Semantic Web Technologies and Applications in e-Biz

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Introduction

- What & Why the Semantic Web?

Semantic Web Applications in e-Biz

- Weaknesses of the Current Web Technologies
- Potentials of Semantic Web Technologies

Semantic Web Technologies

- Ontology Representation
- Languages & Tools

Future of the Semantic Web
The Vision of the Web

- collaboration between people
- collaborations extend to computers

Everything is connected to the Information Space.
The Bottleneck

- The amount of information accessible from the Web is rapidly increasing.

- The information sources are increasingly complicated.

- The types of information source becomes diverse.
The Semantic Web

- **A Vision Of Possibilities**
  - “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.”
The Semantic Web

- enable intelligent services
  - information broker, search agents, and information filters

- further levels of interoperability have been established

- standard must be defined not only for the syntactic form of documents, but also for their semantic content
“The Semantic Web is a web of data, in some ways like a global database.” by Tim Berners-Lee

• Very little information available

• More information available

More Intelligent Knowledge Exchange
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Interoperability Problem in e-Biz

- The lack of proper standards in the e-Biz world
  - HTML does not neither provide syntax and semantics of information
  - Lack of integration of data exchanges between online market participants
  - Existing standards like EDIFACT are isolated and costly to manage

- XML provides some solutions for B2B
  - Human Understandable for Data Description
  - Easy and cheap to maintain
  - ebXML provides a comprehensive set of standardized XML document formats (Syntactic Interoperability)
  - Good tool support for all document processes in e-Biz
Too Many Standards

- There are more “standards” than you would like to have
  - UNSPSC, UCES, ecl@ss, RosettaNet, and much more vertical and horizontal standards
  - Serious translation problem

- All of the “standards” are based on semi-structured descriptions
  - XML based descriptions of products, services, and business processes
Why Semantic Web?

- Mapping and Integration between different “standards”
  - Semantic Interoperability

- Automization of business processes in terms of the formal semantics of descriptions
  - Machine Understandability

- So, buying decisions can be based on the whole of the relevant information
  - Finding all relevant information sources and online stores for a specific product
  - Integrating all information available on the Web, for comparing products and vendors
Potentials of Semantic Web Technologies

- Automatic vendor recognition
- Automatic product and service recognition
- Price and quality comparison
- Automatic negotiation protocols
- Automatic coalition forming of vendor groups
IS Evolution Path

Transaction

Collaborative

ERP Systems

Knowledge Management

K-Commerce

E-Commerce

Internal

External
K-Commerce

Knowledge Products/Services

E-commerce (transactions)

Marketing / Distribution

Internet
Knowledge Packaging

Create → Convert → Commercialize

Uncodified → Codified → Diffused

E.g. processes, databases, documents, drawings

Customized Products/Services
The use of URIs
   - A global identification mechanism for products and traders

The RDF data model
   - The direct publication of data on the Web using XML serialization
   - Rich metadata for contents

The Web Ontology Language (OWL)
   - The definition of common terms and concepts needed to understand RDF data
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How the Semantic Web Will Be Possible

Languages
- Formal Syntax and Formal Semantics
- Real world semantics → “Ontologies”

Tools
- Ontology builders and browsers
- Ontology integration tools
- Semantic annotators
- Reasoners

Applications
- Knowledge management systems
- Natural language search engines
- e-Biz
Ontology

- Shared understanding within a community of people
- Declarative specification of entities and their relationships with each other
- Syntactically and semantically richer than common approaches for databases
- Providing a domain theory and not the structure of a data container
Relational Database Schemas

- Well established technique for specifying the structure of shared data, not for communication between people or agents
- Declarative specification but of tables, not of entities and relationships
- Some constraints are expressible but no significant rules (such as inheritance)
- No explicit behavior
- Standard language is SQL.
Logic

- Very expressive but very difficult to use. Not designed for communication.
- Most logical languages are not based on entities and relationships.
- Very powerful reasoning capabilities.
- Do not usually have any associated behavior.
- Many examples: Prolog, KIF, Slang, ...
Meaning and Human Communication

Concept • ? • Concept

Symbol evokes

Concept refers to Concept

Symbol evokes

Symbol stands for “Concorde”

Symbol stands for “Concorde”

“Concorde”

stands for

stands for

Semantics Web & e-Biz, 2004
Kinds of Ontologies

- Terms
  - ad hoc Hierarchies (Yahoo!)
  - 'ordinary' Glossaries
  - Structured Glossaries
  - Thesauri
  - Data Dictionaries (EDI)
  - Principled, informal hierarchies

- Expressivity
  - DB Schema
  - XML Schema
  - Formal Taxonomies
  - XML DTDs
  - Frames (OKBC)
  - Description Logics (DAML+OIL)
  - General Logic

Semantic Web & e-Biz, 2004
Information Retrieval Using Ontologies

Neither this particular resource nor its metadata explicitly mention the recent occurrence of a RNA related virus in Gyeonggi, South Korea.

Only an assisted search that maps metadata to underlying ontologies could retrieve this resource in response to the query “the recent occur of a RNA related virus in Gyeonggi, South Korea.”
Knowledge Representation on the Web

- **Universal expressive power**
  - A Web based exchange format must be able to express any form of data.

- **Syntactic interoperability**
  - Applications must be able to read the data and get a representation that can be exploited.

- **Semantic interoperability**
  - Semantic interoperability is about defining mappings between terms within data, which requires content analysis.
Limits of XML

- How do I know that you mean the same thing by `<price>` that I do?
  - Does that include tax? shipping? surcharges?

- That is, if the computers of two companies are negotiating, they need to know that they truly understand each other.

- XML provides *syntactic* interoperability. There is a need for *semantic* interoperability.

- The semantic web provides this added layer of interoperability through the use of *shared ontologies.*
Using XML

- In semantic interoperability, it has disadvantages.
Using RDF

- **Expressive power**
  - RDF’s nested object-attribute-value structure satisfies our universal expressive power requirement for an exchange format.

- **Syntactic interoperability**
  - Application-independent RDF parsers are also available.

- **Semantic interoperability**
  RDF has significant advantages over XML.
Three Layered Architecture of the Semantic Web

**Data Layer**
- Simple data model and syntax
- RDF: Instances

**Schema Layer**
- Definition of Vocabulary
- Lightweight ontologies

**Logical Layer**
- Formal Semantics
- Reasoning support
- Heavyweight ontologies

**Higher Semantics**
- DAML+OIL, OWL

**RDF Schema**
- RDF

**XML Schema**
- RDF

**Structure & Syntax**
Three species of OWL

- **OWL full** is union of OWL syntax and RDF
- **OWL DL** restricted to FOL fragment (¼ DAML+OIL)
- **OWL Lite** is “easier to implement” subset of OWL DL

Semantic layering

- OWL DL ¼ OWL full within DL fragment
- DL semantics officially definitive

OWL DL based on SHIQ Description Logic

- In fact it is equivalent to SHOIN(D_n) DL

OWL DL Benefits from many years of DL research

- Well defined semantics
- Formal properties well understood (complexity, decidability)
- Known reasoning algorithms
- Implemented systems (highly optimised)
OWL Example (Classes Description)

- `owl:intersectionOf`
  - links a class to a list of class description
  - represent the “AND”

```xml
<owl:Class rdf:ID="Adult">
  <owl:intersectionOf rdf:parseType="Collection">
    <owl:Class rdf:about="#Person"/>
    <owl:restriction>
      <owl:onProperty rdf:resource="#age"/>
      <owl:someValuesFrom
        df:resource="http://www.w3.org/TR/@@/owl-ex-dt#over17"/>
    </owl:restriction>
  </owl:intersectionOf>
</owl:Class>
```

Adult = Person ∩ ∃ age.over17
**OWL Example (Classes Description)**

- **WhiteWine \( \cap \) hasSugar.(Dry \( \cup \) OffDry)**

```xml
<owl:Class rdf:ID="WhiteNonSweetWine">
  <owl:intersectionOf rdf:parseType="Collection">
    <owl:Class rdf:about="#WhiteWine" />
    <owl:Restriction>
      <owl:onProperty rdf:resource="#hasSugar" />
      <owl:allValuesFrom>
        <owl:Class>
          <owl:oneOf rdf:parseType="Collection">
            <owl:Item rdf:resource="#Dry" />
            <owl:Item rdf:resource="#OffDry" />
          </owl:oneOf>
        </owl:Class>
      </owl:allValuesFrom>
    </owl:Restriction>
  </owl:intersectionOf>
</owl:Class>
```

...
Ontology Tool Architecture

Ontology Middleware

Ontology Editor

Query & Browser

Ontology Repository

Annotated Data Repository RDF

Creation

Integration

Constraint Checking

Reasoning Engine

Ontology Repository (External)

Domain Ontology

..

..

Task Ontology
Modeling Tool: SemTalk
## Tools

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<th>OILEd</th>
<th>OntoEdit</th>
<th>Ontolingua</th>
<th>OpenKnoME</th>
<th>Protégé-2000</th>
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<td>Yes</td>
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Knowledge Modeling Tool for Pathological Gross Description

Template #5: soft tissue which has one structural component

ID: 2003031 20023

Specimen received is SoftTissue and hasState fixed

doneProcess RegenProcess doneWithRegent formalin

hasStructuralComponent CysticWall

this component hasDimension 2.3 x 1.1 and hasStructuralComponent WallStructure

this component hasColor transparent and hasDimension thin

hasShape MassStructure

this shape hasDimension 4.0 x 3.3 x 1. and hasColor dark brown
Ontology-Based Document Management System

Ontalk: Ontology-Based Personal Document Management System

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ABSTRACT

In this paper, we present our development of a document management and retrieval tool, which is named Ontalk. Our system provides a semi-automatic metadata generator and an ontology-based search engine for electronic documents. Ontalk can create or import various ontologies in RDF or OWL for describing the metadata. Our system that is built upon .NET technology is closely communicated with or flexibly plugged into other systems.

The System Architecture

Output Lists

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<tr>
<th>URI</th>
<th>Name</th>
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<td>412.552KB</td>
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</table>
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Semantic Web Technologies
  ➤ Ontology Representation
  ➤ Languages & Tools

Future of the Semantic Web
The Evolution of Information Technology

- **Locative**
  - (공간적 연결성)

- **Dynamic**
  - (프로세스적 연결성)

- **Static**
  - (컨텐츠의 의미적 연결성)

- **Mobile Computing**
- **Ubiquitous Computing**
- **Web Services (UDDI, WSDL, SOAP)**
- **Intelligent Web Services**
- **Semantic Web Ontology Computing**
- **(Ontology-Enhanced) Intelligent Ubiquitous Web Services**

- **WWW (URI, HTML, HTTP)**
Web Services: current technologies
The Web Services Stack

Wire Protocols
- SOAP Blocks
- SOAP/XMLP
- XML
- HTTP/SMTP/BEEP
- TCP/IP

Description
- W3C WS Choreograph Group
- BPEL4WS (Microsoft, IBM, BEA)
- WSCL (HP)BPML (Most but Microsoft)
- WSCI (Sun, BEA, Yahoo, …)
- XLANG (Microsoft), WSFL (IBM), …

Automated
- Agreements
- Process
- WSDL Extensions
- WSDL
- XML

Discovery
- Invocation
- Interoperation
- Composition
- Monitoring
- Verification

DAML
- Registry (UDDI)
- Inspection

Modification of slide by James Snell (IBM)
Semantic Web Services (DAML-S Upper Ontology)

- communication protocol (RPC, HTTP, ...)
- port number
- marshalling/serialization

- input types
- output types
- preconditions
- postconditions

- process flow
- composition hierarchy
- process definitions
Relevant dimensions between technologies

- Web Services
- Collaboration
- Intelligent Web Services
- Interoperability
- Semantics
- Intelligence
- Agent Tech.
- Autonomy
CoBrA Architecture

Contexts in External Sources

- Information Servers (Exchange Server, iCal, YahooGroups, etc.)
- Semantic Web & Web Services (RDF, DAML+OIL & OWL)
- Database (MySQL)

Contexts in the Intelligent Spaces

- Context-Aware Devices
- Context-Aware Agents

Context Broker

- Context knowledge base
- Context Reasoning Engine
- Context Acquisition Module
- Privacy Management Module

SOAP + RDF/OWL
Ethernet
FIPA-ACL + RDF/OWL
Ethernet

Smart Tag Sensors (Radio Frequency Identification)
Environment Sensors (Xanboo & X10 technology)
Device & Gadget Sensors (Java Ring, SmartCard etc.)
Future of the Semantic Web Technology

**Phase 1**
- Market Adoption
- Existing classification to ontology transformation and the construction of early ontologies
- Scientific
  - NIH genome data ontology
- Medical
  - SNOMED, GALEN
- ISO standard classification
- Lightweight ontology
  - Product catalog
  - Site directory

**Phase 2**
- Semantic Web technology maturation
- Various ontologies are constructed and ontology use is increasing
- Ontology development and management tool developers
- EC application ontology use generalization
- RDF, web-based ontology language generalization
- Industry-specific heavyweight ontology development
- Ontology-based horizontal application integration
- Intelligent Web services, semantic applications, agent technology, ubiquitous computing

**Phase 3**
- RDF, lightweight ontology
- Proof and trust services
- Application and process integration for ontology-based integration
- Ontology-based process and workflow
- Industry-specific comprehensive ontology development
- Ontology usage is generalized

Source: Christian Ohms, 2002
Conclusion

- What the Semantic Web is NOT ...
  - The Semantic Web is not Artificial Intelligence
  - The Semantic Web does not allow arbitrary complexity
  - The Semantic Web is not something that will ever be complete

- What the Semantic Web IS ...
  - A great vision
  - Something that will be built over time
  - An emergent property of the global effort towards standardization around XML
Final Words

“Ask not what the Semantic Web can do for you,
ask what you can do for the Semantic Web”

Hans-Georg Stork