

Frameworks for Semantics in Web Services: A position paper for the W3C Workshop

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This position paper proposes directions for the development of a framework for Semantic Web Services, with particular emphasis on automating tasks based on semantic descriptions.

Abstract

Boeing examines the application of Semantic Web Services in a net centric environment. Boeing envisions a wide range of possible benefits in this context. The key functionality needed is the automated and dynamic composability of services in an ad hoc environment.

Net-Centric Environment: Use of Dynamically Composable Semantic Web Services

“The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation.”¹
“There’s a revolution occurring and it’s all about making the Web meaningful, understandable, and machine-processable, whether it’s based in an intranet, extranet, or Internet. This is called the Semantic Web, and it will transition us towards a knowledge-centric viewpoint of *everything*.”²

A net-centric environment is characterized by seamless interoperation between systems. As more networks and nodes are introduced, the environment becomes more robust, increasing its combined capabilities.

Completion of the net-centric environment vision requires mobile ad hoc collaboration of disparate systems. Systems will be interacting in new ways, supporting each other through a wide variety of advertised services. In the ad hoc environment, not all of the desired capabilities can be known in advance. These capabilities will be used by communities of interest (COIs) which form in an ad hoc manner. Leveraging the added functionality of many individual systems requires exposing the capabilities of those systems as Web Services. The ability to dynamically compose several services is required to meet a complex need.

¹ Tim Berners-Lee, James Hendler, Ora Lassila, The Semantic Web, Scientific American, May 2001

² Stephen Ibaraki, Towards a Dynamic Semantic Web

Each system in the net-centric environment offers a finite set of unique services. Suppose there are three systems: S1, S2, and S3. System S1 offers services A, B, and C; system S2 offers services D, E, and F; and system S3 offers services G, H, and I. Without dynamic composability, when systems S1, S2, and S3 form a COI, 9 distinct services are offered: A, B, C, D, E, F, G, H, and I. The ability to offer each other services is useful, but no new capabilities are offered by the three systems teaming together. Without dynamic composability of services, a teaming of systems does not provide new capabilities and does not offer added value in the net-centric environment. With semantically enabled dynamic composability, services can be seamlessly integrated to form new capabilities, increasing the set to A, B, C, D, E, F, G, H, I, AB, AC, AD, ... , ABC, ABD, ABE, ..., ABCD, ABCE, ... ABCDE, ... potentially just under a million combinations. Though most of these combinations will not be useable, semantics will help determine which are formerly unrealized viable capabilities.

Semantic descriptions characterizing the services and the data are critical to achieving the required automation and flexibility. These descriptions need to be expressed using a common terminology agreed upon by a COI and expressed in a formal ontology in order to be understood by different systems. The descriptions are critical for both the effective advertisement and the dynamic composition of services, especially for ad hoc machine-to-machine collaboration.

Semantic descriptions can also help in determining relationships to services used by the members of a COI. Orchestrating several Web Services enables not only new connections between “first tier” members of a COI, but also forms connections of services provided to those loosely associated with the COI (i.e., dynamically composed services provided by the COI as a whole to other entities/groups). As more services are composed, a greater need arises to include semantics in the service description so that services are self-described and machine-understandable.

Developing a “generic extensible framework based on Semantic Web technologies, to support longer-term objectives, while continuing to develop immediate solutions for the most pressing Web Services requirements”³ is progress in the necessary direction. The framework Boeing envisions will contain at least the following:

- Languages for expressing formal ontologies that characterize:
 - the subject matter of a given domain
 - the capabilities of the services
- Formal semantic descriptions of service capabilities, using the vocabulary from the ontology
- Service capability descriptions as the basis for:
 - advertising the services to potential users
 - dynamically composing multiple services to create larger granularity capabilities

³ W3C - <http://www.w3.org/2005/01/ws-swsf-cfp.html>

- Services descriptions using multiple ontologies, requiring an infrastructure characterized by the following:
 - registering different ontologies
 - mapping between different ontologies
 - providing on-the-fly translation services to map between descriptions using different ontologies

The transition to a higher degree of automation will shift towards direct machine-to-machine collaboration. The key to successful service automation is semantic web services, where semantics bring meaning to Web Services. A framework for Semantic Web Services is critical to successfully automating the composition of an appropriate set of services.

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