Semantic Web Services

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- WSMO Working Group
Outline

- Service Orientation and Web Services Technologies
- Semantic Web Services Overview and Techniques
- Main Conceptual Frameworks
  - OWL-S, WSMO
  - WSDL-S/SAWSDL, WSMO-Lite
  - SAREST, MicroWSMO
- Applying Semantic Web Services
Service-Oriented Architecture & Web Service Technologies
Service Orientation

- A Service is a reusable software component offered through a language independent interface.
- Service-orientation regards the development of systems as the composition of loosely coupled services.
- Promotes reuse and improves the maintenance and evolution of systems.
SOA Approach

- Provider
  - Publishes Services (1)
  - Invokes Services (4)
- Registry
  - Publishes Services (1)
  - Discovers Services (2)
  - Ranks & Selects Service (3)
- Client
  - Invokes Services (4)
Related Technologies

Source: Steve Bratt W3C - http://www.w3.org/2005/Talks/1103-sb-mit-mwi/
# Web APIs and RESTful Services

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Semantic Web Services
Limitations of WS Technology

- Current technologies allow usage of Web Services but:
  - Only provide syntactical information descriptions
  - Web Service discovery, composition, and invocation need to be done manually
  - Manual labour reduces scalability
  - The situation is considerably worse for Web APIs
Semantic Web Services

- Automate Web Service technologies by using
  - Formal annotation of Web Services
  - Inference-based techniques for (semi) automated discovery, composition, mediation, execution of Web Services
- Integration with the Semantic Web
  - Ontologies as data model
Service Discovery/Matchmaking
Service Discovery/Matchmaking

- Find candidate Web Services that can provide the desired functionality using
  - Structural analysis
  - IR techniques
    - Match natural language keywords in resource descriptions, similarity analysis
  - Semantic Matchmaking
    - Reasoning applied over descriptions, i.e., Inputs/Outputs, Preconditions, Effects, Classifications
- Hybrid IR/semantic solutions perform better
Service Ranking & Selection

- Registry
  - Publishes Services (1)
  - Discovers Services (2)
  - Ranks & Selects Service (3)

- Provider
- Client

Sunday, 7 November 2010
Service Ranking & Selection

- Rank and eventually select the best service given certain criteria

- Often applied after service matchmaking using
  - Different degrees of match for ranking (exact > plugin, etc)
  - Non-functional properties (QoS, response time, user location, etc)

- Techniques
  - Weighted combination, skyline, fuzzy reasoning
Service Invocation

Provider

Invokes Services (4)

Registry

Publishes Services (1)

Discovers Services (2)

Ranks & Selects Service (3)

Client
Service Invocation

- Invocation of selected service
- Typically involves lifting and lowering
- Often requires mediation
Mediation

• Heterogeneity as inherent characteristic of the Web:
  • Heterogeneous terminology, formalisms, functionalities, communication protocols and business processes
  • Often approached by means of a generic mismatch resolution machinery
    • Mediation definition language & mediation patterns
    • Execution environment for mediation definition
Data Mediation Techniques

- **Ontology Mapping**: Mapping Rules
- **Ontology Alignment**: Ontology A is made compatible to ontology B
- **Ontology Merging**
Process Mediation

Diagram: Process Mediation

1. **Business Partner1**
   - A
   - B

2. **Business Partner1**
   - A
   - B

3. **Business Partner1**
   - A and B

4. **Business Partner1**
   - A
   - B

5. **Business Partner1**
   - A
   - AckA

6. **Business Partner2**
   - B

7. **Business Partner2**
   - A

8. **Business Partner2**
   - B

9. **Business Partner2**
   - A

10. **Business Partner2**
    - B

11. **Business Partner2**
    - A

12. **Business Partner2**
    - B

The diagram illustrates the flow of communication and mediation between Business Partner1 and Business Partner2.
Service Composition

Source: Matthew Zager - http://soa.sys-con.com/node/155631
Service Composition

- Combine several Web services for solving a request
- Applied if no directly usable Web service exists to solve the goal of a client
- Often approached as
  - Planning, i.e., devise a set of actions that will take us from the current state to the state requested
  - Parametric Design, i.e., given a skeleton, find the right configuration of parameters that can achieve our goal
Main Conceptual Frameworks
Main Approaches

✦ Web Services
  ✦ Top-down: OWL-S, WSMO
  ✦ Bottom-up: WSDL-S/SAWSDL, WSMO-Lite

✦ Web APIs
  ✦ SAREST
  ✦ hRESTS/MicroWSMO
Types of Service Semantics

* **Information model semantics**: semantics of the data used and exposed by the service

* **Functional semantics**: what the service does, e.g., categorisation, capability

* **Non-Functional semantics**: semantics related to the non-functional aspects of the service, e.g., Quality of Service (QoS), security, etc.

* **Behavioural semantics**: semantics related to the behaviours, e.g., choreography, faults, etc.
Web Service-centric Models
OWL-S

- ServiceProfile
  - presents (what it does)

- Service
  - supports (how to access it)
  - describedBy (how it works)

- ServiceGrounding
- ServiceModel
Objectives that a client may have when consulting a Web Service

WSMO

Provide the formally specified terminology of the information used by all other components

Semantic description of Web Services:
- Capability (functional)
- Interfaces (usage)

Connectors between components with mediation facilities for handling heterogeneities
SAWSDL in a Picture
SAWSDL is Purposely Underspecified

No predefined semantics

No fixed formalism
WSMO-Lite in SAWSDL
Web API-centric Models
Web APIs Descriptions

Most often described via plain HTML pages

Unstructured

Highly heterogeneous descriptions

Often incomplete descriptions
SAREST

- SAREST is a microformat (poshformat) for RESTful services
- Currently uses RDFa to annotate Web pages
- Basic SAREST properties
  - domain-rel: domain information of a resource
  - sem-rel: captures the semantics of a link
  - sem-class: annotation of a single entity within a resource
- Includes a non-normative minimal service model
hRESTS/MicroWSMO

- hRESTS is a microformat (poshformat) for Web APIs
- Service, its operations
- Resource address, HTTP method
- Input/output data format
- MicroWSMO extends hRESTS with SAWSDL-like hooks for pointing to semantic descriptions
- Proposes as normative the minimal service model
Processing Web API Annotations

- Web API annotations are usually extracted from the Web page (e.g., GRDDL)
- The resulting annotations are used as the basis for manipulation
- Processing of Web API annotations builds upon existing work on Semantic Web Services by applying the same or slightly adapted algorithms
- Invocation is however a significantly different task
Applying Semantic Web Services
E-Science

 Courtesy of Carole Goble
Software Interoperability

If the Capabilities Available provide a “reasonable match” to the Capabilities Needed, Interoperability may be achieved.

Otherwise ➞ No Interoperability
Autonomous Vehicles

Decompose Tasks

Map Tasks to Agent Architecture

Map Task Decisions To State-Tables

Identify Task Relevant Entities and Objects

Derive the Relevant Task Situations from World States and Object Parameters

Services

Roles

Processes

Parameters

Conditions
Emergency Planning
General Broker-based Approach

Client → SWS Broker → Services
General Broker-based Approach
Conclusions

- Services provide means for effective reuse of functionality and the creation of added value solutions (businesses) through composition.

- The core Web Service technologies require the use of semantics for a greater level of automation.

- There are a number of conceptual models that have been proposed for annotating and reasoning over Web Services and Web APIs.

- Alongside many engines, frameworks and algorithms have been devised that support discovery, composition, invocation, etc.

- Further details and pointers at the end of your handouts.
Thank you for your attention
References


References


References


Useful Links

- SOAP: http://w3.org/TR/soap12
- WSDL: http://w3.org/TR/wsdl20
- WS-Addressing: http://w3.org/TR/ws-addr-core
- WS-Policy: http://w3.org/TR/ws-policy
- UDDI: http://uddi.xml.org/
- W3C: http://w3.org/
- OASIS: http://oasis-open.org/
Useful Links

- OWL-S: http://www.daml.org/services/owl-s/
- WSDL-S: http://www.w3.org/Submission/WSDL-S/
- SAWSDL: http://www.w3.org/2002/ws/sawSDL/
- SWSF & FLOWS: http://www.w3.org/Submission/SWSF/
Useful Links

* WSMO-Lite: http://cms-wg.sti2.org/TR/d11/v0.2/
* hRESTS/MicroWSMO: http://cms-wg.sti2.org/TR/d12
* SAREST: http://www.w3.org/Submission/SA-REST/
* REST & RESTful Web services: http://en.wikipedia.org/wiki/REST
* Microformats: http://microformats.org/
Useful Links

- WSMX: http://www.wsmx.org/
- IRS-III: http://technologies.kmi.open.ac.uk/irs/
- METEOR-S: http://lsdis.cs.uga.edu/projects/meteor-s/
- Glue: http://glue.cefriel.it/
- OWL-S VM: http://projects.semwebcentral.org/projects/owl-s-vm/