Dynamic Reconfiguration of Web Service using Middleware-based Approach

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Highlights: Dynamic reconfiguration of Web Service (WS) is an important role in Service-Oriented Architecture (SOA) that has an ability to adapt changes in Service-based systems during runtime stage without interrupting existing services or business processes. This is crucial to prevent service-based systems from failure while the environment is changing or to allow system being modify immediately whenever necessary. However, dynamic reconfiguration in SOA is a difficult process and presently there are lacked of attempts to handle the process appropriately. Thus, we developed Dynamic Reconfiguration of Web Service (DREWS) a middleware-based model to handle dynamic reconfiguration of web service during runtime without human intervention.

Key words: Dynamic Reconfiguration, Web Service, Middleware-based, SOA

Introduction

Service-Oriented Architecture (SOA) is an important paradigm for organisations using modern computing because of its abilities to develop a system from different types of components called Web Services (WSs). According to the latest software industry demand and a
research report, the SOA market size at $5.7 billion in 2013 is anticipated to reach $16.4 billion by 2020 (John, 2016). These numbers all point to exponential growth and the enormous importance of SOA. SOA is defined as an approach to develop service-based systems by integrating independent services or called Web Service (WS) (Fang & Liu, 2009; Chen et al., 2010). The WSs communicate with each other. The communication could involve simple data passing or involve two or more services coordinating some activities. One of the main purposes of implementing SOA is the ability to reuse existing loosely coupled WS from a third party to operate independently. This is a major advantage for organisations, which constantly finds ways to reduce development time and cost while improving their software quality.

Currently, there is an increasing trend that service-based systems will be composed of third-party WSs accessible over the Internet. Consequently, the capabilities and quality of service-based systems will depend more on the quality of their third-party WSs. Therefore, SOA must be able to provide a way to cope changes that occur due to dynamic changes in the system requirements and the environment in which the system operates, also known as a dynamic reconfiguration web service. Previous related research works on handling dynamic reconfiguration service focused on functional requirements during service replacement without paying attention to quality of service (QoS) requirements, service backup were handled inappropriately with reconfiguration failure, and inadequate support of reconfiguration process during pre- and post-adaptation stages (Valls et al., 2013, Gomaa & Hashimoto, 2012, Agarwal & Jalote, 2010, Irmert et al., 2008).
Therefore, this work has developed a middleware-based model to improve SOA dynamic reconfiguration service process during runtime. This model intended to handle QoS requirements during dynamic reconfiguration process and to provide explicit mechanism during pre-, in-, and post-adaptation stages. The result of this research was a middleware-based model that can be used as a main standard to outline dynamic reconfiguration process in SOA. A self-adaptive tool was developed based on the model to support the dynamic reconfiguration process that allowed minimum human intervention. The tool is developed using Java programming language, Eclipse IDE and Apache Tomcat. DREWS tool is deploy separately from the service-based systems which eases the dynamic reconfiguration process because it decouples the system and DREWS (refers Figure 1). Meanwhile, DREWS communicates with the service provider using a standard network protocol. The main advantages of using DREWS and its toolset by the software engineers are as follows:

1. DREWS handles dynamic adaptation process during pre-, in- and post-adaptation at middleware layer. The middleware-based approach allows a minimum communication abstraction layer that could provide an efficient mechanism to handle flexible composition and heterogeneous services and to supports the specification of QoS-based execution properties and temporal characteristics.

2. DREWS during pre-adaptation stage find and validate a suitable WS replacement for dynamic reconfiguration. The new WS is selected from a set of WS candidates. Dynamic service environments cause some difficulties in service selection. Thus, DREWS has to ensure two
important factors are considered, i.e. functional requirement and QoS to find the suitable new WS.

3. DREWS during in-adaptation stage systematically and automatically handle incoming requests to invoke the existing WS are put on hold. This step is executed to prevent operation failure during reconfiguration process.

4. DREWS during in-adaptation stage handle state of the systems that do not react to any requests due to dynamic reconfiguration process, this period is also known as the blackout period. Thus, DREWS adopts a blocking approach during the blackout period to ensure predictable processing time.

5. DREWS during post-adaptation stage provide a rollback mechanism to ensure continuous service availability by having an ability to return to the previous web service. In addition, restoration mechanism is crucial to restore data or requests that exists in the previous service to the new service after in-adaptation stage is completed

Finally, evaluations were conducted to evaluate the effectiveness of the proposed model: The first evaluation is comparing the existing reconfiguration middleware processes with the developed solution. The second evaluation is involving experts in providing reviews based on their expertise and experience. Evaluation two involved expert to evaluate the effectiveness of the dynamic reconfiguration of WSs middleware-based model and its tool support. The evaluation is an experiment using two treatments on the experimental groups based on the types of dynamic reconfiguration automation. The evaluation results were promising, as the empirical validation has proven that the proposed
work supported the dynamic reconfiguration process more accurately and effectively.

![Figure 1 DREWS and Service-based system integration with service provider](image)

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