D 1.5.1 Project Presentation and showcase

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Abstract.
EU-IST Network of Excellence (NoE) IST-2004-507482 KWEB
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Project presentation and showcase with the aim of supporting the dissemination tasks and the establishment of contacts with other networks and projects. It will serve as a supporting element for network cooperation and industry dissemination.

Knowledge Web Consortium

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Changes

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Executive Summary

This document presents the IST Project IST-2004-507482 Knowledge Web. The main project data, the project logo and the members of the consortium are listed. Knowledge Web main goals, including the project rational, the short, medium, and long term support, the project main objectives and its detailed objectives are summarized. The project's key issues, its technical approach and its expected achievements and impact are then discussed. Finally, the coordinator contact details are given.
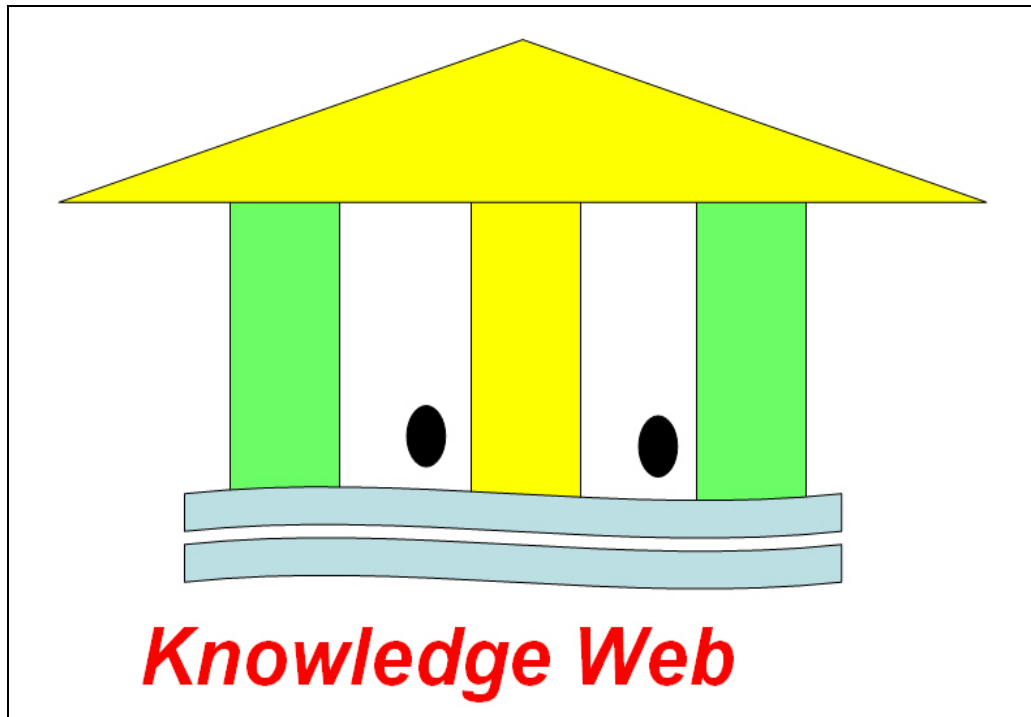
Contents

1. Project Data

- Contract number: IST-2004-507482

- Project acronym: **Knowledge Web**

- Project name: ***Knowledge Web -- Realizing the Semantic Web***

- Key Action: VI

- Action line: IST-2002-2.3.1.7

- Total cost: 7.8 million Euro

- Commission Funding: 6.7 million Euro

- Project duration: 48 months

- Web site: **http://knowledgeweb.semanticweb.org/**

2. Project Logo

The Knowledge Web logo represents the three pillars of industry, research and education, their integration and the creation of an infrastructure to support the building of a European research area.

3. List of Participants

The project coordinator is:

- 1. University of Innsbruck, UIBK, Austria

Members are:

- 2. École Polythechnique Fédérale de Lausanne, EPFL, Switzerland

- 3. France Telecom, FT, France

- 4. Freie Universität Berlin, FU, Germany

- 5. Free University of Bozen-Bolzano, FUB, Italy

- 6. Institut National de Recherche en Informatique et en Automatique, INRIA, France

- 7. Informatics and Telematics Institute, CERTH, Greece

- 8. Learning Lab Lower Saxony, L3S(UHAN), Germany

- 9. National University of Ireland Galway, NUIG, Ireland

- 10. The Open University, OU, UK

- 11. Universidad Politécnica de Madrid, UPM, Spain

- 12. University of Karlsruhe, UKARL, Germany

- 13. University of Liverpool, LivUni, UK

- 14. University of Manchester, VUM, UK

- 15. University of Sheffield, USFD, UK

- 16. University of Trento, UniTn, Italy

- 17. Vrije Universiteit Amsterdam, VU, The Netherlands

- 18. Vrije Universiteit Brussel, VUB, Belgium

Knowledge Web is bringing together a critical mass of scientific and technological leaders in the field of ontologies and Semantic Web from several European countries.

The consortium is formed by a wide core of scientific and technological experts in the R&D area of ontologies and the Semantic Web, including leading *Universities and Research Centers* in ontologies and the Semantic Web from: Austria (UIBK), Belgium (VUB), France (INRIA, FT), Germany (UKARL, L3S), Ireland (NUIG), Italy (UniTn, FUB), the Netherlands (VU), Spain (UPM), and United Kingdom (OU, VUM). Besides, to promote collaboration with other R&D areas and their corresponding communities (currently multimedia, Human Language Technology, workflow, and agents), the consortium includes scientific and technological leaders in the following fields:

- Leading partners in *Multimedia* from Greece (CERTH);

- Leading partners in *Human Language Technology (HLT)*, from the United Kingdom (USFD);

- Leadings partners in *Workflow* from Germany (FU Berlin) and Switzerland (EPFL);

- Leading partners in *Agents* from the United Kingdom (LivUni) and Switzerland (EPFL).

The current consortium will ensure that Knowledge Web is open for further academic members and research institutions that provide substantial contributions on any of the main goals of the network: outreach to industry, outreach to education, and research. Based on the importance of Knowledge Web's main research topics, the high number of participants in OntoWeb (143 participants) and the exponential growth rates in the area of ontologies and the Semantic Web, we expect to attract many additional academic and research members.

Knowledge Web will be also open for further industrial members that provide substantial contributions to the network goals. Best-practice cases, interesting applications, training courses, deploying ontology-based applications, learned lessons in the application of ontologies and Semantic Web technology, etc., are good examples of the contributions that we are expecting from these industrial members. Industrial partners play also the role of a window to the standardization efforts.

4. Project Main Goal(s)

4.1 Project Rationale

The current World Wide Web (WWW) is, by its function, a syntactic Web where the structure of the content has been presented while the content itself is inaccessible to computers. Although the WWW has resulted in a revolution in information exchange among computer applications, it still cannot provide interoperation among various applications without some pre-existing, human-created agreements outside the Web.

The next generation of the Web (the *Semantic Web*) aims to alleviate such problems and provide specific solutions targeting concrete problems. Web resources will be more readily accessible by both human and computers with the added semantic information in a machine-understandable and machine-processable fashion. In this context, *ontologies* play a pivotal role by providing a source of shared and precisely defined terms that can be understood and processed by machines. A typical ontology consists of a hierarchical description of important concepts and their relations in a given domain, task or service. The degree of formality employed in capturing these descriptions can be quite variable, ranging from natural language to logical formalisms, but increased formality and regularity clearly facilitate machine understanding.

The Semantic Web has the potential to significantly change our daily life due to the hidden intelligence provided for accessing services and large volumes of information. It will have a much higher impact on e-work and e-commerce than the current version of the Web. Nonetheless, there is a long way to go to transform the Semantic Web from an academic adventure into a technology provided by the software industry. *Supporting this transition process of Ontology technology from Academia to Industry is* **the main and major goal of Knowledge Web**.

4.2 Short, medium, and long term support

The main goal of Knowledge Web, supporting the transition process of Ontology technology from Academia to Industry, naturally translates into three principal objectives given the nature of this transformation:

Short-term support Industry requires immediate support in taking up this complex and new technology. Languages and interfaces need to be standardized to reduce the effort and provide scalability to solutions. Methods and use cases need to be provided to demonstrate in practice and to provide guidelines for how to work with this technology. Training courses will introduce this technology to programmers and consultants as a prerequisite for them to work with it.

Medium-term support Typically technology is transferred from Universities to industry by students who learn about it during their studies and want to apply it during their professional career. On the other hand, technology transfer from academia to industry is hampered when employees have not learnt about this technology during their studies. Therefore, an important support to industry is provided by developing high-class educational materials in the area of Semantic Web, Web Services, and ontologies. This is the mission of the Virtual Institute for Semantic Web Education (VISWE) that we will create in the course of Knowledge Web.

Long-term support Research on ontologies and the Semantic Web is yet to reach maturity. New areas such as the combination of Semantic Web with Web Services realizing intelligent Web Services require substantial new research efforts. Therefore, we will coordinate the research capabilities of the leading research groups in Europe to maintain this research area and to provide European industry with important stimuli ensuring its further progress and development.

4.3 Main objectives

In a nutshell, it is the mission of Knowledge Web to strengthen the European industry and service providers in one of the most important areas of current computer technology: Semantic Web enabled e-work and e-commerce. We will concentrate our efforts around the outreach of this technology to industry. Naturally, this includes education and research efforts to ensure the durability of impact and support of industry. Therefore, the main Objectives of Knowledge Web are:

Outreach to Industry We will jointly set up an Ontology language, tool, and method set that cover all the major tasks in working with ontologies. Developing standards helps to solve the interoperability problem. It includes benchmarking, compliance testing, usage scenarios, cookbook style textbooks with best practices, and definition of tool environments based on loosely coupled Web Services. In addition, we will push the creation of an Ontology Registration Authority (ORA).

Outreach to Education The goal will be to establish a Virtual Institute for Semantic Web Education (VISWE), which will act as the principal focus for educational activities on the Semantic Web. In working towards this end, we will build on the experience of several leading European University groups in designing and delivering courses in this area to provide up to date learning materials, curricula and, ultimately, new degree programs. At the same time we will enhance the delivery of course materials by making use of novel Semantic Web technologies in combination with more traditional e-learning environments. VISWE will be without parallel elsewhere in the world and will provide a competitive advantage to European research and industry.

Coordination of Research We will join our research efforts on combining Semantic Web with Web service technology. This is a very interesting problem because it is a very difficult problem (the declarative description of software has challenged computer science for quite a while) and when it is solved this solution will deeply impact on the next generation Web. A strong cooperation with other relevant fields such as multimedia, agent technologies and human language technologies will also be established. The technology developed in those fields will play an essential role in the realization of the Semantic Web and, furthermore, the Semantic Web itself poses new challenges and influences research developments in the fields mentioned before. We will establish a Virtual Research Centre to further the coordination of research.

4.4 Detailed objectives

Outreach to industry

The main objective of Knowledge Web's outreach to industry area is dedicated to promoting *greater awareness* and *faster take-up* of Semantic Web technology within Europe in full synergy with the research activity in order to *reduce time needed to transfer the technology to industry and so to market.*

In the increasingly knowledge-intensive economy, the search for *competitive advantage* creates a pressing need for *evaluating the contribution to value creation* of any *new technologies and specifically the ones that are potentially disruptive*. This is especially true of IT and knowledge-intensive applications for which this value creation is not always clear and easy to justify.

Outreach to industry will provide *awareness*, *bridge building*, *cross-fertilization*, *software framework* and *industry-enabling services* to *boost opportunities* for *market take-up* of the *key results* of Semantic Web technology. The main focus is on accelerating the rate of the technology transfer from research, which can be divided into the following tasks:

- Integrate and consolidate related research into interoperable tools and methods thus providing a more coherent European Semantic Web technology environment *(consolidate)*;
- Show the value of Semantic Web technology applications *(innovation)*;
- Improve the adaptation of user needs and requirements *(usability and utility)*;
- Formulate new scientific challenges from market needs *(cross-fertilization)*;
- Create new commercial and business value *(benefits and business model)*;
- Show that Semantic Web technology works *(reliability and scalability)*;
- Offer a framework for comparing technological results *(benchmark)*;
- Accelerate the rate of Semantic Web transfer from research to market *(transfer and deploy)*;
- Contribute to standards from an industry perspective *(interoperability)*.

We will provide *targeted business case studies* to illustrate best practice in technology transfer and take-up. We will *capitalize* on the dynamics, intellectual capital and skill base generated in the *IST-OntoWeb* thematic network to create a broader European information and support platform for adding value to national and European level Semantic Web initiatives.

We would act as a *central resource* of technology support, providing information to show the value of the Semantic Web and Web Service technology.

We will also *produce and disseminate white papers*, *case studies of Semantic Web and Web Services* transfer success stories, reports on best practice, directories of players, contact databases, electronic forums, and participate in national and cross-border sector events.

Finally, Knowledge Web will integrate the results of research from related fields to provide joint education and promotional efforts, both in academia and industry. Knowledge Web will spread its integrative and concerted actions to other similar efforts in related thematic networks and Networks of Excellence. Specifically identified partners will act as a bridge for coordinating actions on topics such as multimedia technologies, workflow, agents, human language technology and reasoning systems. This activity will initiate joint efforts on all aspects of the network: industry (joint standard proposals), research (joint interest groups and workshops) and education (joint lectures).

Outreach to education

If the European workforce is to establish and hold a lead in the use of Semantic Web technologies, it is absolutely vital that we provide the means for educating the next generation of Semantic Web application developers and researchers. Moreover, since learning can take place in a variety of contexts, we will provide training courses for professionals in industry. It is our intention to work towards the establishment of a *Virtual Institute for Semantic Web Education (VISWE),* which will act as the principal focus for educational activities focused on the Semantic Web. In working towards this end, we will build on the experience of several leading European University groups in designing and administering courses in this area to provide up to date learning materials, curricula and, ultimately, new degree programs. At the same time we will enhance the delivery of course materials by making use of novel Semantic Web technologies in combination with more traditional e-learning environments. VISWE will be without parallel elsewhere in the world and will provide a competitive advantage to European research and industry.

Three main work areas will converge with the establishment of the Virtual Institute for Semantic Web Education:

- *Establishing the Virtual Institute for Semantic Web Education (VISWE)* We will establish an administrative infrastructure for a European virtual institute, as well as all necessary agreements between cooperating partners/universities.

- *Learning Materials and Curricula about the Semantic Web* This will involve the provision of content for learners who need to know how to work with Semantic Web technologies, as well as for teachers who need educational material for their

courses. The result will be a repository of learning objects, curricula and syllabi suitable for the European context, which will be used within summer schools, degree programs, and training courses.

- *Semantic Web based Facilities for Delivery* This will involve the creation of sophisticated and novel facilities for delivery of educational materials about the Semantic Web using advanced Semantic Web features, combined with conventional, but otherwise also state-of-the-art, distance learning infrastructures. The new facilities will form part of a semantic platform on which all Knowledge Web content providers, coordinated by VISWE, will be able to deliver their educational resources. This platform will, at some point of the project, be integrated with the main Knowledge Web semantic portal.

The three strands represent minimal requirements for the future Virtual Institute for Semantic Web Education. During the course of the Knowledge Web project participants will provide the educational material, the delivery platform and the basic administrative structure. This will allow for the extension of courses delivered during Knowledge Web into one or more full degree programs. It will also form the basis for more wide-ranging programs of learning courses for professionals. Both of these will continue after the end of the Knowledge Web project itself.

Coordination of research

The leading position of Europe in the area of ontology can only be maintained and strengthened by continuing to perform cutting edge research. The role of Knowledge Web will be to ensure that research as performed by the leading groups in this area will be sufficiently coordinated to avoid both duplication and fragmentation. Such coordination is particularly important for the Semantic Web: since it is an inter-disciplinary area, joint collaborations among and across various research communities is essential.

We have identified two related challenging areas, plus a third activity aimed at a Virtual Research Centre:

Making the Semantic Web a reality

The first research area is required for the Semantic Web to make the transition into full scale industrial applications. Transforming ontology technology into a mature technology is required for this. The first area focuses on three main aspects for realizing the semantic Web: *scalability, heterogeneity, and dynamics.* The emphasis here is on large ontologies with several tens to hundred thousands of definitions; on heterogeneous ontologies with conflicting definitions; and on ontologies that keep changing depending on the underlying reality and design rationales i.e., efficient support for ontology evolution and versioning has to be developed.

- *Scalability* how can storage and reasoning engines deal with the sizes of ontologies expected to be deployed on the Semantic Web. Besides efficient algorithms and representations, significant conceptual advances are also required

to achieve scalability, such as modularization, principles of information hiding in ontologies, etc.

- ↓ *Heterogeneity* how can we establish mappings (possibly partial and incomplete) between heterogeneous ontologies with different vocabularies or even conflicting axiomatizations.

- ↓ *Dynamics* how must current ontology languages, methods and technologies deal with ontologies in a rapid changing world, where both the content and the structure of an ontology is likely to have a high change rate (sometimes changing on the order of minutes).

Semantic Web Services

The second research area (Semantic Web Services) is a good focal point to ensure the coherence of a number of separate strategic research activities. All of these problems are also relevant for other areas (knowledge management, e-commerce, mobile information, etc.), but placing all the research topics around a common focus will help to foster joint work, and build momentum towards a virtual cross-Europe research centre, much more so than each group investigating these problems in a different setting.

Web services can significantly increase the Web architecture's potential. Recent efforts around UDDI, WSDL, and SOAP try to lift the Web to a new level of service based on integrating it with *computational aspects*. A service can provide information, e.g. a weather forecast service, or it may have an effect in the real world, e.g. an online flight booking service. However, in their current state of development they significantly fail to realize their vision. First, important functional elements are missing that are required by a platform for eCommerce. Current technology provides limited support in mechanizing service recognition, service configuration and combination (i.e., realizing complex workflows and business logic with Web Services), service comparison and automated negotiation. Second, all the given service descriptions are based on *semi-formal natural language descriptions*. Therefore, the human programmer needs be kept in the loop and the scalability as well as economy of Web services is limited. Keeping the human in the loop prevents scalability, maturity, and economy in price. In consequence, they currently fail as an infrastructure for open and flexible eCommerce. Bringing them to their full potential requires their combination with semantic Web technology. **Semantic Web Services** will provide automation in service identification, configuration, comparison, and combination. Semantic Web enabled Web Services have the potential to change our life to a much higher degree than the current Web has done already. The following elements are necessary to enable efficient inter-enterprise execution: public process description and advertisement; discovery of services; selection of services; composition of services; and delivery, monitoring and contract negotiation. Currently, we observe the first academic trials in this area. DAML-S (www.daml.org) is a service description language proposed by the DAML consortium, and WSMF is an architecture for describing Web services developed within the European SWWS (swws.semanticWeb.org) project. Significant efforts are required falling into the following categories: (1) Additional layer of functionalities need to be defined and developed on top of the current Web standards. (2) Scalable description and reasoning mechanisms for Web services have to be developed

and implemented. (3) Semantic Web Services have to be developed as an infrastructure for eWork and eCommerce.

Additionally, within this activity we will develop techniques enabling the integration of agent-based services as Semantic Web Services. Specific services include intelligent middleware agents/broker services and semantic routers, argumentation/negotiation services, dynamic coordination, and the dynamic reconfiguration of software organizations and services.

Towards a Virtual Research Centre

Knowledge Web will coordinate and strengthen these research activities in order to prepare the ground for a Virtual Research Centre:

- It will be the organization for European ontology research, interoperation, and application;

- It will be a centre to facilitate exchange and research collaboration;

- It will be a host for diverse joint intra- and inter-disciplinary research;

- It will be an international centre for cooperation within the pan-Europe areas and with other researchers from America, Asia, and Australia;

- It will be the information access and dissemination point for ontology researchers, engineers, application and content developers in both academic and industrial institutions.

We will move towards a European research space for the next generation Web by defining a shared research program. We will focus our diverse research interests on a single theme for demonstration purposes. This will build up real commitment and momentum towards a virtual research centre in the longer term.

To ensure the integration and coordination of activities performed in the three areas of Knowledge Web: industry, research and education, we have proposed a horizontal activity to detect overlaps between areas, common functionalities, infrastructure needs and cross-fertilization possibilities. Knowledge Web will promote the construction of an integrated software infrastructure underpinning the integration of activities of the knowledge Web partners on the areas of industry, education and research.
In the end, we will establish the basic infrastructure for a Virtual Research Institute by creating a highly interconnected ontology research community in Europe.

5. Key Issues

The Knowledge Web organization is targeting three main cross-linked areas: Industry, Education and Research. *Integration* will take place within each of these areas through a particular instrument and/or virtual institute:

- Outreach to Industry Area: *Ontology Outreach Authority (OOA)*
- Outreach to Education Area: *Virtual Institute for Semantic Web Education (VISWE).*
- Research Coordination Area: *Virtual Research Centre*

Moreover the strict *coordination* of these areas within Knowledge Web aims at shortening the path from research to education and industry and especially at making the *outreach* to and feedback from industry more efficient.

European industry members will benefit greatly from the direct input of consolidated results from research and be given the opportunity to test these research results and software and to provide the required feedback to researchers.

Depending from which angle Knowledge Web is approached it will act as:

- An *Ontology Outreach Authority*, being "the" meeting place for interacting with interested industrial parties to take advantage of the latest research results, including tools. In the end, Knowledge Web will strive to set up an alliance with several industry bodies in order to set up an Ontology Outreach Authority, certifying, and serving *validated* ontologies.

- A *Virtual Institute for Semantic Web Education (VISWE)* where a specialized and adapted curriculum, which no single university can offer, is created for students coming from all over Europe.

- The *Virtual Research Centre* will coordinate the research carried out within Knowledge Web and take care that its results are shared and disseminated.

In brief, this will form the single contact point for European industries and service providers to learn and adopt the semantic computing paradigm.

6. Technical Approach

The workpackages of KnowledgeWeb are:

6.1 Industry

- ➕ *Industrial application needs*, in order to understand the needs, difficulties and problems of migrating Semantic Web technologies to current industrial systems.

- ➕ *Evaluation for technology selection:* survey and profile of the existing ontologies, tools, infrastructures and methodologies in the light of understood industrial requirements for the adoption of Semantic Web technologies.

- ➕ *Technology recommendations:* make recommendations, guidelines and standards to help industry organize, design and implement their migration towards Semantic Web technology enabled IT systems.

- ➕ *Promotion of ontology technologies:* promote awareness of the added value of the Semantic Web technologies in the increasingly competitive knowledge economy.

- ➕ *Cross-network cooperation:* organize cross-disciplinary research in related areas to provide joint education and promotional efforts, both in academia and industry.

- ➕ *Semantic portal infrastructure*, underpinning the integration of the activities of the Knowledge Web partners.

6.2 Research

- ➕ *Scalability:* how knowledge processing and ontology-based tools and tool suites can scale to the Web (or an important part of it) to deal with large volumes of information.

- ➕ *Heterogeneity:* how to deal with resources using different languages, terminologies and models.

- ➕ *Dynamics:* how to deal with knowledge evolution, knowledge evaluation and how to reach dynamic consensus on ontologies according to their semantics.

- ➕ *Semantic Web Services* will provide input and problems to the other vertical activities (Scalability, Heterogeneity, Dynamics and Languages). We will investigate a scalable infrastructure for Web service discovery and orchestration that provides a new infrastructure for e-work, e-government and e-commerce.

- **Semantic Web language extensions:** identify precise requirements for new languages and language extensions, and to represent the interests of the Knowledge Web network in the development and standardization of such languages and language extensions, including rule languages and query languages.

- **Towards a virtual research center,** that will monitor and organise the research carried out within Knowledge Web, including dissemination activities such as focused workshops, managing a programme of exchanges for researchers, and organizing the cooperation within Europe and with other international initiatives in America, Asia, and Australia.

6.3 Education

- **Foundations for Virtual Institute for Semantic Web Education (VISWE):** lay the foundations of VISWE by preparing all prerequisites for its formal foundation.

- **Collect course materials and organize and deliver educational events,** summer schools, complete courses and training programmes.

- **Develop a Semantic Platform** for delivering/interacting with learning material about the Semantic Web.

6.4 Cooperations

The network will cooperate with the following projects and initiatives:

Cooperation with other networks

- **Agentcities.NET** (http://www.agentcities.org/EURTD/)

- **REWERSE Network of Excellence**: to investigate and develop reasoning languages for the Semantic Web. This has an obvious link with our language extension and scalability research activities. Knowledge Web focuses on ontology languages and will coordinate its action with reasoning method providers.

- **REWERSE, MUSCLE, Aim@Shape, KB2.0 and Agentlink III:** support and cooperation actions on certain tasks, pooling resources, dissemination channels, administrative structures where possible and relevant to achieve greater impact.

- **ProLEARN Network of Excellence:** to bring together the most important research groups in the area of professional learning. This NoE will have an important link to the education activities of Knowledge Web.

Cooperation with projects from Framework Program 5

- **OntoWeb:** strong links will be established to OntoWeb, as this thematic network from FP5 will act as a driving force for the success of Knowledge Web.

- **SWWS** (http://swws.semanticWeb.org/)*:* links will be established to this FP5 project, which aims at realizing Semantic Web enabled Web Services, specifically to cooperate in the area of bringing together Web Services and the Semantic Web.

- **SCHEMA** (http://www.schema-ist.org/)*:* links will be established to the SCHEMA Network of Excellence in Content-Based Semantic Scene Analysis and Information Retrieval. SCHEMA objectives include content-based multimedia analysis, semantic web technologies, access to the information using query structures that come naturally to human beings, copyright issues of multimedia, new methods for multimedia access and delivery, MPEG-7 and MPEG-21 standards, user interfaces and human factors.

Cooperation with projects from Framework Program 6

- **DIP:** the link to this Integrated Project will focus on the realization of Semantic Web Services and its application to eWork and eCommerce, including subtopics such as Knowledge Management, Enterprise Application Integration and eGovernment.

- **SEKT:** the link to this Integrated Project will focus on substantially reducing the overhead of knowledge modelling and annotation of sources by integrating Ontology & Metadata Technology (OMT), Human Language Technology (HLT), and Knowledge Discovery (KD) into a uniform and scalable framework that supports the integrated learning and management of ontologies and metadata in a (semi-) automatic way.

- **aceMedia:** links will be established to this Integrated Project, focusing on the semantic annotation of multimedia content, in order to enable it to be self organizing, self annotating, self associating, more readily searched, and adaptable to user preferences and environments.

Cooperation with other initiatives

- **SWSA** (www.iswsa.org): the Semantic Web Science Association (SWSA) is a non-profit organization incorporated in Karlsruhe, Germany for the purpose of promoting and exchanging scholarly work in Semantic Web and related fields throughout the world.

- **SWSI** (swsi.semanticWeb.org): the Semantic Web Services Initiative (SWSI) is an ad hoc initiative of academic and industrial researchers, many of which are involved in DARPA and EU funded research projects. The major objective of the Semantic Web Services Initiative (SWSI) is to bring current Web technology to its full potential by combining and improving recent trends around the Web.

- ***Global Grid Forum Semantic Grid Research Group*** (http://www.semanticgrid.org)

7. Expected Achievements/Impact

7.1 Industry

- Jointly set up an Ontology language, tool, and methodology set that covers all the major tasks in working with ontologies.
- Developing standards that help to solve the interoperability problem.
- Benchmarking, compliance testing, usage scenarios, cook-book style textbooks with best practices, and definition of tool environments based on loosely coupled Web Services.
- Creation of an Ontology Outreach Authority (OOA).
- The elaboration of a consortium for sharing the tools developed within Knowledge Web is one of the main durable structures that can be proposed to industry. It is also expected that Integrated Projects which may grow out of the network will provide sustainable activity for industry.

7.2 Education

- Establish a Virtual Institute for Semantic Web Education (VISWE) which will act as the principal focus for educational activities on the Semantic Web.
- Provide up to date learning materials, curricula and, ultimately, new degree programmes.
- Enhance the delivery of course materials by making use of novel Semantic Web technologies in combination with more traditional e-learning environments
- VISWE will provide a competitive advantage to European research and industry.
- Several high level educational institutions will guarantee that the proposed curriculum shall persist as long as it is necessary (or necessary at the European level).
- Creation of a well-trained European workforce, also guaranteeing some homogeneity within this work force, which will be a benefit, both to research and industry. This will include:
  - o training with the tools developed in research and industry activities,
  - o spreading methodology and best practices, and
  - o teaching standards.

7.3 Research

- Join research efforts on combining Semantic Web with Web service technology.
- The links already established between a wide core of scientific and technological experts in the R&D area of ontologies and the Semantic Web will be made more explicit and tightened through the Virtual Research Centre and the Joint Programme of Activities.
- The mobility encouraged by travel grants could provide a wider recruitment pool for research institutions.

- Research will be carried out in such a way that a European critical mass will be available for taking advantage of and enhancing the results. The dissemination of research results will be done through many different instruments:
- Publications (the OntoWeb network has already been the driving force to create sustainable disseminating activities such as an international conference and a scientific journal and this effort will be pursued),
- norms (many Knowledge Web members are members of normative efforts, W3C WebOnt, RDFCore and we are in contact with other institutions, e.g. FIPA),
- Knowledge Web semantic portal,
- lectures given to the Virtual Institute for Semantic Web Education, and
- industry seminars and tutorials.

7.4 Contribution to Standards

- Knowledge Web will continue and extend standardization efforts. In particular, the following contributions are expected:
- Continued involvement in the W3C Web Ontology Working Group, which is responsible for the OWL recommendation. One Knowledge Web participant acts as co-chair of this group; other Knowledge Web participants play key technical roles in this group.
- Involvement in new W3C activities with respect to semantic-Web education and outreach. W3C is currently considering setting up a "*Semantic Web Best Practices*" Interest Group, which is intended to publish technical reports on tools, applications, and guidelines for ontology construction. This group also has a goal of promoting existing thesauri (e.g. WordNet, the Art and Architecture Thesaurus, various medical thesauri) and making domain content standards publicly accessible. One of the Knowledge Web participants is the candidate co-chair of this W3C group.
- Linking between ontologies and mainstream modelling techniques. The Object Management Group (OMG) has started an initiative to develop a UML profile for ontologies, thus enabling the development of graphical UML tools for ontology visualization and construction. Knowledge Web participants will continue to be involved in this process.
- Linking between ontologies and topic maps. OASIS has released an XML-based standard for topic maps (XTM). The ISO Topic maps standard is being used by industry and is closely linked to ontologies. At the moment, informal contacts are being established to publish technical notes on the relationship between W3C's Web ontologies and topic maps, so that they can interoperate. There are already a number of efforts showing how topic maps can be represented in RDF.
- Ontology query and rule languages. Once the W3C ontology-representation standards are finished, new standardization efforts are being planned for query mechanisms and for rules. Knowledge Web participants are already contributing to this.
- Web Services at W3C. At the W3C work on Web Services standards is performed by the Web Services Activity, which currently contains four working groups where Knowledge Web will contribute: the XML Protocol Working Group; the

Web Services Description Working Group; the Web Services Architecture Group; and the Web Services Choreography Group.

- Web Service architecture, choreography, and security. Whereas SOAP and WSDL have reached a certain degree of maturity and are widely accepted as basic ingredients of Web Service technology, there is still no common viewpoint on architecture, choreography or security. Thus, for the general issue of combining individual Web Service operations into complex workflows there are at least four current competing proposals that need to be monitored and influenced by Knowledge Web: BPEL4WS 1.0, BPML 1.0, WSCI 1.0, and WSCL 1.0.

- Linking between ontologies and multimedia. The Motion Pictures Expert Group has used the XML and RDF standards for the definition of descriptions multimedia documents. Knowledge Web Groups will provide new standardization efforts for the definition of multimedia knowledge using ontology definition languages (like OWL).

8. Coordinator Contact Details

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