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A review of Effective Service Discovery and Composition in Service Oriented Architecture

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Abstract

Service Oriented Architecture (SOA) has got popularity in the past 17 years or so. It provides different types of solutions in the form of services. Services register, discovery and effective service composition is explored by a number of researchers. This paper is aimed to focus on the literature review on efficient service discovery and composition in SOA. There is a comparative study of various models in order to efficiently discover web services followed by effective service composition.

Keywords: Service Oriented Architecture, Web Service, Service Registry, Service Consumer, and Service Provider.

1. Introduction

The scientific advancements and development of new standards has open new ways for the design and development of web applications. The web services are combined to produce a larger web service for achieving a bigger task provided all of these web services are independently published. But after their composition which is accomplished through input/output variables and interfaces results in improvement the way we do business worldwide. SOA is a paradigm which facilitates business operations by combination of granular web services in order to device bigger business solutions SOA also defines the IT infrastructure to be pervasive and independent of any specific platform thus facilitating the exchange of data for ultimate business processes. It is achieved by loose coupling of different functions used in operating systems and programming languages used underlying the applications [16]. In past few years, the world has witnessed a paradigm shift in distributed computing, from the middleware oriented design to Service Oriented Architecture. Following is the evolution of the architecture.
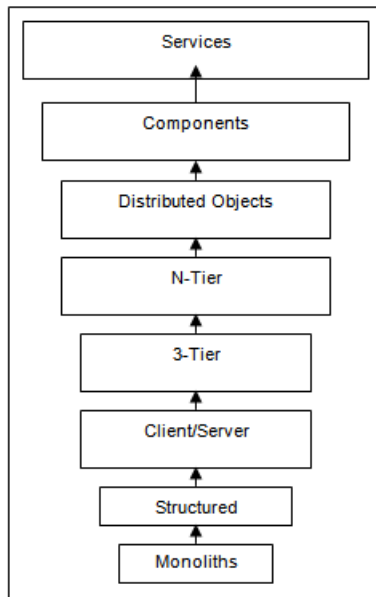
Figure 1: Evolution of architecture [8]

Collaboration of the following entities yield to support finding, binding and invoking of corresponding web services. [17]
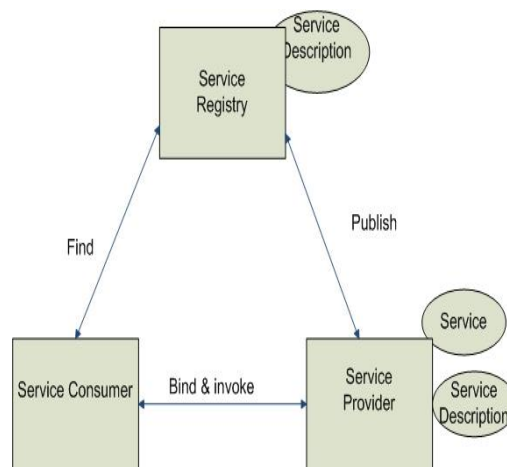

Figure 2: SOA collaborations [17]

Service registry: Before service discovery, services are needed to be registered. A list of all services becomes available only after service registry. Service registry provides consumers the interfaces of concerned web services by the service providers [17].

Services provider: Consumers request for their desired web services and service provides responds to them accordingly. At the time of service registry, the interface and contract is provided by the provider. The services and available in a manner which can be accessed by the consumer as per his/her need [17].

Service consumer: In order to perform a bigger task, we need to assemble several web services. The consumer of web services could be a service itself or an application. The process starts with the generating of request for a service in the registry. The second step is binding of the concerned

service over the transport and services are executed in the context of user requirements. Interface of the service opens the gateway for service consumers [17].

2. Literature Review

This paper describes dependency award service composition along with service management [1]. The focus is on service development and service composition in the light of dependency awareness. Service dependency and composition are explored with the help of extended Service Oriented Model (SOA). Conventional Service Oriented Computing (SOC) loses the composition information after services binding and execution. But in Dependency Aware Service Oriented Architecture (DSOA), the information about composition are stored and registered. The interfaces for composed services are deployed on the internet in contrast to composed applications [1]. DSOA keeps the record of service composition for later use along with dependency among services. The shortcoming in the proposed idea is inadequate information availability for services interactions and ultimate service composition.

The paper attempts to propose a blend of Service Center Architecture (SCA) and Randomized Reinforcement Learning (RRL) algorithm in order to facilitate distribution, openness and service composition driven by multi criterion at run time [3]. The given system provides the capability of dynamic adaptation while working in varying operating conditions. The Mediator Web Service (MWS) in SCA makes use of RRL algorithm in order to combine exploitation and exploration that yields the following benefits [3]:

1. Changes adaptability while dealing with web services performance levels and availability.
2. Guiding service composition through different criteria.
3. Decentralized architecture through localized composition decisions.

The strength of the paper is that Niave Boltzmann and greedy exploration strategies are outperformed by the proposed algorithm proved through experiments. This approach works fine in several conditions but if concurrency of task is required it does not give the desired results.

The focus of the paper is to effectively discover web services in SOA with the help of JIT philosophy [1]. User queries are analyzed in terms of context awareness. Based on consumer's input, services are discovered which makes it possible to match services to consumer's requirements with the removal of irrelevant services. Above mentioned idea is facilitated through intelligent search by means of neural network. The paper also presents a couple of scenarios to illustrate above mentioned work [1]. The strength of the paper is the feeding of experience as input in the search system based on intelligence to facilitate effective service discovery as opposed to other available techniques. The overall work in this paper is fine but it does not have specified any method for service composition as it only focus on service discovery.

The paper attempts to present F-Match [1] that matches services on the basis of service functionality. It employs SAW-OWL-S for specifying service advertisements and discovery requests. F-Match categorizes functionality compatible services after trimming out incompatible services [1]. Such ranking is based upon the combination of similarities against preconditions, input/ output parameters and service attributes of the request. The strength of the paper is that experimental results validate the efficient identification of functionality compatible services through F-Match [1]. The main weakness of this research work is that it does not have specified any QoS criterion for service discovery and no work is done for keeping intact the NFR of the service for service discovery.

The paper attempts to explain ontology enabled service oriented architecture (OSOA) in order to assist users (non-experts) to utilize devices [18] and combine their functionality devoid of an explicit goal. OSOA mingles interoperability and semantic description provided by web services and ontologies respectively. OSOA based adhoc service composition provides promising solution to combine devices devoid of an explicit goal. In spite of interoperability among different services to be the main issue, it is possible to exchange data reliably and securely among applications operating in different environments in order to provide a good base for solutions of pervasive computing. Control devices along with unanticipated compositions of any existing services to uncover those which might be of use for non expert users is provided by adhoc service composition. The strength of the paper is that adhoc service composition produces new object with the consumption of old one. If a service has no output in terms of a new object, it is basically the final service that ends composition [18]. The main weakness of this research work is that it does not have specified NFR of the service for service composition.

Another paper describes ontology based web service discovery making use of WSMO language for Service Oriented Architecture [16]. Semantic description facilitates service discovery for achieving overall goals of efficiency and effectiveness. The issues of service description and discovery are addressed by WSMO. User's requirements satisfaction is achieved by using goals. WSMO language takes in to account functional requirements of web services along with non-functional requirements and that is the strength of the given work [16]. The deficiency of service interface development by mediators becomes the weakness in the current scenario. Further, the results are not quantifiable in the current work.

In this paper, Extended Service Oriented Architecture (ESOA) is discussed. Here we have separate tiers for coordination and composition of web services [11]. While working in an open market place, ESOA facilitates services management making use of grid services. High level services along with Distinct Integration Tier (SGB) improves application development and deployment. Moreover, service interacting, aggregation, security and overall service management are achieved using high level services [11]. In ESOA, the services composition layer offers all required functionality and roles for creating a single composite services using multiple web services. The positive role of this paper is unlike SOA, ESOA solves the overarching problems like coordination, transaction management and security. The availability of coupling value added services is the main advantage of SGB. For common development needs, the solutions are provided in the form of packages. In this work the architecture has been proposed but no validation mechanism has been specified to compare it with the existing models.

This paper solves the problems of communication latencies that occur between admission control and services for service composition making use of 3 phase composition technique [3]. In the proposed algorithm, as early as composition happens, the admission control is taken into account. For soft real time systems, a probabilistic admission control mechanism is used. In case of real SOA systems, a timing specification model along with an analysis technique is proposed. The proposed model helps in timing analysis therefore specify timing requirements and service composition [3]. The service composition is improved keeping in view its effectiveness and timing requirements for real time systems. The main weakness of this research work is that it does not have specified any QoS criterion for service composition to have a service level agreement.

In this paper a comprehensive work upon meshup is presented. Meshup architecture has been proposed and current SOA is extended with this new scheme [16]. An analysis is then performed to identify how it assists service composition. Moreover a meshup component model is also proposed to assist developers in order to create composite services on their own. Very much like three tier architecture, meshup application is comprised of: API providers, consumer's web browser and the meshup hosting site [16]. Core features of meshup include: increased reusability, being web based, light weight and end consumer centric. UI component, service component and action component are classified as the three elements of component model. The strength of meshup is that it provides simpler, cost effective and self served approach regarding service composition which reduces SOA service composition complexities and barriers. It also offers end consumers the potential to create self services. The weakness in the proposed work is that due to the immatureness of meshup technology, still a bunch of problems are left unsolved.

The main theme of this paper is to illustrate two ways of tackling Web Service Composition (WSC) procedures and their subsequent modification to work with volatile information [15]. Among the two ways, black box approach doesn't concerns with the internals of WSC procedures rather it treats WSC procedures to be wrapped in a wrapper while considering volatile information. The gray box approach on the other hand is partially concerned with the internals of WSC procedures which enables it to insert coding in the given procedure in order to carry out some bookkeeping operations [15]. In this paper, four WSC procedures regarding volatile information are implemented: Eager and lazy strategies incase of black box translations while Active-Inactive and Active-Only strategies in gray box approach. At the end theoretically it has been shown that besides both approaches to yield correct results, experimental results reveal that gray box approach produces WSC procedures much faster as compared to black box approach and that is the strength of the proposed work. The weakness of this paper is that it doesn't cater white box approach, which if defined would have definitely improved the presented work.

The focus of this paper is to look at service composition information. A context aware service management platform [18] is developed to compose services with respect to service dependencies. Despite of being function centric, the traditional description of web services do not hold the composition information that badly affects service composition keeping in view the consideration of service contexts. The structure of web service dependency and services contexts is identified along with discovering dependency aware service composition. Service dependency and context dependency are the sub categories of web service dependency. The categorization of service contexts is: actor, interface, service and data etc while context dependency is further categorized into 8 subtypes each specifying the relationship between service object and a context object [18]. The strength of this paper is a prototype for service development and management keeping in view context awareness. It uses (Universal Plug and Play) UPnP technology and is installed in the Open Service Gateway Initiative (OSGi) framework. In this work a platform for service composition has been proposed but does not have discussed results to compare it with the existing techniques.

The paper attempts to propose an approach regarding service composition for migrating an e-learning legacy system (MELS) using mining techniques [18]. An apt sequence mining algorithm is to be developed that would be used for mining connected data being collected from an e-learning legacy system. An algorithm for sequential mining is proposed to mine data of the legacy systems [18]. Real data is collected from an e-learning legacy system and the proposed approach is applied on the collected data for validation along with a few investigation questionnaires for collection of

satisfaction data. The strength of the paper is better results generated from an investigation which is 90% identical to our approach [18]. One of the shortcomings of this research work is that it does not have specified NFR of the service for service composition.

The paper describes an information systems development framework dealing specifically with the characteristics of SOA systems [14]. The limitations regarding current development methodologies while dealing with SOA systems are highlighted. Service Oriented Systems Model (SOSM) is proposed in order to align development of information systems with service orientation [14]. SOSM can be used to model system's analysis, planning and design workflows for Service Oriented Architecture within the context of an organization. An information system can be built through a development method offered by SOSM which can trim down the intricacy of automating qualifying evaluation. The strength of the proposed work is an efficient system in which changes can be accommodated irrespective of middleware technologies for independent service modules implementation. Moreover new service level agreements are easily settled up through flexibility of service interfaces [14]. In this work the architecture has been proposed but the simulation results are not discussed to clarify the effectiveness of the underlying approach and its comparison with the existing models.

The paper presents an approach regarding service composition that takes inspiration from Blackboard systems. Blackboard systems provide an architecture that is modular and very flexible. It makes easy to integrate independent coarsely grained components. Composition is integrated into Onto⇔SOA in the context of Blackboard systems [15]. A composition mechanism based on blackboard systems approach is devised to utilize homogeneously arranged repository and controller components in order to facilitate services interaction. Tying together multiple services along with their interaction through shared repository of data is being enabled by the proposed approach. The strength of the paper is that the given approach is independent of explicit workflow specification and extensive service model. Further it is also feasible for the ontology based and document oriented service model. The main weakness of this research work is that it does not have specified any QoS criterion for service composition.

The paper proposes an approach for the improvement of non-semantic web service discovery through clustering [11]. Web services are clustered based on similar nature and make use of mining Web Service Definition Language (WSDL) documents. There are five important features which are identified that need to be extracted and integrated for developing clusters from web services based on similar functionality. In order to identify relevant web services in response to user's request, quality of the discovery regarding web services can be improved through integration of the proposed clustering approach in search engines [15]. The strength of the proposed work is that as compared to preceding approaches the quality of retrieving web services has improved that is also proved through experiments. The overall works done in this research is good in performing service composition but have done work for optimizing the service integration as the number of request increases.

3. Comparative Analysis

Serial No.	Author (s)	Problem discussed	Strengths	Weaknesses	Possible Improvement
1	Ezhilarasi G and Dhavachelv an P	To effectively discover web services in SOA with the help of JIT philosophy. User queries are analyzed in terms of context awareness	The feeding of experience as input in the search system based on intelligence to facilitate effective service discovery as opposed to other available techniques.	The overall work is fine but it does not have specified any method for service composition as it only focus on service discovery.	
2	Hachem Moussa, Tong Gao, I-Ling Yen and Farokh Bastani · Jun-Jang Jeng	Solving the problems of communication latencies that occur between admission control and services for service composition making use of 3 phase composition technique [3].	The proposed model helps in timing analysis therefore specify timing requirements and service composition [3]. The service composition is improved keeping in view its effectiveness and timing requirements for real time systems.	It does not have specified any QoS criterion for service composition to have a Service level agreement	
3	Ivan J. Jureta, Stephane Faulkner, Youssef Achbany, Marco Saerens	Proposing a blend of Service Center Architecture (SCA) and Randomized Reinforcement Learning (RRL) algorithm in order to facilitate distribution, openness and service composition driven by multi criterion at run time [3].	Niave Boltzmann and greedy exploration strategies are outperformed by the proposed algorithm proved through experiments.	The approach works fine in several conditions but if concurrency of task is required it does not give the desired results.	
4	Jiehan Zhou, Danial Pakkala, Juho Perala, Eila Niemela Jukka Riekki and Mika Ylianttila	Describes service management along with dependency aware service composition [1].	DSOA keeps the record of service composition for later use along with dependency among services.	The proposed idea has inadequate information available for services interactions and ultimate service composition.	It can have good results if proper mechanism is proposed for defining service composition pattern and how service performs interactions with each other.
5	Jiehan Zhou, Eila Niemelä, Juho Perälä and Daniel Pakkala	Looking at service composition information. A context aware service management platform [18] is developed to compose services with respect to service dependencies.	Prototype for context aware service development and management that uses UPnP technology and is installed in the OSGi framework.	A platform for service composition has been proposed but does not have discussed results to compare it with the existing techniques.	

6	Khalid Elgazzar, Ahmed E. Hassan	An approach for the improvement of service discovery in case of non semantic web services through clustering [11].	As compared to preceding approaches the quality of retrieving web services has improved that is also proved through experiments.	As number of request increases, optimization of the service integration is not addressed.	
7	Krzysztof Brzostowski, witold Rekuc, Janusz Sobecki and Leopold szczurowski	Ontology based web service discovery making use of WSMO language for Service Oriented Architecture [16]. Semantic description facilitates service discovery for achieving overall goals of efficiency and effectiveness.	WSMO language takes in to account functional requirements of web services along with non-functional requirements and that is the strength of the given work [16].	The deficiency of service interface development by mediators becomes the weakness in the current scenario.	
8	Maksym Korotkiy and Jan Top	An approach regarding service composition that takes inspiration from Blackboard systems.	The given approach is independent of explicit workflow specification and extensive service model. Further it is also feasible for the ontology based and document oriented service model	It does not have specified any QoS criterion for service composition.	
9	Mike P. Papazoglou	Extended Service Oriented Architecture (ESOA) is discussed. Separate tiers for coordination and composition of web services [11]. While working in an open market place, ESOA facilitates services management making use of grid services.	Unlike SOA, ESOA solves the overarching problems like coordination, transaction management and security. The availability of coupling value added services is the main advantage of SGB. For common development needs, the solutions are provided in the form of packages.	No validation mechanism has been specified to compare the proposed architecture with the existing models.	
10	Qun Ni	Ontology enabled service oriented architecture (OSOA) in order to assist users (non-experts) to utilize devices [18] and combine their functionality devoid of an explicit goal	Adhoc service composition produces new object with the consumption of old one. If a service has no output in terms of a new object, it is basically the final service that ends composition [18].	It does not have specified NFR of the service for service composition.	
11	Stephen S. Yau and Junwei Liu	F-Match [1] that matches services on the basis of service functionality. It employs SAW-OWL-S for specifying service advertisements and discovery requests.	Experimental results validate the efficient identification of functionality compatible services through F-Match [1].	It does not have specified any QoS criterion for service discovery and no work is done for keeping intact the NFR of the service for service discovery.	

12	Thomas, Manoj, Weistroffer, H. Roland,	An information systems development framework dealing specifically with the characteristics of SOA systems [14].	Efficient system in which changes can be accommodated irrespective of middleware technologies for independent service modules implementation. Moreover new service level agreements are easily settled up through flexibility of service interfaces [14].	No simulation results are discussed to clarify the effectiveness of the underlying approach and its comparison with the existing models.	
13	Tsz-Chiu Au Ugur Kuter Dana Nau	Two ways of tackling Web Service Composition (WSC) procedures and their subsequent modification to work with volatile information [15].	Besides both approaches to yield correct results, experimental results reveal that gray box approach produces much faster running WSC procedures as compared to black box approach that is the strength of the proposed work.	It doesn't cater white box approach, which if defined would have definitely improved the presented work.	
14	Xuanzhe Liu, Yi Hui, Wei Sun and Haiqi	A meshup architecture has been proposed and current SOA is extended with this new scheme [16]	It provides simpler, cost effective and self-served approach regarding composition of services. It reduces SOA service composition complexities and barriers. It also offers end consumers the potential to create self-services.	Due to the immatureness of meshup technology, still a bunch of problems are left unsolved.	
15	Zhuo Zhang, Dong-Dai Zhou, Hong-Ji Yang, Shao-Chun Zhong	An approach regarding service composition for migrating an e-learning legacy system (MELS) using mining techniques [18].	Better results are generated from an investigation which is 90% identical to our approach [18]	It does not have specified NFR of the service for service composition.	

CONCLUSION

Our literature reviewed a number of papers each focusing on aspects of service discovery and composition in Service Oriented Architecture. Intially effective service discovery in Service Oriented Architecture (SOA) is explored. Web Service composition and their dependencies are explored with the help of extended SOA model. A blend of Service Center Architecture (SCA) and Randomized Reinforcement Learning (RRL) algorithm facilitates distribution, openness and service composition driven by multi criterion at run time. JIT philosophy helps to effectively discover web services in SOA. F-Match categorizes functionality compatible services after trimming out incompatible services to facilitate efficient identification of functionality compatible services through F-Match. Ontology enabled service oriented architecture (OSOA) assists users (non-experts) to utilize devices and combine their functionality devoid of an explicit goal.

In an open market, distinct tiers are provided by ESOA for composing and coordinating web services. Making use of grid services helps in effective management of web services. WSC procedures enable to insert coding in a given procedure in order to carry out some bookkeeping operations. An information system can be built through a development method offered by SOSM which can trim down the intricacy of automating qualifying evaluation. Blackboard systems provide an architecture that is modular and very flexible. It makes easy to integrate independent coarsely grained components. Critical analysis presents the pros and cons of several approaches in the paradigm of SOA regarding effective service discovery.

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