

Semantic Web Service

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Outline

- Introduction
- Specification
- Discovery
- Composition





The VisionThe ProblemThe Solution

















Current Affairs









The Problem

SOAP+UDDI+WSDL

Data exchange between two programs in XML format

- Operate on syntactic level : Web services infrastructure do not access data content
- Semantics are critical to support the next generation of the Web.
- WSFL/BPML/XLANG/emXMI/BPEL4WS
- There are many layer required to achieve automatic web service discovery, selection, mediation and composition into complex services
- Discovery: The programs such as agents have no way to locate one that will perform a specific function. This process, called service discovery, can happen only when there is a common language to describe a service in a way that lets other agents "understand" both the function offered and how to take advantage of it.
 - Jini...low level, syntactical based, standardized functionalities.
- Integration. The development of integrated services is still largely ad-hoc, time-consuming and requiring a considerable effort of low-level programming.



Big Challenges

- Semantics are critical to support the next generation of the Web.
- The important contribution of the "Semantic Web", vis-à-vis the current Web, is the ability to represent and process descriptions of every resource on the Web.
- A resource description, informally called its "semantics", includes that information about the resource that can be used by machines - not just for display purposes, but for using it in various applications.

WS



- Missing Concepts in Web services
 - Data definition
 - XML Schema is definition language for input and output message
 - No domain specific data definitions
 - Invocation behavior
 - No operation sequence definition
 - All operations are equal w.r.t. behavior. Any restriction to be known (by magic) by invoker
 - Mediation
 - No mediation of data
 - No mediation of behavior



WS(contd.)

Missing elements in Web services (continued)

- Composition
 - No concepts for composition
- Trading Partner Management
 - Web services recognize URIs as endpoints and do not incorporate trading partner management
- Service level guarantees
 - Web services do not contain any service level agreements
 - Emerging Work
 - Web Services Security
 - http://www-106.ibm.com/developerworks/library/ws-secure
 - Business Transaction (OASIS)
 - http://www.oasis-open.org/committees/business-transactions



The Solution

WS-ISWS

Solutions



- The lack of high-level abstractions and functionalities for web service application has triggered a considerable amount of research.
 - Industry focused on modularization of services layers-mostly for usability in the short term
 - Academic Research has been mostly concerned with expressiveness of service description using Semantic Web technology.

WS-I



Web Services Interoperability

- Web Services Interoperability Organization
- Define interoperable standards versions
- Provide tools for interoperability testing
- http://www.ws-i.org



Limits of Industry Effort

- Little new really technology, using the standardized taxonomies and vocabularies that exhibit little flexibility and expressiveness and that restricts that usability of web services to human users rather than machine agents.
 - E.g. UDDI: A Web Service user retrieves advertisement out of registry based on keyword search.UDDI search mechanism relies on pre-defined categorizations through keywords and does not refer to the semantic content of the advertisement. Search only for the on tModelkey,not every attributes. UDDI does not support Semantic description of Services.
 - WSDL has not precondition, postcondition. It does not support the definition of logical constraints between its input and output parameters, limited in invoking.



Semantic Web Service

- Make services computer-interpretable, userapparent and agent –enabled.
- Personalized machine agents to support automatic Web service discovery, execution, composition and interoperation.
- Break out the virtual realm and extend it to into our physical world.





- DAML-S (DAML for Services)
 WSMF (Web Services Modeling Framework)
- Process Ontology
- Other Researches

DAML-S



- A DARPA Agent Markup Language for Services. Semantic markup of Web Services that makes them machine understandable and use –apparent.
- BBN Technologies, Carnegie Mellon University, Nokia, Stanford University, SRI International, Yale University



DAML-S: Ontology

Service ontology



http://www.daml.org/services/daml-s/2001/10/daml-s.html

Service Profile





- Specify the intended purpose of the service.
- For service discovery.
- Three types
 - Provenance and Description
 - Functionality Description
 - Functional Attributes.



Description in Service Profile

- Service Name
- Intended Purpose
- textDescription
- Provided by
- Requestedby
- Actor (requester or provider)
 - Name
 - Phone
 - Fax
 - Email
 - Physical Address
 - webURL



Functionality Description in Profile

- Input
- Output
- Precondition
- Effect
- domainResource

- The Class ParameterDescription is used to provide values to inputs and outputs.
 - parameterName
 - RestrictedTo
 - RefersTo
- The Class ConditionDescription is used to provide a conditions and effects.
 - conditionName
 - Statement*(not done)
 - refersTo

Functional Attributes

- Address the problem that there are other properties that can be used to describe a service other than a functional process.
- E.g. A service may accessed from anywhere on the Internet, it may only applicable to a specific audience. For instance, although it is infeasible to order food from D.C in Atlanta.

- GeographicRadius
- degreeOfQuality
- Service Parameter
- communicationThru
- serviceType
- serviceCategory
- QualityGuarentee
- qualityRating



Modeling Service as Process

- Two chief components:
 - Process- enables planning, composition, and interoperation.
 - Process control Model, which allows agents to monitor the execution of a service request.(not available in DAML-S 0.6).



The Process Ontology





The Process Ontology (cont'd)

- Three types of Process:
 - Atomic Process
 - Directly invocable.
 - Execute in single step.
 - Simple Process
 - Provide a view of atomic process
 - Simplified representation of some composite process(for planning, reasoning).
 - Composite Process

Control Structure

- Sequence
- Split
- Unordered
- Split+Join
- Choice
- If-Then-Else
- Iterate
- Repeat-Until



Congo Purchase: ProcessModel



CongoPurchaseProcessModel.daml

```
<process>
  <name> purchase </name>
  <sequence>
     cess> locate goods (?goods)</process>
      <alternative>
       <alt1><task> One step </task></alt1>
       <alt2> <sequence>
          <task> put in cart(?goods)</task>
            <process>
              <name> check out info</name>
               <alternative>
                <alt1> <sequence>
                   <task> Sign in (?user)</task>
                    <task> Load profile(?user.profile) </task>
                 </sequence></alt1>
                 <alt2> <sequence>
                    create Account (?user)</process>
                    create profile(?user.profile) </process>
                 </sequence></alt2>
                </alternative>
              </process>
           <task> Select Payment Method </task>
          cess> Select Delivery Address 
         </sequence></alt2>
        </alternative>
       <task> Finalize </task>
  </sequence>
</process>
```



Process Control Ontology

- To monitor and Control the execution of a process, an agent needs a model to interpret process instantiations with three characteristics:
 - Provide the mapping rules for various input state properties to the corresponding output state state properties.
 - Provide a model of the temporal or state dependencies described by the constructs, sequence...etc.
 - Provide representation for message about the execution.

Resource





B2C-Purchase: Grounding

- Transport: Secure HTTP
- Protocol: HTTP Forms
- Address: https://buybot.congo.com:4040/initsub.htm
- Type Serializations
 - ItemDescription (keywords): Set of DAML literals
 - PriceRange: pair of monetary units, ISO 5678
 - CreditCard:

https://transcredit.com/S1.daml#SecureTransferFormat

WSMF



- Strong de-coupling of various components that realize an E-commerce application.
- Strong mediation service enabling anybody in a scalable manner

The Web Service Modeling Framework (WSMF)

- Ontology: define the terminology that is used by other elements of WSMF specification.
- Goal Repository: specify that a client may have in case he consults a web service.
 - Pre-condition
 - Post-condition
- Web Services: define various aspects of a web service.
- Mediator: bypass interoperability problem.

Web Services

- 1. Name: a unique identifier.
- 2. Goal.
- 3. Precondition and Postcondition
- 4. Input Data and output data
- 5. Error Data

These description elements still tried a web service as a **black box**. We need want to have more complex description, **failure**, **concurrent execution**, **concurrent data input** and **output**, **dynamic service binding**.

- 6.Invoked web service proxy.
- 7.Input ports and output Ports.
- 8.Data Flow and Control Flow
- 9. Exception handling
- 10. Error State
- 11.Message exchange protocol.
- 12.Non functional properties.



Mediator

- Mediation of data structures.
- Mediation of business logics.
- Mediation of message exchange protocols.

DAML-S vs. WSMF



- Ontology for Web Service.Easily to establish the relationship of services.
- Public process for monitoring.
- Lack of interface definition.

- Ontology for concepts.No Service Ontology.
- Emphasize the process and mediation in interactions.
- Conflicting points in the composition by requestor, since the process is blackbox, how requestor know the process?
- No semantic support for service composition.



Semantic Service Discovery

Example:

Find a service that sells airline ticket from Beijing to Shanghai and accepts payment by the MMM Club credit card"

Shoe and Ontobroker. Semantic Search are not enough for the services, especially for the altering-world services since we should consider personal constraints and consequence of services for execution and composition.



Service Matching and Discovery

- ATLAS: Based on DAML-S by CMU
- Matchmaking Service by HP Lab, UK
- Matchmaking using Process Ontology.
- DReggie: Semantic Service Discovery for Mcommerce application



CMU-ATLAS

- Based on the DAML-S.
- Providers advertise the services with one or more middle agents.
- Matching Functional attributes.
 - Determine the applicability of advertisement
 - achieved by performing conjunctive pair-wise comparisons of the properties.(?)
 - Different type of inference for the different attributes.
 e.g. geographicradius and serviceType



Matching Functional Attributes

- Multiple criteria decision making (MCDM) refers to making decisions in the presence of multiple, usually conflicting, criteria. MCDM problems are common in everyday life. In personal context, a house or a car one buys may be characterized in terms of price, size, style, safety, comfort, etc
- Conjunctive constraint method: By setting up a minimum standard for each attribute, the alternative selection or evaluation process is simplified to compare each attribute against its standard. If the standard reflects the decision maker expectations, the obtained solutions are satisfying solutions.



CMU- ATLAS (cont'd)

- Matching Service Functionalities
 - Service functionalities grouped into two sets, input and output.

Requester input is Ri, output is Ro Provider input is Ai, output is Ao

- (1) Set Ri is compared to the set Ai, and match is determined if Ai is subset of Ri.
- (2) Output sets match when all the elements in Ro are subsumed by elements in Ao. (i.e)



HP-DL Reasoner

- Description Languages are logic based KR formalisms
- Based on concepts and roles.
 - E.g. Man= Human Π Male
- DL System provide efficient inference services
 - Careful choice of logic/algorithm
 - Highly optimized implementation
- DL have been influential in development of Semantic Web



HP- DL Reasoner

- Based on DAML+OIL, using description logics.
- Concept of Match:a service D1 is a match for a service description D2 if there is no contradiction between all of the restrictions in D1 and D2.
- Algorithm: The match for service description S
 - Equivalent concepts to S
 - Sub-Concept of S
 - Super-concept of S that subsumed by the Root
 - Sub-concepts of any direct super-concept of S whose interaction with S is satisfiable.



HP-DL Reasoner (cont'd)

- Requirements for DL Reasoner for matchmaking
 - SHOQ (D) is the minimum expressive required.(compared to SHID that does not support individuals or datatypes.
 - Dynamic
 - Ability to deal with multiple interconnected with Tboxes
 - Scalability
 - Persistency
 - Support for DAML+OIL



DReggie

Based on DAML

- For m-commerce
- Prolog Reasoner for Semantic Discovery
 - Representation of a body of knowledge as a set of declarative.
 - Central to Prolog are concepts from logic:axiom and inference. Prolog makes inference from those axioms about whether certain sentences follow from them
 - Forward Reasoning and backward Reasoning.



Service Composition

Travel Solution

- Flight Booking
- Accommodation Booking
- Tourist attraction searching
- Bicycle hire and car rental booking
- Event attendance planner.



Problem for Composition

- How to you know when it is "safe" to compose A and B?
 - Output semantics of A match input semantics of B
- The main problem is semantic mapping of arguments
 - In most systems to date, this requires human level knowledge.
 - If system is purpose-built for composition, semantic mapping can be explicitly coded into service interface.



Two Types of Service Composition

Static Service Composition:

- Plan of the composite service is known a priori.
- **E-flow** is platform for the specification, enactment and management of composite e-services.

Service Discovery Pattern:

- What type of information is needed to identify service components at run-time?
- How to integrate the component services in the provision of this composite service?



Service Discovery Pattern(cont'd)

Solution:

- An automated service discovery:given that component services are described using software interpretable information(ontology), this facility provides means(service discovery engine) to locate component services based on constraints over their meta-data.
- A composite service specification allows component services to be automatically discovered and integrated.

Implementation.

- CMI(placeholder->selection policy)
- Push-Community.(WebBIS)



Push-Community

- Describes the capabilities of a desired service without referring to any specific service.
- A services can register with it to (fully or partially)offer the desired operations. This involves the definition of the mappings between operations defined in the community and those defined in the actual services.
- Push Community defines a request for services.
- The task of composing a complex service is gracefully distributed by enabling each provider to contribute to one or more communities without knowledge of the details of other participating services.
- Abstract Service Ontology, instead of the concrete service in the query.