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A formal approach for change impact analysis of long term composed services using Probabilistic Cellular Automata

M. Thirumaran, M. Jannani *, N. Sivakumar

Pondicherry Engineering College, Puducherry, India

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Abstract Incorporating changes into the logics of composed services dynamically and successfully is a challenge for sustaining a business' image and profit in the society, especially when the change is expected to be made immediately at low cost. In this paper, we address this challenge by proposing a change impact analysis framework for long term composed services (LCS) which: (i) enables the business people to implement the changes by themselves through their analysts, (ii) reduces cost and time by eliminating the dependence on IT developers once the application services are developed and delivered, (iii) ensures effective incorporation of the changes made by using standard methodologies for evaluation – finite state automaton for verifying the runtime compatibilities and change evaluation and probabilistic cellular automaton for impact analysis and prediction. Through the evaluated probability measures and effective incident matching, the knowledge gained by the analyst over his service logics and the efficiency of incorporating changes are increased.

1. Introduction

Service Oriented Computing (SOC) is emerging as a new paradigm and is accruing the outsourcing of the required functionalities from third party web based providers especially through service composition. Composite services are built from aggregates of other autonomous services which collectively provide a value added service. In a long term composed service (LCS), the partnership among the services in composition and the business objective to be attained are for a long run. LCSs facilitate dynamic modification of the composition structure by choosing the best services and dissolving the services whose execution is no longer needed. They thus enable dynamic selection of the partners and aid the end users and consumers to be highly benefited from the open competition among the businesses. As the end users are always interested in latest techniques and technologies, the LCSs are more prone to changes, as time passes. Changes to an LCS can be of two types: top down changes or bottom up changes (Liu et al., 2011). In the former, the changes are initiated by the owners of the LCS and in the latter they are originated from the outsourced service providers. With the increase in the emanation of wide range of business competitors and the demands of

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the end users, effective change management in LCSs has become vital. The dependence on the IT developers for the incorporation of these changes claims the investment of a considerable amount of time and cost which poses a significant threat to the business' income.

So there is a need for a framework which would enable the business people to make changes to the LCS through their analysts without the aid of the IT developers. Once a change occurs, the framework must enable the LCS to adapt itself quickly and automatically in order to satisfy the business need. However such changes should be incorporated systematically without any issues (Maamar et al., 2008) and hence change impact analysis which involves analyzing the impact which the incorporated change would have on the LCS, is essential and would increase the accuracy of the changes made. Though there are a lot of research works focusing on automatic composition and integration of the services, change impact analysis in web service change management using formal approaches has not been lime lighted much. The existing frameworks do not provide maximum runtime support and degree of automation and do not enable changes at the analyst level (Apostolou et al., 2010). They do not perform change impact analysis and incident matching which are very much essential for a timely and cost effective change management (Rovegard et al., 2008; Setzer et al., 2010; Chua and Aslam Hossain, 2012). There are frameworks for handling top down and for handling bottom up changes but not for both. There are no standard procedures and methodologies adopted in the existing works and even if the changes are made, there is no means to find the exact reason for the change being unmanageable in the current static scenario. In the current situation it is very difficult to incorporate the changes perfectly into the logics of the LCS. All these together have motivated our research question, "How can the change management process in long term composed services be enhanced such that the changes can be made by the analysts in a timely and cost effective manner and with reduced risk?".

In this paper, we have addressed this issue through the proposed change impact analysis framework which adopts formal methods and standard procedures for analyzing the impact of the changes through effective runtime support, change evaluation, constraint evaluation and QoS factor evaluation. When a request for making a change is received, the framework verifies if there are no runtime issues in the business logic extracted by property pre evaluation using Finite State Machine (FSM) and only then it allows the analyst to make the changes over the logic. After the changes are made, the change evaluation is done which verifies if the change made can be committed safely or not. This involves the checking over the deviation of the functionality of the logic after change through change factor evaluation, over the workflow of the logic through constraint factor evaluation and over the quality of the modified LCS using QoS factor evaluation for differentiating from competing service providers. All these evaluations are performed using FSM which provides the formalism required for verifying the changes made. The impact that the changes would have on the LCS is indicated through impact analysis and incident matching. The evaluated factors are compared with the threshold estimations and impact value estimations from the previous incidents and Cellular Automata (CA) is used to validate the evaluation and to generate the change factor, constraint factor and QoS factor patterns. The current changes are matched with the pre occurred, similar change request patterns followed by the behavioral analysis which is performed using Probabilistic Cellular Automata (PCA). PCA makes use of the knowledge extracted from these patterns and indicates the risk, degree of automation, accuracy and degree of incident matching involved which would aid the analyst in making the changes confidently and maximize the market attraction of the LCS.

2. Change impact analysis of LCS using Probabilistic Cellular Automata

In this section, we present our change impact analysis framework for managing changes in LCS using Probabilistic Cellular Automata. We first illustrate the working of the change impact analysis framework shown in Fig. 1 by means of the sequence of operations and activities involved in the change impact analysis and their dependencies depicted in Fig. 2. We then describe how the framework reduces the cost and time involved in effectively incorporating the changes with the help of a motivating example of a sample web service composition. The impact of a change, the construction of LCS schema, FSM and the associated PCA for the example are demonstrated manually. LCSs have attracted a lot of attention since they provide a powerful tool to offer value-added and customized services. These vividly contribute toward the need to standardize and fine tune the change management process for LCSs and to follow structured approaches to make error free changes in the functionality of the services without compromising the quality of the business process.

2.1. Overview of change impact analysis approach and framework

The importance of the change impact analysis approach can be adumbrated with the help of the following example. Consider a business analyst working on services in long term composition. In case of a situation where a change has to be made to the service logic immediately and at low cost, the analyst is put in a situation where he cannot wait for the development team and has to make the changes by himself. So, there are high chances for him to make a bug introducing change and inject incorrect statements into the logic of the LCS which might end with the changed LCS exhibiting an undesired behavior. Even if the changes are made as careful as possible, without analyzing the impact that the changes would have on the logic, it is not possible to assure a risk-free and accurate incorporation of the changes which in turn serves as a serious threat to meet the business outcome. This problem is addressed by the change impact analysis framework depicted in Fig. 1.

Initially the received request for change is sent to the change request manager to identify the part of the business process in which the change has to be made. The change request consists of the command to be executed i.e. the DML operations to be performed like an addition or a substitution etc., the resource to which the change is to be done expressed in terms of the process name and the condition to be followed i.e. performing the mentioned steps on the satisfaction of certain condition mentioned. Then, the source code of the composed service which can be in any language, to which the change is to be made, is extracted by analyzing the change