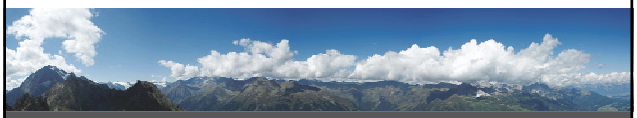
STI · INNSBRUCK

Semantic Web Services

Introduction

Lecture I – 5th March 2009

Dieter Fensel



What is the course about?

- New, emerging sciences: web science, service science
- Service based technologies: Web services, Web2.0/Restful services
- Semantic Web services: vision, approaches, usage

Course Organization

- Course is organized into:
  - 12 lectures (Thursday 14-16)
  - 7 tutorials (Tuesday 15-17)
- The lecturers are:
  - Dieter Fensel (dieter.fensel@sti2.at)
  - Federico M. Facca (federico.facca@sti2.at)
- The tutor is:
  - Dumitru Roman (dumitru.roman@sti2.at)

Course material

- Web site:
  http://www.sti-innsbruck.at/teaching/courses/ss2009/details/?title=semantic-web-services
  - Slides available online before each lecture
- Mailing list:
  https://lists.sti2.at/mailman/listinfo/sws2009

Where are we?

#	Date	Title
1	5th March	Introduction
2	12th March	Web Science
3	19th March	Service Science
4	26th March	Web Services (WSDL. SOAP, UDDI, XML)
5	2nd April	Web 2.0 and RESTful services
6	23rd April	WSMO
7	30th April	WSML
8	7th May	WSMX
9	14th May	OWL-S and others
10	28th May	WSMO-Lite, MicroWSMO
11	4th June	SWS Use Cases
12	18th June	seekda: the business point of view
13	25th June	Mobile services
14	2nd July	Exam Preparation

Examination

- Exam grade:

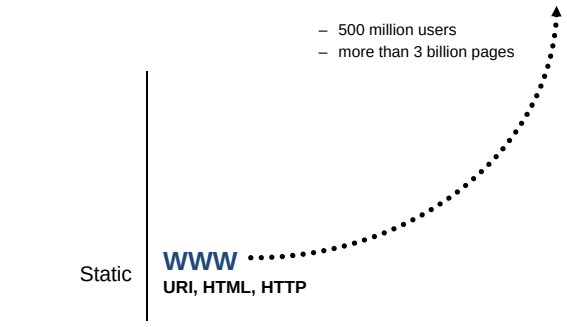
score	grade
75-100	1
65-74.9	2
55-64.9	3
45-54.9	4
0-44.9	5

- Tutorial and Exam have separate grades since this is not an integrated course

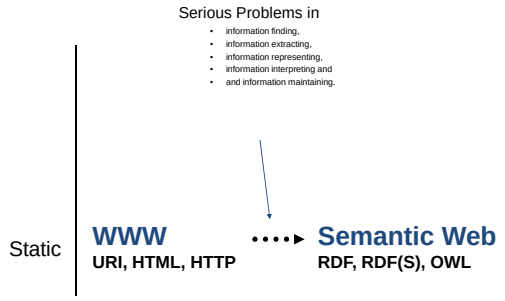
In this lecture

- **The vision of the Semantic Web**
- **Ontologies as the basic building block**
- **Current Web Service Technologies**
- **Vision and Challenges for Semantic Web Services**

The Vision



The Vision (contd.)



What is the Semantic Web?

- *"An extension of the current Web in which information is given well-defined meaning, better enabling computers and people to work in cooperation."*
  - Sir Tim Berners-Lee et al., Scientific American, 2001: tinyurl.com/i59p
- *"…allowing the Web to reach its full potential…"* with far-reaching consequences
- *"The next generation of the Web"*

What is The Semantic Web?

- The next generation of the WWW
- Information has machine-processable and machine-understandable semantics
- Not a separate Web but an augmentation of the current one
- Ontologies as basic building block

The Semantic Web is about…

- Web Data Annotation
  - connecting (syntactic) Web objects, like text chunks, images, … to their semantic notion (e.g., this image is about Innsbruck, Dieter Fensel is a professor)
- Data Linking on the Web (Web of Data)
  - global networking of knowledge through URI, RDF, and SPARQL (e.g., connecting my calendar with my rss feeds, my pictures, ...)
- Data Integration over the Web
  - Seamless integration of data based on different conceptual models (e.g., integrating data coming from my two favorite book sellers)

Ontology Definition

unambiguous terminology definitions

conceptual model of a domain (ontological theory)

formal, explicit specification of a shared conzeptualization

machine-readability with computational semantics

commonly accepted understanding

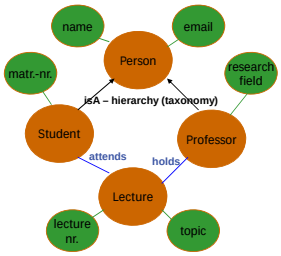
Ontology Example

Concept
conceptual entity of the domain

Property
attribute describing a concept

Relation
relationship between concepts or properties

Axiom
coherency description between Concepts / Properties / Relations via logical expressions



holds(Professor, Lecture) =>
Lecture.topic = Professor.researchField

Ontology Technology

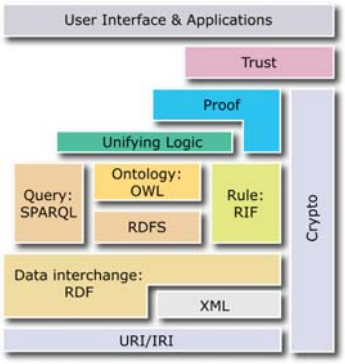
To make the Semantic Web working we need:

- **Ontology Languages**:
  - expressivity
  - reasoning support
  - web compliance
- **Ontology Reasoning**:
  - large scale knowledge handling
  - fault-tolerant
  - stable & scalable inference machines
- **Ontology Management Techniques**:
  - editing and browsing
  - storage and retrieval
  - versioning and evolution Support
- **Ontology Integration Techniques**:
  - ontology mapping, alignment, merging
  - semantic interoperability determination
- and … **Applications**

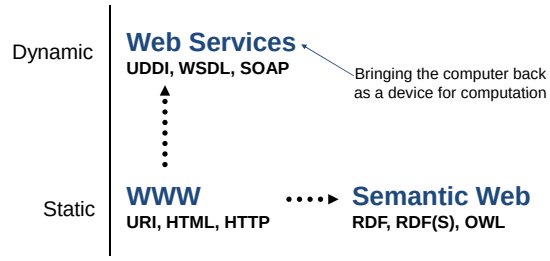
Ontology Languages

- Requirements:
  - ”expressivity“
    - **knowledge** representation
    - ontology theory support
  - ”reasoning support“
    - sound (unambiguous, decidable)
    - support reasoners / inference engines
- Semantic Web languages:
  - web compatibility
  - Existing W3C Recommendations:
    - XML, RDF, OWL

"Semantic Web Language Layer Cake"



The Vision (contd.)



Web Services: Definition

1) "Loosely coupled, reusable software components that encapsulate discrete functionality and are distributed and programmatically accessible over standard Internet protocols", *The Stencil Group*
2) Web service applications are encapsulated, loosely coupled Web "components" that can bind dynamically to each other, *F. Curbera*
3) "Web Services are a new breed of application. They are self-contained, self-describing, modular applications that can be published, located, and invoked across the Web. Web Services perform functions, which can be anything from simple request to complicated business processes", *The IBM Web Services tutorial*

Common to all definitions:

- Components providing functionality
- Distributed
- Accessible over the Web

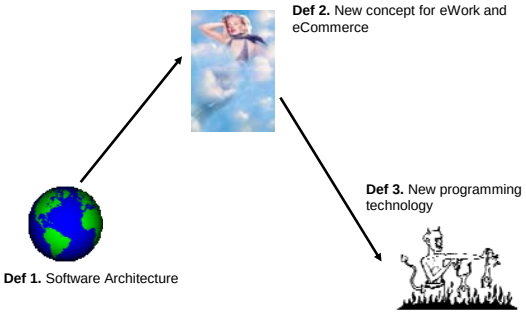
Web Services

- Loosely coupled, reusable components
- Encapsulate discrete functionality
- Distributed
- Programmatically accessible over standard internet protocols
- Add new level of functionality on top of the current web

Web Service vs. Service

- Service
  - A provision of value in some domain (not necessarily monetary, independent of how service provider and requestor interact)
- Web Service
  - Computational entity accessible over the Internet (using Web Service Standards & Protocols), provides access to (concrete) services for the clients.

Definitions



Definitions

- Web Services connect computers and devices with each other using the Internet to exchange data and combine data in new ways.
- The key to Web Services is on-the-fly software creation through the use of loosely coupled, reusable software components.
- Software can be delivered and paid for as fluid streams of services as opposed to packaged products.

Definitions

Def 2. Web Services as a new Concept for eWork and eCommerce

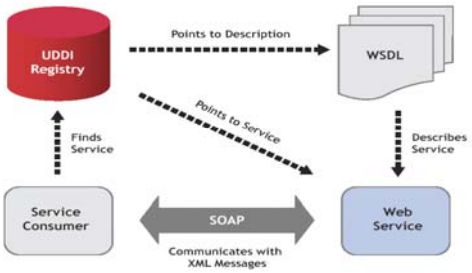
- Business services can be completely decentralized and distributed over the Internet and accessed by a wide variety of communications devices.
- The internet will become a global common platform where organizations and individuals communicate among each other to carry out various commercial activities and to provide value-added services.
- The dynamic enterprise and dynamic value chains become achievable and may be even mandatory for competitive advantage.

Definitions

Def 3. Web Services as a programming technology

Web Services are Remote Procedure Calls (RPC) over HTTP

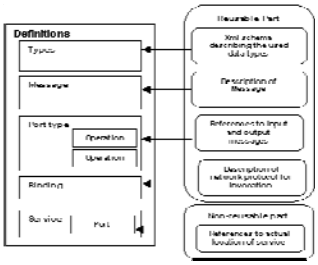
Web Services



WSDL

- Web Service Description Language
- W3C effort, WSDL 2 final construction phase

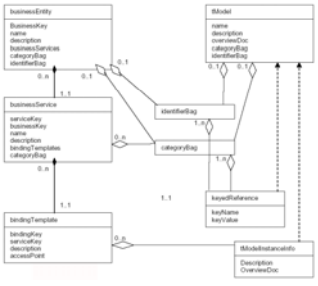
describes interface for consuming a Web Service:
- Interface: operations (in- & output)
- Access (protocol binding)
- Endpoint (location of service)



UDDI

- Universal Description, Discovery, and Integration Protocol
- OASIS driven standardization effort

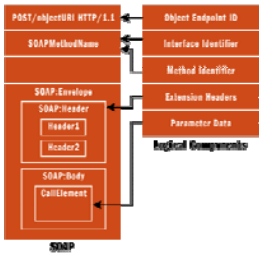
Registry for Web Services:
- provider
- service information
- technical access



SOAP

- Simple Object Access Protocol
- W3C Recommendation

XML data transport:
- sender / receiver
- protocol binding
- communication aspects
- content

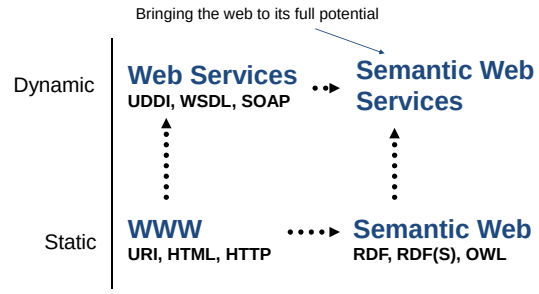


Restful services

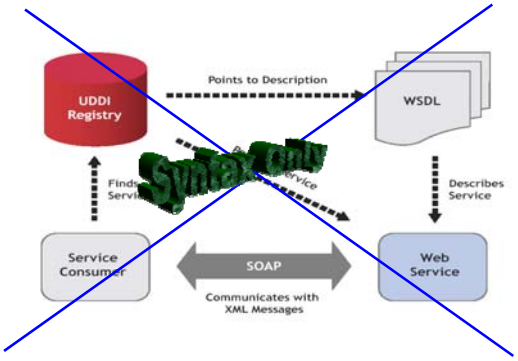
- Another way of realizing services, other then SOAP/WSDL/UDDI approach
- Follows the Web principles (REST principles)

- Services expose their data and functionality through resources indentified by URI
- Services are Web pages that are meant to be consumed by an *autonomous* program
- Uniform interfaces for interaction: GET, PUT, DELETE, POST
- HTTP as the application protocol

The Vision (contd.)



Deficiencies of WS Technology



Deficiencies of WS Technology

- current technologies allow usage of Web Services
- but:
  - only syntactical information descriptions
  - syntactic support for discovery, composition and execution
  - ***=> Web Service usability, usage, and integration needs to be inspected manually***
  - no semantically marked up content / services
  - no support for the Semantic Web

=> current Web Service Technology Stack failed to realize the promise of Web Services

So what is needed?

- **Mechanized support** is needed for
  - Annotating/designing services and the data they use
  - Finding and comparing service providers
  - Negotiating and contracting services
  - Composing, enacting, and monitoring services
  - Dealing with numerous and heterogeneous data formats, protocols and processes, i.e. mediation

=> Conceptual Models, Formal Languages, Execution Environments

Semantic Web Services

Semantic Web Technology

- allow machine supported data interpretation
- ontologies as data model

+

Web Service Technology

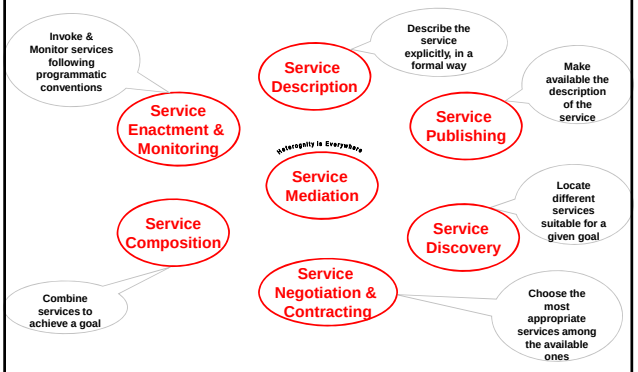
automated discovery, selection, composition, and web-based execution of services

=> Semantic Web Services as integrated solution for realizing the vision of the next generation of the Web

Semantic Web Services

- define exhaustive description frameworks for describing Web Services and related aspects **(Web Service Description Ontologies)**
- support ontologies as underlying data model to allow machine supported data interpretation **(Semantic Web aspect)**
- define semantically driven technologies for automation of the Web Service usage process **(Web Service aspect)**

Tasks to be automated

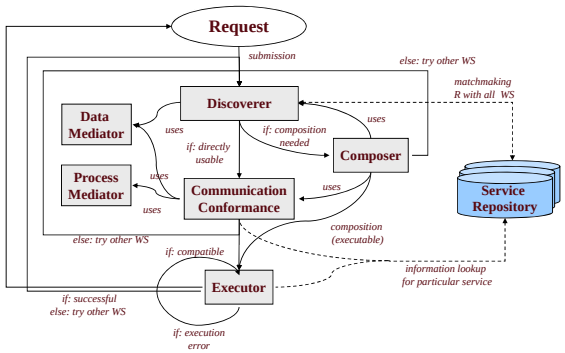


Semantic Web Services

Usage Process:

- Publication: Make available the description of the capability of a service
- Discovery: Locate different services suitable for a given task
- Selection: Choose the most appropriate services among the available ones
- Composition: Combine services to achieve a goal
- Mediation: Solve mismatches (data, protocol, process) among the combined
- Execution: Invoke services following programmatic conventions

An example of a SWS usage process



Semantic Web Services

Execution support:

- Monitoring: Control the execution process
- Compensation: Provide transactional support and undo or mitigate unwanted effects
- Replacement: Facilitate the substitution of services by equivalent ones
- Auditing: Verify that service execution occurred in the expected way

Conclusions: Why Semantic Web Services ?

- To overcome limitations of traditional Web-Services Technology by integrating it with Semantic Technology;
- To enable automatic and personalized service discovery;
- To enable automatic service invocation and execution monitoring;
- To enable automatic service integration;
- To enable semantic mediation of Web-Services.

Next Lecture

#	Date	Title
1	5th March	Introduction
2	12th March	Web Science
3	19th March	Service Science
4	26th March	Web Services (WSDL. SOAP, UDDI, XML)
5	2nd April	Web 2.0 and RESTful services
6	23rd April	WSMO
7	30th April	WSML
8	7th May	WSMX
9	14th May	OWL-S and others
10	28th May	WSMO-Lite, MicroWSMO
11	4th June	SWS Use Cases
12	18th June	seekda: the business point of view
13	25th June	Mobile services
14	2nd July	Exam Preparation

Questions?