REDUNDANT-FREE WEB SERVICES COMPOSITION WITH USER REQUIREMENTS CONSIDERATION

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Dedicated with much love and affection to my beloved family

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ABSTRACT

Service Oriented Computing (SOC) has become a leading study in recent years. It is based on the concept of composing distributed applications within heterogeneous environments by discovering and invoking web services to perform some complex tasks when there is no existing web service to fulfill the user request. Service Oriented Architecture (SOA) is known as a solution to accomplish composing autonomous, platform-free web services. However, the composition of web services without considering their underlying functional and non-functional attributes assures that it can adversely affect the composition process by increasing overall cost and leads to slow performance. This dissertation puts forward an idea of composing a redundant-free web service by considering user requirements. Non-functional attributes of services are prioritized to rank web services by using QoS aggregation function that leads to obtain more service requester satisfaction. After designing redundant-free web services composition, a method for optimal web services composition with several QoS attributes is proposed. At the end of this dissertation, the effectiveness and efficiency of proposed method based on execution time and optimal web service selection are evaluated. The proposed method is a considerable modification of the Global QoS Composition (GQC). This can be shown in the execution time improvement, which has been improved approximately seventeen percent as compared to the GQC method. In addition, the overall cost of web services composition is decreased due to deducting redundant Web services' price from the sum of component services' price in a composite service.

ABSTRAK

Pengkomputeran Berorientasikan Perkhidmatan (SOC) telah menjadi kajian utama pada tahun-tahun kebelakangan ini. Ia adalah berdasarkan kepada konsep aplikasi mengubah teragih dalam persekitaran heterogen dengan menerokai dan menggunakan perkhidmatan Web untuk melaksanakan beberapa tugas yang kompleks apabila tiada perkhidmatan Web yang sedia ada untuk memenuhi permintaan pengguna. Senibina Berasaskan Perkhidmatan (SOA) dikenali sebagai penyelesaian untuk mencapai autonomi gubalen, Perkhidmatan Web bebas platform. Walau bagaimanapun, pergubahan perkhidmatan Web tanpa mengambilkira atribut-atribut berfungsi dan bukan fungsi untuk memastikan bahawa ia boleh memberi kesan dalam proses penggubahan dengan peningkatan kos keseluruhan dan juga membawa kepada prestasi yang lembab. Disertasi ini mengenengahkan idea penggubahan perkhidmatan Web bebas lewah dengan mengambil kira keperluan pengguna. Atribut bukan fungsi bagi perkhidmatan adalah diutamakan untuk menyusun perkhidmatan Web dengan menggunakan fungsi pengagregatan QoS yang membawa kepada lebih kepuasan peminta perkhidmatan. Selepas mereka bentuk lebihan komposisi perkhidmatan Web percuma, satu kaedah komposisi pekhidmatan jaringan percuma optima dicadangkan dengan beberapa atribut Qos.Di akhir disertasi ini, keberkesanan dan kecekapan kaedah yang dicadangkan berdasarkan masa dan pemilihan perkhidmatan Web yang optima dinilai. Kaedah yang dicadangkan adalah pertimbangan pengubahsuaian global komposit QoS.Ini dapat ditunjukkan dalam pelaksanaan peningkatan masa yang mana ia dapat ditingkatkan dalam anggaran tujuh belas peratus berbanding kaedah GQC. Di samping itu, kos keseluruhan komposisi perkhidmatan Web berkurang disebabkan oleh pengurangan lebihan harga jaringan perkhidmatan daripada jumlah harga komponen perkhidmatan dalam perkhidmatan komposit.

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LIST OF ABBREVIATIONS

ASP	–	Active Server Page
BCCbSS	–	Backward Context-based Service Selection
CL	–	Composition List
DT	–	Delay Time
DPL	–	Dynamic Pattern List
DPSO	–	Discrete Particle Swarm Optimization
EC	–	Enactment Cost
IP	–	Internet Programming
MIP	–	Mixed Integer Programming
MCDM	–	Multiple Criteria Decision Making
NRC	–	Non-redundant Web Services composition
PI	–	Parameter Index
PT	–	Process Time
QoS	–	Quality of Service
RC	–	Realization Cost
SOA	–	Service Oriented Architecture
SOAP	–	Simple Object Access Protocol
SOC	–	Service Oriented Computing
UDDI	–	Universal Description Discovery and Integration
WMS	–	Workflow Management System
WS	–	Web Service
WSDL	–	Web Service Description Language
WSQoSX	–	Web Service Quality of Service Architectural Extension
WWW	–	World Wide Web
XML	–	Extensible Markup Language

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CHAPTER 1

INTRODUCTION

1.1 Overview

The World Wide Web (WWW) which began as a system for exchanging research information between scientists, is now a part of daily life for billions people. As it became a new medium of communication for all classes of the people, the data and applications available on the web got to be tremendous. Since its spectacular growth went beyond the prediction of its innovators, it is no wonder that people cannot be satisfied with the web as it stands. As a result, a new web paradigm for better use of WWW has been suggested, which is called semantic web (Kil, 2010) .

1.1.1 Web Services in SOA

”Web services are a new breed of Web application. They are self-contained, self-describing, modular applications that can be published, located, and invoked across the Web. Web services perform functions, which can be anything from simple requests to complicated business processes. Once a Web service is deployed, other applications (and other Web services) can discover and invoke the deployed service.” - IBM Web service tutorial (Tidwell, 2000) In this research Web services and Services will be used interchangeably. Moreover, methods and algorithms have the same meaning in this thesis and are using interchangeably.

It should be considered that any change on the location of service implementation should have minimal impact on clients, and service availability characteristics should not impact on availability of service consumers. For example, maintenance of services should not synchronize with service consumers. In addition, it should be possible to update services without requiring upgrading service consumers. Here, Service Oriented Architecture (SOA) is suggested which satisfy all the requirements. SOA is discussed as a paradigm where software resources are packed as services to provide standard business functionality and are independent of the context of other services. SOA enables the development of applications that are built by combining loosely coupled and interoperable services. In SOA, center of gravity is moved from development to integration phase (Tomasz, 2010).

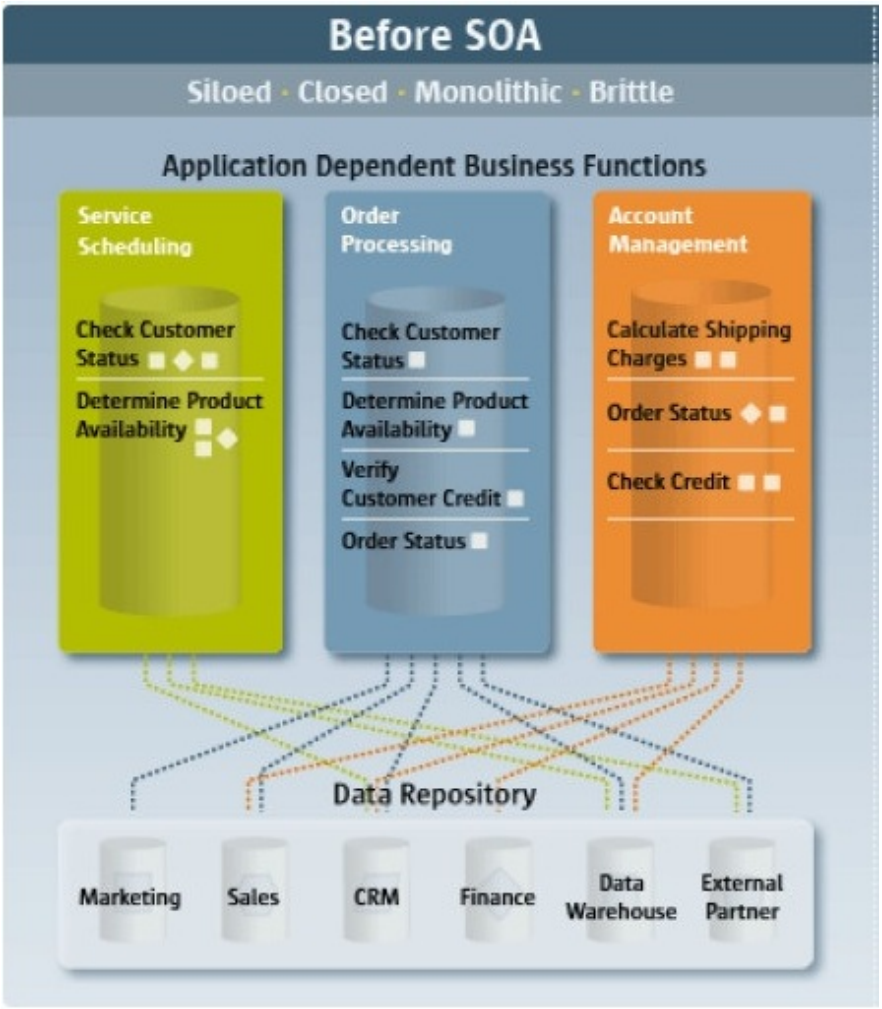

Figure 1.1: Before SOA (Sun Microsystems)

Software suppliers who provide tools for developing SOA applications, clearly knows the differences between software before and after SOA. Figure 1.1 shows the specification of software before SOA. As we can see applications usually have separate databases and networks; they are also incompatible with each other. Otherwise, Figure 1.2 depicts the software specifications after SOA which provide an integrated service and due to this there is no need to navigate between applications and necessary data is provided as an integrated service. In SOA infrastructure service interact with each other in unified manner.

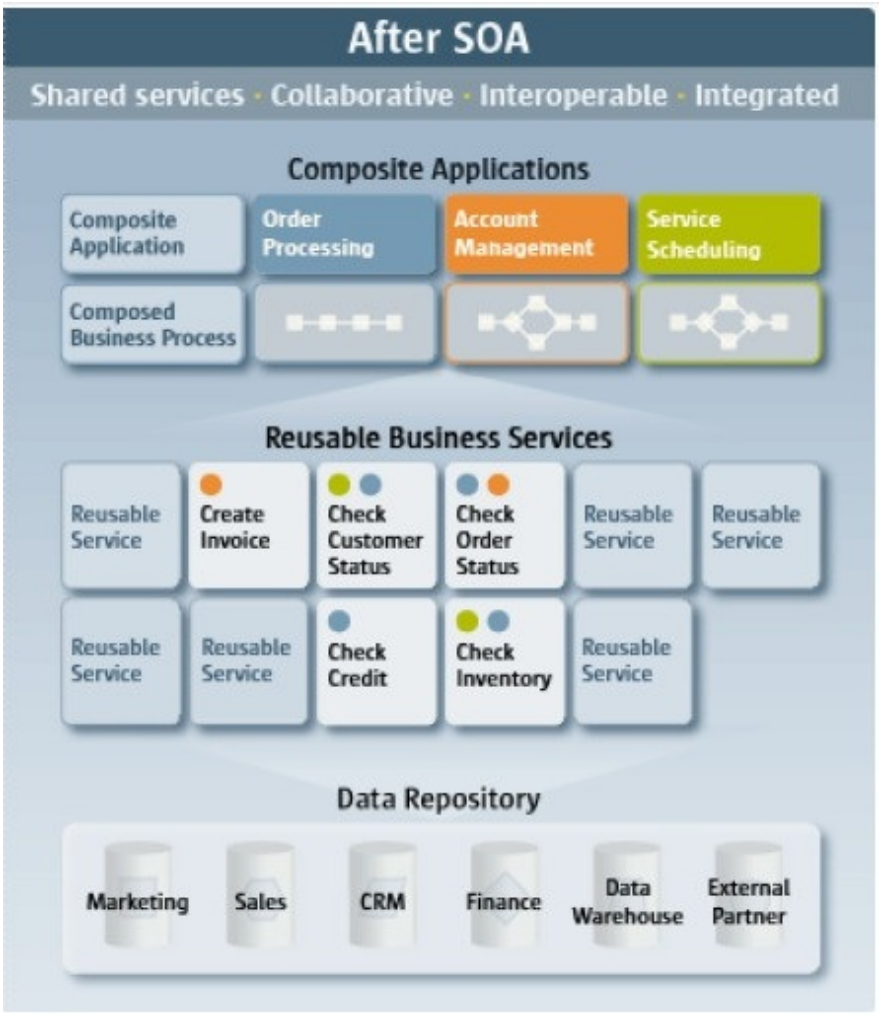

Figure 1.2: After SOA (Sun Microsystems)

1.1.2 Web Service Composition

As mentioned earlier, web services perform some functions and tasks. In the service oriented environment, there are some client requests that cannot fulfill with a single web service. So, several web services should work together to satisfy the request by composing a value added composite service.

Nowadays most of the available software is composed of various modules and services provided by several providers. The procedure of service composition and execution includes a workflow creation which understands the functionality of a new service, following by its deployment and execution on a runtime infrastructure (Yu and Lin, 2005). For example, if a client wants to have a trip, he needs to refer to a travel agency to book a flight, hotel, rent a car and make payment. If we map these steps to SOA, web services can be defined as Figure 1.3.

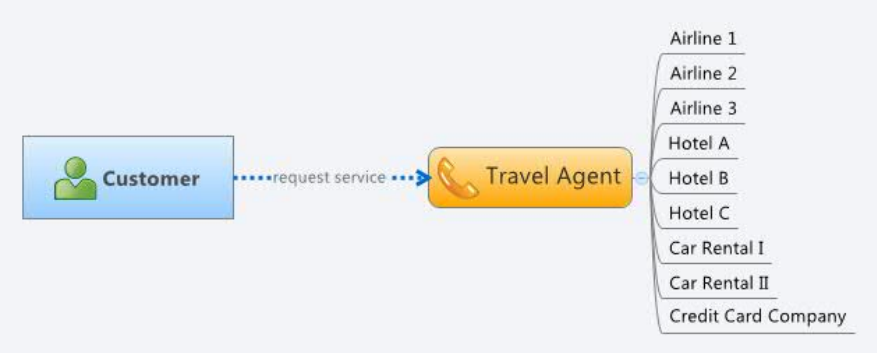

Figure 1.3: Travel agency service

1.2 Problem Background

A service-oriented architecture is made of several web services which can be implemented in various techniques. An SOA needs that at development phase

developers find service descriptions in repository systems and by understanding these descriptions they are able to program client applications that can (at run time) bind to and cooperate with services of a particular type. Understanding the execution semantics is a rather huge task (Mike and Willem, 2007). To solve this problem Deora, et al. (2003) proposed a quality of service management framework based on user expectations. This framework gathers expectations as well as rating from the users of a service and then the quality of the service is computed only at a time a request for the service is made and only by using the ratings that have related expectations. Mohabbati, et al. (2011) also proposed an aggregation model for QoS computation with takes both variability and composition patterns into account.

Web service composition is the ability to provide value-added services through composition of simple Web services, offered by different companies. Because of its potential, there are many researches focusing on it. The first struggle is that numerous Web Service composition languages are created by many giants in software industry, such as IBM, Microsoft, etc. These are proposing their languages as the standard for composing Web Services. On the other side, the academic researchers have focused on Semantic Web Service. Semantic Web Service Language and Automatic Web Service Composition are two important topics for these researches. The first topic focuses on making a powerful language to add more semantic into the description of Web Service. The second topic tries to automate the composite processes as much as possible. Web services composition contains the combination of a number of web services to create a more complex and useful service. It can be beneficial when we are looking for a web service with particular inputs and outputs, and there is no single web service satisfying the request (Kwon and Lee, 2011).

Therefore, research on web services composition efficiently has been accompanied. Most approaches to web services composition can be categorized into four main groups:

1. composition schemes that consider only input/output parameters of web services,
2. web services composition schemes that consider input/output parameters, pre-conditions, and effects of web services,
3. semantic composition schemes that consider input/output parameters, pre-conditions, and effects of web services, and a domain ontology, and

4. QoS-aware composition schemes (Kwon and Lee, 2011)

While SOA becoming more popular more services appear in the e-business market and due to this main issues changes from service discovery to service selection and discovery. Most searches are now about finding an efficient way for composing web services. The QoS aware web service composition plays an essential role in SOA, because most service consumers want to use services which meet their requirements more accurately. Yu, Zhang, and Lin (2007) design a broker-based architecture to facilitate the selection of QoS-based services. Currently, the Universal Description, Discovery and Integration (UDDI) catalogue supports only simple matching tools and offers no control on the quality of registered services. Rajendran,et al. (2010) suggest a QoS broker based architecture for dynamic web service selection which simplifies the clients to specify the non-functional requirements like QoS along with functional requirements. In addition, some other researchers like Yu and Reiff-Marganiec (2009) proposed an Automated Web Service Selection.

Other topic that gains interest of researchers in recent years is about finding and removing redundant services in composition process. Redundant services can be identified as excessive services that increase composition time and overall cost of a composite service. Kwon and Lee proposed a non-redundant web services composition search system, which is based on a two-phase algorithm (2011).

1.3 Problem Statement

There are still some constraints in web service composition referring to the literature review. Quality of service is determined based on user satisfaction. QoS criteria consist of cost, response time, reliability, availability, throughput, and etc. The objective of almost all researchers in service composition is to maximize the application-specific utility function under the end-to-end QoS constraints. However, most of the previous approaches return a composite web service consisting redundant web services. Redundant web services might have effect on increasing execution time for calculating web services composition.

Another problem needs to be highlighted is that the proposed QoS aggregation function of almost all previous researchers are not adoptable to clients' preferences. This means that the output of aggregation function is the same for different kinds of user preferences. For instance, some clients may prefer faster response time rather than a lower cost service.

1.4 Research Question

In this study, we intend to propose a solution to the mentioned problems. The research question is as follows:
"How to reduce overall execution time and cost of web service composition by considering quality of service, user requirements, and also by removing redundant services in web service composition process?"
In order to answer the main issue mentioned above, the following issues also need to be addressed:

1. What are the ways of improving overall QoS in service composition?
2. How QoS aggregation functions contribute on selecting an optimal web service?
3. What are the effects of redundant web services in web service composition?
4. How to overcome redundant web services' drawbacks?

1.5 Research Aim

The aim of this research is to suggest a new method to automate redundant-free web service composition. The main concern of service composition is to select optimal services that can significantly reduce overall execution time, costs, or any others specifically formulated objective. The resulting challenge is referred to as the redundant-free QoS-aware service composition by considering user requirements.

1.6 Objectives

In order to achieve aforementioned aim, the objectives of this study are as follows:

- Prioritize non-functional attributes of services and rank services with QoS aggregation function to obtain more service requester satisfaction
- Design redundant-free web service composition workflow
- Proposing a method for optimal web service composition with several QoS attributes
- Evaluate the effectiveness and efficiency of the proposed method based on execution time and optimal web service selection

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