Context Based Dynamic Web Services Composition Approaches: a Comparative Study

Yashpalsinh Jadeja, Kirit Modi, and Ankur Goswami

***Abstract*—Web Services Composition has evolved much interest amongst the researchers in the academic world as well as the industry. With the proliferation of the Internet amongst the masses and the increasing need for making Web Information System components interoperable, research in this field requires new architectural approaches for composing Web Services. One of the goals by adding the Semantic Web in Web Services research is to provide methods and tools to cater for automatic composition of services on the Web. Such dynamic composition of web services can serve applications and users 'anytime and anywhere'. Though various Web Services Composition approaches out there, in most of these approaches, the 'context' in which the web services are offered is ignored to a certain extent. By the term 'context', we mean any information that can be used to characterize the entity. In this paper, we have presented Context Based Web Service Composition approaches and provided a comparative study of them.**

***Index Terms*—Context, semantic web, SOA, SOC, web services composition**

I. Introduction

Service-Oriented Computing (SOC) has shaped the modern era in all the areas such as health, education, business or research. The basis for SOC is composition of web-services. As a result, service composition has gained enormous popularity as the composite service presents the features that an individual service cannot present. However, the researchers are much interested in dynamic service composition approaches to make software reusable and on-the-fly adaptation of the web services provided. Semantic Web is the next iteration or an advance form of the traditional web that we started to use. The Semantic Web is an extension of the current web in which information is given well defined meaning, better enabling computers and people to work in co-operation [1].

A. Web Services

Web services are applications that are self-contained, self-describing and modular that can be published, located and invoked as and when required on the Web. Web services adopt the Service-Oriented Architecture (SOA) in which different applications can be deployed and accessed by businesses or services. Web Services can be defined as software that describes a collection of operations that can be accessed through standardized XML messaging over the network [2]. In today's world, a large number of organizations only implement the core business and outsource other application services over the Internet. As a result, the proper selection of such Web Services from a repository is the need of the day.

The web service model comprises of three entities: The service provider, the service registry and the service consumer.

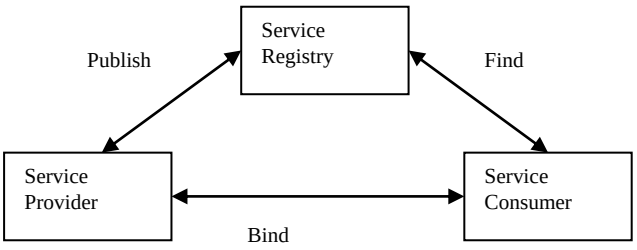

Fig. 1. The web service model

As shown in Fig. 1, the service provider creates and offers the web service. The web service offered by the web service provider is described in a standard format using XML. Once the service is created, it is then published to the Service Registry. The service registry acts as a repository for different services providing details about the services available to the service consumers. The Service Consumer retrieves the information and invokes the web service.

B. Web Services Composition

Web Services Composition is a method to connect together various web services available for creating a high-level business process. It involves compiling of atomic web services to provide functionalities that are not available at design times. As a result a new functionality can be developed through reusing of components that are already available, but unable to accomplish a task on their own.

Web service composition can be classified into two types: Static and Dynamic. A static web service composition is performed at the compile time, whereas, the dynamic web service composition occurs autonomously when a user queries for a web service at runtime. However, dynamic web service composition involves much work compared to static web service composition.

Other web services composition approaches are also classified by various authors. In [3], the authors have grouped Static and Dynamic Web Service Composition approaches into one single approach and based on their study,

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they have listed other possible approaches for composition as below:

1) Static and Dynamic Composition
2) Model Driven Service Composition
3) Declarative Service Composition
4) Automated and Manual Composition
5) Context-based Service Discovery and Composition

The various approaches that are classified in [3] have been implemented and studied by various authors. Among these the context-based/context-aware web service composition approach is defined here.

II. Context Based Web Services Composition

Web Services Composition based on 'context' can give a personalized behavior to the client by utilizing information about the client. The information can be anything, such a profile of the person, which includes name, country, language, his current location or it can also be the device on which he intends to invoke the service. For e.g., if the client wants to access a web page on his mobile device, then the page needs to be modified or customized so that it can fit into the requirements of the mobile device, the memory to be used. It can be customized so that the heavy graphics can be avoided, considering the low-bandwidth of the device.

In [4], the authors have defined the term 'context' as any information that can be used to characterize the situation of entities (i.e. whether a person, place or object) that are relevant to the interaction between a user and an application, including the user and the application themselves.

Before the concept of context-based composition came into existence, the main focus of web services was to just provide them as and when required, irrespective of any meta-data about the client. Sometimes this resulted in irrelevant invocation of services. Context –based composition relies on the ability of the application to detect and respond to changes in the milieu in which it needs to operate. To make web services context-aware requires resolving many issues.

A. Issues in Context Based Web Services Compostion

- Structuring of the context
- Binding of the context to a web service
- Address of the context – where is it stored?
- Frequency at which the web service takes into consideration the context
- How to detect and address changes
- Burden on the web service for taking context into consideration
- Quality of Service

B. Context Based Web Services Composition Approaches and Related Work

In this section, we present a brief overview of the existing Web Services Composition Approaches that take 'context' into consideration. The approaches that we have reviewed are : SeGSeC (Fujii and Suda, 2004), STONE (Minami *et al*., 2003), Sirin *et al*. (2002), SHOP2 (Wu *et al*., 2003), CB-SeC (Soraya Kouadri Mostefaoui *et al*., 2003), Keidl and Kemper (2004), Argos Project (Ambite *et al*., 2005), Mrissa M. and Benslimane, D., *et al*. (2005) and CACS (Nan Luo *et al*., 2006).Out of these approaches, SeGSec and STONE, provide only partial support for 'context', whereas the all other approaches have full support for 'context'.

III. Conclusion and Future Work

Different researchers have tried to provide their approaches on how to take context into consideration while composing web services. Each of the approaches described here has their own way of taking context into consideration. Some of the other web services composition methods also support 'context' in partial form.

Future work in context-based web service composition can include the parameter of QoS. The QoS parameter can define the quality provided by the web service in reference with the context. Also the challenge lies in selecting appropriate service out of many services available.

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Approach	Semantic Based	Test Model	Context Based Support	Description
SeGSeC [5]	Yes	Map Generation	Partial	Involves composing a service from multiple components based on the semantics the client has requested. Semantic queries using natural language sentences are permitted and it also generates execution paths.
STONE [6]	No	Name Management	Partial	STONE consists of two major components: a functional object (FO) and a service resolver (SR). FO can be a hardware device or a software component with capability to connect to a network. The SR manages the FOs and composes various services.
Sirin *et al.* [7]	Yes	Sensor Networks	Full	A prototype that guides a user in the dynamic composition of web services. Authors have developed a semi-automatic process which includes presenting matching services to the user at each step of a composition and filtering the possibilities. The generated composition is then made to execute through WSDL.
SHOP2 [8]	Yes	AI based HTN	Full	SHOP2 is a Hierarchical Task Network (HTN) planner in which a task is broken into smaller subtasks, until primitive tasks are found that can be performed directly. In order to do planning in a given domain, SHOP2 needs to be given the knowledge of that domain. It consists of facts and axioms.
CB-SeC [9]	Yes	Library Reminder System	Full	CB-SeC provides an enhancement of WSDL language with context-aware features. A Context Function (CF) to the WSDL. CF is used to select the best service available
Keidl and Kemper [10]	Yes	Customized Delivery of Content	Full	This approach allows the context information to be extensible to our plain old web services i.e., without context information.
Argos Project [11]	Yes	Goods Movement Analysis	Full	Involves developing a flexible data query and analysis system based on the web services paradigm. It is a workflow based technique.
Mrissa M., *et al*. [12]	Yes	Weather Forecast	Full	Combined concepts like mediation, ontologies and context to enable web the semantic reconciliation among heterogeneous web services and to make composite web services context aware.
CACS [13]	Yes	Visitor Oriented Service Composition	Full	This framework performs capability matches and composes service flow based on goal-driven. Then, it filters out unsuitable composition of matched services according to available context information.

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