

# Architecture based Comparison of Semantic Web Service Composition Processes

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## ABSTRACT

Semantic web services development become rapidly increased as dynamic changes are occurred. Various approaches are adopted to develop composite service systematically. This paper aims to make development process easier by classifying the literature on web services composition based approaches like selection, discovery, orchestration, choreography, mediation, automatic composition to facilitate the end to end semantic web service composition easier. Applying semantics in web process cycle helps to address critical issues in reuse, integration and scalability. In order to find best approach, various composition approaches on these requirements were evaluated and suggestions were provided on what approach can be used in which scenario to achieve best results.

## Keywords

Semantic web service, Service Composition approaches, Selection, Discovery, Orchestration, Choreography.

## 1. INTRODUCTION

Semantic web is an extension of current web, in which information is given well defined meaning, better enabling computer and people to work in cooperation [1]. The objective of research around semantic web service is to facilitate automatic handling of web services. Semantic web transforms the web into repository of computer readable data, while web services provide tool for automatic reuse of that data. Sometimes single service component unable to satisfy user needs then some mechanisms like discovery [4], selection [18], mediation [12], matchmaking etc. are used for finding service component and semantic composition helps to aggregate the component of various services according to tasks. In previous work we have made a survey on different approaches of semantic web services [18]. The main objective of this paper is to discuss some existing composition techniques like Workflow based, Artificial Planning, Context based, Agent based, Ontology based, Orchestration and Choreography to solve semantic web composition problem with their attributes. In addition, we have also classified and compared different web service composition methods. Apart from introduction part, section 2 deals with various composition based method for semantic web service, section 3 covers framework of service composition methods, section 4 covers classification and comparison among several approaches and conclusion in section 5.

## 2. EXISTING APPROACHES FOR WEB SERVICES COMPOSITION

Various software programs are available to facilitate automatic composition of services. Such programs enable user

to specify composition of programs to perform some varied tasks. In this section we will focus on several approaches like workflow based, AI Planning approach, Orchestration, Choreography, Mediation, Ontology based, Agent based, Discovery, Selection for semantic web service composition.

### 2.1 Workflow based SWS Composition approach

A workflow is abstraction of a business process. It comprises of tasks, dependencies among tasks, rules and participants. Task represent a software system in which task flow from one web services to another service and performed appropriate functionality. OWL-S process model [2] is work flow driven model for web service composition. This model uses DAML based match maker. Workflow is composed with help of composite and atomic processes. Various compositions constructs like conditional and looping constructs are used to perform automated composition. Knowledge based approaches used domain knowledge for composition and selection of services and also used WSDL [9] to accompanied the description and execute the workflow. Framework must comprise of knowledge representations and ontology, web services modules, semantic environment. Input request matching also uses work flow pattern, this matching process is used to find services available for clients input request and output matching is done with last service in work flow.

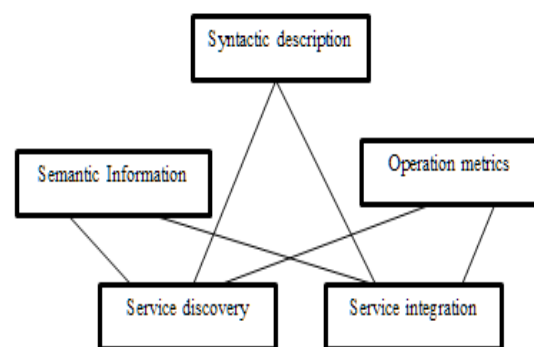


Fig 1: Workflow based Service Composition

### 2.2 AI Planning based approaches

AI Planning is fully automated semantic based approach; it focuses on goal driven architecture for automated problem solving. In AI Planning on the client side user specifies his objective and planning algorithm takes the objective of client as goal and produces a plan for goal resolution process. In this plan construction takes place repetitively to achieve static, finite, automated environment. OWL-S is used in AI planning

based approaches. Precondition and effect properties of service in OWL-S indicate the state change during implementation of services. Various AI planning based model developed like Zeng et al. [3] proposed rule inference engine in which services are annotated with QoS features. Sirin et al. [4] Proposed hierarchical task network planning which supports non deterministic services and observability of service effects. Berardi et al. [5] discussed automatic synthesis of finite state machines to support real world, external services. Functional compositions based planning model [6] uses Casual Link Matrix (CLM) to composite link between various services and store these casual links. Links shows dependency between input and output parameters of different web services.

### 2.3 Service orchestration & choreography

Orchestration refers to an executable process and choreography tracks message sequence between parties and

source. In orchestration the involved web service are under the control of single end point central process. This process coordinates the execution of different operations on web service participating in orchestra. BPEL is an orchestration language with an XML based syntax supporting specification of process that involves operations provided by web services. Choreography doesn't depend on central coordinator. Each web service that participates in choreography has to know exactly when to become active and with whom to interoperate. It must be conscious of business process, operations to execute, messages to exchange, as well as timing of message exchange. WS-CDL is a recommendation language in area of service composition.

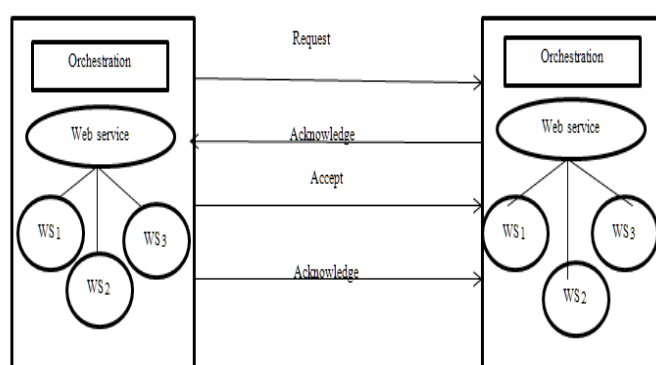


Fig 2: Service orchestration and Choreography

### 2.4 Ontology based composition approach

Ontology describes the knowledge representation about specific domain. Relationship among classes and objects is used for semantic composition of services in ontology domain. Stack of ontology based model [7] uses ODE reasoning. In this services are graphically designed and then instance is created. Design of service ontology is checked and instance of ontology are translated into OWL-S specification. It helps in producing graphical design of services.

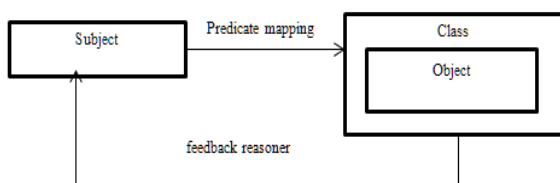


Fig 3: Ontology relation

### 2.5 Semantic service mediation

Semantic level mediation is a mediator between concurrent semantic representations of services, to allow semantic web service matchmaking algorithms to compare capabilities of distinct semantic web service. It requires identifying similarity across distinct web service representations. Manual one to one and semiautomatic mapping are governed in mediation process level. They used mediation space as a mediator approach. It computes similarity to identify most appropriate semantic web service for given request.

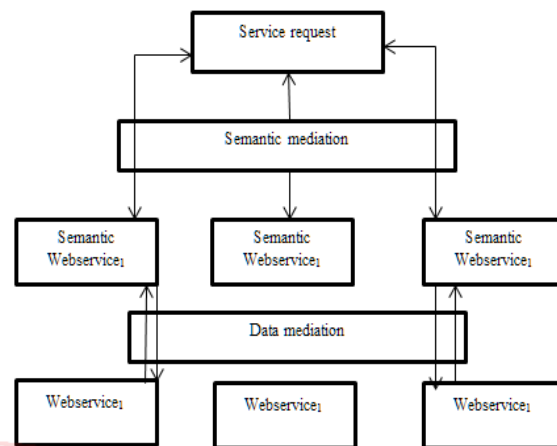


Fig 4: Service mediation

### 2.6 Agent based approach for composition

Reusable software components are known as agents. Main capability of agent is to coordinate, communicate and collaboration. Multi agents are required to achieve composite service composition. Discovery, selection and composition processes divides complex tasks to small modules and then select suitable service provider agent for specific tasks after decomposition. Various languages like DAML, RDF and XML are used to create agents. Various ontological tools like protégé, OWDS, are proposed to build such agents. Deliberate agent architecture such as BDI [8] called belief, desire and intention used to make composition more intelligent. Learning

feedbacks techniques are used to improve agent intelligence to complete desired tasks.

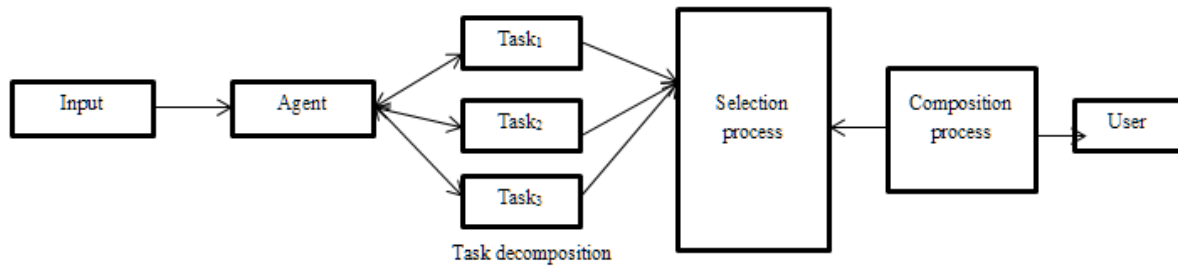


Fig 5: Agent based composition approach

### 3. FRAMEWORK OF SERVICE COMPOSITION METHOD

Service composition life cycle involves following phases to develop end to end service composition. It includes

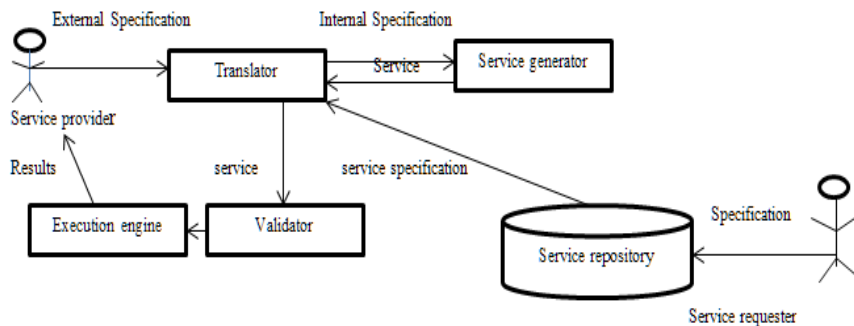


Fig 6: Framework of service composition

Service provider propose web services for use, service requester consume information or service offered by service provider. Translator converts or translates external language used by participants and internal languages used by service generator. If more than one plan found validator validates and evaluates all plans and proposes the best plan for execution. Execution engine executes the plan and return the result to service provider.

### 4. CLASSIFICATION AND COMPARISON OF VARIOUS SEMANTIC WEB SERVICE COMPOSITION TECHNIQUES

Various semantic web service composition techniques or approaches are classified as shown in figure name. Service classification is based on six categories user defined, service selection, automatic, discovery, mediation and matchmaking. Main concern here is to include all static and dynamic automated approaches like orchestration, choreography, discoveryetc.

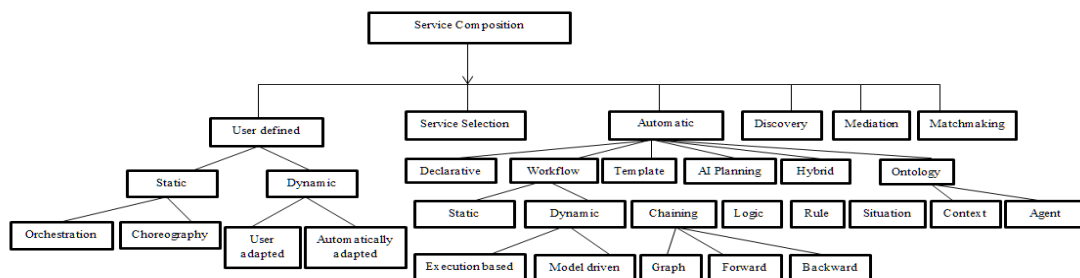


Fig 7: Classification of service composition approaches

A tabular comparison for service composition approaches mentioned on the basis of approach used, feature supported or comparison approach, tools used, language and interface.

**Table 1: Tabular comparison of AI Planning approaches**

Author	Method name	Comparison process	Tools used	Language used	Interface
Zeng et al. [ 2]	Rule inference engine	Services are annotated with QoS and cost features	JADE	JAVA	GUI
Pistore et al.[3 ]	Model checking planner	Non deterministic service and partial observation of service effects	MBP	BPEL4WS	GUI
Sirin et al. [ 4]	Hierarchical task network planning	Hierarchical decomposition of tasks into atomic-invokable service	No specific	OWL-S	Not specific
Zixin et al. [5 ]	Automatic	Message is converted into BPEL format to select the best element, executable control flow performed	Jena	JAVA, BPEL	GUI
Freddy et al.[6 ]	Functionality based	Semantically ordered and linked plan on basis of casual link for web services	CLM	OWL-S	No interface

**Table 2: Tabular comparison of Orchestration and Choreography approaches**

Author	Method name	Comparison process	Tools used	Language	Interface
Jaydev & William [ 7]	Orc	Orc supports a structured model of concurrent and distributed programming	Orc tool	RDF-S, JAVA, BPEL	GUI
Sung –Shik et al. [ 8]	Reo based	Input as description of service, WSDL interface to generate code	Reo Map	Reo, JAVA	GUI

**Table 3: Tabular comparison of Workflow based compositions methods**

Author	Method name	Comparison process	Tools used	Language	Interface
BROGI et al. [ 9]	YAWL	Simulation and analysis of behavior of P2P peers and services	Not specific	SMoL, BPEL	GUI
Rongen et al.[10 ]	Knowledge based system	Web service creation using knowledge base and ontology for composition	FaCT	DAML-S	WCI- GUI
Javier Rios et al. [ 11]	Magallenes	Enables web service discovery and automatic work flow composition	Magallenes tool	RDF-S	GUI

**Table 4: Tabular comparison of semantic level mediation service**

Author	Method name	Comparison process	Tools used	Language	Interface
Stefan Dietze et al. [ 12]	Mediation	Using mediation spaces to identify most appropriate web service	MS	OWL-S	GUI

**Table 5: Tabular comparison of agent based semantic web service composition**

Author	Method name	Comparison process	Tools used	Language	Interface
Ermolayev et al. [ 13]	Behavior agent (BDI)	Behavior of web pages and agents are specified using behavior oriented design	XML conventions	DAML-S	No specific
Kumar and Mishra [14 ]	Multi agent	Handling negotiation condition and handling request	Multi agent based composition tool	OWL, RDF	GUI
Kungas and Matskin [ 15]	P2P based Mas system	Take available service as input and transfer them in logic formula by applying deduction	Distributed Symbolic Reasoning	OWL-S	GUI

## 5. CONCLUSIONS

The motivation behind this paper is to study the various researches carried out in semantic web services. This paper puts an effort in comprehensive study on Web service composition and related techniques or approaches. This paper

mainly focus towards popular automated composition approaches like AI planning to automate plan for execution of specific service, Work flow approach to find out flow from input to output on work items, orchestration and choreography to identify business processes and service interactions,

ontology among classes objects and their relationships and agent based technology to mediate agents and their problem solving approach. As growing need of semantic web services there is need to provide flexible, dynamic, intelligent solutions to remove limitations of AI planning approaches and focused more on agent based approach to facilitate real world applications.

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