A Study on Reliable Service Composition Model- Research Issues and Opportunities

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ABSTRACT
As services are available on the Internet, only single services do not satisfy the user requirements. In order to satisfy the user demand, Service-Oriented Architecture (SOA) is an Architectural approach that supports integrating required services from the Service Repository. One of the main aspects in SOA is Service Composition that gives us an opportunity for integrating many services in order to solve the functionality requested by the user. In the existing system, Services are composed using patterns, namely sequential, branch, parallel, and loop patterns. Once services are composed, it is required to check for the quality, for that we consider non-Functional (QoS) aspects such as Reliability, Interoperability, Scalability, Performance, Cost, Accuracy, and Availability, etc. Suppose, if any fault has occurred during service composition, this makes the overall business process to slow down their activity. Thus, Reliability aspects play a vital role in handling any failures during service composition. Therefore, aim of our study is to identify all the Reliability definitions, composition patterns, various Reliable Service Composition Models and factors used to check for reliability aspects and final outcome of our study will explore various research issues and opportunities in reliable service composition.

INTRODUCTION

Service Oriented Architecture (SOA) (Gerardo Canfora and Massimilino Di Penta, 2009) is an architectural style and it is basically a collection of services and these services can communicate with each other by either data passing or it could involve two or more services coordinating some activity by connecting services effectively. Some means of connecting services to each other is needed. Since SOA is implemented using Web Service (WS) (Rajeswari, et al., 2013) and it is the technology which is the most likely connection technology of Service-Oriented Architectures. As shown in Fig 1. There are three main components of Service Oriented. They are Service Provider, Service Consumer and Service registry. The Service Consumer sends request to the Service Provider. Service Providers are used to provide or respond requested service to service consumer and also to publish all the existing services in the Service Registry. Service Registry is a place where we can store all the available service and service consumer is to retrieve service from the Service Registry. Service Consumer will discover and invoke the required service from Service Registry and Service Provider respectively.

Every industry or Service Oriented Environment should follow a necessary principle for building a service effectively by many organizations. These principles provide Abstraction, Reusability, Autonomy, Loose Coupling Statelessness, Standardized Service Contracts Discoverability, and Composability (Gerardo Canfora and Massimilino Di Penta, 2009). Service composition and Service Discoverability (Goran Delac et al., 2013), (Huiyuan Zheng et al., 2013) are the main aspects in Service Oriented Environment. Service Discoverability (Rafael Angarita et al., 2014) ,(Goran Delac et al., 2013) is ability to search or find the location of every service and when storage of web services increases and therefore there will be need of very large repository for storing and retrieving many information. Service composition (Huiyuan Zheng et al., 2013) has the capability of combining many services together to solve the functionality of the user.

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Functional Requirement

Section 2.

developing new

Pivot, Compensatable and Retriable are existing transactional properties that are used to ensure reliability. (Kanchana Rajaram and Chitra Babu, 2014) has proposed a transactional property such as cancellable property

1. Related Works:

Fig. 1: Service oriented Architecture

Service composition (Huiyuan Zheng et al., 2013) is an important aspect which is used to build new value added services than single services. Existing workflow models are to fulfill the consumer request, which requires a specification of how to regulate component services from failures. For example, when a consumer uses service to take a business trip, the following steps are taken into consideration in the service process. First, the consumer would contact a travel agency’s service to make a reservation for a hotel room and an airplane seat. Considering his or her schedule and financial economy the consumers select the best one among several reservation choices. The consumers then may request additional services such as car rental and insurance related to the business trip. After all, services have been determined, the approval service will be activated. As this example indicates, a composite service is a partially ordered collection of component services. By choosing appropriate services offered by different service providers, can provide it more valuable and complete service than a single service. It can also reuse individual services more efficiently. It can be done by three methods, namely static, dynamic and semi-automatic (Dustdar and Schreiner, 2004). Static service composition is made by human using tools and execution language, namely Business Process Execution Language (BPEL) but it is very time consuming and also error prone and it is developed by designers at design time, whereas dynamic service composition does not need human involvement so they use Artificial Intelligence and Semantic web techniques and it is done by a service provider at run-time or execution time of certain services and it. Semi-automatic service composition is a combination of both static and dynamic service composition.

As many services are deployed on the web and those services can be accessed or invoked by other services by using four composition patterns or workflows (Kanchana Rajaram and Chitra Babu, 2014), (Rajeswari et al., 2013), (Goran Delac et al., 2013), (Zuohuo Ding et al., 2013), (Huiyuan Zheng et al., 2013), (Mansour et al., 2011) namely, Sequential, parallel, branch and loop patterns. Sequential workflow is one in which all services are executed one after another this makes system to take more time to complete their process when execution path increases. Parallel composition pattern is one in which two or more services are executed concurrently at the same time. Branch Workflow is based on branch constraints; it makes a decision to execute services either sequential or parallel. Loop workflow is used to repeat the execution path, service when it is invoked. Thus, service is composed within a short period of time and also within limited Lifecycle specified by the user.

QoS is NonFunctional Requirement (Rajeswari et al., 2013) and it must be ensured while developing new composite services from existing service. These aspects are Reliability, Performance, Interoperability, Scalability, Accuracy, Cost and Availability (Wei Zhou et al., 2013). In this study, Reliability aspects plays an important aspects while composing services (Guisheng et al., 2012), (Goran Delac et al., 2013), Reliability is defined as “the ability to function correctly and consistently and it is measured in terms of number of transaction failures per year or month” (Wei Zhou et al., 2013).

The rest of the paper is organized as follows: Section 1 gives an overview of the various models proposed by the different service providers while developing reliable service composition. Section 2, is to have a discussion about the different Reliability definition, the contribution of each researcher in reliability aspects, Reliability models used at design-time, algorithms, techniques and also have an analysis of their composition patterns used for composing reliable services and also to identify factors used to check reliability aspects. Finally, the paper concludes with the various research issues and opportunities faced by different service providers while composing services are discussed in section 3.

1. Related Works:

This section is to identify what are all the transactional properties and evaluation required to check reliability aspects during service composition and also have an analysis about the various models used for deriving a reliable service composition has been presented.

1.1 Transactional Properties:

Transactional property is one of the important aspects that have to be addressed while verifying reliability. Pivot, Compensatable and Retriable are existing transactional properties that are used to ensure reliability. (Kanchana Rajaram and Chitra Babu, 2014) has proposed a transactional property such as cancellable property
for long running services. To check reliability they also proposed the model, namely Finite Automaton model which is used for deriving Transaction properties of Composite web service and also to predict the behavior of overall composite services. They also guarantee for valid composition with consistent outcomes using cancellable property. Similar to (Kanchana Rajaram et al., 2014), (Guisheng et al., 2012) have also contributed a another model called Transactional matching model(Petri Net model). For verifying actions of service composition either during design or after runtime, here they use Transactional property such as failure processing mechanism, for repairing any faults. Only transaction properties are addressed, they didn’t consider any additional aspects of verifying reliability. If any fault occurred during the execution of services and in order to recover from failure (Rafael Angarita et al., 2014) also proposed recovery strategy such as forward and backward recovery based on transaction properties. Proposed model that dynamically decides which recovery strategies is appropriate according to execution time restrictions. Here the reliability is measured by using the execution time and other aspects are not considered.

1.2 Evaluation of Reliable Service Composition Aspects:

To evaluate the reliable service composition we need to identify what are the factors required to check the reliability aspects an effective one. According to (Thirumaran et al., 2013) reliability has been evaluated using Finite State Machine based evaluation model, which checks whether service are executed correctly and also to check whether all resources are available. Factors that are used to check reliability factors are Availability, Service Interruption time. Other Reliability factors such as execution time, accuracy, accessibility, maintainability are not considered for verifying reliability. (Rajeswari et al., 2013) uses the utility function for evaluating service composition. Similarly, (Wei Zhou et al., 2013) proposed Order Relation Vector Model for calculating QoS preference based on four QoS attributes such as Price, Response time (the delay), Reliability and Reputation. A method such as Defuzzifying and Normalization are presented to deal with QoS attribute matrix. This attribute matrix is used to calculate the QoS attribute weight vector and service composition model are evaluated and experiments are conducted to how to reduce errors and also optimized results. Issues such as only a limited number of factors have been considered for checking reliability. (Zuohuo Ding et al., 2013), proposed Design-time Reliability Improvement Method (RIM) for detecting weak points. The belief Network reliability model uses recommendation algorithms are proposed for yielding better performance and also varies accuracy and complexity. Evaluation results show that WP-WeightedPath is more accurate than WP-WeakestPath as it achieves 3.26 times lower MAPE. By applying RIM which is more efficient by reducing solution space. (Zuohuo Ding et al., 2013) has proposed Port-based reliability model for computing the reliability of composite services based on program invariants. (Huiyuan Zheng et al., 2013) proposed goal service model for composing reliable service composition. Services are composed using Composition patterns such as sequential, parallel, loop and conditional. (Mansour and Dillon, 2011) proposed hybrid (Path and state based) reliability models is used to check the reliability aspects and simulation results are also presented and bounded set approach is used to evaluate the reliability of composite web services and only two state model is done effectively and it also extended to three state model to determine reliability.

All those previously described works, there are only a limited number of factors are used to check reliability aspects during service composition.

2. Reliable Service Composition Models:

This section, is to analyze all the reliability definitions, various reliability models, algorithms, techniques used in the recent research area for reliable service composition, also have a review on composition patterns used for composing composite services and also to identify what are the factors used for checking Reliability aspects and their future directions are also explained clearly in the table 1 given below.

2.1. Definitions of Reliability:

From the section 1, following are the definitions of reliability are obtained:

- To guarantee consistent outcomes using transaction property (Kanchana Rajaram and Chitra Babu, 2014).
- Reliability (Goran Delac et al., 2013) is defined as the possibility that a service invocation will complete correctly, i.e. according to its specifications, potentials in the presence of faults.
- Number of failures (bad invariants) for each port at different times (Zuohuo Ding et al., 2013).
- If any failure occurs the entire execution of services are aborted and also to check for consistent outcomes (Guisheng et al., 2012).
- It also be defined as, how correctly service request is executed based on comprehensive evaluation criteria (Wei Zhou et al., 2013).

From the various definitions, it is obviously known that reliability is defined as the ability to function correctly and consistently and it is measured in terms of failures per year or month.
### Table 1: Study on Existing Reliable Service Composition Models and Factors to check Reliability aspects

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Authors</th>
<th>Contributions</th>
<th>Composition Patterns Used</th>
<th>Reliability model/Algorithms/Techniques</th>
<th>Factors Used to Check Reliability</th>
<th>Future Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>(Kanchana Rajaram and Chitra Babu, 2014).</td>
<td>To achieve reliable execution of composite services and also to predict overall behavior of composite services.</td>
<td>Sequence and parallel composition of Transactional composite webservices.</td>
<td>Finite Automaton model for deriving transactional properties such as compensable, pivot, Retriable. New transactional property such as cancelable web services is used.</td>
<td>Transactional property</td>
<td>Only transactional properties are addressed, they have not concentrated on other aspects to verify reliability.</td>
</tr>
<tr>
<td>2.</td>
<td>(Rafael Angarita et al., 2014).</td>
<td>To estimate execution time of Composite web service using different recovery techniques. Execution Engine will decide to choose best recovery strategy.</td>
<td>Composite Web service Graph/Directed acyclic Graph) Sequential and Parallel workflows.</td>
<td>Dynamic Recovery Decision model. Recovery Techniques (Forward recovery, Backward and Replication)</td>
<td>Reliability aspects is not verified only execution time is calculated.</td>
<td>Need a checkpoint based recovery strategy for checking reliability aspect effectively without any failure.</td>
</tr>
<tr>
<td>3.</td>
<td>(Guisheng et al., 2012).</td>
<td>To create new value added system that satisfy user requirements.</td>
<td>Nil</td>
<td>SCRN model. Transactional matching model (Petri net). Reliable strategy and enforcement algorithms are proposed for dynamically allocate available services.</td>
<td>Transactional attributes and Reliability, availability.</td>
<td>Future research is to investigate integration using configuration tools which are applied in online.</td>
</tr>
<tr>
<td>4.</td>
<td>(Thirumaran et al., 2013).</td>
<td>To evaluate the functional metrics of any business logic using finite state machine.</td>
<td>Nil</td>
<td>Finite State Machine based evaluation model for evaluating the functional metrics of any business logic by checking whether service are executed correctly.</td>
<td>Availability, Reliability and Service Interruption time are also checked.</td>
<td>Other Reliability factors such as execution time, accuracy, accessibility, maintainability are not considered for verifying reliability.</td>
</tr>
<tr>
<td>5.</td>
<td>(Rajeswari et al., 2013).</td>
<td>To estimate QoS based on Composition Patterns for composite service.</td>
<td>Sequence, Loop, Repetition, Branch and Parallel.</td>
<td>WebService composition model based on QoS. Hybrid approach(local and global selection ) to select reliable services.</td>
<td>Utility function to evaluate all QoS parameters.</td>
<td>Further their work focus on QoS tradeoff at runtime by providing scalability and integration with third party business model.</td>
</tr>
<tr>
<td>6.</td>
<td>(Wei Zhou et al., 2013).</td>
<td>To calculate user preference effectively using model.</td>
<td>No workflows, and uses QoS attribute preference function (i.e)“better pay attention to”.</td>
<td>Order relation vector Model is proposed to calculate User preference effectively.</td>
<td>Cost-type(Delay, cost) and Benefit-type (Reputation and Reliability).</td>
<td>To find optimal services which meet user requirements.</td>
</tr>
</tbody>
</table>
Discussion:

Reliability is one of the important aspects that have to be verified while composing a service. Section 1 and 2, had an analysis of various Reliability definitions, Reliability models. Those models are Finite Automaton model (Kanchana Rajaram and Chitra Babu, 2014) for deriving transactional properties such as compensable, pivot, Retriable. Dynamic Recovery Decision model (Rafael Angarita et al., 2014) for estimating execution time, Transactional matching model (Guisheng et al.,2012) for checking reliability. Finite State Machine based evaluation model (Thirumaran et al., 2013), is to evaluate the functional metrics of any business logic. QoS based on Web Service composition model (Rajeswari, et al., 2013), Order relation vector model (Wei Zhou et al., 2013) is to calculate user preference effectively, Reliability Improvement method (Goran Delac et al., 2013), Port-based reliability model (Zuohuo Ding et al., 2013) and Service Graph model (Huiyuan Zheng et al., 2013) is to calculate reliability of composite services, Hybrid (Path and state based) Reliability models. Bounded set approach to determine reliability of CWS. And all these models are used at design-time, algorithms, techniques, what are the composition patterns used for composing reliable services and also discussed what are all the factors used to check reliability aspects.

In our study have identified the various research issues and opportunities that are not addressed while checking reliability during service composition in an SOA environment are:

- Based on the analysis of different researchers only limited number of factors has been addressed for verifying reliability. Some of research contributors consider only availability and execution time as important aspects of checking reliability.
- As the number of service increases, composition patterns or the workflow execution path also increases (Huiyuan Zheng et al., 2013) this makes difficult to estimate probabilities of QoS within a short period of time. Transactional property and evaluation are important aspects of checking reliability.
- Constituents of reliable service composition have not been addressed and measured exactly. These constituents include direct and indirect measurement of reliable service composition is not measured completely. There is no metric suite for measuring reliability of service composition. From the research contribution of different researchers they also didn’t provide complete measures for assessing reliability in service composition. There arises a demand for quantification techniques are required for ensuring and measure reliability in an effective manner.

Conclusion:

The objective of our study is to identify all the Reliability definitions, composition patterns, various Reliable Service Composition Models and factors used to check for reliability aspects. The outcome of our study will explore various research issues and opportunities in reliable service composition. From the research contribution of different researchers only a limited number of factors are used for checking reliability and also there are no complete measures for assessing reliability in service composition. It is concluded that reliability aspects has not been addressed and measured completely.
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