Dynamic Web Services Composition: Current Issues

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ABSTRACT

A great deal of recent web-related research has concentrated on automated web service composition. The main advantage of web services technology is the possibility of creating value-added services by combining existing ones to achieve customized tasks. How to combine these services efficiently into an arrangement that is both functionally sound and architecturally realizable is a very challenging topic that has founded a significant research area within computer science.
Our research contribution lies in the area of dynamic composition service selection. We have started by collating and analyzing current outstanding problems within the dynamic composition area. To help explain the background to these challenges we compare, firstly, the key components of distributed computing technologies with web service composition. Then we define the 'execute ability' problem - the key idea that preconditions of web services must be satisfied before or during composition. We discuss data distribution strategies among services, how they can be used to overcome problems in dynamic composition problems and how they relate to the quality of service. Finally, we present our proposed framework model to handle the process of web service composition and execution. We propose that this framework eliminates the main problems as discussed in the paper.

Keywords Dynamic Web Services, Composition, Quality of Service

SECTION I

1 INTRODUCTION

People use the internet daily to look up financial market quotations, buying different manufacture's products, searching, filling in forms and to get the latest updates. This level of interaction is useful for information retrieval purposes. Most of the information on the web is designed only for human use [1,6,23,24]. Humans can read HTML documents and understand them, but their inherent meaning is not shown to allow their interpretation by computers. In other words the essential text-based web does not support software interactions. How we give meaning to the text based web is precisely the objective of the Semantic Web – to make possible the processing of Web information by computers [24]. The Semantic Web is a future vision of an extension of the www, in which information is given machine-readable semantics, enabling computers and people to work in cooperation [4,7,19]. Internet based applications need to be capable of performing search and automatically interact with other internet-based application. The goal is to enable software systems to automatically perform operations that previously required human intervention, such as searching for and buying goods and services while optimizing user criteria such as a resource (price, time etc). All these examples come from relatively different areas but still share some fundamental characteristics [1,6,22]. Figure 1 shows a common operation scenario of available services. A service is offered by service provider, an organization that procures the service implementation supplies its service description (WS Register), and provides technical and business support to clients [7,11,16].

Previous research [14,17,21,23,29] has divided the process of composition of services into static and dynamic. Static composition is purely manual i.e. firstly, the user problem must be defined and then a manual selection of services according to desired outputs is performed. In dynamic composition, automated tools are used to analyze a user problem, and select and assemble web service interfaces so that their composition will solve the user problem [4]. In other words, from a user perspective, this composition will continue to be considered as a simple service, even though it is composed of several web services [30].

In our research project, we are aiming to create methods for the automatic, dynamic composition of web services. In particular the methods will be able to cope with problems associated with the distributed, independent, and uncertain nature of the web. Individual service availability, reliability and quality are factors which make composition difficult. This paper discusses the main issues faced by web services composition researchers and proposes some solutions.

The paper is structured as follows: section 1 discusses web services, distributed computing technologies and the execute ability problem as discussed in [15]. This is to do with determining

whether the preconditions of the actions which make up a composite service can be satisfied in the "open world" environment of the web, where information is incomplete. We try to discuss execute ability issue in section I because actually it is common problem in both approaches (web services and distributed application development methods). In section II, we try to advocate data distribution strategy in the composition process model, web services selection criteria on the base of QoS (Quality of services) issues like throughput Capacity, Latency, Response Time, Availability, Reliability, Reputation and Execution cost[18,19]. Although different approaches are available to address this problem, but we are trying to start with current problems from different approaches in this area. In proposed frame work model, our main attention is to eliminate currently faced problem during composition, which we discussed in section I and II.

2 A MOTIVATING EXAMPLE

Web services are self contained programs that can be executed through the standard, global protocols of the internet. There are many services around the web and each one has a limited functionality. In many cases, a single web service is not sufficient to respond to the user's request and often services should be combined through services composition pattern to achieve a specific goal [3,5,7,9,22,29]. Such composition is carried out manually at present, which means that a user needs to execute all these services one by one and these tasks can be time and effort consuming. Due to constant changes in output/input parameters values, interfaces, networking issues, it is difficult to integrate these services.

As an example application, we consider the work by Hu, who has used the web service paradigm in an effort to make more the communication between police departments and UK government agencies more effective [3, 23,29]. Each of the providers (the agencies) offers data and enquiry capabilities to the police forces (a range of services are offered as shown in Figure 2). In a typical police enquiry, whenever a police officer wants to investigate about any person he has to search through for a criminal record, fingerprints, vehicle registered in the person's name, insurance details and vehicle movement in a particular interval of time across the country. In fact, more than 50 department's services required integration in this project [29].

To date this work has achieved limited success towards the application of automated, dynamic composition of web services, as in the Police domain, only authorized persons have access to some of these services [4, 5]. So just in time integration of services is not possible at the moment. Currently they are using a semi-automatic static composition method as shown in figure 2. Enquiry officer is getting query response after execution of composer process. But for real time results we need dynamic composition. Such a type of dynamic composition is difficult because of the following factors.

- Firstly, it is very difficult to analyze services (even manually) from the web services repository (the UDDI) and integrate them to get specific required outputs.
- Secondly, web services contents are going to be changed routinely to fulfil the user requirements. On selection time before composition the system must be able to select up-to-date services. There has been a considerable research to get updated web services at the time of composition but still unable to fulfil dynamic composition requirements.
- Thirdly, web service suppliers are using different conceptual models to describe their services. To enable an automated dynamic composition process we need one structure (model) of available services so that a service can easily invoke other services with out any technical overhead. Figure 3 provide us summarize overview of bottom to top development stages of web services. We also try to draw sub stages on some levels.

On next stage of composition process selection of services is also very important issue. There are three types of rules to consider, whether involved in static or dynamic composition, as illustrated in Figure 3.In Template Based, a specific template either needs to be created, or acquired from a repository. A user has to locate the respective template first (in static composition process) before compose services. This is time consuming process as well. In Interface Base, on the base of inputs and outputs through interfaces, user is getting services reference and these composite services after composition process provide final results. It is highly adaptable method but functionality is not guaranteed. During composition process, some time we are getting similar interfaces, but after composition undesirable outputs (final results). Mostly automated composition available tools using interface base selection concept. In Functionality Base Composition, along with pre-conditions and post-conditions, user has to provide first-order logic (formula representing the logic) into the interface information. The above mentioned individual rules are adaptable if we are interested in manual selection. In the context of our interface and functionality based (two rules combination) approach, the problem of dynamic selection can be solved as discussed in section II.

3 WEB SERVICES AND DISTRIBUTED COMPUTING

It has been claimed that web services are reinventing the wheel because they share many characteristic with other distributed computing architecture, such as CORBA, Distributed Smalltalk, RMI or DCOM [14, 24]. Technologies from distributed computing normally have a tightly coupled relationship between client and server where the coupling between various components in a system is high. In RPC–oriented interaction, the service request takes the form of a method call defined by a name and a set of input and output parameters. During execution it waits for a response in a real time. In the web service-oriented interaction style, the particular web service request takes the form of complete XML (query) document and will provide result on screen, acknowledgement in the form of email or any other type of real time response. In both above cases we need detailed knowledge of available services and about all involved overheads (physical and logical structure) to combine them. Although less effort is required during the setup of such structure. It still leads to some type of static binding. Because in distributed object technologies we are normally following object reference call procedure, defined data structures, language specific protocols. Therefore it cannot inherently take the advantage of the existing available services, while the web assumes that parties can connect without prior knowledge of participants, by following URL links and observing some fundamental rules [7, 24]. The main question arising at this point is how can we reduce tight coupling and static binding between these components? Otherwise web service composition will give us same concept like any distributed computing applications. The main potential advantage, therefore, of web services over RPC's is the potential for service (application) to automatically discover and compose services on demand. One technology for achieving this is AI planning, which can be used to automate the composition of semantic web services and dynamic discovery [7,10,12,13]. These techniques can potentially enable client and web services to find each other with out prior knowledge of each other. To apply these techniques for accurate results we have to introduce semantic and ontological concepts to our web service model. Hence the act of looking up capabilities of a Web services can be done at the same time as dynamically composing it with others, rather than the use of inflexible static binding between one or more services. These two previous concepts make web services stand out against distributed applications. So it will be impractical to develop real time applications (like Hu's police example explained above) by using distributed technology environments.

4 EXECUTE ABILITY PROBLEM

Web services are some times portrayed as "silver-bullet" solutions to integrated web applications, because they have the potential to replace the role of the original web and relational database-related technologies [24]. Web service technology enables application-to-application interactions over the web, since any interaction with a web service involves sending and receiving messages [15,28]. One way to describe a particular service is in terms of its preconditions on input parameters values, precondition on prior operations invoked, and its output conditions and effects. In web services composition process, the two terms choreography and orchestration are very important. Web services choreography is to do with the interactions of services with clients/users, and determines the specification of operations, states and conditions, which control how the interaction occurs [27]. Following the temporal constraints output by the choreography process should result into the completion of a useful function [23]. As stated by Micheal Hu, Web service choreography permits the description of how web services can be composed, how rules and association in the web services can be established, and how the state, if any, of composed services is to be managed [29]. The World Wide Web Consortium introduced the Web Services Choreography Description Language (WS-CDL) which captures the interaction in the participating services. The choreography model also helps out to determine control-flow dependencies, message correlation, time constraints and transactional dependencies. On the other hand an orchestration defines the sequence and condition in which one web service invokes other services in order to carry out any specific task, i.e. an orchestration is the pattern of interaction that a web service planner must follow in order to achieve goal [23,29].On the base of above discussion we can say the dynamic composition model requires four additional layers Semantic, Ontological, Choreography description and Orchestration concepts. Choreography Model and Orchestration Model provide us a comprehensive solution for basic issues like precondition, effect and post condition.

SECTION II

5 DATA DISTRIBUTION AND QUALITY OF SERVICES

Service-Oriented Architecture is recently defined paradigm for organizational models of systems, aimed at simplifying large business operations using existing services. SOA's main manifestation is in the area of web services. Although there is plenty of controversy about how SOA will manifest itself in the context of web services technologies, the issue of the quality of services will always be central to the argument [2, 24]. Businesses will have to have secure web services and will have to be able to guarantee that messages arrive at their intended destination and are processed reliably [4, 7, 23]. During this web services composition process we also required output variable values from different services (data servers). If some parameters are missing or due to any reason not available for next service then process will fail. Web services standards and technologies are composed of two major types of application interaction patterns on the basis of their database interaction access. Centralized dataflow and Decentralized dataflow. If our focus is towards dynamic service composition then in both approaches there are some limitations [3,8,9,11,17,19]. In Centralized Dataflow, data between components services is passed through the composite services and in that situation bottleneck problem occur, that is why throughput and response time affected. On the other end in Decentralized Dataflow Components, services exchange data directly with various data base servers. This result is that the distribution of network traffic among all the services involved improves loading characteristics on the composite service, improving in particular throughput and response time. Both of the models have there own advantages in distributed computing environment [7,13,21,23,25]. The Decentralized Dataflow seems to be very efficient for dynamic services composition but in some situation like Police example it will affect QoS factors like latency, execution cost and capacity. For automatic web services composition we can use centralized data model by adding middleware extension support to avoid tight coupling between services. This type of extension will be automatically added in our model if we use UDDI (Universal Description Discovery and Integration) or WS-Coordination and WS-Transaction. Proposed frame work model will result in performance improvement, lower time response and higher throughput maintainability. The web services QoS requirement refers to both functional as well as non-functional quality aspects of web services [2,16]. The overall performance of web services depends on the complexity of the application, as well as the network, messaging and transport protocols (SOAP.HTTP).Automatic service compositions are error prone, while developing web services following practices are very important [2].Adopting standards such as BPEL4WS, WS-Coordination, WS-Transaction, and WSCI (Web Service Choreography Interface), Service Pooling and Load Balancing, Web Service Clustering, Use of Security Assertions, P3P (Platform for Privacy Preferences), Use of Asynchronous message queues, Use of simple data types in messages as discussed in [8,21,24,26,27].

6 CURRENT TECHNICAL AND FUTURE WORK

In this short paper our discussion is around distributed technologies, execute ability issues, data distribution, QOS issues and how to avoid execute ability issues. So this basic path provide us a way leading to one real time integrated setup for execution of these composed services with out any dependencies and faults as mentioned in [14, 11, 19, 23]. In proposed model as shown in figure 4 we try to add solution of main problems which we discussed in section I and II. The activity of this process starts when a new service is firstly registered in service repository. We use a translator if any type of language conversion is required. The service composition request is firstly coming to web server. Web server will try to locate in its own services database if already such type of interface base composition exists then integrated result will send to client. Otherwise server will try to search from web services database. The web server will find desired services through matching engine from web service database. Evaluator will evaluate these services on the base of interface base search in first round. On the base of results during first round, evaluator again apply functionality base rule in second round. Composer will compose these selected services and return services address to web server. The composed solution results will send to composition requestor. The copy of this services integration will also be saved in service repository for future use. For practical implementation of such desired framework we tried by using Eclipse version 3.4.0 with GEF (Graphical Editing Framework) plug-in, Apache tomcat server 6.0, UDDI server based integrated platform. The above mentioned path actually leads us towards semiautomatic type of composition. If any of servers is not responding or

input/output issues then composition process will fail. Secondly during experiment we also observe that composition process is not getting any advantage from the new uploaded services. To include new services into our composition process we have to re instantiates both servers. By this integrated environment we are trying to fill the gap between distributed network application development and web services as discussed in section I. In SOA paradigm if we introduce communication links between distributed technologies and web services then automatically we will find autonomous environment. Where applications can connect without prior knowledge of platform, human interaction and technical details, then we can achieve loosely-coupled, platform-agnostic, self-describing and self-healing application properties.

To overcome this issue we have to introduce a plan which (planner) itself produces required outputs on the base of input values as discussed in [7, 13]. So our next step is to view dynamic web composition process as AI planning problem. We can consider composition tasks process in different states i.e. initial state, final state and goal (composition final result) of a planner.

7 CONCLUSIONS

At this stage, automated dynamic web service composition development process is still under development, although some automated tools and proposals are available. The full automation of this dynamic process is still ongoing research activity. In this paper we outlined the main challenges faced by web service composition, like execute ability, data distribution and its effect on QoS. We also tried to elaborate the main differences and advantages of web services over distributed application development. Based on an analysis of current problems, we have introduced a model of dynamic services. In the proposed model we try to fix current issues for dynamic composition. In our future work we intend to elaborate the phases of the proposed model, and develop searching algorithms, leading to a robust solution to the dynamic composition task.

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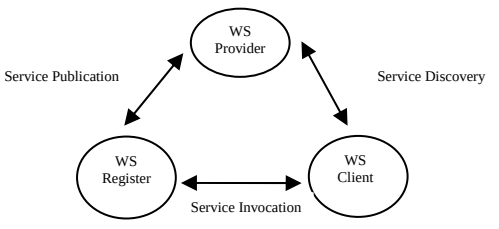

Figure 1 Web Services Operation scenario

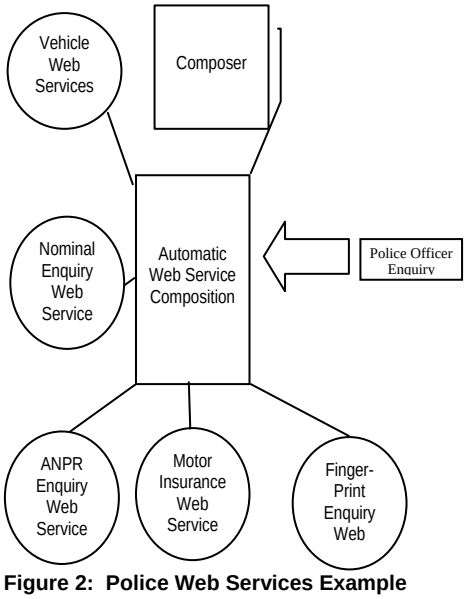

Figure 2: Police Web Services Example

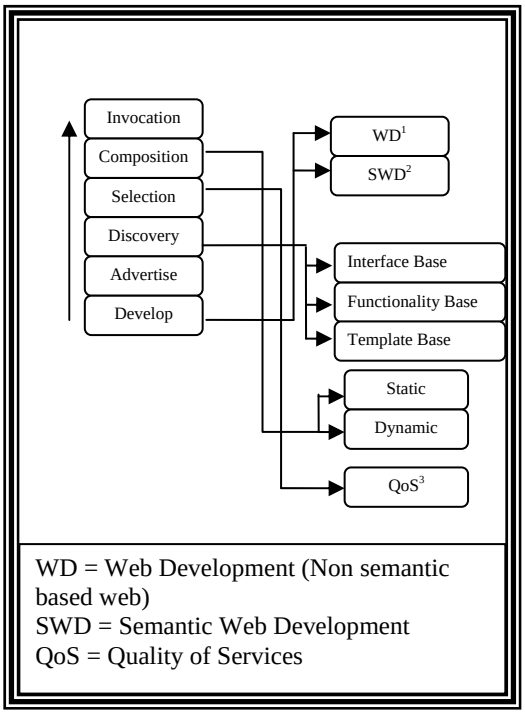

Figure 3: Stages towards Composition Process

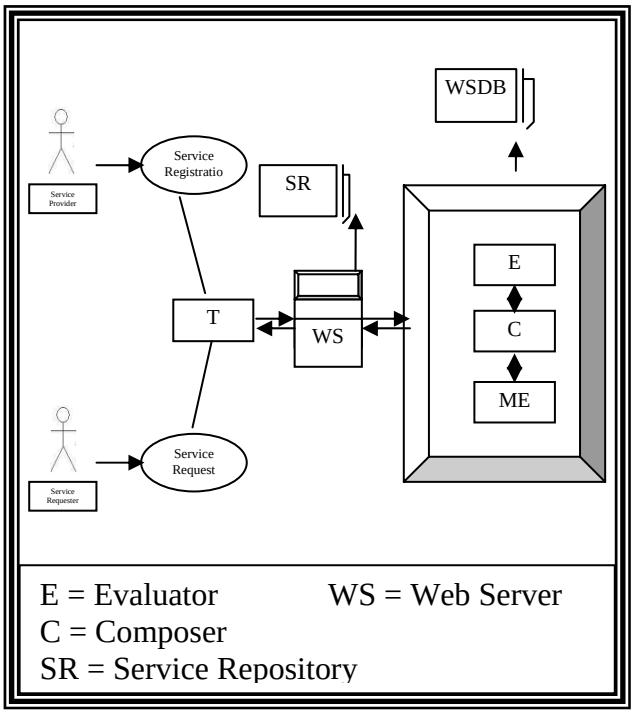

Figure 4: Proposed Frame work Model