CHAPTER 4

A COMPREHENSIVE SURVEY OF WEB SERVICE CHOREOGRAPHY, ORCHESTRATION AND WORKFLOW BUILDING

4.1 INTRODUCTION

Web services and composition of web services play an important role in building a workflow. This contribution discusses the basics of a web service, service composition and methods used for service composition. It also discusses various proposals that has been provided as solutions to the problems existing in web service composition. It also proposes future research directions that can efficiently tackle the issues of web service composition.

4.1.1 QoS based Workflow Design

A service selection algorithm that helps in web service composition is discussed in (Rathore 2013). The Local Selection of Local Optimization (LSLO) based on linear programming. The best web service from each class is selected. Services are ordered based on the score. (Rathore 2013) have considered QoS parameters during service selection and optimization and select only the best service for composition.
It uses a three step process for service selection, Selection of service candidates, optimization of best candidate and composition using the best candidates. The advantage of this approach is that only the selected number of QoS parameters is used for analysis, which reduces unnecessary computations to a large extent. However, the drawback of this approach is that it takes up high composition time.

Partitioned web service orchestrations is the process of dividing the centralized web services into fragments, such that the aggregation of these services will provide the functionality that would be provided by the original orchestration. (Fdhila 2012) presents an efficient framework for partitioning a web service orchestration. This helps in the change propagation from a centralized structure to a distributed structure.

The execution plan formulation for a web service composition is discussed in (Liu 2012). The plan formulation also includes the QoS attributes, hence (Liu 2012) is a QoS aware process that provides maximum QoS performance. User preference takes the highest priority. It is a branch and bound technique that considers flexible constraints. In its raw form, (Liu 2012) uses the constraint satisfaction problem as the base logic for performing its operations.

The problem in this approach is that decomposing a global optimum into Local Optima that are independent is not a very effective mechanism. There will be dependencies among all QoS parameters such as availability, security, cost etc. So we cannot treat them individually as independent elements. (Hwang 2007) presents a probabilistic approach to model and estimate the QoS of workflows.
A genetic based hybrid method for web service selection and composition is proposed in (Tang 2010). Dependency & conflict constraints are considered in this approach. Genetic Algorithm is used for the process of Web Service Selection. Individual elimination from the population is carried out using the local optimization technique. The workflow design consists of all the available implementations of the web service. It constructs an array of web services.

All individual web services are considered and infeasible individuals have reduced fitness value. Knowledge based crossover is performed, i.e. concrete web services are selected from parents to form children. Local optimization (optimization of individuals) is performed in the beginning and end each generation. This method helps to increase overall QoS and reduce the number of constraint violations.

A QoS aware multi-granular service composition method is discussed in (Feng 2013). It defines behavioral model and proposes a behavioral extracting algorithm. It obtains behavioral signature model from a service composition plan and ensures the best optimal solution. It preserves external observable behavior of composition plan, which can be performed using graph searching technology (DAG).

The drawbacks of this approach is that it assumes the need for a granular web service, while the current necessity is for a complete service. Hierarchical business process notation is not common and not practically used. Virtual service class regards only course grained services while ignoring fine grained services.
4.1.2 Semantic Analysis of Web Services

A semantic and Quality of Experience (QoE) based approach for service selection is described in (Júnior 2013). It provides methods to translate QoE (easy for users) parameters to QoS (easy for service providers) parameters, provides rules for publishing QoS/QoE parameters. This approach is quite flexible in terms of parameters and QoS expression levels. It uses fixed set of parameters are used to specify quality level.

This method does not deal with problem of heterogeneity and it has no standardized SLA/SLS or universally adopted QoS parameters. In real time, several QoS or QoE parameters are available, hence this is not a standardized method, and the parameter list keeps expanding. Different network service providers adopt different parameters according to their needs.

A semantic based composition technique is presented in (Yan 2009). It helps improve the web’s expressability. This process works on overall QoS composition rather than on specific services.

It creates a data index table that maintains three basic details; relationship between data, relationship between data and web services and the QoS offered by the web services. The composition task uses both top down and bottom up approaches. The top down approach is used for the search process and the bottom up approach is used for optimization.

A semantic fault management approach is proposed in (Etzioni 2010) which deal with providing composite smart home services. The web service based abstraction layer is used for network service composition in
the home area network. Semantic fault management, i.e. diagnosis and correction is performed. Business Process Execution Language (BPEL) is used for performing the web service orchestration. (Hai-tao 2010) presents a semantic based method for web service composition and realization. Dynamic composition of web services are performed based on the domain ontology.

4.2 SERVICE SELECTION PROBLEMS

Web service selection is the shortlisting of a single or a handful of services that performs the required task satisfying the basic required QoS properties. The description of the process of web service selection is easily said than done.

This is because, numerous amount of web services are available in the network and appropriate selection of services that perform the specified task is itself a very complex task, while the QoS parameters add another dimension to the complexity.

Selecting a web service that solves the user's problem and provide the required QoS proves to be very difficult. The current selection methods use a user's request and perform the task. This works like an almost tailored search.

Also other user's requests are not considered during the search process. Hence, as users grow, computation time increases. Too many users requesting the same services would also make the process more tedious. This has lead to the development of a centralized orchestration technique.
Even though this helped in the search process, a centralized orchestration technique itself has some apparent disadvantages. A centralized orchestration leads to unnecessary traffic, along with inappropriate dependencies. Output confidentiality is reduced.

Thus a decentralized architecture was proposed. This architecture has a few disadvantages such as high cost and weak execution monitoring. Further, the distributed and dynamic nature of the web services will lead to a lot of uncertainties, such as in availability, reliability etc.

Issues faced during a web service paradigm as described in (Angus 2009) include, creation of a QoS model, QoS-based service discovery and QoS-based optimization of service composition. Further, the QoS described by the consumer might be very different from the provider’s requirements, even though they might semantically be same. The mapping from consumer to provider is one of the most important issues faced during a service selection process.

A workflow requires interconnection of many such web services and thus the appropriate service selection problem is magnified. Using any web service in creating the workflow will not be efficient. Each selected service must meet the QoS requirements specified by the consumer. Further, web services are loosely coupled and there is no centralized middleware for performing the coordination of the services. An efficient web service selection or workflow selection algorithm should be designed to overcome all these issues.
4.3 RESEARCH DIRECTIONS

Based on the above mentioned discussions, the shortcomings of the existing approaches were analyzed and the gaps in literature were identified. This section presents the research directions that discusses techniques to solve the currently existing issues.

Web service selection can be performed by using the Mixed Integer Programming (MIP) method. An integer programming problem is a mathematical optimization or feasibility program in which some or all of the variables are restricted to be integers. Mixed Integer Linear Programming (MILP) involves problems in which only some of the variables, are constrained to be integers. E-commerce negotiations are considered for building the workflow. Analytic Hierarchy Processing (AHP) is used for rating the services according to their QoS parameters. The AHP rating is performed either as pair wise comparison or is directly rated.

The classical approach of Mixed Integer Programming can be superseded by using a Genetic based Approach. Employing a heuristic based approach will help provide much efficient results. Using a GA based approach will further result in obtaining new sequences that have not been discovered earlier. The heuristic based approach can be further optimized by adding a meta heuristic based approach. Optimization of workflow sequences can be carried out by this approach.
Modification of optimization techniques can be used. Parallel programming and transaction based web service selection and processing can be used for further enhancements.

4.4 CONCLUSION

The importance of web services, along with their methods of usage has been discussed. Further, workflow building, which can be decomposed into multiple service selection algorithms, is discussed along with the problems encountered during a web service selection process. Available solutions for web service selection are divided into three sections (Ranking and selection of services, workflow design and semantic analysis of web services) and contributions in each section are discussed in detail. It also provides the available research directions for solving the above discussed problems.