Intelligent Web Services

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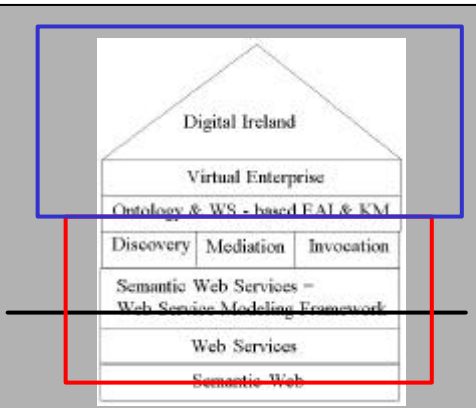
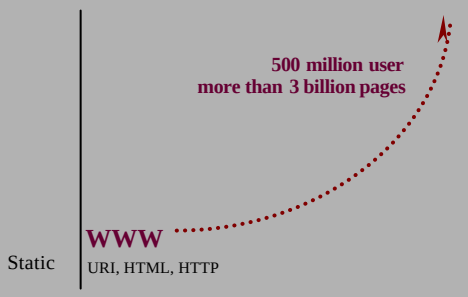
Contents



1. The General Vision



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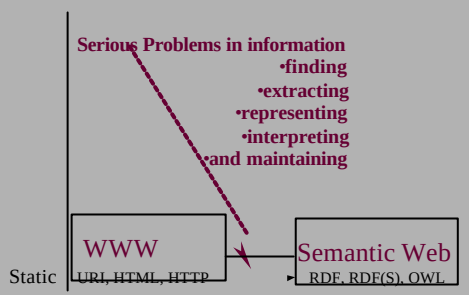

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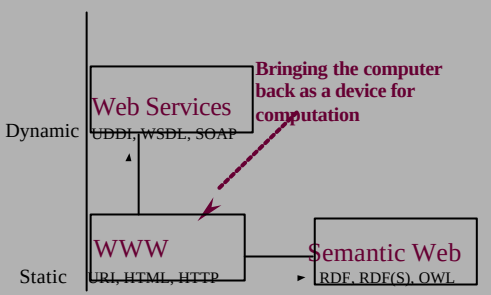

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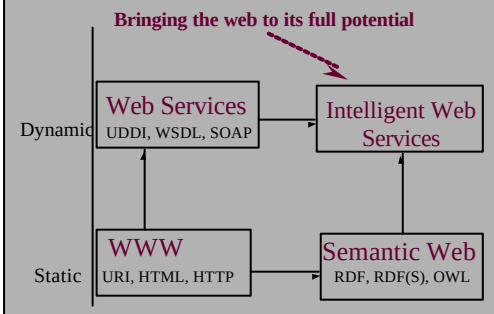

The General Vision

Do not forget: The story with the telephone!

2. Semantic Web

- It is the sucess of the web that creates serious needs for its improvement.
- The web uses the computer as a device for rendering information for the human reader but neither for information processing nor computing.
- The semantic web is aiming on bringing back the computer as a information processing device.

Semantic Web

- The semantic web is based on **machine-processable** semantics of data.
- It will significantly change our information access based on a higher level of service provided by computers.
- It is based on new web languages such as XML, RDF, and OWL, and tools that make use of these languages.
- Applications are in areas such as knowledge management, eWork, eCommerce, and EAI.

Semantic Web

Ontoknowledge:
Content-driven Knowledge management through Evolving Ontologies

IST project January 2000 – September 2002

Semantic Web

Main achievements:

- A ontology language proposal called:
  OIL

Semantic Web

Main achievements:

- A ontology language proposal called: DAML+**OIL**

Semantic Web

Main achievements:

- A ontology language proposal called: **O**W**L**

Semantic Web

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- Several case studies for intranet applications and a methodology.

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- A three-layered software architecture for making the semantic web a reality.

Semantic Web

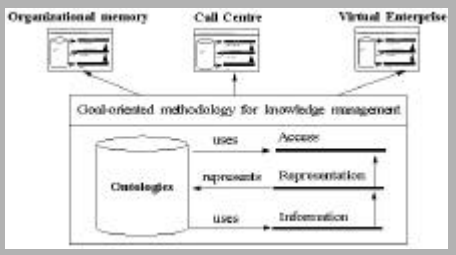
Main achievements:

- A ontology language proposal called OWL.
- Several case studies for intranet applications and a methodology.
- A three-layered software architecture for making the semantic web a reality.
- A large number of interwoven web services that implement this vision.

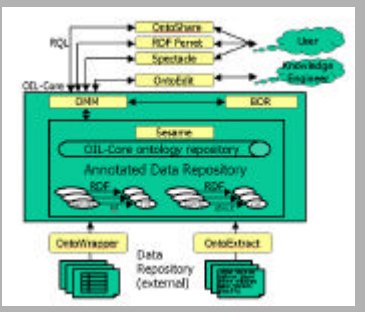
Semantic Web

- The goal of the On-To-Knowledge project is to support efficient and effective knowledge management.
- It focuses on *acquiring*, *representing*, and *accessing* weakly-structured on-line information sources:
  - *Acquiring*: Text mining and extraction techniques are applied to extract semantic information from textual information.
  - *Representing*: XML, RDF, and OIL OWL are used for describing syntax and semantics of semi-structured information sources.
  - *Accessing*: Novel semantic web search technology and knowledge sharing facilities.

Semantic Web



Semantic Web



Semantic Web

www.ontoknowledge.org

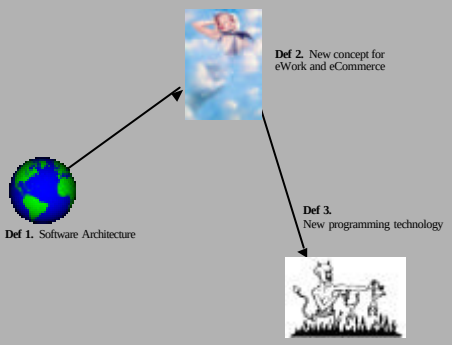
3. Web Services

- Web Services will transform the web from a collection of information into a distributed device of computation.
- There are important steps to take to bring web services and fully enabled E-commerce to reality.
- Bringing E-commerce to its full potential requires a Peer-to-Peer (P2P) approach. Anybody must be able to trade and negotiate with everybody else.
- However, such an open and flexible E-commerce has to deal with many obstacles before it becomes reality!
- The issue is ***scalability*** and ***economy in price.***

Web Services

- Web services should transform eCommerce from a nice application into a mass phenomena.
- Over the next years, the most interesting application area is Enterprise Application Integration (EAI).
- eWork = eCommerce

Web Services



Web Services

Def 1. Web Services as a Software Architecture

"Web services are a new breed of Web 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 requests to complicated business processes. …

Once a Web service is deployed, other applications (and other Web services) can discover and invoke the deployed service."

IBM web service tutorial

Web Services

➔ 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.

Web Services

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

„Web Services, are Services accessible via the web"

Dieter Fensel, private definition

Web Services

- 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.

Web Services

- Large companies shrink around their core competencies.
- Vica versa, virutal enterprises are set up on the fly reflecting current marketr needs.

➔eWork and eCommerce will be the two sides of the same coin.

Web Services

Def 3. Web Services as a programming technology

„Web Services are Remote Procedure Calls (RPC) over HTTP“

current state of the art

Web Services

The web is organized around URIs, HTML, and HTTP.

- URIs provide defined ids to refer to elements on the web,
- HTML provides a standardized way to describe document structures (allowing browsers to render information for the human reader), and
- HTTP defines a protocol to retrieve information from the web.

==> Not surprisingly, web services require a similar infrastructure around UDDI, WSDL, and SOAP.

Web Services

Web Services

- **UDDI** provides a mechanism for clients to find web services. A UDDI registry is similar to a CORBA trader, or it can be thought of as a DNS service for business applications.
- **WSDL** defines services as collections of network endpoints or *ports*. A port is defined by associating a network address with a binding; a collection of ports define a service.
- **SOAP** is a message layout specification that defines a uniform way of passing XML-encoded data. In also defines a way to bind to HTTP as the underlying communication protocol. SOAP is basically a technology to allow for "RPC *over the web*".

Web Services

- UDDI, WSDL, and SOAP are important steps into the direction of a web populated by services.
- However, they only address part of the overall stack that needs to be available in order to achieve the above vision eventually.
- There are many layer requires to achieve automatic web service discovery, selection, mediation and composition into complex services.

Web Services

Layer / Standard	EDI	RosettaNet	ebXML	SOAP	OAGIS	
Document type	X	X			X	
Semantics	X	X				
Process		X	X			
Exchange Sequence		X	X			
Packaging		X	X	X		
Transport binding		X	X	X		

Web Services

- Many organizations had the insight that message definition and exchange are not sufficient to build an expressive web services infrastructure.
- In addition to UDDI, WSDL and SOAP, standards are proposed such as WSFL, XLANG, ebXML, BPSS, BPML and WSCL.
  … and **BPEL4WS**

4. Semantic Web Services

- Mechanized support is needed in finding and comparing vendors and their offers. ***Machine processable semantics*** of information allows to mechanize these tasks.
- Mechanized support is needed in dealing with numerous and heterogeneous data formats. ***Ontology technology*** is required to define such standards better and to map between them.
- Mechanized support is needed in dealing with numerous and heterogeneous ***business logics***. Mediation is needed to compensate these differences, allowing partners to cooperate properly.

Semantic Web Services

Imagine a travelling service:

- Decompose into elementary services
- Describe elementary services by goals instead of hardwiring them.
- Keep the human programmer out of the loop to keep it economic, on demand, and scalable.
- You cannot achieve this vision without semantic web technology that maintains selection and combination of heterogeneous web services during runtime.

Web Services

- Very important is to reflect the *loose coupling* and *scalable mediation* of web services in an appropriate modeling framework.

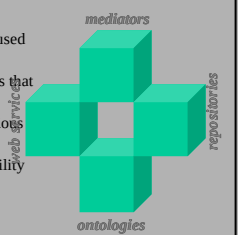
==> Therefore, we developed a full-fledged **Web Service Modeling Framework (WSMF)**. It provides a rich conceptual model for the development and the description of web services as a prerequisite to combine web service with semantic web technology.

Semantic Web Services

- Fully enabled E-commerce based on workable web services requires a modeling framework that is centered around two complementary principles:
  - Strong *de-coupling* of the various components that realize an eCommerce application. This de-coupling includes information hiding based on the difference of internal business intelligence and public message exchange protocol interface descriptions.
  - Strong *mediation* service enabling anybody to speak with everybody in a scalable manner. This mediation service includes the mediation of different terminologies as well as the mediation of different interaction styles.

Semantic Web Services

- The WSMF consists of four main different elements:
  - *ontologies* that provide the terminology used by other elements;
  - *goal repositories* that define the problems that should be solved by web services;
  - *web services* descriptions that define various aspects of a web service;
  - and *mediators* which bypass interoperability problems.



The Web Service Modeling Framework (WSMF):

Ontologies

- Ontologies are key enabling technology for the semantic web.
- They interweave human understanding of symbols with their machine processability.
- In a nutshell, Ontologies are formal and consensual specifications of conceptualizations that provide a shared and common understanding of a domain, an understanding that can be communicated across people and application systems.

The Web Service Modeling Framework (WSMF):

Ontologies

-> In our framework ontologies are used to define the terminology that is used by other elements of WSMF specifications.

-> Therefore, they enable reuse of terminology as well as interoperability between components referring to the same or linked terminology.

The Web Service Modeling Framework (WSMF):

Goals

- The description of a *goal* specifies objectives that a client may have in case he consults a web service. A goal specification consists of two elements:
- **Pre-conditions** describe what an web service expect for enabling it to provide its service.
- **Post-conditions** describe what a web service returns in response to its input.
- Goal specifications should be kept separate from actual web service description because there is an *n2m* mapping between them, i.e., the same web service can serve different goals and obviously different (competing) web services can serve the same goal.

The Web Service Modeling Framework (WSMF):

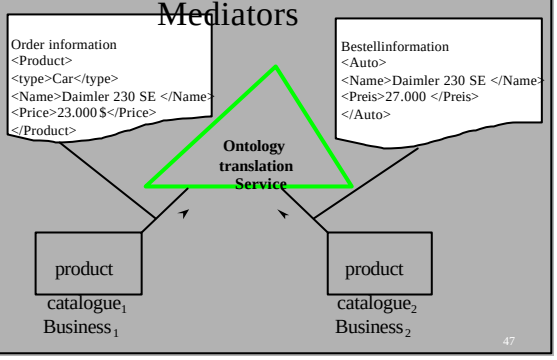
Mediators

For an open and flexible environment such as web-based computing, *adapters* are an essential means to cope with the inherit heterogeneity. This heterogeneity can wear many cloths:

- Mediation of **data structures**.
- Mediation of **business logics**.
- Mediation of **message exchange protocols**.
- Mediation of dynamic **service invocation**. A web service may invoke other web services to provide its functionality. This can be done in a hard-wired manner, however, it can also be done more flexible by just referring to certain (sub-)goals.

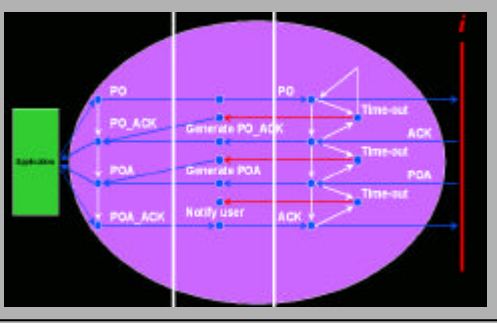
The Web Service Modeling Framework (WSMF):

Mediators



The Web Service Modeling Framework (WSMF):

Mediators



The Web Service Modeling Framework (WSMF):

Mediators versus Capabilities

Web services need description related to the **message exchange protocol**.

- ***Can you hear me?***
  Messages from a web service requester to a web service provider and vice versa are sent over networks like the Internet. Networks can be reliable as well as unreliable.
- ***Do you understand me?***
  Second, even when receiving a message it is not at all clear whether one understoods a message (Bbusiness signals in ebXML).
- ***Do you agree?***
  Acknowledgement here means legal binding steps like accepting an offer.

WSFL

- We did not define a concrete syntax for **WSMF**.
- The **WSMF** language can be defined as an extensions of as **WSFL**, which is a language close in spirit to our framework.
- Many concepts of WSMF are present in WSFL.
- Things like Ontologies and some web service elements are missing.
- Upps, we mean BPEL4WS

DAML-S

- Also we did not define a concrete web-based syntax for **WSMF**, i.e., we did no define any web-based mark up language.
- Here one could take **DAML-S** as a starting point and extending it with the necessary modeling features that are missing there.

DAML-S

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- Here one could take **DAML-S** as a starting point and extending it with the necessary modeling features that are missing there.
- DAML+**W**S**MF !**

SWWS

A new IST project will start in September 2002 on ***Semantic Web enabled Web Services (SWWS)*** in line with the mentioned ideas.

Partners are:

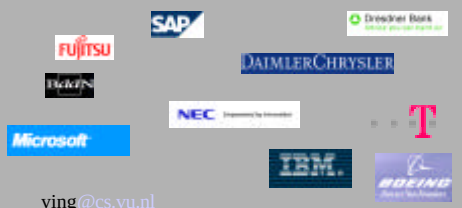
- University of Innsbruck (coordinator)
- University of Ireland, Galway
- FZI Karlsruhe, Germany
- Hewlett-Packard, UK, Ireland, and US
- iSOCO, Spain
- Ontotext, Bulgaria
- Oracle, U.S.A.
- BT Labs., UK

SWWS

- The main objectives of SWWS are:
  - Provide a comprehensive Web Service ***description*** framework.
  - Define a Web Service ***discovery*** framework.
  - Provide a scalable Web Service ***mediation*** platform.
- The adivisory board of SWWS has more than 70 companies as members.
- More infos are under:
  - http://www.cs.vu.nl/~dieter/wsmf
  - http://swws.semanticweb.org/

SWWS www.ontoweb.org swws.semanticweb.org

Over 70 industrial in the advisory board:



ying @cs.vu.nl

5. Applications: EAI & SCM/VE

- EAI
- Supply Chain Management / Virtual Enterprises
- Digital Ireland

Enterprise Application Integration

- It is a major IT issue as it may consume more than 50% of current OT budgets.
- Its market share will quickly outrange the database business.
- It is about the Integration of
  - Data, Information, and Knowledge
  - Processes
  - Applications, and
  - Business

Why is EAI important?

- Increased number of mergers.
- Increased investment in existing software and hardware infrastructure.
- There is no best solution for all purposes.
- High change rate in the IT solution area.

How can cEAI be achieved?

- How can it NOT be achieved:
  - **Adhoc** integration do not scale
  - **Global integration** cannot be paid for, always come to late, and never hit the current state.
- How can it be achieved?
  - It must be **purpose-driven!**
  - It must be **extentable!**
  - It must be **reusable!**

How can cEAI be achieved?

- **Adhoc integration** works great because it does not require any management and maintenance overheard.
- We would recommend an adhoc integration when you have less than 5 business processes and 2 databases.
- As long as integration is a side aspect, adhoc treatment works best.
- However, when your integration needs become serious, adhoc integration transforms from a solution of the problem to an additional burden that makes the problem more serious and unsolvable.

How can cEAI be achieved?

- After a phase of adhoc integration companies start to search for the Silverbullet that may help to solve the growing problem.
- They are now in the phase were they are willing to buy a global integration platform such as …
- Why is this not a solution, either?

How can cEAI be achieved?

- Having 1000 business processes and 1000 information sources we would require 1.000.000 adhoc mappings and 2000 global integration.
- 2000 is smaller than one million but it is still to big.

How can cEAI be achieved?

- A global integration platform that mediates between all business processes on the one site and all information sources on the other site requires:
  - A large scale investment
  - A long-term development time

➔This makes it outdated whenever it is implemented.

How can cEAI be achieved?

- Business processes have changed reflecting new demands from the market
- Applications and data sources have changed reflecting new IT and business environments.
- A global integration project will always behind the development of what it is supposed to integrate.

➔It only would work in a static environment
➔however it is the dynamic nature of the environment that creates its need.

How can cEAI be achieved?

- A successful integration strategy must combine the advantages of adhoc and global integration strategies.
  - Learn from *adhoc* integration: We must reflect business needs as THE driving force for the integration process.
  - Learn from *global* integration: We must create extendable and reusable integrations.
- We have been developed such an approach called

Cost-sensitive Enterprise Application Integration

cEAI

What is cEAI?

- **Purpose-drive** : Lets your business needs drive the integration process.
- **Extendable**: Use Ontologies to prevent adhoc integration
- **Reusable**: Use web service technology to reflect further integration needs based on standardization.

Purpose Driven

- We need to identify the major integration needs in terms of business processes and available information sources.
- We structure our integration efforts around these needs.
- We employ integration techniques that prevents us from the disadvantages of adhoc integrations, I.e., we care for extendibility and reusability.

Extendable: Ontologies

- We use **Ontologies** for publishing the information of data sources and for aligning it with business needs.
- Ontologies are key enabling technology for the semantic information integration.
- By using ontologies for making information explicit we ensure that our integration efforts can be extended in response to new and changed business needs.
- Ontologies provide controlled terminologies based on structured and well-defined domain theories.
- Ontologies enable reuse of terminology as well as interoperability between components referring to the same or linked terminology.

Reusable: Web Services

- Ontologies provide extendable integration solutions.
- It remains to ensure that our chosen software architecture enables their actual **reuse** on new business context.
- Here, **web services** as a vendor and platform independent software integration platform are of critical importance.

Web Services

- 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 the use of loosely coupled, reusable software components.
- Business services can be completely decentralized and distributed over the Internet.
- EAI and Virtual Enterprises become two sides of the same coin.

cEAI

- Purpose-driven based on Business needs.
- Extentable based on reusable schemas, i.e., Ontologies.
- Reusable based on web service technology that interweave intra and inter application and business integration.

Supply Chain Management

...

6. Conclusions: The Invisible Web

- The best tool is the tool you do not „see“ when you use it.
- Only in case it brakes or it disturbes you in reaching your purpose it become the center of your focus.
- The invisible web is a device for smooth information access and fully enabled eCommerce.

The Invisible Web

- Realizing the vision of a web that is
  - based on machine-processable semantics
  - a distributed device of computation and services
  - based on intelligent web services by combining semantic web and web service technology.
- Developing new tools, methods, and business cases for Enterprise Application Integration and eWork.
- Developing new tools, methods, and business cases for Supply Chain Management and Virtual Enterprises.

OntoWeb

- EU funded Thematic Network
- **Homepage: www.ontoweb.org**
- **Mailing list:**
  - **seweb-list@cs.vu.nl**
  - **ontoweb-list@cs.vu.nl**
  - **Next meeting: December 16-18, 2002 in …**