Digital Enterprise Research Institute

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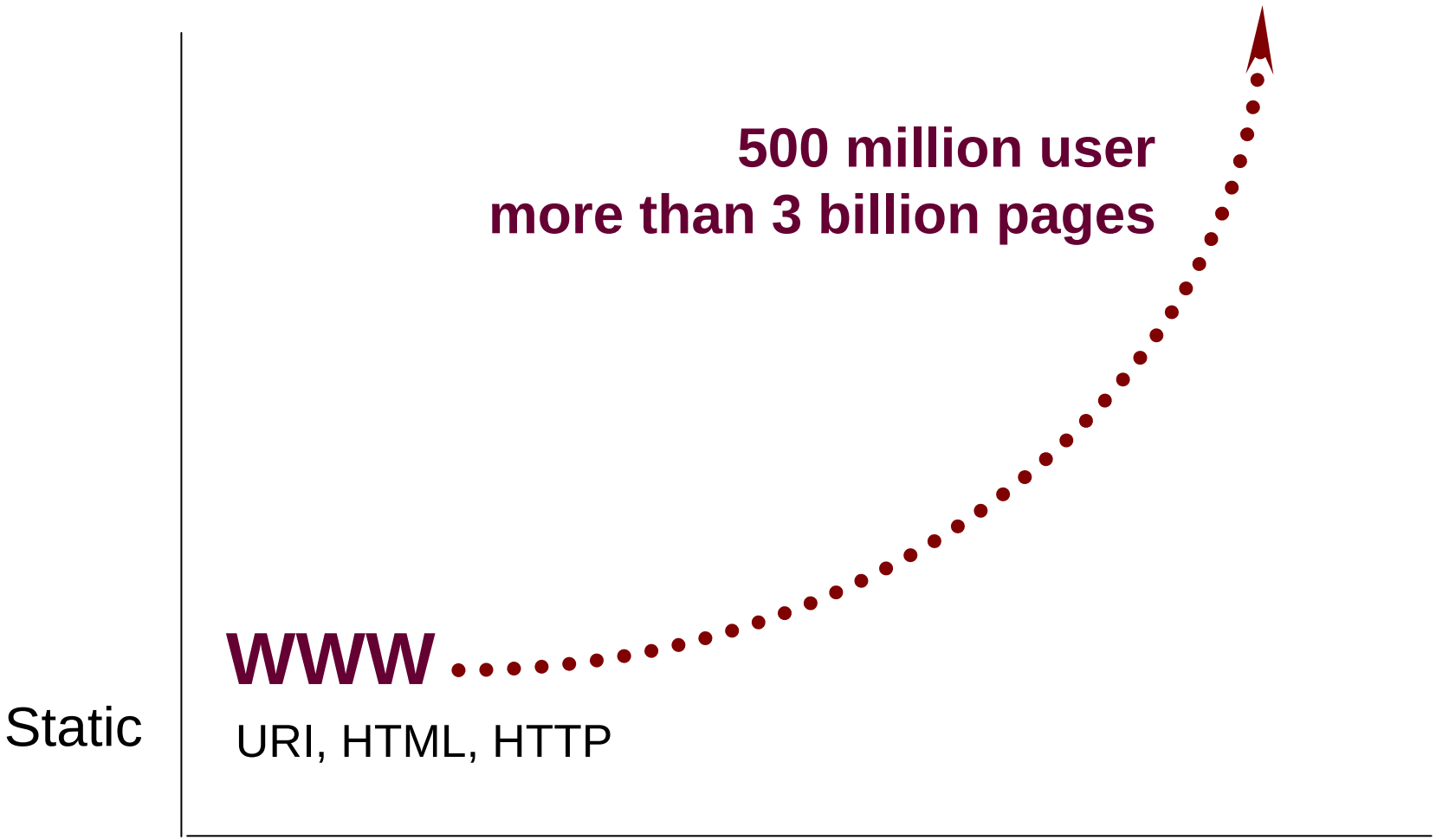
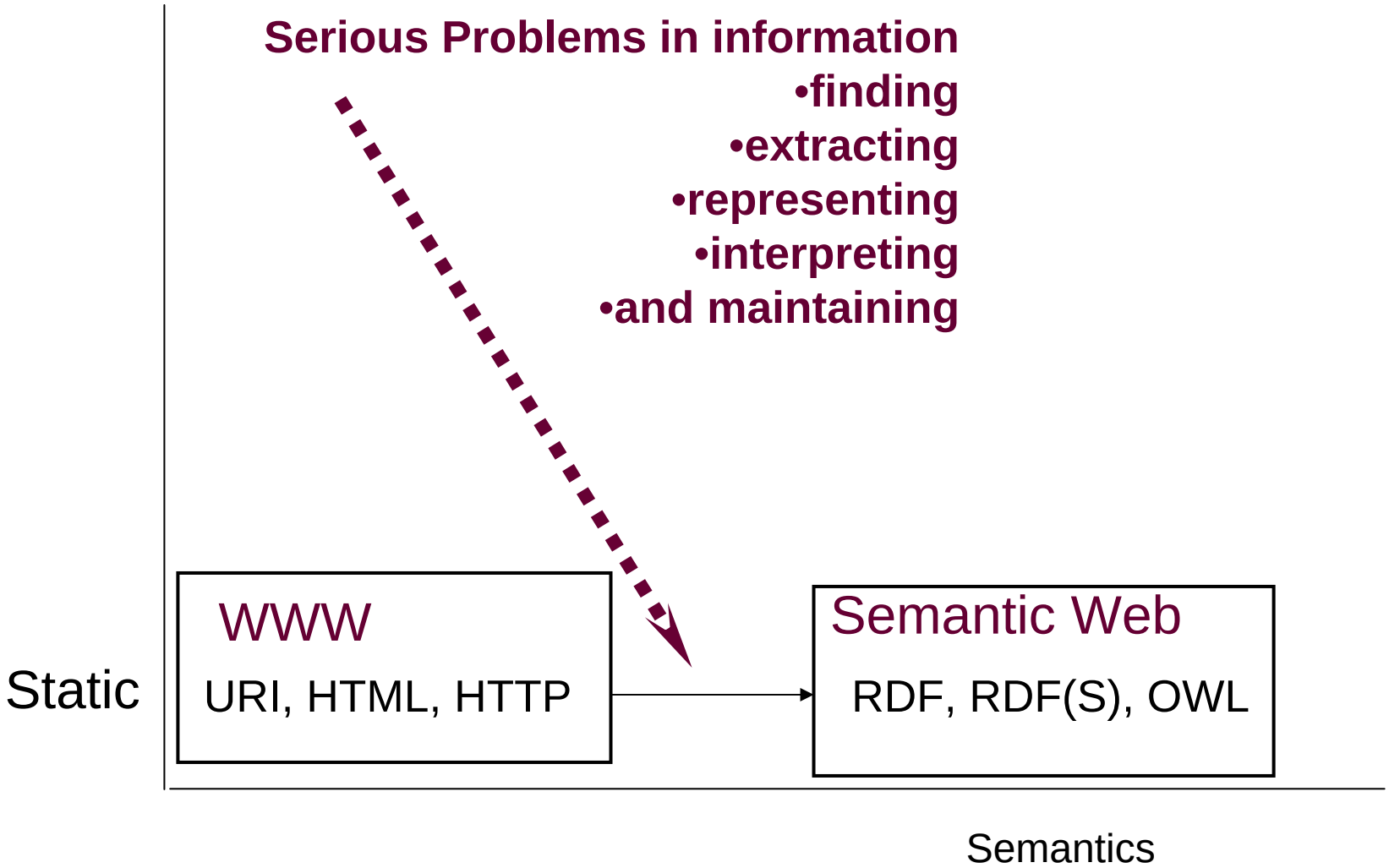
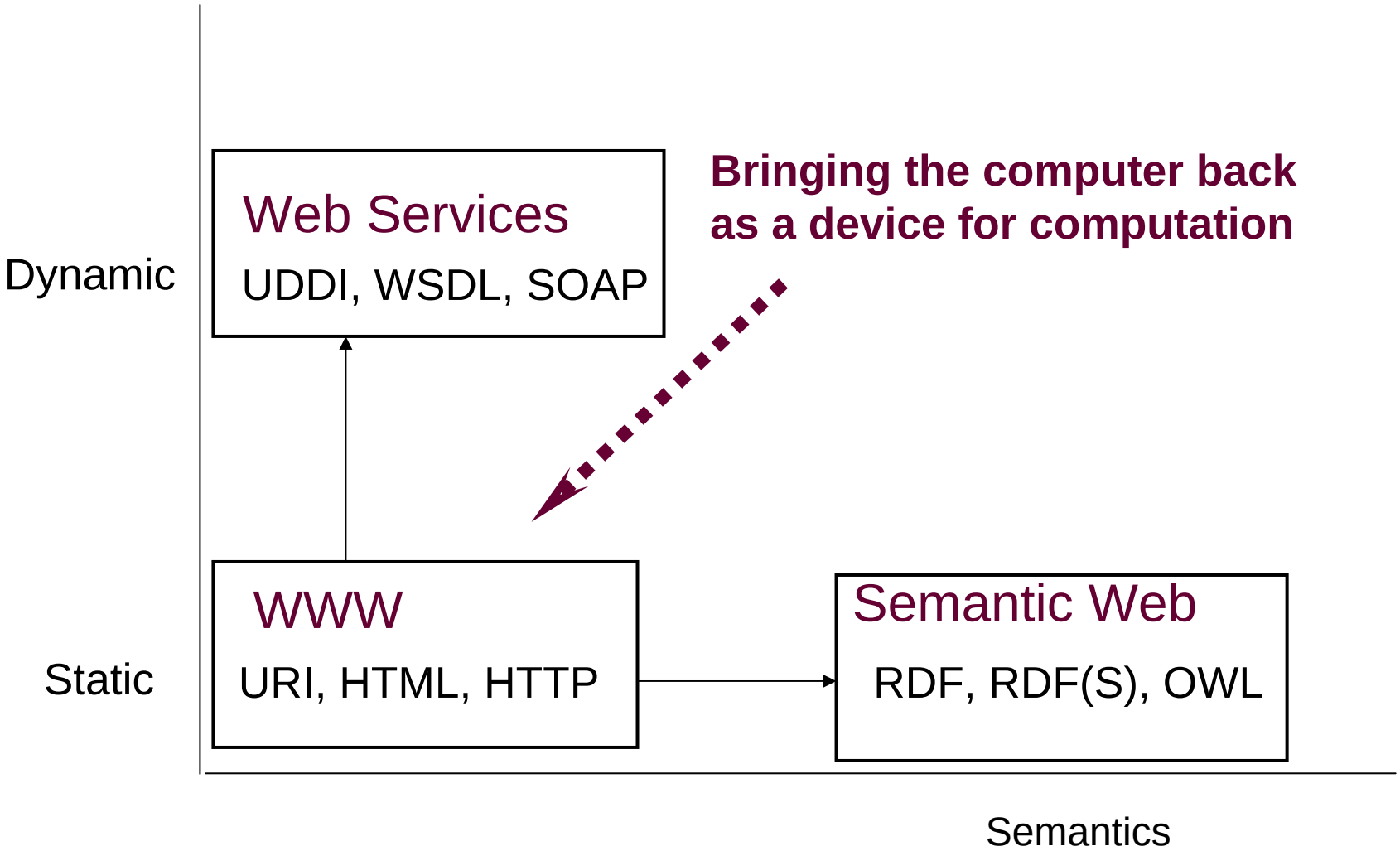
1. DERI and its Vision



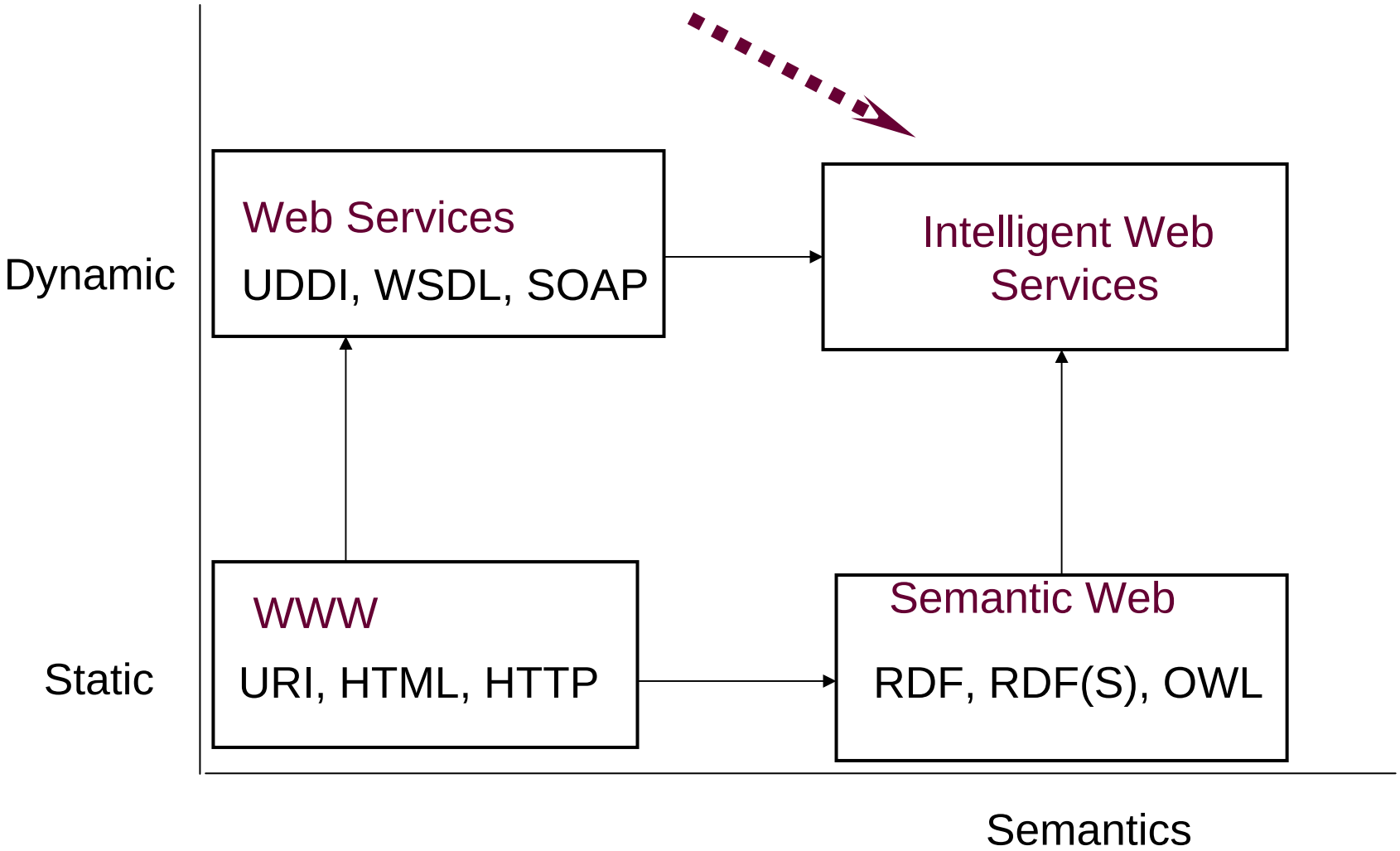
1. DERI and its Vision



1. DERI and its Vision



Bringing the web to its full potential



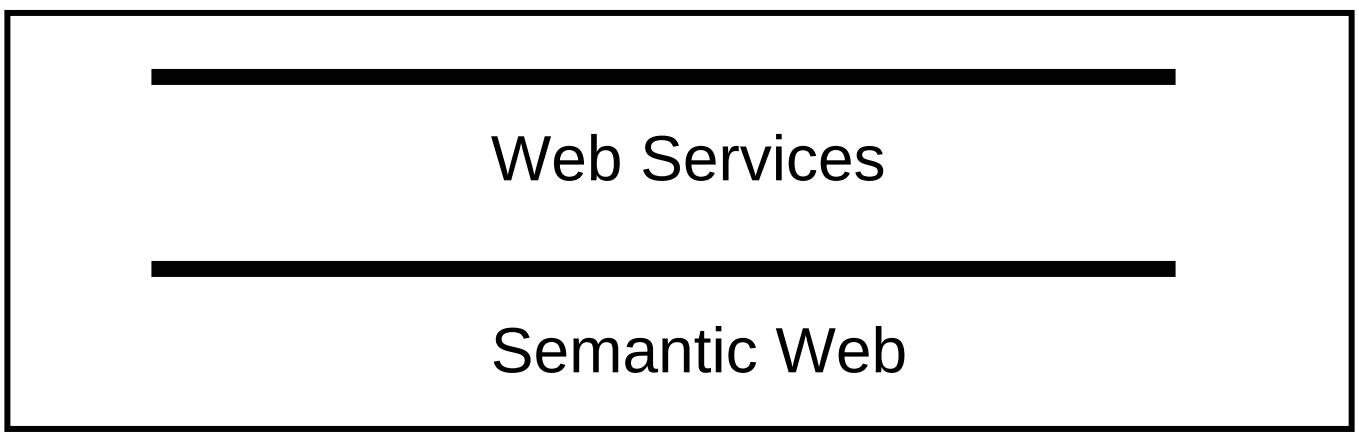
1. DERI and its Vision

- Semantic Web Services have the potential to become a key-enabling infrastructure for:
- Knowledge Management and eWork
- Enterprise Application Integration
- eCommerce

=> In consequence Semantic Web Services are one of the key areas of applied computer science.

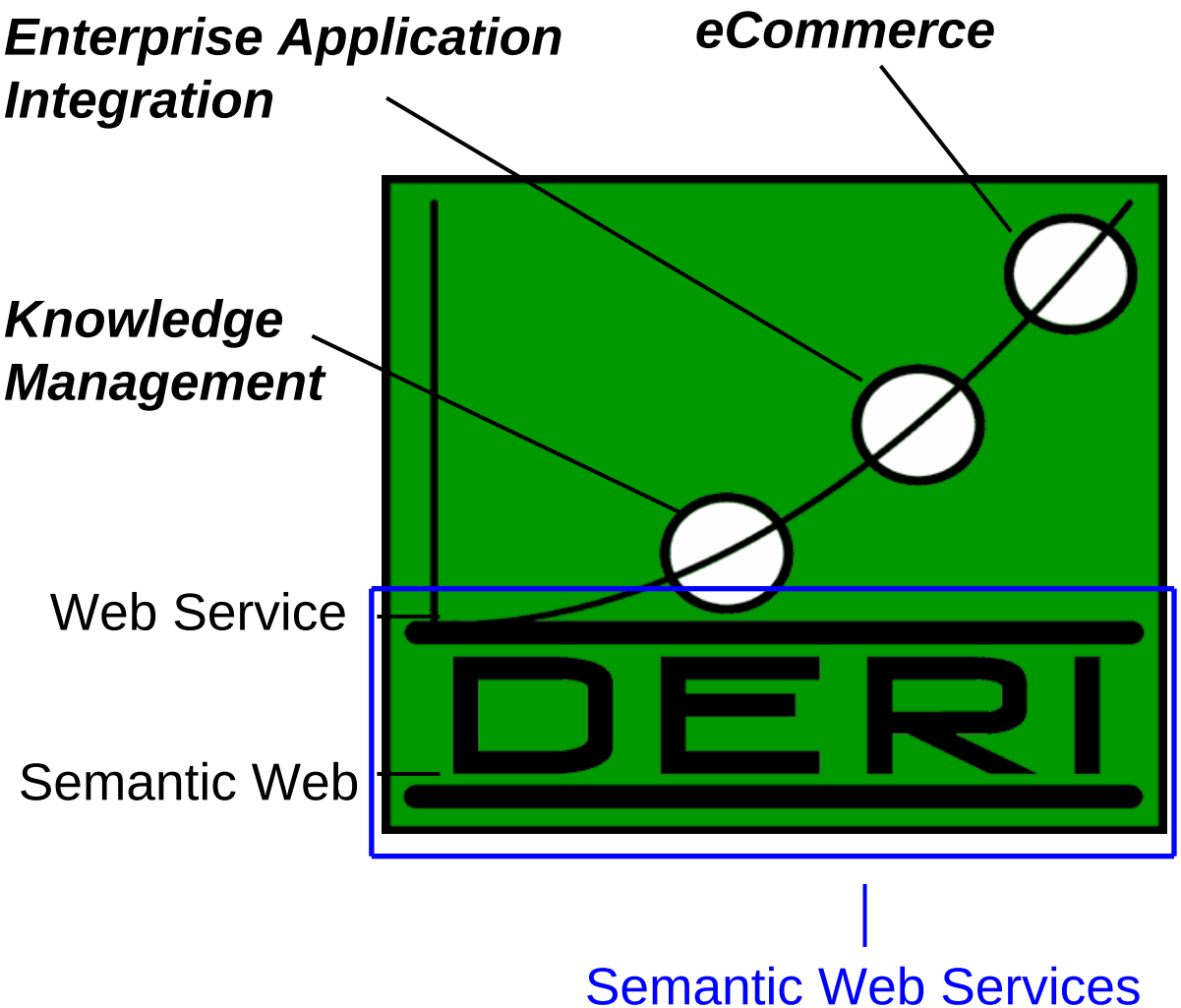
1. DERI and its Vision

- **eCommerce**
- **Enterprise Application Integration**
- **Knowledge Management**



SWS

1. DERI and its Vision



1. DERI and its Vision

DERI International € 32 Mio

Institute Level

DERI Galway € 23 Mio

- **DERI – Lion € 18 Mio**
- **DIP € 2 Mio**
- **ASG € 1 Mio**
- **Knowledge Web € 0.5 Mio**
- **SWWS € 0.2 Mio**
- **University € 1.4 Mio**

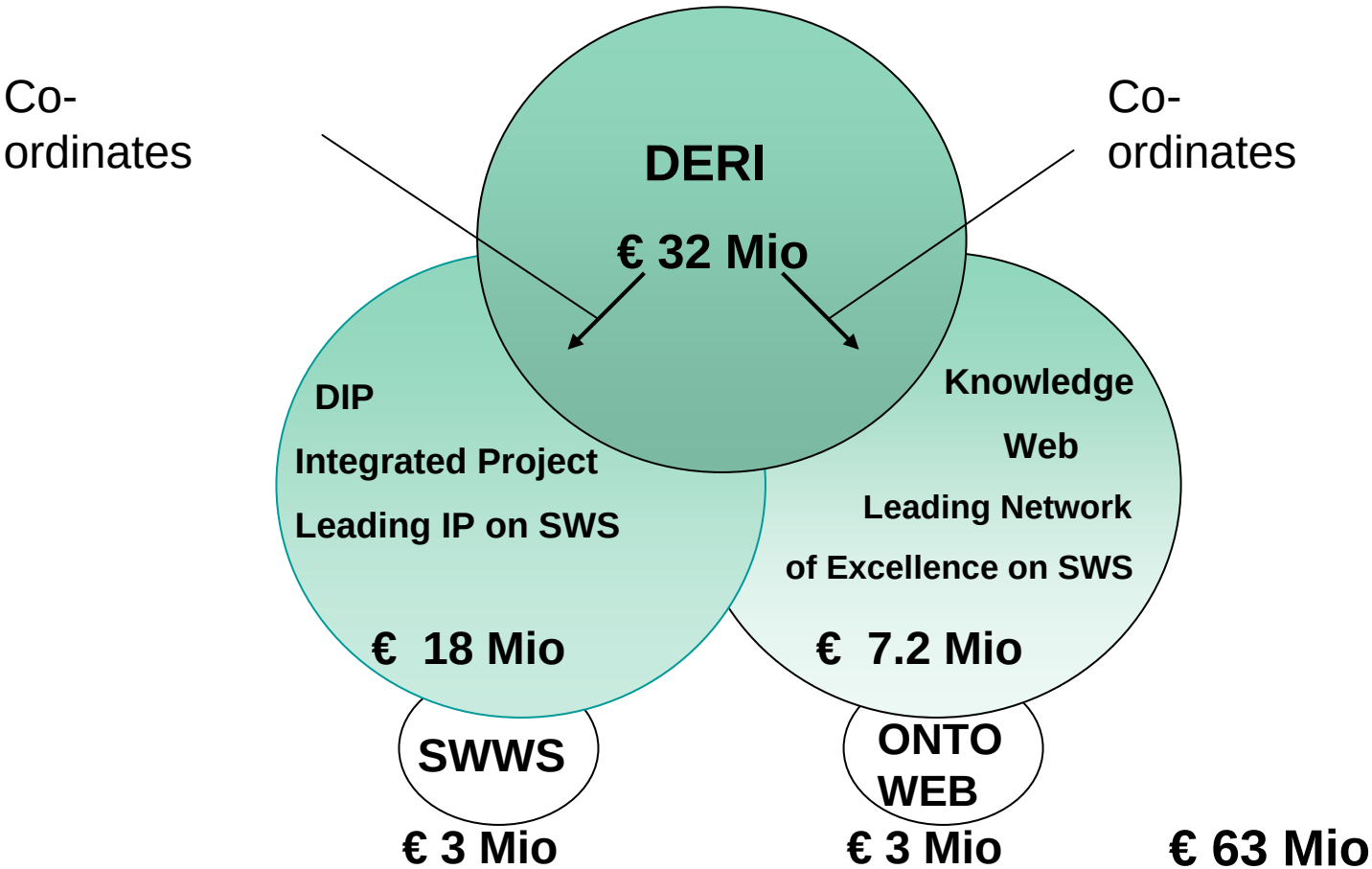
DERI Innsbruck € 9 Mio

- **Knowledge Web € 1.4 Mio**
- **DIP € 1 Mio**
- **SEKT € 0.7 Mio**
- **SWWS € 0.6 Mio**
- **ONTOWEB € 0.3 Mio**
- **Esperonto € 0.2 Mio**
- **h – Techsight € 0.15 Mio**
- **COG € 0.25 Mio**
- **Austrian projects € 0.2 Mio**
- **University € 3 Mio**
- **ASG € 1 Mio**

Centre Level

Project + Cluster Level

1. DERI and its Vision



2. Semantic Web

- The semantic web is based on ***machine-processable*** semantics of data.
- Its backbone technology are ***Ontologies***.
- It is based on new web languages such as XML, RDF, and OWL, and tools that make use of these languages.
- It repairs obvious problems of the current web.

2. Semantic Web

- ***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.

2. Semantic Web

- Main achievements of Ontoknowledge:
- 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.

2. Semantic Web

- The goal of the On-To-Knowledge project was to support efficient and effective knowledge management.
- It focused on *acquiring*, *representing*, and *accessing* weakly-structured on-line information sources:

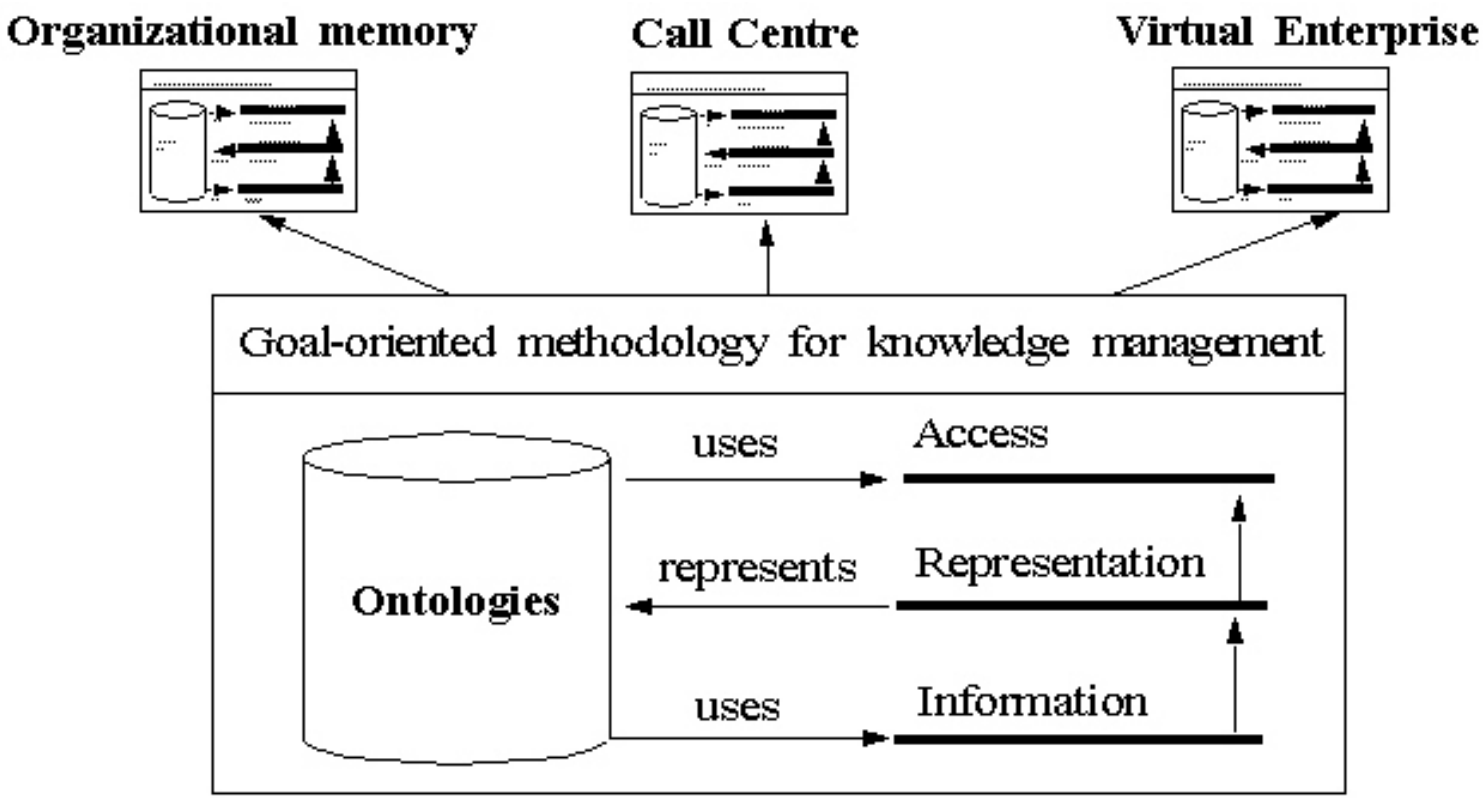
Acquiring: Text mining and extraction techniques are applied to extract semantic information from textual information.

Representing: XML, RDF, and OWL are used for describing syntax and semantics of semi-structured information sources.

Accessing: Novel semantic web search technology and knowledge sharing facilities.

ON knowledge TO

2. Semantic Web



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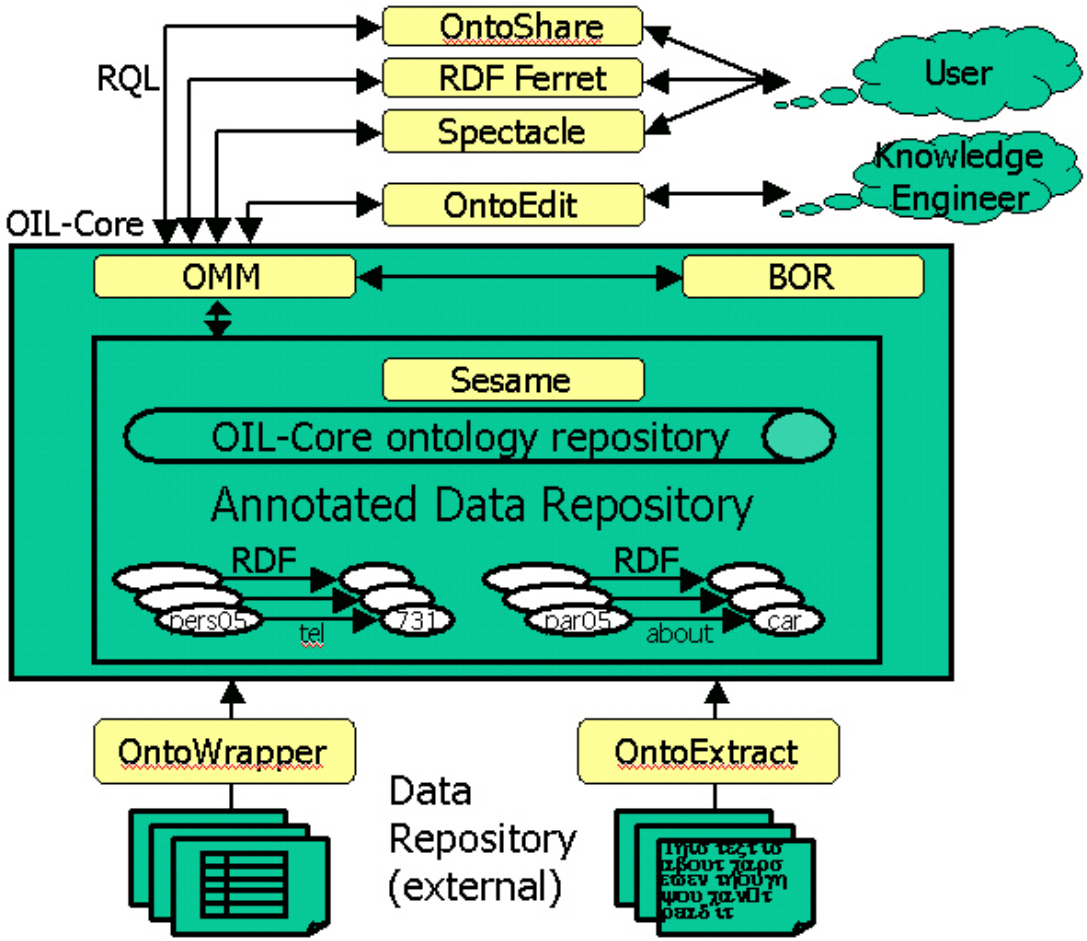
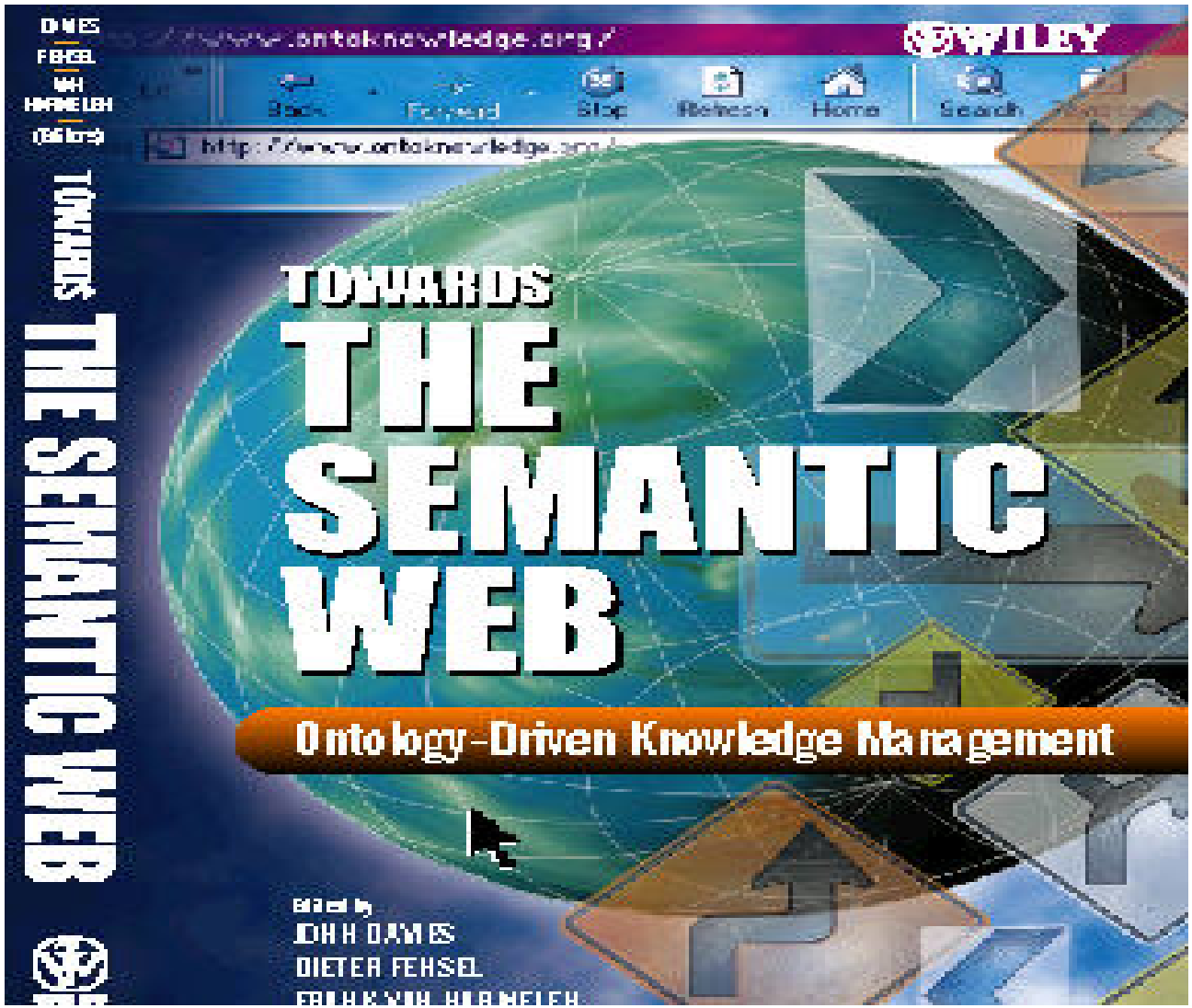


ON knowledge TO

www.ontoknowledge.org



3. Web Services

"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

3. 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.

3. Web Services

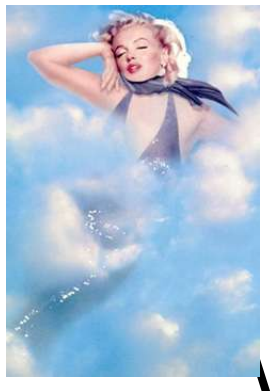
- **UDDI** provides a mechanism for clients to find web services. A UDDI registry is similar to a CORBA trader, or it can be thought of as a DNS service for business applications.
- **WSDL** defines services as collections of network endpoints or *ports*. A port is defined by associating a network address 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*”.

3. Web Services

Do not forget:

The story with the telephone!

3. Web Services



Def 2. New concept for eWork and eCommerce

Def 3.
New programming technology

3. Web Services

Def 1. Web Services as a Software Architecture

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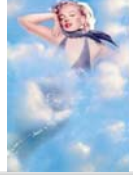
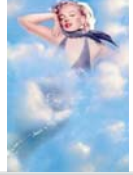


Def 2. Web Services as a new Concept for eWork and eCommerce

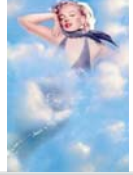
„Web Services, are Services accessible via the web“
Dieter Fensel, private definition

3. 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.

3. 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.

3. Web Services

Def 3. Web Services as a programming technology

„Web Services are Remote Procedure Calls (RPC) over HTTP“
current state of the art

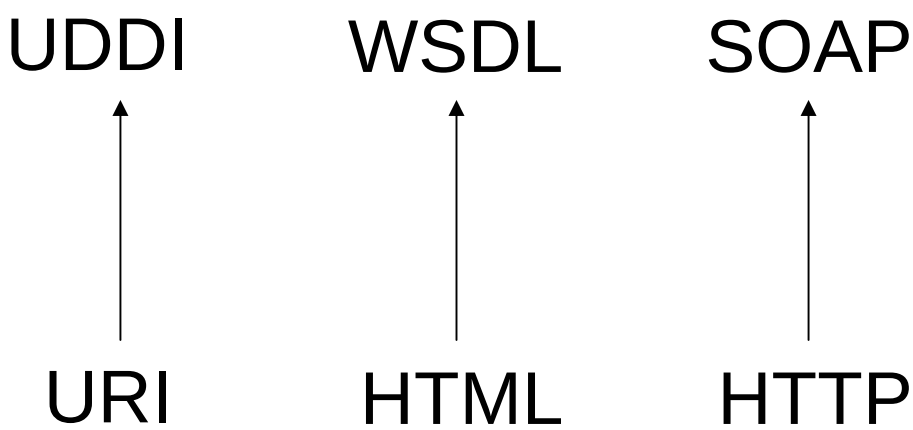
3. Web Services

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.

3. Web Services



3. 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.

3. 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		

3. 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, WSCL, and BPEL4WS.
- **Bringing web services to their full potential requires their combination with semantic web technology.**

4. Semantic Web Services

"Semantic differences, remain the primary roadblock to smooth application integration, one which Web Services alone won't overcome. Until someone finds a way for applications to understand each other, the effect of Web services technology will be fairly limited. When I pass customer data across [the Web] in a certain format using a Web Services interface, the receiving program has to know what that format is. You have to agree on what the business objects look like. And no one has come up with a feasible way to work that out yet -- not Oracle, and not its competitors..."

--- Oracle Chairman and CEO Larry Ellison

4. Semantic Web Services

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- 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.

4. Semantic Web Services

- Semantic Web Services combine Semantic Web and Web Service Technology.
- Automatization of Web Service Discovery, Combination, and Invocation makes the technology scalable.
- This combination is a pre-requisite to make web service technology scalable and mature.
- This technology is a pre-requisite to enable fully open, flexible, and dynamic eWork and eCommerce a reality.

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.

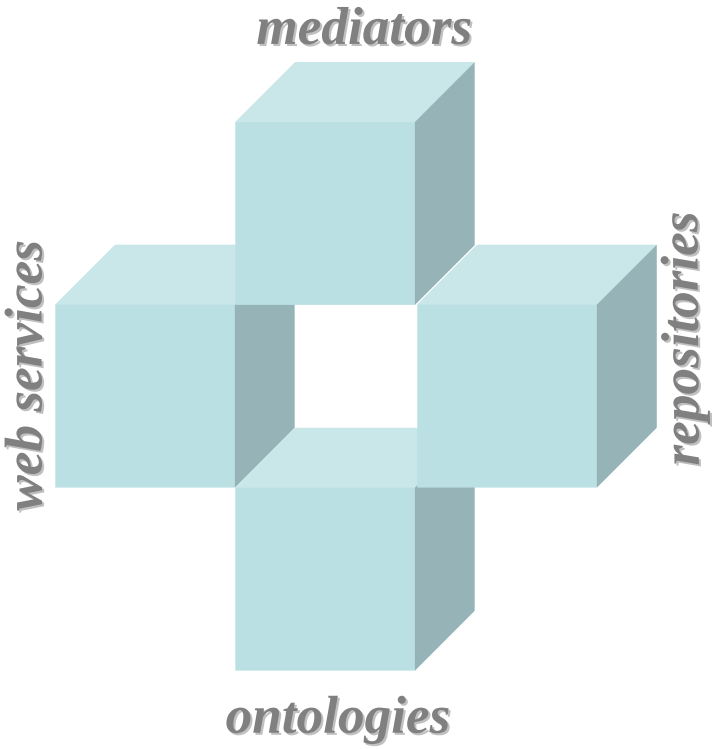
4. Semantic Web Services

- 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.

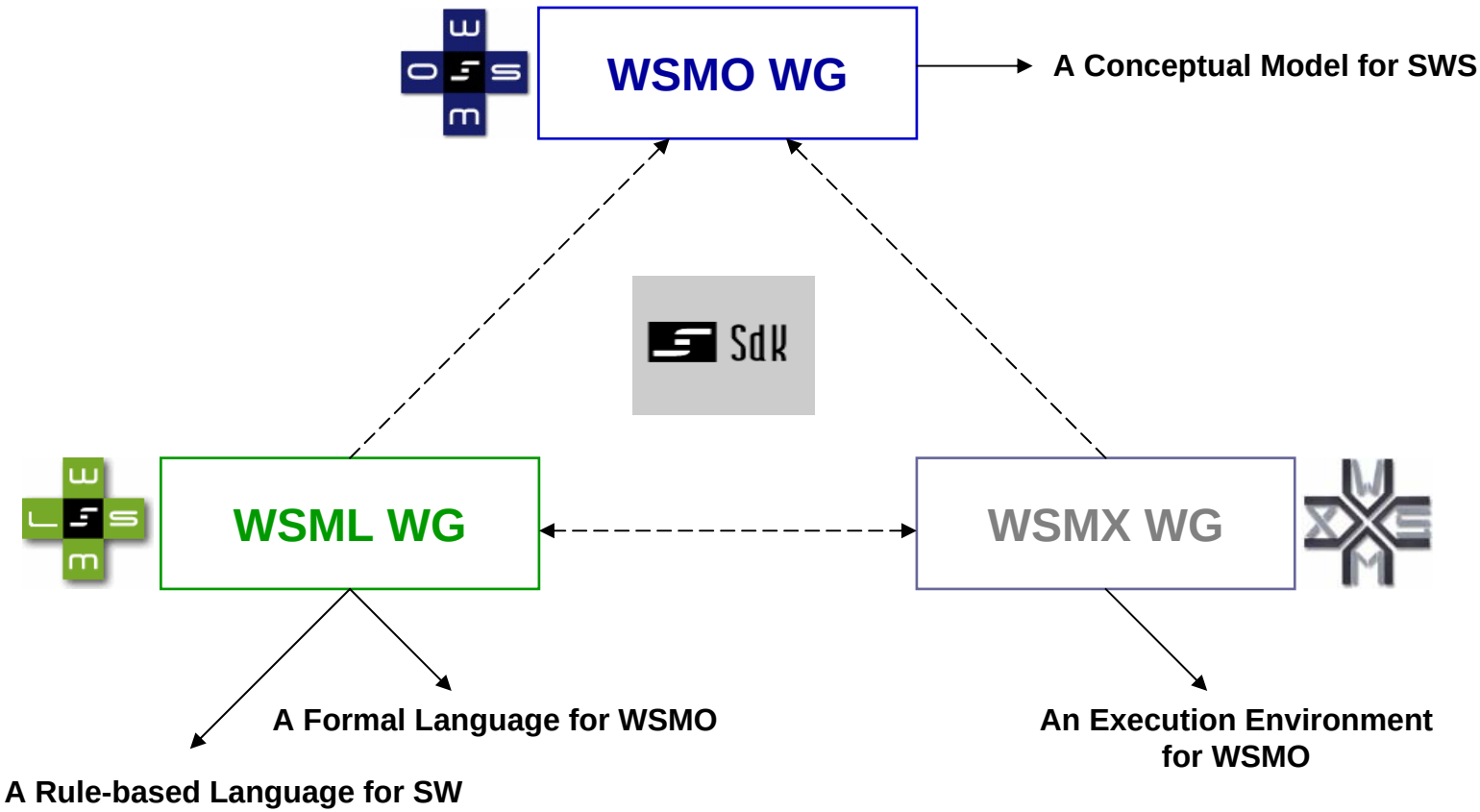
4. Semantic Web Services

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.



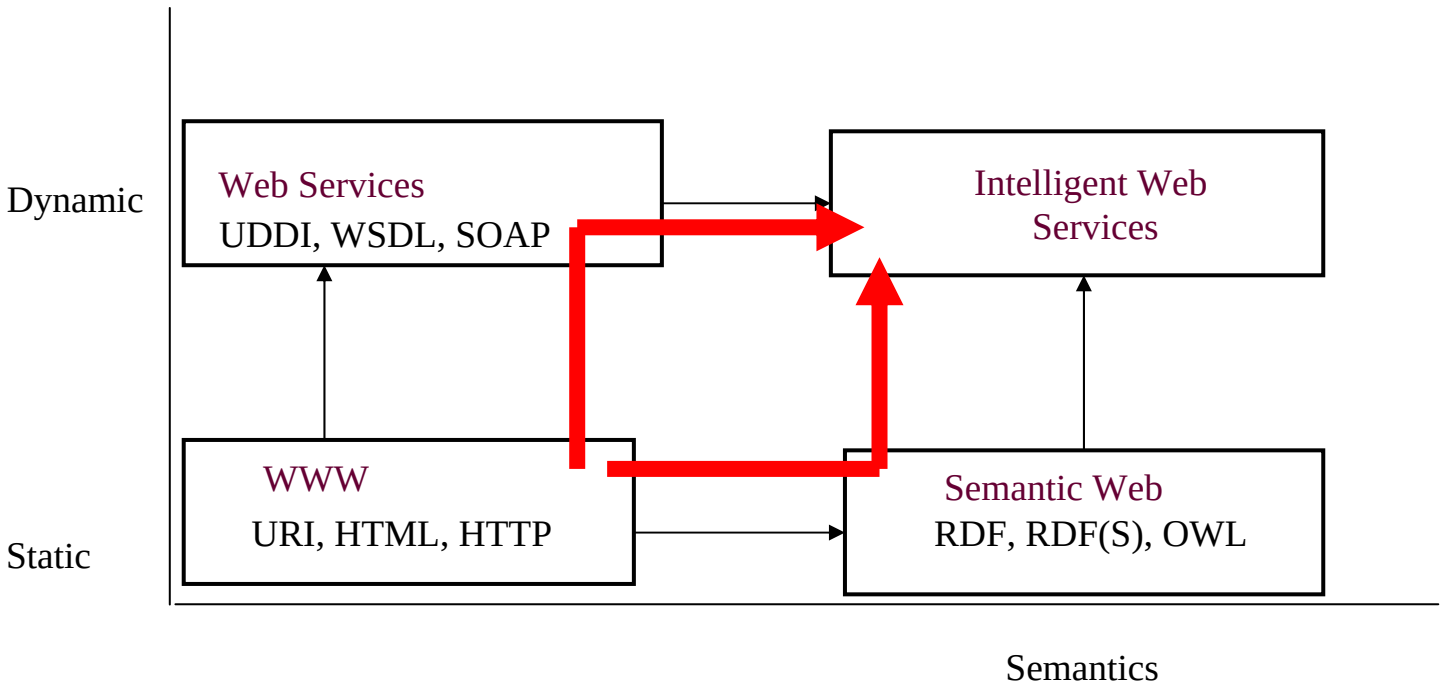
4. Semantic Web Services



http://www.wsmo.org/

4. Semantic Web Services

When taking a closer look at the figure it turns out that *two potential paths* in achieving semantic web services are implicitly present there.



4. Semantic Web Services

- Most semantic web service projects follow the first path. The current web service stack is taken as a starting point and semantic annotations are designed to complement these elements.
- In fact, this is not the only possible road to semantic web services.
- Alternatively one could directly focus on further developing the semantic web.
- By putting more and more ontologies and semantically annotated data on the web, services will evolve naturally that make use of these descriptions.

4. Semantic Web Services

- **Are web services really web services? - No!**
- Web services require close coupling of applications they integrate.
- Applications communicate via message exchange requiring strong coupling in terms of reference and time.
- The web is strongly based on the opposite principles. Information is published in a persistent and widely accessible manner.
- Any other application can access this information at any point in time without having to request the publishing process to directly refer to it as a receiver of it's information.
- It is true that web services uses the internet as a transport media, however that is all they have in common with the web.

4. Semantic Web Services

Tuple-spaced computing

- Tuple-based computing has been introduced in parallel programming languages to implement communication between parallel processes.
- Instead of sending messages backward and forward a simple means of communication is provided.
- Processes can write, delete, and read tuples from a global persistent space.
- Tuple or space-based computing has one very strong advantage: It de-couples three orthogonal dimensions involved in information exchange: reference, time, and space.
- This strong decoupling in all three relevant dimensions has obvious design advantages for defining reusable, distributed, heterogeneous, and quickly changing applications like those promised by web service technology.

4. Semantic Web Services

- There are also shortcomings of current tuplespace models. They lack the means to name spaces, semantics, and structure in describing the information content of the tuples.
- The tuplespace provides a flat and simple data model that does not provide nesting, therefore, tuples with the same number of fields and field order, but different semantics, cannot be distinguished. Instead of following their ad-hoc repairs we propose a simple and promising solution for this.
- We propose to refine the tuplespace into a *triple space, where <subject, predicate, object> describe content and semantics of information*. The object can become a subject in a new triple thus defining a *graph structure* capturing structural information.

4. Semantic Web Services

- Fortunately with RDF this space already exists and provides a natural link from the space-based computing paradigm into the semantic web.
- Notice that the semantic web is not made unncessary based on the tuple-spaced paradigm.
- The global space can help to overcome heterogeneity in communication and cooperation, however, it does not provide any answer to data and information heterogeneity.
- In fact, this aspect is what the semantic web is all about.

4. Semantic Web Services

Triple-spaced computing

- The web and the tuplespace have many things in common.
- They are both global information spaces for persistent publication. Therefore, they share many of the same underlying principles.
- They differ in their application context. The web is a world wide information space for the human reader and the tuplespace is a local space for parallel processes in an application.
- Thus, the web adds some features that are currently lacking in the tuplespace.

4. Semantic Web Services

- First, with URIs the web provides a well-defined *reference mechanism* that has world-wide scalability to address chunks of information.
- Second, the namespace mechanism of the web allows different applications to use the same vocabulary without blurring up their communications.
- Third, the web is an information space for humans and the tuplespace is an information space for computers, however, the *semantic* web is for machines too. It provides standards to represent machine-processable semantics of data.

4. Semantic Web Services

- Therefore, the semantic web has the true potential to become the global space for application integration, like the tuplespace became a means for the local integration of parallel processes.
- It provides the means for global integration with the inherent complexity stemming from information heterogeneity and dynamic changes.

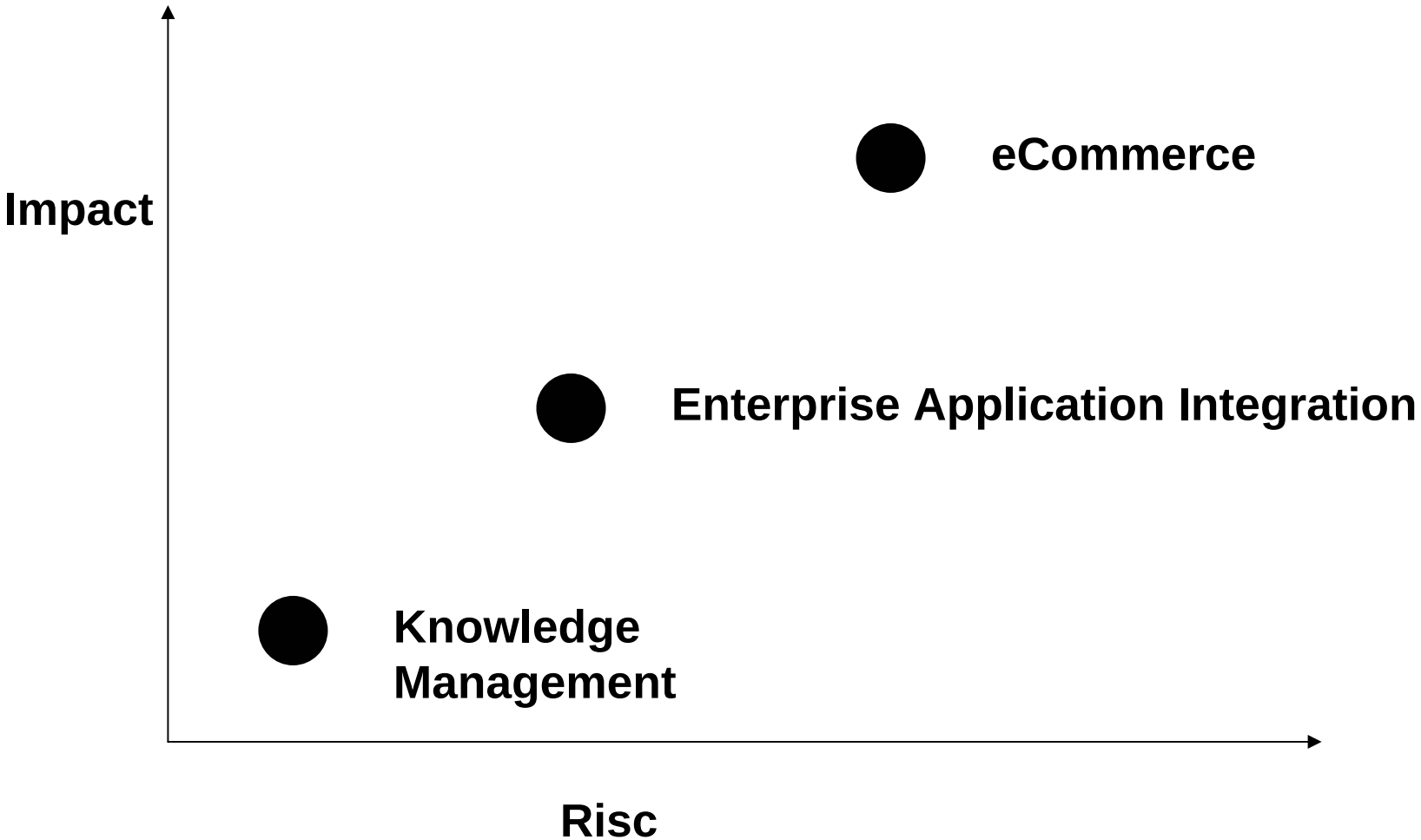
4. Semantic Web Services

Semantic Web Enabled Web Services	Semantic Web Services
email	web

Machine net

Human net

5. The Application Areas



5.1 Knowledge Management

- The competitiveness of companies in quickly changing markets depends heavily on how they exploit and maintain their knowledge.
- Increasingly, companies realize that their intranets are valuable repositories of corporate knowledge.
- To deal with this, several document management systems entered the market. However, these systems have severe weaknesses.

5.1 Knowledge Management

- **Searching information**: Existing keyword-based search retrieves irrelevant information that uses a certain term in a different meaning, and misses information when different terms with the same meaning about the desired content are used.
- **Extracting information**: Currently, human browsing and reading is required to extract relevant information from information sources and they need to manually integrate information spread over different sources.

5.1 Knowledge Management

- **Maintaining weakly structured text sources** is a difficult and time-consuming activity when such sources become large. Keeping such collections consistent, correct, and up-to-date requires mechanized representations of semantics that help to detect anomalies.
- **Automatic document generation** would enable adaptive websites that are dynamically reconfigured according to user profiles or other aspects of relevance.

5.1 Knowledge Management

- The Semantic Web will provide much more automated services based on machine-processable semantics of data, and on heuristics that make use of these metadata.
- Currently, we see many projects and products that are close to the market employing such concepts and ideas.

5.2 **Enterprise Application Integration**

- The integration of data, information, knowledge; processes; applications; and business becomes more and more important.
- Therefore, the Enterprise Application Integration area will have soon a major share of the overall spent IT expenses.
- A number of reasons are responsible for this trend.

Serious estmiates assume:

- that more than 30% of all IT budgets are spent on application integration
- this market has a size of more than a trillion dollar per year world wide.

5.2 **Enterprise Application Integration**

- Up to now, many companies trying to solve their integration needs by adhoc integration projects, however, adhoc integration do not scale.
- Therefore, after a phase of adhoc integration companies start to search for the Silver bullet that may help to solve the growing problem.
- However, global integration requires serious investments and time.

- A successful integration strategy must combine the advantages of adhoc and global integration strategies.
- Learning from *adhoc integration* means to make sure that we must reflect business needs as **the** driving force for the integration process.
- Learning from *global integration* means to make sure that we must create extendable and reusable integrations.

- **Purpose-driven**. We need to identify the major integration needs in terms of business processes and to structure our integration efforts around these needs.
- **Extendable**. We use Ontologies for publishing the information of data sources and for aligning it with business needs. By using Ontologies for making information explicit we ensure that our integration efforts can be extended in response to new and changed business needs.
- **Reusable**: Use web service technology to reflect further integration needs based on standardization. Web services as a vendor and platform independent software integration platform are of critical importance.

- We expect that Enterprise Application Integration will be the major application are of Semantic Web technology before it will take the next logical step:

=> the integration of several organizations, i.e., eCommerce.

5.3 eCommerce

- eCommerce in business to business (B2B) is not a new phenomenon.
- However, the automatization of business transactions has not lived up to the expectations of its propagandists.
- Establishing a eCommerce relationship requires a serious investment and it its limited to a predefined number of trading partners.

5.3 eCommerce

- Internet-based electronic commerce provides a much higher level of *openness, flexibility* and *dynamics* that will help to optimize business relationships.
- Anytime, anywhere, and anybody eCommerce provides completely new possibilities.

5.3 eCommerce

- Instead of implementing one link to each supplier, a supplier is linked to a large number of potential customers when he is connected to the marketplace.
- A supplier or customer can change its business relationships reflecting new demands from his market.
- This enables virtual enterprises and vica versa it enables to brake large enterprises up into smaller pieces that mediate their eWork relationship based on eCommerce relationships.

5.3 eCommerce

- However, enabling flexible and open eCommerce has to deal with serious problems.
- Heterogeneity in the *product*, *catalogue*, and *document* description standards of the trading partner.
- Effective and efficient management of different styles of description becomes a key obstacle for this approach.

5.3 eCommerce: Openess

- **Openness** of eCommerce cannot be achieved without standardization.
- This we can learn from the web!
- Here, we also require standardization of the actual content, i.e., we require Ontologies.

5.3 eCommerce: Flexibility

- **Flexibility** of eCommerce cannot be achieved without multi-standard approaches.
- Ontology need to be implemented as networks of meaning where from the very beginning, heterogeneity is an essential requirement for this Ontology network.
- Tools for dealing with conflicting definitions and strong support in interweaving local theories are essential in order to make this technology workable and scalable.

5.3 eCommerce: Dynamic

- **Dynamic** of eCommerce requires standards that act as living entities.
- Products, services, and trading modes are subject of high change rates.
- Ontologies are used as a means of exchanging meaning between different agents.
- They can only provide this if they reflect an inter-subjectual consensus.
- By definition, they can only be the result of a social process.

5.3 eCommerce: Dynamic

- For this reason, Ontologies cannot be understood as a static model.
- An Ontology is as much required for the exchange of meaning as the exchange of meaning may influence and modify an Ontology.
- Consequently, evolving Ontologies describe a process rather than a static model.
- Ontologies must have strong support in versioning and must be accompanied by process models that help to organize evolving consensus.

6. Some Core Projects

- DERI Lion
- Dip
- Knowledge Web
- WSMO

DERI-Lion

- A joined initiative with the National University of Ireland, Galway and HP Galway.
- Science Foundation Ireland (SFI) provides funding for a research center on SWS.
- Hewlett-Packard invest several millions in this project.
- Budget around 18M€
- http://lion.deri.ie/

dip

- An integrated project coordinated by DERI.
- Objective is to develop Semantic Web Services as infrastructure for eWork, eGoverment, Enterprise Application Integration, and eCommerce.
- Around 25 partners from industry and Universities.
- Budget 18M€.
- http://dip.semanticweb.org/

Knowledge Web

- A Network of Excellence coordinated by DERI.
- Objectives are the outreach of Ontology technology to industry and the establishment of a virtual Ontology University Europe.
- Around 20 Universities.
- Budget around 7,5 M€
- http://knowledgeweb.semanticweb.org/

WSMO

- Providing a standard for describing semantic web services.
- Stands for the Web Service Modeling Ontology
- WSMO is derived from WSMF
- Backed up by DERI and a cluster of European research projects.
- http://www.wsmo.org/

7. Summary

- Semantic Web Service are a major challenge that
- Solves the AI problem
- Solves the automatic programming problem
- Deal with 50% of the future IT market.

7. Summary

- 40 people in Innsbruck
- 50 people in Galway

Feel free to join us!!!

DERI Team Members