WSC-2010: Web Services Composition and Evaluation

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Abstract

The Web Services Challenge (WSC) is a forum where academic and industry researchers can share experiences of developing tools that automate the integration of web services. In the sixth year (i.e. WSC-10) of the Web Services Challenge, software platforms will extend their solutions to the several composition challenges. Again this year, requests and results will be transmitted within SOAP messages. Semantics will be represented as ontologies written in OWL, services will be represented in WSDL, and service orchestrations will be represented in WSBPEL. Non-functional properties (Quality of Service) of a service will be represented using WSLA format.

1. Introduction

The annual Web Services Challenge has provided a platform for researchers in the area of Web Service Composition since 2005. Succeeding the EEE-05 [2][11], WSC-06, WSC-07, WSC-08, WSC-09 Challenges [3][4][5], the 2010 Web Services Challenge (WSC-10) (http://www.wschallenge.org/) is the sixth year of this SOA venue [1] that looks to benchmark software applications that automatically manage web services. WSC-10, held at the 12th *IEEE Conference on Commerce and Enterprise Computing (CEC 2010)* continues to provide a forum where researchers can collaborate on approaches, methods and algorithms in the domain of web service discovery and automated composition. This forum provides quantitative and qualitative evaluation results on the performance of participating matchmaking and automated composition software and facilitates the dissemination of results that advance this field.

The WSC-10 represents the sixth event of the matchmaking and composition challenge series. It extends the original criteria of the first two competitions which focused on service discovery and service composition based on the syntactic matching of WSDL part names. It also further extends the third and fourth competition in 2006 and 2007 which provided taxonomy of parameter types represented using the natural hierarchies that are captured using simple and complex types within XML documents. WSC-08 further evolved with the adoption of ontologies written in OWL to provide semantics.

The 2010 competition is a continuation of the evolution from the 2009 composition with the challenge considering non-functional properties of a web service. The Quality of Service of a web service is expressed by its response time and throughput. It has been the tradition of the WSC events to adhere to technology-independent approaches to semantics. In this way, the competition attempts to circumvent debates on representations, such as differences between approaches like OWL-S [8], WSML [7], and WSDL-S [12]. In 2006, the use of pure XML-based semantics allowed for a *bi-partisan* approach. In 2007, we have evolved the challenge by mirroring the XML-based semantics with equivalent representations using OWL ontology. During the previous three years, web service challenge focused on optimizing the discovery and composition process solely using abstractions from real-world situations. The taxonomies of semantic concepts as well as the involved data formats were purely artificial. In 2008, we have further evolved the challenge by using data formats and contest data based on OWL, WSDL, and WSBPEL schemas for ontologies, services, and service orchestrations.

In the WSC-08, concurrency was introduced into the composition problem sets. The combination of complex, workflow-based heuristics with semantically-rich representations required participants to create new software that is both robust and efficient. The problem sets in WSC-09 and WSC-10 also are inherently concurrent.

2. Related Venues

Although WSC is perhaps the first venue, other unique venues have been established to investigate the need for solutions to the Service Composition Problem. The Semantic Web Services Challenge [9] is less of a competition and more of a challenge. Both business

cases and solution applications are the focus of the venue. Participants are placed in a forum where they can incrementally and collaboratively learn from each other. While WSC venues are more driven by application, the SWS venues concentrate more on the environment. As such, the SWS venues place more focus on semantics where the WSC favors applied, short-term solutions.

Alternatively, the SOA Contest [10] held at the International Conference on Services Computing (SCC2006, SCC2007, SCC2008, and SCC2009) allows participants to openly choose the problems that best demonstrate their approach. The benefit of this venue is that participants can show the best approach for a particular domain-specific problem. In contrast, the WSC venue attempts to set a common problem where approaches can be evaluated side-by-side.

There is a unique niche for each forum and the *composition* of the results from all the venues will undoubtedly advance the state-of-the-art in service-oriented computing.

3. The Challenge

In the competition, we adopt the idea of so-called Semantic Web Services that represent Web Services with a semantic description of the interface and its characteristics. The task is to find a composition of services that produces a set of queried output parameters from a set of given input parameters. The overall challenge procedure is shown in Figure 1. The composer software of the contestants is placed on the server side and started with a bootstrap procedure. First of all, the system is provided with a path to a WSDL file. The WSDL file contains a set of service descriptions along with annotations of input- and output parameters. The number of services will change from challenge to challenge. Every service will have an arbitrary number of parameters. Additional to the WSDL file, we also provide the address of the OWL file during the bootstrapping process. This file contains the taxonomy of concepts used in this challenge in OWL format. The bootstrapping process includes loading the relevant information from these files. The challenge task will then be sent to the composer via a client-side GUI very similar to last year's challenge. After the bootstrapping on the server side is finished, the GUI queries the composition system with the challenge problem definition. The contestant's software must now compute a solution – one or more service compositions – and answer in the solution format which is a subset of the WSBPEL schema. When the WSBPEL document is received by the GUI, we will stop a time measurement and afterwards evaluate the compositions themselves.

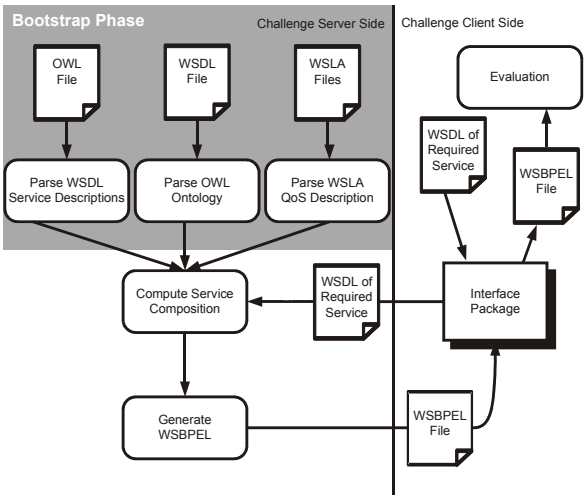


Figure 1: The steps of the 2009 and 2010 WSCs.

3.1. What's New

- **Document Formats**: WSLA format
- **Quality of Service (QoS)**: Each service will be annotated with its non-functional properties on response time and throughput. The contestants do not have to find the shortest or minimal composition considering the amount of services. The contestants should, instead, find the composition with the least response time and the highest possible throughput.

3.2. Semantics

Ontologies are usually expressed with OWL's XML format [13][14]. We use OWL format in the 2009 challenge, but like in the previous years, we limit semantic evaluation strictly to taxonomies consisting of sub and super class relationship between semantic concepts only. OWL is quite powerful. In addition to semantic concepts (OWL-Classes), OWL allows to specify instances of classes called individuals. While we also distinguish between individuals and classes in the competition, the possibility to express equivalence relations between concepts is not used. In OWL, the semantics are defined with statements consisting of subject, predicate, and object, e.g. `ISBN-10 is_a ISBN` (`ISBN` subsumes `ISBN-10`). Such statements can be specified with simple triplets but also with XML-Hierarchies and XML-References. The implementation of an OWL-Parser is hence not trivial. In order to ease the development of the competition contributions, we will stick to a fixed but valid OWL-Schema.

3.3. Quality of Service

The Quality of Service for a service can be specified using the Web Service Level Agreements (WSLA) [15], language from IBM. In contrast to the Web Service Agreements (WS-A) language, WSLA is in its final version. Furthermore, WSLA offers more specific information than WS-A. We cannot only specify the Service Level Objectives (SLO) of a service and its service operations, but also the measurement directives and measurement endpoints for each quality dimension. WSLA represents a configuration for a SLA management and monitoring system. In contrast to WS-A, WSLA enables the automated discovery and deployment of service contracts inside SOAs. In the WSC-10, we define the following quality dimensions for a Web Service. They can be accessed in this document format and must be calculated for a whole BPEL process.

• **Response Time**: In a data system, the system response time is the interval between the receipt of the end of transmission of an inquiry message and the beginning of the transmission of a response message to the station where the inquiry originated.[1] *Example*: 200 milliseconds.

• **Throughput**: In communication networks such as Ethernet or packet radio, throughput is the average rate of successful message delivery over a communication channel.[2] *Example*: 10.000 (successful) invocations per minute.

We define one WSLA document containing the specification of the average response time in milliseconds and the throughput (invocations per minute) of each service in a challenge set. Metrics can be omitted as they do not contain relevant information for the service composition. They are interesting nonetheless as they present the capabilities of WSLA.

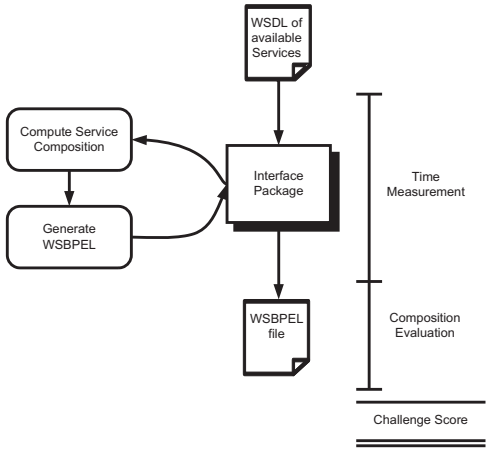
3.4. Evaluation

The Web Service Challenge awards the most efficient system and also the best architectural solution. The best architectural effort will be awarded according to the contestant's presentation and system features. The evaluation of efficiency consists of two parts as shown in Figure 2.

The BPEL checking software evaluates the results of the participant's composition system. The BPEL file is examined for a solution path and its correctness with respect to the challenge task.

1. Three challenge sets are provided and each composition system can achieve up to 18 points.
2. The time limit for solving a challenge is five minutes. Every composition system replying with a solution later than five minutes will receive 0 points for the challenge set.
3. The task is to find the service composition solution with the lowest response time. Additionally the composition system that finds the service composition with the highest throughput in the fastest time will be rewarded. With this rule set, the WSC transcends from an (informed) search task to an optimization problem [16] in the space of possible compositions.

Figure 2: Evaluation in the WS-Challenge 2010.



3.5. 2009 Results

In terms of performance (see Figure 3), two Chinese teams ranked top: The Chinese Academy of Sciences (Zhenqiu Huang et al.) followed by the Tsinghua University (Yixin Yan et al.). They were followed by European competitors who also excelled in overall architectural criteria: The third place was achieved by the Slovak University of Technology (Peter Bartalos and Maria Bielikova) who additionally won the Architecture Challenge. The University of Groningen, Netherlands (Marco Aiello et al.) scored fourth and took home place two of the Architecture Challenge.

		1. Place		2. Place		3. Place		4. Place	
		Result	Points	Result	Points	Result	Points	Result	Points
Challenge Set 1	Lowest Response Time	500	+6	500	+6	780		880	
	Highest Throughput	15000	+6	15000	+6	15000	+6	15000	+6
	Composition Time (ms)	< 300	+6	< 300	+6	< 300	+6	531	
Challenge Set 2	Lowest Response Time	1690	+6	1690	+6	2100		2110	
	Highest Throughput	6000	+6	6000	+6	6000	+6	6000	+6
	Composition Time (ms)	< 300	+6	< 300	+6	< 300	+6	2219	
Challenge Set 3	Lowest Response Time	760	+6	760	+6	760	+6	950	
	Highest Throughput	4000	+6	4000	+6	4000	+6	4000	+6
	Composition Time (ms)	< 300	+6	< 300	+6	< 300	+6	21438	
Challenge Set 4	Lowest Response Time	1470	+6	1470	+6	2070			
	Highest Throughput	4000	+6	2000		4000	+6		
	Composition Time (ms)	< 300	+6	< 300	+6	< 300	+6		
Challenge Set 5	Lowest Response Time	4070	+6	4070	+6	4500			
	Highest Throughput	4000	+6	4000	+6	4000	+6		
	Composition Time (ms)	< 300	+6	938	+2	< 300	+6		
	Sum	90 Points		80 Points		66 Points		18 Points	

Figure 3: Performance Results of the 2009 WSC.

[1] http://en.wikipedia.org/wiki/Response_time_(technology) [accessed on 2009-05-12]

[2] http://en.wikipedia.org/wiki/Throughput [acc. 2009-05-12]

4. Logistics of the Web Services Challenge

WSC-10 has attracted international teams which come from universities and research organizations in countries including the China, Germany, Netherlands, South Korea, and the United States. The organization of this event is divided into two phases: The first phase focuses on evaluating the technical viability of the methodologies proposed by the participating teams. A four-page technical description submitted from each team is peer-reviewed and included in the proceedings of the conference SOCA 2010. Once the reviewing and acceptance notification phases have completed, teams that successfully complete this first step are asked to submit a version of their software for evaluation. Preliminary tests are conducted using this evaluation version to ensure the compatibility and applicability during the final competition. The main objective is to avoid, in advance, potential format related problems that may otherwise occur when the competition takes place.

The second phase is the final competition which is scheduled for two days at CEC-09. On the first day, all the participating teams will present their approaches in a specialized session of the conference. On the same day, the participants are allotted times to install the latest version of their software on the evaluations stations located onsite at the conference. On the second day, the teams must execute their software using a customized data set prepared specifically for the competition. Participating software is measured for performance during any indexing phases and during the actual composition routine. Composition results are evaluated against known solutions for correctness and completeness. In 2010 there will be multiple sets of correct answers with variable length chains. Applications will be judged with weighted scores based on the best solutions that they present.

The solution application with the best qualitative and quantitative scores when run against several datasets is awarded first place. The competition typically has a winner and several runner-ups.

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```

Results of the Web Service Challenge 2010

Technical Challenge

1st Place: Chinese Academy of Sciences (CAS)
Beijing, China
Huanyu Ma, Wei Jiang, Songlin Hu, Zhenqiu Huang

2nd Place: Tsinghua University
Beijing, China
Sen Luo, Bin Xu, Yixin Yan

3rd Place: University of Groningen
Groningen, The Netherlands
Viktoriya Degeler, Ilče Georgievski, Alexander Lazovik, Marco Aiello

Architectural Challenge

1st Place: University of Groningen
Groningen, The Netherlands
Viktoriya Degeler, Ilče Georgievski, Alexander Lazovik, Marco Aiello

2nd Place: Chinese Academy of Sciences (CAS)
Beijing, China
Huanyu Ma, Wei Jiang, Songlin Hu, Zhenqiu Huang

3rd Place: Tsinghua University
Beijing, China
Sen Luo, Bin Xu, Yixin Yan

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