, 2003). The establishment of a set of common characteristics for these service types including properties such as self-description, internet accessibility and message-oriented communication has been one of the main research topics in this area and existing results comprise models such as the ones that have been specified by W3C in (Booth, 2004), by Werner Vogels in (2003), and by Karl Czajkowski, et al. in (2004). These features along with the use of XML standards (Bray, 2004) provide an infrastructure that promises to leverage interoperability among the components of a service-oriented system.

Nonetheless, although existing SOC instantiations, provide for a basic infrastructure that tackles interoperability, they still do not fully address it. This is mainly due to the multidimensional nature of interoperability, as it has also been noted in (Fang, 2004; Burstein 2005). Furthermore, the multiplicity of continuously emerging service types, see for example Sensor services (Gibbons, 2003) or UPnP services (Newmarch, 2005), is further aggravating the problem, as, albeit these service types share some common characteristics, they adhere to incompatible models and standards and rely on distinct platforms and middleware to perform their basic activities. It is worth noting here that, the interoperability problem exists, not only between services of different types, but also between services of the same type. See for example the area of P2P services, where there are no common standards or reference models; existing P2P platforms, e.g. JXTA (Gong, 2001), Gnutella (Ivkovic, 2001) or Edutella (Nejdl, 2001), use proprietary advertising, discovery and invocation mechanisms, thus hindering interoperability between these P2P services. Another example is the area of Web services, where, despite the use of standard protocols, there are still interoperability problems between Web services. Efforts such as those undertaken by WS-I (Ballinger, 2004) try to tackle the latter problem; specifically, WS-I has provided a basic interoperability profile for addressing some of the interoperability problems encountered between Web services; such an effort foregrounds the need for addressing the problem in various dimensions. However, there are still a lot of open issues which remain to be solved.

This article provides a solution on Interoperability between P2P and Web services. The provided solution is based on a generic framework which provides for interoperability between any type of service. This generic framework has been developed in the SODIUM project\textsuperscript{1}, which employs a unified approach towards the interoperability of heterogeneous service types. One of the advantages of this unified interoperability approach is that it allows the various service types to retain their own traits and characteristics. In this article we present: (i) the foundation of the SODIUM work which comprises a generic service model (GeSMO) that constitutes the underlying basis for the development of appropriate software for supporting service interoperability and, (ii) a specific solution that has been provided for the integration of P2P services with Web services which has been utilized in the SODIUM and SeCSE\textsuperscript{2} projects.

The provided interoperability solution between Web and P2P services is described in detail in the rest of the article which we have structured as follows: We first present a moti-

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