Using Event B to Specify Context Awareness for Service Discovery in Pervasive Environments

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ABSTRACT

The environments of pervasive computing are open and dynamic. In order to ensure the dynamic discovery of services evolving in a heterogeneous and dynamic environment, specific extensions to WSDL, known as A-WSDL are suggested. These extensions permit to a service provider to define the context of service use and the behavior associated to each change of context. To verify and prove the expected behavior of the suggested discovery protocol in the design phase, the Event-B formalism is adopted. One of the advantages of the Event B formalism is the application of the refining techniques which permit to express complex features by means of mathematical proofs and moves from an abstract specification to a concrete specification by using the Rodin tool which offers a support for the refining and the proofs.

KEYWORDS

Adaptation, Context, Event-B Language, Pervasive Computing, Service Discovery, WSDL

1. INTRODUCTION

The emergence of pervasive computing is based on the possibility to access to services anywhere and at any time (Weiser, 1991). The service discovery necessary for the design of pervasive informatics systems, presents a major problem related to the heterogeneity of services, the limitation of resources of devices applied in their execution, and the dynamicity where the services appear and disappear at anytime.

Most of research works dealt with about the discovery of services focus on the phase of syntactic matching between service supply and demand such as (Jini, 1999), (UPnP, 1999), (UDDI, 2002), and so on. However, with regard to the diversity of users and the conditions under which they access to services, other parameters must be considered during the discovery, such as the type of the device used (PDA, laptop, and so on), the user’s preferences, the user’s localization and so on. All these parameters form a particular context of use (Bouyakoub & Belkhir, 2013). In such a context, the selection process of services that meet the user’ needs must be able to adapt in a dynamic way to changes of context.

To overcome the limits imposed by the norms which have not dealt with the questions related to the description of service adaptation aspects, we have suggested in a previous work to integrate the aspect of context in the service specification. In this case, the standard WSDL has been used as a service description technology to add context-related extensions named A-WSDL (Adaptive WSDL). These extensions present many advantages, in such a way that services may act as context sources or...
context consumers. Thus, the A-WSDL extension made it possible to improve the service discovery process by describing the adaptations necessary for a service context change and to add contextual characteristics during the questioning of service registers.

However, the A-WSDL description remains informal and does not ensure the availability and reliability of services evolving in a dynamic environment, with the complexity of the contextual information used for the discovery of these services which makes reasoning over this information difficult. Consequently, the lack of a solid formal basis to master this complexity and ensure the control of context-aware services, imposes a search for a formal method which must be efficient and rigorous to formally express evidence-based features of the suggested service discovery protocol at the design phase.

In this paper, the objective is to suggest an approach for the discovery of context-adaptive services based on a formal framework to verify and reason about the features through mathematical proof.

Consequently, the Event-B (Metayer & Abrial, 2005) formalism is suggested to adequately meets the need for a rigorous design of context-aware systems based on mathematical notions in terms of first order logic with the theory of sets. A great advantage of event B formalism lies in the refining technique which permits to express complex features and goes from a high level abstract specification to a concrete specification, which can be automatically translated into a programming language. Specification and verification are realized with the Rodin platform, which is a support for the Event-B method as indicated by (Abrial et al., 2010).

The remaining of this article is organized as follows. In Section 2, a brief overview is given of context-awareness and Event B Model. Section 3 introduces the suggested approach of service dynamic discovery based on context. Section 4 describes how to use Event B formalism to model the different aspects of context awareness in the service discovery protocol. In Section 5, the Rodin tool is used to validate the coherence of our suggested approach. In Section 6, some related works are presented and the results are discussed. Section 7 also gives an overview of our work. Section 8 concludes this work and gives some perspectives for a future research work.

2. BACKGROUND

In this section, necessary concepts are presented to help understand the suggestion made in this paper.

2.1. Context-Awareness

The pervasive systems are characterized by context awareness according to Weiser (Weiser, 1991). This notion appeared in different works, (Schilit &Theimer 1994) have defined the context awareness as the aptitude of an application to adapt to the context of its execution according to localization, the nearby persons, and their change over time. (Dey, 2000) says that a system is context-aware if it uses context to provide relevant information and/or services to the user.

In this framework, the notion of context is largely used in different domains of informatics, but today there is no agreement on a unique definition. According to (Dey & Abowd, 1999), the context is any information which may be used to characterize the situation of an entity, where an entity is a person, a place or an object, and is considered as relevant for the interaction between a user and an interface.

In the literature, the context is defined according to the objective of the suggested approach. In the context of our approach, the objective is the use of the context for the discovery of services. However, services develop in a dynamic environment which provides context information, where services use this information to adapt their behavior. The objective is to determine the context of their use to suggest an environment adaptive to its users. As such, the services and the discovery processes must integrate this sensitivity to the contextual information. Thus, services become context aware.

For the construction of context aware services, the context management is a crucial step which ensures the separation of the context capturing process and its use. The majority of works in the
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