CbSSDF:
A Two-Layer Conceptual Graph Approach to Web Services Description and Composition – A Scenario Based Solution Analysis and Comparison with OWL-S

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ABSTRACT

Web services as a new distributed system technology have been widely adopted by industries in the areas, such as enterprise application integration (EAI), business process management (BPM), and virtual organization (VO). However, lack of semantics in the current Web service standards has become a major barrier in service discovery and composition. To tackle the semantic issues of Web services, this paper proposes a comprehensive semantic service description framework – CbSSDF and a two-step service discovery mechanism based on CbSSDF—to help service users to easily locate their required services. The authors give a detailed explanation of CbSSDF, and then evaluate the framework by comparing it with OWL-S to examine how the proposed framework can improve the efficiency and effectiveness of service discovery and composition. The evaluation is carried out by analysing the different proposed solutions based on these two frameworks for achieving a series of tasks in a scenario.

Keywords: Distributed System Technologies, Semantic Web Services, Service Composition, Service Discovery, Web Services

1. INTRODUCTION

Service description, discovery and composition are three major research topics in the research fields of Web Services and Service Science. In the past decade, enormous research effort in Web services has been spent on service description (Paolucci et al., 2003; Du et al., 2007), discovery (Ludwig & Reyhani, 2005; Paolucci et al., 2003; Song & Li, 2005; Song et al., 2009), and composition (Agarwal et al., 2005; Du et al., 2006). In order to effectively and efficiently perform Web service discovery and composition, a comprehensive service description framework is essential. There are several semantic service description frameworks proposed to provide semantic rich service descriptions, such as OWL-S (Martin et al., 2004), WSDL-S
(Akkiraju et al., 2005), and WSMF (Fensel & Bussler, 2002). The main idea of these works is to build a semantic layer either on the top of or to be integrated into the WSDL documents to semantically describe the capabilities of Web services so that a software agent or other services can reason about the service’s capabilities and knows how to interact with it.

However, the problems still exist in the current study of semantic service description and discovery:

- Insufficient usage context information. Usage context information of a service represents an informative surrounding in which the service is invoked or applied. Current semantic Web service description frameworks are mostly focusing on the ontology based data and capability semantics of Web services. They do not sufficiently address the usage context information of a service. Although there are some research work (Maamar et al., 2005, 2007; Medjahed et al., 2007) addressing Web services context, they mainly study the runtime environmental context, and hence help very little in allocation of the required services at the stage of service discovery. The usage context of a service includes the information about how a service is used and its relationships with other services. This kind of context information can be helpful for service users to locate their required services.

- Precise service specifications. In order to locate a required service, the current service discovery requires precisely defined technical specifications for the required service, such as service input and output data types and service capabilities in WSDL and OWL-S. This kind of information is difficult for a service user to provide at the preliminary stage of service discovery, especially when the service user is not a domain expert in the required service area.

- Insufficient information about inter-relationships among services. The current work inadequately addresses the inter-service relationships. A Web service needs to interact with other Web services to achieve its capabilities. If we consider each service as an isolated individual and ignore its relationships with other Web services, the efficiency of service discovery and composition for this service will decrease.

- Lack of incomplete information handling. Although some of the existing work support rules in service description and composition (Martin et al., 2004; Orriens et al., 2003; Charfi & Mezini, 2004), these rules are based on monotonic logic and reasoning which are not suitable for handling incomplete information.

To address the above problems, we introduce a new concept, termed as Service Usage Context (SUC), to describe a service’s usages at both the conceptual level and instance levels (to be discussed in Section 2), and based on SUC, a new, comprehensive description framework, called Context-based Semantic Service Description Framework (CbSSDF). CbSSDF aims to improve the semantic capability of service discovery and simplify the service composition process. It contains these main components: a set of Service Conceptual Graphs (S-CGs) and a Semantic Service Description Model (SSDM). The set of S-CGs gives an abstract description of the relationships between services and concepts. S-CG is the implementation of the conceptual level SUC. The formalism behind S-CG is conceptual graphs (Sowa, 1984). SSDM gives a comprehensive semantic description of a service through different semantic aspects. It also addresses the instance level SUC of services.

1. 1. Service Usage Context

The term “context” is frequently referred to in the computer science literature, whose meaning is mainly based on each individual researcher’s understanding (and its usage is implicit). There are a lot of researches focusing on the term “context” or “contextual situation” and providing various definitions, which we discuss as follows:
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