Designing the Semantic Web for Higher Education -

Technological and Socio-economical Challenges

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Outline

- What is the Semantic Web all about?
- How do Use Cases of the Semantic Web look like and how can we realize them?
- What is missing from the socio-economical point of view?
What is the Semantic Web all about?
“The vision of the semantic web aims to have distributed data and services defined and linked in such a way that they can be used by machines not just for display purposes, but for automation, integration and reuse of data and services across various applications.“

Berners-Lee, Hendler, Lassila 2001
High Expectations

“What we’re seeing is just the first version of the Web. The next version will be even bigger and more powerful...“

Fensel, Musen 2001
Emphasize on Services  McIlraith et al., 2001

- **Automatic Web service discovery**: automatic web service discovery involves the automatic location of Web services that provide a particular service.

- **Automatic Web service invocation**: Automatic Web service invocation involves the automatic execution of an identified Web service.

- **Automatic Web service monitoring**: Once a web service has been invoked, one may want to know the status of the service.

- **Automatic Web service composition**: This task involves the automatic composition and interoperation of Web services to perform some task, given a high-level description of an objective.
Semantic Web Stack - The Layer Cake

Berners-Lee, 2000
<?xml version="1.0"?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
    targetNamespace="http://www.books.org"
    xmlns="http://www.books.org">
    <xsd:element name="BookStore">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref="Book" minOccurs="1" maxOccurs="unbounded"/>
            </xsd:sequence>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name="Book">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref="Title" minOccurs="1" maxOccurs="1"/>
                <xsd:element ref="Author" minOccurs="1" maxOccurs="unbounded"/>
            </xsd:sequence>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name="Title" type="xsd:string"/>
    <xsd:element name="Author" type="xsd:string"/>
</xsd:schema>
XML Instance

<?xml version="1.0"?>
<BookStore xmlns="http://www.books.org"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.books.org BookStore.xsd">
    <Book>
        <Title>My Life and Times</Title>
        <Author>Paul McCartney</Author>
    </Book>
    etc...
</BookStore>
Resource Description Framework (RDF)

Resource

Property Type

Property Value

urn:univ:lr-WUW-tenzi-1

dc:title

The Emerging Paradigm for Electronic Commerce
<rdf:RDF
    xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
    xmlns:dc="http://purl.org/dc/elements/1.1/">

    <rdf:Description rdf:ID="urn:univ:lr-WUW-tenzi-1">
        <dc:title>
            The Emerging Paradigm for Electronic Commerce
        </dc:title>
        <dc:creator rdf:resource="urn:univ:us-1"/>
        <dcq:created>
            <dcq:W3CDTF>
                <rdf:value>2000-05-07</rdf:value>
            </dcq:W3CDTF>
        </dcq:created>
    </rdf:Description>
</rdf:RDF>
Differences between XML and RDF Schema

- XML Schema is used for describing the valid syntax of an XML document
- RDF Schema is used for describing differences between concepts (RDF Schema vocabulary: class, property, subclass, type,
Differences between XML and RDF

- XML focuses on syntax and document structure, RDF on semantic.
- RDF supports the creation of self-describing documents.
- RDF namespaces are part of tags providing a semantic identifier at an attribute level.
- RDF has its foundations in logic.
Using XML and RDF to describe services

- Web Service Description Language (WSDL)
- SOAP: Remote Procedure Calls via Web
- Universal Description, Discovery and Integration (UDDI): white, yellow and green pages (uses WSDL and SOAP).
- DAML (Darpa Agent Markup Language) provides means for expressing knowledge of a service:
  - What does the service require?
  - How does it work?
  - How is it used?
Ontologies

Ontologies provide an explicit, formal specification of how to represent the objects, concepts and other entities that are assumed to exist in a domain and the relationships that hold among them.
Sample Ontology: African Wildlife

class-def animal
class-def plant
  subclass-of NOT animal
class-def tree
  subclass-of plant
class-def branch
  slot-constraint is-part-of
    has-value tree
class-def leaf
  slot-constraint is-part-of
    has-value branch
class-def defined carnivore
  subclass-of animal
  slot-constraint eats
    value-type animal
class-def defined herbivore
  subclass-of animal, NOT carnivore
  slot-constraint eats
    value-type plant
    OR (slot-constraint is-part-of has-value plant)
class-def giraffe
  subclass-of herbivore
  slot-constraint eats
    value-type leaf
class-def lion
  subclass-of animal
  slot-constraint eats
    value-type herbivore
class-def tasty-plant
  subclass-of plant
  slot-constraint eaten-by
    has-value herbivore, carnivore

% animals are a class
% plants are a class
% that is disjoint from animals
% trees are a type of plants
% branches are parts of trees
% leaves are parts of branches
% carnivores are animals
% that eat only other animals
% herbivores are animals, but not carnivores
% that eat only plants or parts of plants
% giraffes are herbivores
% and they eat leaves
% lions are also animals
% but they eat herbivores
% tasty plants are plants that are eaten by
% both herbivores and carnivores

Decker, et al. 2000
Ontology Engineering

- ... develops and uses techniques for accumulating knowledge within reasonable size of stratified domains. The product of such a study is a catalog of the types of things that are assumed to exist (Sowa, 2000).

- Ontology discovery (Maedche and Staab, 2001) extends ontology-engineering environments by using semiautomatic ontology-construction tools.
How do Use Cases of the Semantic Web look like and how can we realize them?
Designing Smart Spaces for Learning and Teaching - Definition

- Smart Spaces are defined as peer-to-peer networks (spaces) that mediate learning and teaching services (e.g. delivery of courses or educational material)
- Take advantage of distributed, intelligent user profiling services in order to support the service and artefacts selection process.
Services for Learning and Teaching

Curriculum Creation & Management
- Accreditation Services
- Curriculum Evaluation Services

Content Development & Acquisition
- Development Tools, e.g. AuthorWare, PowerPoint, RealPresenter, Quest
- Content Brokerage Platforms, e.g. The Gateway, LydiaLearn, Merlot, Universal

Learner Acquisition & Competence Management
- CRM Components of ERP Systems, e.g. SAP
- Virtual Campus
- Competence Management Systems, e.g. SABA Learning, Clixx

Learning Delivery
- Learning Management Systems, e.g. Hyperwave ELS, Lotus Learning Space, WebCT, Blackboard
- Collaborative Teaching Tools, e.g. Isabel

Learner Assessment & Instructor Evaluation
- Evaluation Tools, e.g. Zoomerang

CRM Components of ERP Systems e.g. SAP
Virtual Campus
Competence Management Systems, e.g. SABA Learning, Clixx
Learning Management Systems, e.g. Hyperwave ELS, Lotus Learning Space, WebCT, Blackboard
Collaborative Teaching Tools, e.g. Isabel
Evaluation Tools, e.g. Zoomerang
Interaction Scenarios within Smart Spaces

Nodes of Content Brokerage Network

Network of Video Conferencing Devices

Assessment Services Site

Human Resources Management Systems

Smart Space for Learning & Teaching

Services delivering artefacts for learning
Artefacts involved

- Educational Material, e.g. case studies, textbooks, support material, simulations, ...
- Educational Activities, e.g. lectures, tutoring sessions, online courses, ...
- Accreditation and Assessment data of ed. activities and ed.material
- Learner profiles and personal development plans
- Instructor track records, ...
Envisioning a Communication Framework

Smart Space for Learning and Teaching

- Curriculum Exchange & Accreditation
- Exchange of Edu. Material
- Joint Teaching Activities
- Learner Assessment
- Teaching Evaluation
- Learning Management System
- ...  

Learning Management Network

Artefacts and Service Network (Peer-to-Peer Middleware Layer)

Learning Services Network
What is missing from a technical point of view?

- Mobile network connectivity
- Standards for all artefacts involved
- Ontologies for learning resources (ed. material + ed. activities)
- Ontologies for learning services
What is missing from a technical point of view?

- Standards for Peer-to-Peer integration providing peer authentication and communication (early research: http://edutella.jxta.org)
- Replication of repositories describing artefacts descriptions (early research: Nejdl, et al 2002)
What is missing from the socio-economic point of view? - A Case Study from the Universal Project
Envisioning a Smart Space for Teaching


- Examples: Edutella, Universal (http://www.ist-universal.org),

- Based on traditional Web technology: Gateway to Educational Material, Merlot, dSpace @ MIT, Virtual University @ Wirtschaftsuniversität Wien
Why a smart space for teaching?

Benefits for the provider of learning resources

- **Share** the creativity of your work with others who might be desperately looking for exactly the kind of learning objects you have created;
- **Get feedback** from your learning object consumers, which will enable you to enhance your own material;
- **Gain reputation** in a growing community;
- **Access** new academic distribution channels;
- **Encourage others** to put material online, from which you might benefit as well.

Proved by User Survey
Benefits for the consumer of learning resources

- **Reuse** existing material instead of paying the costly price of developing it on your own;
- **Contribute** to a community of scholars through interaction with instructors, experts and peers;
- **Enhance** quality teaching;
- **Foster** national and international academic **alliances** and exchanges;
- **Enable partnerships** between faculty members.

Proved by User Survey
UNIVERSAL SYSTEM ARCHITECTURE I

Delivery System for Packaged Content (e.g. Apache Web Server)

Delivery System for Packaged Content (e.g. Real Networks Streaming Server)

UNIVERSAL Brokerage Platform

Meta Data

Learning Resource
UNIVERSAL System Architecture II

Procedure:
1. UBP sends a connection command to all registered end-user sites before a session starts.
2. A terminal connects the end-user site to the delivery platform.

1. UBP sends connection command

2. Site connects to delivery platform

LR Delivery

LR Consumption

Live Delivery Platform (e.g. ISABEL)

MCU

MCU

MCU
In the past users have been reluctant to use smart spaces:

- 1998: STRIKE at York University;
- 2000: At the Virtual University of Wirtschaftsuniversität Wien only 48 References to Learning Resources were found (given that Wirtschaftsuniversität Wien offers 1,900 courses per semester);
- 2001: UNIVERSITAS 21 faculty and students boycott a smart space project among American and Australian Universities
Socio-economic Research Question:
What are success factors of smart spaces for teaching?
Design Spaces

Business Model Design Space
Organizational Design Space
Artefacts Design Space
Agent Design Space

Cost and Benefits of users, revenue streams
Hierarchies and Processes
Authentication and Roles
Description, Categorisation
Methodology

- **Interview technique**
  - Telephone Interviews based on questionnaire

- **Survey population**
  - Faculty of four European Business Schools: Wirtschaftsuniversität Wien, Universität St. Gallen, Universität zu Köln, HEC Paris
  - Weighted Random Sample of 127 faculty members
Fundamental Decision in Business Model Design Space

**Community Model**
Collaborative Design and Delivery of Learning Resources „Co-operate“

**Transaction Model**
External Acquisition and Distribution of Learning Resources „Buy“
Design of a Community Scenario

- Business Model Design Space
  - Promotions aspect important
  - Organisational environment important
  - Service free of charge important
  - Reputation of smart space important

- Organisational Design Space
  - User support important
  - Peers evaluation important
  - High Quality of Artefacts very important
  - Research content very important

- Artefacts Design Space
  - Access Restrictions important

- Agents Design Space
  - Restricted Access also for Learners very important
Design of a Commercial Scenario

**Artefacts Design Space**
- **Research content**: Less important
- **Peer evaluation**: Less important

**Organisational Design Space**
- **User support**: Less important
- **Organisational environment**: Important
- **Service free of charge**: Important
- **Access Restrictions are mandatory**: Very important

**Business Model Design Space**
- **Promotion aspect**: Very important
- **Reputation of smart space**: Less important
- **Restricted Access also for Learners**: Very important

**Agents Design Space**
- **Restricted Access**: Very important
Success Factors Relating to User Type

**Supporter of Community Model**
(General interest: 70.9 %)

- Higher interest on exchanging research content
- Early adaptor
- Most likely not in a leading position
- Access restriction less important
- No willingness to pay for the service

**Supporter of Transaction Model**
(General interest: 37.8 %)

- Less interested in exchanging research content
- Not an early adaptor
- Being represented in the smart space is important
- Access restriction very important
- Higher willingness to pay for the service
References 1/2


