

# Semantic Web: A Study on Web Service Composition Approaches

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## ABSTRACT

A Web service is a collection of open protocols and standards used for exchanging data between applications and systems. Web Service discovery, selection and composition are the important tasks of the any automated business processes. In a web service composition set of web services are collectively executed to achieve the objectives. This study reveals the existing approaches used for web service composition in both syntactic and semantic environments. We have reviewed more than 40 articles in this domain and concluded with merits and demerits of the methodologies applied for the implementation of the web service composition.

## KEYWORDS

Service oriented architecture, Web service composition, Semantic web, Semantic service discovery

## I. INTRODUCTION

Web service is a component can be remotely identified by the URL and they are heterogeneous in nature [1]. These components are described and accessed by using the various standards XML, SOAP, WSDL and UDDI [2]. Web services are constructed based on the Service Oriented Architecture (SOA), which is depicted in the figure 1 and are distributed across the web to service numerous business applications. Implementation of business applications with the help of web services includes various operations such as service request, request preprocessing, service matching, service discovery, service selection, service composition.

These operations can be done in many ways and various methodologies and approaches have been developed and employed. Considering and selecting those approaches for the specific environment is a tedious task because numbers of services are keep on

increasing over the year. This article aims to simplify the searching process for the appropriate methodologies for the designated web service composition. We have surveyed more than 40 research articles and are listed with merits and demerits of it.

A web service composition problem can have six dimensions such as composition language, knowledge reuse, automation, tool support, execution platform, target users. It is also determining the work flow for an automated process [3]. The selection of the approaches was a three-step process that involved preliminary selection, further selection, refinement.

The general framework of a web service composition has different components, one of them is process generator based on the external and internal specification of a service of a service consumer and service provider respectively. There are 12 platforms: eFlow, FormSys, Intalio BPMS, Self-Serv, SHOP2, Sword, Taverna, XL, Yahoo!Pipes, YAWL, jBPM, JOpera [8].

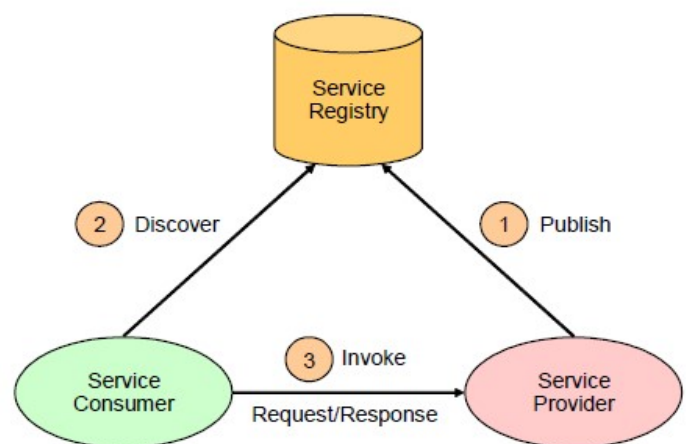


Fig 1. Components of SOA

Integration of web services into composite services or applications, which is a highly sensible and conceptually non-trivial task and is recognized in both

the enterprise and the consumer areas [10] [13][20]. The criteria based web service selection methods are mostly used to achieve the objectives of domain, which can be classified as follows [14]

- service-ranking approach
- linear programming method
- fuzzy model
- QoS-based service selection method
- hybrid models
- ANP

The entire article is organized as follows Section-I contains the introductory concepts. Section-II give the overview of the various approaches, merits and demerits of them and Section-III concludes article with the observations of the review.

## II. OVERVIEW

Web service integration is an important task of any automation of business process. Web Service Discovery is the process of finding a suitable web service for a given task. The life cycle for semantic web services composition includes technologies used for composition approaches, modeling and service management [32]. Web Service Composition is the process of integrating related web services, is to provide set of composite services. Web service searching, selection and composition can be done in two ways: a) syntactic b) semantic [31]

The various approaches for dynamic web service composition have been discussed. To meet the user's requirements regarding on-demand delivery of customized services, dynamic web service composition approaches have emerged. In a dynamic environment, realizing dynamic web service composition is not so easy. The evaluation shows that transactional support is still missing. The verification of the compositional correctness is also missing Self-Healing Web Service Compositions [43].

This literature survey about web service composition, discovery and selection shows evaluation in the service oriented architecture domain. The following Table 1 lists the methodologies, outcome, merits and demerits of those approaches. The primary task of any web service composition can be started with service discovery. The semantic based discovery model is explained in [33].

Petri Net based approach, which focuses on the reliability calculation method. It uses Fuzzy Reasoning Colored Petri Net (FRCPN), Service-Oriented Architecture (SOA), Supercomputing Cloud Platform (SCP); Sequential Linked List for Filling Reliability Value (SLLFRV), Ontology, Web language for Services (OWL-S), a method called T is proposed to quantify the reliability of a repairable system [4].

Non-deterministic planning methods for automated web service composition is explained in [5]. Performance of a web service composition can be improved by minimizing the response time of web service composition. QoS Properties Response Time, Execution Time, Reputation, Availability, Accessibility, Throughput and Scalability [6]. Consideration of e-government services and its service composition is discussed with semantic features. It encompasses information and communications technologies (ICT) with customer-centric approach. It is a Semantic Web (SW) enabled Multi-Agent System (MAS), Autonomic Computing especially self-healing propriety, Artificial Intelligent Planning (AIP), ontoGov (Ontology-enabled e-Gov Service Configuration), WebDG, eGOIA (Electronic Government, Innovation and Access) eMayer [7].

Dynamic Web Services Composition uses QoS parameters with the utilization of genetic algorithm is described in [9] and gives optimized results. [11] Proposed an approach to compose the web service based on the trustworthiness of it. From the basic observation a graph is formed which denotes the web service participated in the service composition. The basic notions used for representing the graph is such as Petri nets, oWF-nets, Labeled Transition Systems and Opacity of a Labeled Transition System [12]. Criteria based service selection methods were introduced and approach considers various parameters such as Quality of service, User Preference and Scalability [14].

Semantic web service discovery has so many challenges in-terms of technologies to be used such as OWL-S, WSMO, WSML, WSMX, SAWSDL and the tasks needs to be carried out by the discovery process such as publishing, mediation, storage, request, matchmaking, negotiation and selection [17][27][31] [35].

The privacy data are distributed across the web for example medical data. These data are to be shared by means of web services and its composition. This type of composition is disused in [15]. The level of privacy is determined by the rules defined in the composition architecture. Clustering Web services is very much important to facilitate service discovery. It can be done in many ways, one of them is based on the parameters used in the web service invocation [16]. QoS-based web service composition based on Genetic Algorithm (GA) is introduced in [18][21]. This GA based approach is considering QoS parameters. Business Process Execution Language (BPEL) based composition uses behavioral approach by verifying the concurrent properties [19].

Web service composition process can employ either manual or semi-automatic or automatic methodologies. Automatic web service composition is used when dynamic composition is required [22]. Firefly approach is the which provides optimal solutions for dynamic service composition[23] and another web service composition framework provides the solution for the composition problems on the fly that is dynamically called User-Centric WS-Mediator framework for on-the-fly Web Service Composition [24] [26].

An Optimization Method of Workflow-based Web Service Composition Model is a computational model, calculates QoS and then formulates the composition [25]. The researchers, software developers, advanced practitioners, documentation writers, and users involved in Web services domain for QoS predictions exploring development opportunities especially in web databases.

Log-based mining techniques are used to identify the patterns of the web service access and composition. It's a reengineering approach for service composition and another easy web service discovery approach is a query-by-example approach [28] [29]. Well defined business process can employ the goal-based approach for Web service composition [34]. A linear approach for web service composition uses QoS parameters and provides transactional aware results [36] and context aware solution is useful for domain specific problem and yields better results [34].

A theorem proving framework for the formal verification of web services composition has

explained and the methodologies can be used in post composition[38] [39]. Optimization and Ranking in web service composition using Performance Index (PI) [42]. Huge number of services in the repository increases the processing time for selection, discovery and composition. The performance of the composition framework can be reduced by means of parallel processing [44].

A number of web services have been carried out on cloud computing, including performance analysis, market-oriented graph Semantic Web Services, management tool, workload balance, dynamic selection, etc. semantic I/O information of the services. presenting the nonfunctional characteristics of the software systems and services.

QoS of cloud services can be measured from either the client side (e.g., response time, throughput, etc.) or at the server side (e.g., price, availability, etc.).

#### *A. QoS Perspective*

Quality-of-service can be measured either at the server side or at the client side. Client-side QoS properties provide more accurate measurements of the user usage experience. The commonly used client-side QoS properties include response time, throughput, failure probability, etc. This paper mainly focuses on ranking prediction of client-side QoS properties, which likely have different values for different users (or user applications) of the same cloud service.

Definition and Execution of Composite Web Services  
The SELF-SERV Project [40] The SELF-SERV project aims at providing tool support and middleware infrastructure for the definition and execution of composite Web services. SELF\_SERV system: key aspects, Declarative service composition the number of services to be composed may be large and continually evolving highly distributed nature of services. In SELF-SERV, the process model is specified as a state chart, states and invocations to Web services transitions events, conditions, and variable assignment operations.

SELF-SERV exploits the concept of service community. Prototype system in which Web services are declaratively composed and the resulting composite services can be orchestrated either in a

peer-to-peer or in a centralized way within a dynamic environment. SELF-SERV is an ongoing research project that aims at providing tool support and middleware infrastructure for facilitating the composition of Web services in large, autonomous, heterogeneous, and dynamic environments. Several obstacles still hinder the seamless provisioning of Web services in mobile environments. Examples of such obstacles are:

- throughput
- connectivity of wireless networks,
- limited computing resources of mobile devices
- risks of communication channel
- disconnections

The SELF-SERV architecture to support service provisioning in mobile environments. The issues are,

- Context-sensitive service selection and
- Handling disconnections during composite service execution

**TABLE 1 Web service composition methodologies**

S.No	Approach/Methodology	Outcome	Features	Limitations
1.	Fuzzy approach [4]	Composition is returned as SLLFRV linked list with the reliability value of FRCPN	Reliability of the Web service composition has a correlation with the number of web services and the range of reliability transition values.	If the FRCPN values of the reliability range of transitions is smaller, then the reliability value of FRCPN is smaller.
2.	Non-Deterministic planning methods: 1) Background 2) Probabilistic planning 3) Determination methods 4) Planning in the belief state space 5) Translation methods Web service composition methods: 1) Deterministic methods 2) Middle ground methods 3) Non-deterministic and contingent planning methods [5]	Deterministic method generates all feasible solution based on service graph.	Fully automatic and Graph based composition	In a stochastic environment, output is not predictable. Outcome of the execution of n web service cannot always be anticipated.
3.	QoS Normalization [6]	Based on QoS properties	QoS score and user requirements.  Optimized response time.	Web service selection and discovery system is essential to provide clients with proper results according to their requirements. It is impossible to fulfill this task without considering the ranking relation

				between thousands of available candidates with similar functionalities
4.	customer-centric approach, Multi-Agent System (MAS) [7]	Dynamic way to provide a personalized service that improves the satisfaction of the citizen and thus increase the quality of public services.	e-Government Web services, enabling citizens to dynamically compose services according to their goals and through a single point of access. Its faster, cheaper, more personalized and more efficient delivery services	
5.	QoS Parameters and Genetic Algorithm (GA) [9]	Optimal composition.	Dynamic web services composition use of QoS parameters and GA.	
6.	Diversified Service Rank (DSR). Web service reputation update algorithm. Reputation module discovery approach [11]	Returns the matching list of services.	Consumer provides more accurate values of reputation. Returned list of nominated web service is the most relevant to the consumer request.	
7.	Symbolic Observation Graphs (SOGs)-verification of their individual abstractions [12].	Abstract and check the opacity of Web services and their composition, and therefore prove their	Privacy, through the use of Symbolic Observation Graphs.	Information leakage, hiding the encryption keys of protocols and systems is not enough to hide protocol workings and secret information
8	Criteria based service selection methods [14].	Determines the weights of criteria based on user preference and accounts for the confidence	More efficient	The behavior of QoS-based service selection leads to service selection problems in Multi-Criteria Decision Making (MCDM).

		level of decision makers.		
9	<p>Privacy based</p> <ol style="list-style-type: none"> <li>1) Privacy Level</li> <li>2) Privacy Rule</li> <li>3) Privacy Policy</li> </ol> <p>Mechanism: Negotiation</p> <p>Approaches: Privacy Preserving DaaS composition [15].</p>		<p>Data as a Service (DaaS) builds on service-oriented technologies to enable fast access to data resources on the Web.</p> <p>DaaS composition may reveal privacy-sensitive information.</p> <p>The privacy model allows a service to define a privacy policy and a set of privacy requirements.</p>	<p>Two factors exacerbate the problem of privacy in DaaS.</p> <ol style="list-style-type: none"> <li>1) DaaS services collect and store a large amount of private information about users.</li> <li>2) DaaS services are able to share this information with other entities.</li> </ol>
10	<p>Hybrid Web service tag recommendation strategy, named <i>WSTRec</i></p> <p>Normalized Google Distance (NGD)-to compute the content-level similarity between 2 web services [16].</p>	<p>Utilize tagging data to improve the performance of traditional WSDL document-based Web service clustering for the purpose of more accurate Web service discovery.</p>	<p>92% of Web services cached by Web service search engines are valid and active.</p> <p>Web services search engine Seekda!1 allows users to manually associate tags with Web services.</p>	<p>More than 53% of registered services in UDDI business registries are invalid.</p>
11.	<p>QoS approach. GA based algorithm has 2 constraints:</p> <ol style="list-style-type: none"> <li>1) only one web service among candidate web services should be chosen for a task</li> <li>2) the service composition must satisfy user constraints [18].</li> </ol>	<p>GA, plan optimizer with constraints</p>	<p>It overcome local optimums with less computation time.</p> <p>GA is a K beam search; it can find suitable composition plan much faster than other random search approaches.</p>	

12.	<p>Extended control flowgraph (XCFG). WS-BPEL Two main tasks:</p> <ol style="list-style-type: none"> <li>1) XCFG construction</li> <li>2) property verification.</li> </ol> <p>XCFGV4BPEL: a tool for verifying concurrent properties</p> <ol style="list-style-type: none"> <li>1) Automata Based Techniques</li> <li>2) Process Algebra Based Techniques</li> <li>3) Petri Net Based Techniques</li> </ol> <p>[19]</p>	Verifies concurrent behavior in BPEL.	<p>XCFG can model not only the workflow ofBPEL but also the synchronization control dependencies among concurrent activities.</p> <p>XCFG Advantages:</p> <ol style="list-style-type: none"> <li>1) XCFG supports concurrent control flow compared with traditional CFG</li> <li>2) XCFG can model <i>link</i> which indicates the synchronization dependency between concurrent activities</li> <li>3) field in XCFG is introduced to record the information of related elements for the purpose of analysis and verification.</li> </ol>	
13.	Hybrid firefly method for selecting the optimal solution in semanticWeb service composition [23].	Firefly-inspired method for selecting the optimal or a near optimal solution in semantic Web service composition.	Biological systems have led to the design of efficient techniques that can be used to solve optimization problems.	
14.	A User-Centric WS-Mediator framework for on-the-fly Web Service Composition Next Generation Network(NGN)Next	User centric WS-mediator which allows the end-user to	Comprehensive framework for a user centric WS-mediator which is	Existing work has limitation on their agility to create a composed service

	Generation Service(NGS)composition engine which generates an executable autonomous entity. Next-Generation Service Overlay Networks (NGSON) [24].	mash up the service in his way on the fly.	capable of dynamic service composition.	on the fly according to the desire/need of an end-user at a given time/place.
15	Computational model of service quality to calculate the service parameters of specific quality topological sorting algorithm [25].	The combinatorial optimization method for web services based on workflow model. Scheduling algorithm for service composition have been optimized.	Optimization program enhances the web services quality of service, optimizes service scheduling function, and shorts the response time of the application services portfolio, in the case of large-scale applications.	Existing workflow-based web service composition programs lack the flexibility to choose high-quality services. The scheduling performance degenerates as the size increases.
16	<ol style="list-style-type: none"> <li>1. "Local" pattern's discovery that covers partial results through a dynamic programming algorithm.</li> <li>2. Composite service (CS) mining algorithm.</li> <li>3. Approach Summarization:</li> <li>4. Collecting execution history</li> <li>5. Analyzing the execution history</li> <li>6. Improving the composition model</li> <li>7. Composite service log:</li> <li>8. Collecting Web service logs</li> <li>9. Composite Service log structure</li> <li>10. Sufficient and minimal number of CS instances</li> <li>11. SDT: Statistics Dependency Table [28].</li> </ol>	Mining approach discovers more complex features with a better specification of the "fork" operator and the "join" operator.	CS mining supports business process rediscovery based on a log analysis. A set of mining techniques to discover CS transactional flow in order to improve CS recovery mechanisms. Deals better with concurrency through the introduction of the "concurrent window"	Previous approaches may fail to ensure CS reliable executions in some cases, even if they formally validate the CS model.
17	Novel search method for Web services called WSQBE. providers may manually assign a category to their services from a number of predefined options [29].	Representing Web services and queries as a collection of vector subspaces.	UDDI registries with search facilities	UDDI registries-difficult to use and often require service consumers to spend too much time manually browsing and selecting service descriptions.
18	Grid technology provides an information infrastructure. Semantic Web Services Integration Life Cycle:	Semantic based discovery and composition	A new and generic semantic Web services integration and	Manual, discovery, invocation and composition of Web services. Significant



	<ul style="list-style-type: none"> <li>➤ Business Process Modelling.</li> <li>➤ Semantics Enrichment of Workflow.</li> <li>➤ Runtime Phase.</li> <li>➤ Development.</li> <li>➤ Service Management [32].</li> </ul>	of SWSs	composition lifecycle to facilitate the semantic based integration and composition of Grid services.	hamper the automatic process of enterprise application integration.
19	Ontology based model [33]	Semantic model for web service discovery and description.	Similarity matching of web services is implemented through summarization of semantic similarity value.	Method has poor precision and recall for service discovery.
20	Engineering approach: <ol style="list-style-type: none"> <li>1) Reflecting the dynamic nature of environment.</li> <li>2) Understanding the types of requirements.</li> <li>3) Linking some of these requirements to capacity development [34].</li> </ol>	Capacities empower Web service with additional 'skills', which make them select the appropriate actions to carry out in response to specific environment requirements.	The first goal identifies the types of requirements The second goal details the Capacities The third goal reviews the business logic	
21.	Mathematical programming model: 0-1 linear program is solved using a standard solver (CPLEX) QoS criteria represent the non functional properties of web services [36].	QoS aggregate measure and satisfying transactional properties.	CPLEX is very performing for solving such very big size problems QoS is measured by a weighted sum.	
22	Web service composition using SHOP2 system architecture: BPEL4WS [37].	SHOP2 and BPEL4WS for web service composition to facilitate context awareness.	Scenario: mail replication system- 2 sub processes 1) Retrieve mail 2) Send mail	Often static and inflexible. Not suited to operate in a pervasive computing environment. The network bandwidth and the type of computing device

				affect the mail retrieval and sending.
23	Rigorous framework for the composition of Web Services within a higher order logic theorem prover [39].	Approach: proofs-as-processes paradigm that enables inference rules of Classical Linear Logic (CLL) to be translated into p-calculus processes.	Web Services compositions described using the p-calculus by performing CLL proofs.	Interesting properties such as liveness, safety, and deadlock-freedom have not been investigated
24	Optimization is carried out by ACO (Ant Colony Optimization) algorithm. Ranking is done using performance index which is calculated dynamically from the non-functional QoS parameters. GA approach-finding the optimal composition [42].	For a scalable application, servicing increasing number of requests is critical for its performance.	Both Optimization and Ranking on this composite Web Service which delivers high performance. <ul style="list-style-type: none"> <li>• Reusability</li> <li>• Robustness</li> <li>• Fault tolerance</li> </ul> Optimization and ranking that ultimately leads to the execution of the best service.	Composite web service without any optimization or Ranking- no guarantee that the best performing web service is selected.
25	Graph based approach. DAG to represent web service composition [44].	The composition algorithm is designed to effectively exploit the possibilities of multiprocessor platforms. The framework's architecture is adjusted to parallel processing over a single data structure.	A huge amount of computation is performed during preprocessing. Supports multiprocessor platforms. Immediate response to queries	Approach-issues, <ul style="list-style-type: none"> <li>• Find all possible solutions</li> <li>• Maximize preprocessing</li> <li>• Parallel processing</li> </ul>

### B. Evaluation of composition approaches

An Evaluation of dynamic Web Service Composition Approaches described and are

very much important for the measurement of the performance of it [41]. Business-to-Business Integration (B2Bi)-technology web service composition languages: WS-BPEL

with WSDL, OWL-S with Golog /Planning.  
Framework categories:

- Monolithic,
- Staged,
- Template-based service composition and execution.

The following dynamic service composition approaches uses the effective performance evaluation methodologies

- eFlow
- METEOR-S
- WebTransact
- DynamiCoS
- SeGSeC

The trustworthiness of the web services is very much important in defining the QoS and obtaining trustworthiness of SOAs can also be achieved as follows [43]

- self-healing web service compositions
- service and process description,
- monitoring and recovery strategies.

Roadmap for research finalized to obtaining self-healing service compositions. The three recovery strategies are easier to understand when used to recover from functional errors. In the field of dynamic composition of web services, WSCG(Web Service Composition Graph) proposes a framework that provides visual design, validation and development of compositions using graph theories. Triana as a Graphical Web Services Composition Toolkit [45]. Extend the functionality of the Triana problem-solving environment into the Web services world. Triana uses a peer to peer subset of the GridLab GAT Interface. Web services composition system needs the following mechanisms:

- Service discovery methods
- Service composition methods
- Transparent invocation methods
- Transparent publishing of services outlined

Triana is a framework to integrate graphical creation of Web services workflows within the open source. In particular, Triana handles discovery, invocation, composition, and publishing of Web services through the WServe API. The GAT/GAP are middle ware independent APIs that allows transparent access to various underlying middle ware architectures. By facilitating the transparent construction of Web services workflows, users can create new composite services which offer more functionality than atomic services; Share and replicate workflows with other users.

### III. CONCLUSION

This review has an objective to give an overview about the recent trends in the development of various web service composition approaches. Initially we identified the existing approaches used for the composition. These approaches are classified according to the processing of the service descriptions, which can be either syntactic or semantic based service process. The review also comprises the methodologies used for composition and the parameters used for selection and matching processes. Every composition approaches have its own merits and demerits. Most of the syntactic approaches have used QoS parameters for composition and semantic approaches are domain specific and the implementation needs basic knowledge about the domain, semantic description, ontologies and composition engine tasks.

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