D 1.4.1v3 Technology Roadmap

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Abstract.
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The Knowledge Web Technology Roadmap (KWTR) promotes a discussion on (i) the current and future trends on semantic web theories, tools and applications, (ii) general organizational needs, social drivers and user requirements, and (iii) technology locks between organizational/user needs and research activities. During the last research period, some emerging challenges have been unveiled and recommendations have been provided. These results are disseminated through the Knowledge Web deliverables and a wiki system that allow the active participation of researchers and practitioners.

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Executive Summary

One of the main goals of the Knowledge Web Network of Excellence (KW NoE) is the establishment of a beneficial relationship between academic institutions and industries. In particular, the purpose of technology roadmap activities in the network of excellence is twofold:

1. to become aware of how, practically, knowledge web or semantic web technologies could help organizations in both delivering new products and services and creating new business value. Thus, to actively encourage industries to effectively introduce semantic web techniques, methods and theories in their value chain.
2. to understand real needs of organizations and the market society, unveiling new desiderata and trends that the KW NoE should try to overcome. Thus, to advice research institutions to invest in specific research challenges, which are helpful for industries.

Companies and industries consider technology roadmap and technology roadmapping processes as key tools and practices to drive R&D actions and competitive strategies. The main benefit of technology roadmapping processes is that it provides information to make better technology investment decisions by identifying critical technologies and technology gaps and identifying ways to leverage R&D investments. In other words, the technology roadmapping process can help organizations to understand technologies, and its results can address firms to effectively change strategies and compete in increasingly complex environments.

Thus, as a strategic tool for managing internal R&D process, a technology roadmap is very often not publicly available, internally defined, with personalized methodologies and processes. It derives that each company must roll out its own process to produce the most appropriate technology timelined vision suited to R&D investments choices that foster organizational strategies and future directions (D1.4.1v1).

The technology roadmap can be used also as a marketing tool. In particular when economic and social interests are of public domain, the technology investment decisions are not straightforward, it is not clear which alternative to pursue and how quickly the technology is needed, and finally the entry cost is high or there is a need to coordinate the development of multiple technologies. These conditions are particularly true for the fast emerging and pervasive knowledge based and information processing technologies (as semantic web is).

As part of activities proposed by the Knowledge Web NoE project, the resulting technology roadmap is called Knowledge Web Technology Roadmap (KWTR), and it will be the result of experts' debates about future trends on both: (i) semantic web tools and potential impact in industry, business and society, and (ii) semantic web research and its applicability in predicted tools and applications.

Consequently to the fact that KWTR will be of public domain, will pay particular attention communicating the results to industry. Namely, it will illustrate the best of the state of the art in the field of knowledge based and information processing technologies

(semantic web), helping European industries and companies to understand and to catch semantic web up in their competitive market.

In the previous versions of KWTR (see D1.4.1v1 and D1.4.1v2) the following activities have been carried out: (i) the definition of the Knowledge Web Technology Roadmap concept (D1.4.1v1), (ii) the definition of KWTR purposes for a network of excellence (D1.4.1v1), (iii) the definition of the KWTR skeleton (D1.4.1v2), (iv) the identification of the roadmapping processes and some methodologies (D1.4.1v1), (v) the classification and characterization of some current trends on semantic web research, considering both fundamental theories and applications, (vi) the detection of some current trends on market and society, considering both business models and knowledge flows.

In this deliverable some new results are summarized such as: (i) the adoption of a new instrument, the wiki system, that might encourage communication among researchers and practitioners, (ii) the identification of some problems generated by the evolution of market and society. Namely, gaps that emerge from the comparison of trends on semantic web research and on market, (iii) the description of some challenges for the future semantic web research, (iv) the revision of the KWTR skeleton. The final version of KWTR will describe the adoption of semantic web technologies in a general way, then will focus on each specific topic described in the Semantic Web Topic Hierarchy. For each one of these a short description and a link to the wiki system will be provided, time to mainstream will identified, open problems and time of resolutions, according to a summary or trends in theories and methods will reported, and a link to possible social and market trends (in the case of topics related to applications) will be provided.

As requested by the commission, deliverables should be of high quality and not very long. Therefore, the WP1.4 partners decided to report on only the research activities carried out during the last period of research. Contents and results are already published in a wiki system (see http://fmsweng.science.unitn.it/wiki/) and are freely available on the web. These latter are continuously updated and refined in order to obtain (at month 48) the final KWTR version.

Therefore, the D1.4.1.v3 reports on: (i) the series of questionnaires that have been circulated among researchers and practitioners, (ii) the creation of a wiki system which collects previous results, the content of previous deliverables and the call for researchers contribution (iii) a draft analysis of the semantic web technologies hype cycle, (iv) a proposal of KWTR dissemination strategies.

One of the main critical aspects of this activity is still to collect and compare the finest expertise in both academy and industry (in particular taking into consideration the opinions of the Knowledge Web Industry Board) to get the most up-to-date short/medium/long term vision of the technology roadblocks toward realizing the semantic web. For this reason, the involvement of senior researchers has been required, and an analysis of previous research results across the NoE has been taken into account.

Contents

1. Introduction

Technology roadmaps are widely used within (and among) organizations to identify some economic market and social trends, namely technology methods, instruments, and applications that will be largely used in the future. Companies and industries consider technology roadmap and technology roadmapping processes as key tools and practices to drive R&D actions and to address strategies of market competitiveness.

For a non profit actor, such as a research group, a European project, a local or regional government, the technology roadmapping process can constitute an effective methodology to understand some economic and social trends. Therefore the resulting technology roadmap can be used as an educational or marketing tool. These conditions are particular true for the fast emerging and pervasive knowledge based and information processing technologies (as knowledge and semantic web), and for the type of technology roadmap that will be developed within the WP1.4.

Concluding, the technology roadmap is not a static document. Its content is continuously refined and updated according to environment and strategic evolutions. Through various versions of technology roadmaps, a clear vision of future applications, products and services should be provided, and new business values should be foreseen. In particular, a clear scenario and its evolution has to be predicted, and the current and future trends on semantic web tools, technology solutions and their characteristics have to be drawn to unveil some research challenges and to provide some recommendations for the future activities. In the last period of our study, in the $4^{th \ year}$, the final version of KWTR and the wiki system will be finalized and disseminated.

1.1 KWTR desiderata

As explained in previous deliverables (D1.4.1v1 and D1.4.1v2), it is important to consider that the KWTR is not developed for a single organization. It aims at discovering future trends on research activities within a Network of Excellence, the whole semantic web area and across other business sectors (financial, education, logistics, healthcare, etc.). Thus, the KWTR final document should give indications on how various autonomous institutions, spread all over Europe, might address their research activity, but it cannot impose a designed process of activity implementation. Therefore, KWTR will be focused only on the forecasting process, the planning process and a part of the decision making process. It will give, in a principled way, some insights and indications on how semantic web technologies will develop, and which research gaps should be covered in the future. Notice that, even if the recommendation activity is a crucial stage of the roadmapping process, it should fit the particular aims of autonomous researchers and developers spread all over Europe, and practitioners involved in various industry sectors. In other words, the KWTR final results should be shared and commonly understood by the majority of the KW NoE members, who commit to the vision depicted within the technology roadmap, and practitioners who can obtain useful insights from this tool. In this sense the technology roadmap might be considered as an agent of change that allows members of the NoE to stress and invest resources on a common and shared vision.

In any case, the final version of KWTR described in the D1.4.1v4 will:
- summarize a common agreement among experts in multidisciplinary sectors from both industry (e.g., healthcare, food, logistic) and academia (e.g., researchers in organization studies, computer science, linguistics, logics);
- capture the environmental landscape, threats and opportunities for a particular group of stakeholders in a technology or application area;
- provide a connection between technology and business strategy, as well as strategies of short/medium/long term planning for both research and industrial initiatives.

The roadmapping process should be carried out according to the following steps (described in detail in the D1.4.1v2):
- Analysis of trends in semantic web research.
- Analysis of market and social trends.
- Analysis of products and services that will be developed and used by consumers.
- Analysis of gaps among research trends, products and services development, and consumers' needs.
- The identification of challenges that research should focus on.
- Recommendations on the future development of semantic web.

Besides, one of the decisive aspects of the KWTR is the definition of an appropriate balance between markets/products and products/technologies, and technologies/research activities, which should guarantee an effective analysis of the current state of the art and trends in technology, business and research activities (see D1.4.1v2). Thus, a valuable mechanism for knowledge flow should be adopted according to the following levels:
- research/technology level: analysis of the theories, methods and technologies, identification of engineering and science skills, definition of technology management processes required for maintaining the technology base;
- product level: analysis of the product and service portfolio and platforms that will be developed in the near future, identification of manufacturing and operations functions, together with innovation in new products development;
- business level: analysis of the organization and associated networks, recognition of successful business portfolios, detection of marketing and financial functions, together with the strategy development and implementation processes required to deliver value to the business in the future.

Both research/technology level (theories, methods, etc.) and business level (semantic based applications) are deeply developed in the technology roadmap wiki system which collects detailed data provided by both researchers and practitioners. The product level is deeply analysed in the task 1.4.3 "Annual international technology show" which attempt to analyse and evaluate tools and demos.

Finally, the methodologies and techniques that take up the KWTR activity (deeply described in D1.4.1v1) are the T-Plan and the COCONET methodologies, and the Delphi technique. Due to a not very active participation, the KWTR teamwork decided to adopt other tools and techniques, such as a wiki system, a series of questionnaires and some face to face interviews. In particular the wiki system potentially allows all the interested individuals to freely contribute to the KWTR.

1.2 Some improvements over D1.4.1v1 and D1.4.1v2

D1.4.1v1 provided general concepts of roadmap and roadmapping processes, main features of technology roadmaps, methods and tools that allow researchers to develop technology roadmaps such as the T-Plan Guide and the COCONET roadmap method, and finally the Delphi techniques. Some of the activities already carried out and described in the D1.4.1v1 are:

- the initiation process of KWTR;
- the definition of the aims that the technology roadmap should stress;
- the identification of a first step in the definition of a common scenario that allows experts to define the 'first-cut' of the KWTR. This aim seems quite difficult to achieve. In fact, just looking at the answers received from experts (researchers and practitioners), it seems that researchers focused on specialized topics answer according to their vision, without taking into account the general scope of KWTR. On the other side practitioners provided very general comments without focusing in any of the specific topics reported by researchers;
- the identification of some challenges that will be deeply analyzed in the next versions of KWTR.

The activities carried out in the second year and the related results are described in the D1.4.1v2. According to the COCONET roadmap method the following analyses have been started:

- the analysis of the current state of the art: through this analysis a general definition of the Knowledge Web environment has been depicted, focusing on semantic web research activities, technologies, and services;
- the analysis of trends and developments in technologies and user work environments: the first draft of foreseen domains on research, technologies, tools and services that will be developed and utilized by users has been defined.

Finally, several important factors have been considered prior to the KWTR start-up process:

- **Identification of appropriate participants:** we consider it very relevant to involve partners from both research institutions and industry. In particular, their views should be merged in order to clearly identify the technology locks that Knowledge Web is resolving and trying to overcome, and the foreseen solutions that might be valuable in the market.
- **Identification of available information:** a small team (at the moment composed by Alain Léger and Roberta Cuel) has devoted to conduct the technology roadmap analysis. These researchers come from industry and business studies, and have a biased view on knowledge web applications, tools and research activities. Thus, the active involvement of appropriate participants has been requested. Unfortunately, only few contributions have been received, which are described in D1.4.1v2.
- **Required resources and scheduling of workshops:** experts should be enabled to meet in a face to face mode. In this way experts are expected to share knowledge and understand each other more effectively. The workshops are organized at least twice a year in line with the Knowledge Web plenary meeting events. During the

Knowledge Web General Assembly in Heraklion, Crete on June 1st 2005, a special meeting for KWTR has already taken place.

In this deliverable the following new activities and results are reported:

- A new web site has been created http://fandango.cs.unitn.it/kw/. In the latter all the tasks of WP 1.4 have been described.
- Some topics from the "Semantic Web Topic Hierarchy" developed in the WP3.1 have been selected. For each of these topics, some contributors have been identified, and asked to participate to this activity. In order to facilitate coherent contributions, an open questionnaire (a sort of framework) through which contributors can write their knowledge and opinions, has been prepared.
- Another questionnaire has been addressed to practitioners. The aim of this questionnaire is to collect information (statistically significant) from the industrial perspective in order to establish a beneficial relationship between academic institutions and industries.
- The names and curriculum vitae of contributors or companies are planned to be cited any time a specific content is cited in the KWTR documents (wiki, KWTR, deliverables).
- The KWTR skeleton has been updated and simplified in order to address an effective communication to industries. It also has the aim to create awareness on how, practically, semantic web technologies could help organizations to deliver new products and services, create new business value, reengineer processes and activities, and finally to measure social impacts
- A wiki system (http://fmsweng.science.unitn.it/wiki/) has been created in order to deeply analyze the semantic web topics reported in the final version of the KWTR.

Finally, according to the several important factors identified prior to the KWTR in D1.4.1v2 some new actions have been carried out:

- **Identification of appropriate participants:**
  - o In the research area, one or more contributors have been selected for each topic defined in the "Semantic Web Topic Hierarchy". All contributors are well known researchers, with high competencies in the topic and a good reputation in the research field. Each contributor has been required to fill the correspondent topic in the wiki system, according to the framework contribution.
  - o In the industry area, all the board members of the Knowledgeweb project are involved. Each one of them has to fill in a questionnaire available at http://fandango.cs.unitn.it/kw/.
- **Identification of available information:** we hope that the wiki system (supported by newsletter, e-mails, call for contributions, etc.) will allow people to provide other very useful information.
- **Required resources and scheduling of workshops:** experts should be enabled to meet in a face to face mode. Next meetings are scheduled for KW Plenary Meetings but other special industry track sessions are planned. There will be co-

located with 1st European Semantic Technology Conference, Formal Ontologies Meet Industry 2007, etc.

1.3 The KWTR skeleton

In previous versions (D1.4.1v1 and D1.4.1v2) some changes occurred in the KWTR skeleton. According to the fact that a lot of content will be freely available on the web n the wiki system, the KWTR final document (month 48) will be structured as follows:

Section 1. Release notes

Section 2. Executive summary

Section 3. Background contents (depict the current trends in semantic web research, market and society)

Section 4. KWTR aims, general concepts of technology roadmap and roadmapping, methods and tools of analysis

Section 5. KWTR 2010 and 2015 high level goals

Section 6. KWTR topic level goals.

Section 7. Summary (threats and opportunities from both social/market and technology/application point of views)

Section 8. The way forward (strategies of short/medium/long term planning for both research and industrial activities/initiatives)

Section 9. Annex

2. The work done by so far

In the last period several activities have been carried out, and are deeply analyzed in the following paragraphs.

2.1 The main activities of year 2006

A new web site has been created and made available at http://fandango.cs.unitn.it/kw/. The aim of this website is to create a common awareness on how, practically, semantic web technologies could help organizations to deliver new products and services, create new business value, reengineer processes and activities, and finally to measure social impacts. In the website all the tasks of WP 1.4 are described as:

1. Knowledge Web Technology Roadmap (KWTR): this webpage describes aims and previous results of task 1.4.1. It also encourages researchers to contribute to the topics defined in the "Semantic Web Topic Hierarchy" developed in the WP3.1, and practitioners to provide some information about their interests in semantic web technologies. To facilitate coherent contributions, two questionnaires (described below) should be filled in and sent to the KWTR teamwork.

2. Success Stories and Best Practices: this webpage describes aims and previous results of task 1.4.2;

3. Technology Show: this webpage describes aims and previous results of task 1.4.3 and makes available the link to a web based repository of the relevant technology applications and tools (http://www.csc.liv.ac.uk/~blacoe/SWtools.html). It will be continuously updated and maintained.

Some topics from the "Semantic Web Topic Hierarchy" developed in the WP3.1 have been selected. For each of these topics, some researchers and experts have been asked to identify and provide inputs for all the proposed themes or, if strategically important, to add other challenging topics. In order to facilitate coherent contributions, we have prepared an open questionnaire (a sort of framework) through which contributors can write their opinion, information, and useful insights. This questionnaire has been distributed and made available on the web site (http://fandango.cs.unitn.it/kw/). It is focused on current trends and challenges in semantic web theories, methods, applications and tools.

A questionnaire addressed to practitioners could either be filled on line, or downloaded from the web site (http://fandango.cs.unitn.it/kw/). The aim of this opinion poll is to collect information about semantic web theories, applications, methods, and foreseen challenges from an industrial perspective. In particular, it refers on features of companies that are interested in semantic web, such as company profile (geographic area, company size, number of employees, etc.), foreseen organizational impacts of semantic web applications, projects related to semantic web in which they are involved, etc. The call for contribution has been sent to all the industry board members of the Knowledge Web NoE project, and is available on line for anyone interested in that activity.

A wiki system has been created at http://fmsweng.science.unitn.it/wiki/. Its aim is to enable awareness on semantic web technologies theories and methods, focusing on how, practically, these could be implemented in semantic based systems, tools and applications. This latter might help organizations to effectively and efficiently deliver and innovate products and services, increasing business value. All these processes will inevitably affect the market and the daily activities of individuals, determining some social impacts that should be predicted. The wiki system is continuously updated, and offers a good point of access to an in depth analysis of the topics described in the "Semantic Web Topic Hierarchy". In particular the wiki system has the following functionalities:

- to collect and to make available on line all the results described in D1.4.1v1 and D1.4.1v2;
- to ask readers to take active part of the wiki system, correcting mistakes and adding comments on existing semantic web topics. Individuals can also add new topics of interests;
- to allow people, who have been asked to contribute, to fill in the framework already made available on the wiki system;
- to collect a list of profiles of experts (including name, affiliations, contacts, content contributions, and curriculum vitae) that have contributed to the wiki system itself. Profiles of contributors will be published in the final version of the KWTR (http://fmsweng.science.unitn.it/wiki/index.php/List_of_contributors).

A special hype cycle curve on semantic web technologies has been drafted organizing a special exercise with a panel of experts in semantic based technologies and applications. They represent USA, France, Italy, Ireland, UK, and Austria and various industries such as mobile communication, oil production, automotive, computer science, and neuro-imaging. They were contacted during a workshop in Trento called "Formal Ontologies Meet Industry (FOMI) 2006" (see http://www.loa-cnr.it/fomi/). They were asked to provide their personal vision on the future of semantic based technologies, identifying a position in the hype curve and the appropriate sign (that indicates years to mainstream adoption) for any element listed in the document.

In parallel with the work performed in this workpackage, a more specific roadmap is also being created by the Ontology Outreach Authority (OOA), which is described in WP1.3. This work can be seen as complementary to the more general overview of the field that is described in this report. Following a successful inaugural workshop, the OOA-HR chapter is producing a white paper for the domain of human resources, which comes not just from the point of view of the ontology experts such as are represented in Knowledgeweb community, but from the HR experts themselves. Whereas, therefore, the generic Roadmap presented here is a top-down approach created by the Knowledgeweb community, the OOA-HR roadmap is a bottom-up approach derived from the HR experts themselves. This kind of approach would not be possible for the whole Semantic Web field as it would be far too intensive; however it serves as a focused example from which generalisations can be later extended to the whole community and which can be reported here at a later stage. The OOA-HR roadmap will be delivered in month 42 as part of D1.3.6.

2.2 Some results

In the following paragraphs some results are summarized. Notice that all the complete version of contributions is available at http://fmsweng.science.unitn.it/wiki/.

2.2.1 The results of the questionnaire addressed to researchers

As explained above, a questionnaire has been addressed to researchers, focusing on current trends and challenges on the specific research topics described in the Semantic Web Topic Hierarchy. According to this latter the following topics have been selected:
1. Knowledge Engineering / Ontology Engineering,
    1. Methodologies,
    2. Ontology Population / Generation,
    3. Maintenance and Versioning (Dynamics),
    4. Mapping / Translation / Matching / Aligning (Heterogeneity),
    5. Validation,
    6. Interoperability / Integration,
    7. Modularization and Composition,
    8. Tools,
2. Knowledge Representation and Reasoning,
    1. Logics,
    2. Logic Programming,
    3. Reasoning,

3. Basic Web Information Technologies,
    1. XML,
    2. Web Data Integration,
    3. Security,
    4. Web Services,
    5. Personalization Techniques,
    6. Web Data Extraction / Information Extraction,
    7. Architecture of Web Information Systems,
4. Resource Description Framework / RDFSchema,
5. Semantic Web Query and Update Languages,
    1. Query Languages,
    2. Update Languages,
6. Ontologies for the Semantic Web,
    1. Ontology Representation / Ontology Languages / OWL,
    2. Ontology Engineering,
    3. Ontology Reasoners,
7. Semantic Web Rules + Logic,
    1. Rule Languages,
    2. Rule Markup,
    3. Reasoning Languages,
    4. Rule Reasoners,
    5. Integration of Rules and Ontologies,
8. Proof in the Semantic Web,
9. Security / Trust / Privacy in the Semantic Web,
10. Semantic Web Applications,
    1. Knowledge Management,
    2. e-Learning,
    3. Bioinformatics,
    4. Multimedia,
    5. e-Health,
    6. e-Business,
    7. Law,
    8. Engineering,
    9. e-Government,
11. Semantic Web Special Topics,
    1. Natural Language Processing / Human Language Technologies,
    2. Social Impact of the Semantic Web,
    3. Social Networks and Semantic Web,
    4. Peer-to-Peer and Semantic Web,
    5. Agents and Semantic Web,
    6. Semantic Grid,
    7. Outreach to Industry,
    8. Benchmarking and Scalability,
    9. Design and Testbed Case Studies,
    10. Semantic Web Services,
12. Other non classified topics,

1. Semantic Browsing and Learning,
2. Semantic Community Portal and Social Networking,
3. Semantic Web and Blogging,
4. Semantics in Mobile Communications.

For each topic, one or more researchers have been identified as experts and potential contributors. They are members of the Knowledge Web NoE project or external experts recognized as experts in their research field and have been selected according to their reputation in the research area.

In order to facilitate the collection of comparable data, a framework has been prepared and enclosed to the call for contributions. Thus, experts can provide their views on:

- Current trends in semantic web:
  - Experts should provide examples or case studies related to the topic. For each case the following information are required: name of the project (if it exists), name of involved institutions or companies, sectors of production, business activities improved by the semantic web solutions, research features, and finally tools and applications implemented in the project.
  - Researchers should describe semantic web based tools used in their field of study. For each of them they should write a general description of the tool and their related open problems.
  - Short summaries of the best paper in the field should be added.
  - Contributors should unveil and describe a list of open problems in theories and methods.
- Trends on theories and methods, services, and applications:
  - Experts should provide the list of research projects in which they are involved, along with a general description. Moreover, they should suggest for each project the possible future uses and applications related to the Semantic Web, the acceptance and diffusion in each period considered, the benefits, and the problems that will be probably occur.
- Trends on tools:
  - Researchers should write a list of the first four relevant semantic based demos in their area. For each of them they should provide a general description, the related features, and, if relevant, open problems or missing semantic web based tools.

A specific call for contribution has been sent to experts, but a small percentage of them answered and concretely provided their insights. After tens of e-mails only 14 topics out of 54, have been completed at December 2006. The content of contributions is reported in the wiki system (http://fmsweng.science.unitn.it/wiki/index.php/Topics_of_contribution). Experts who contributed to this activities are: Walter Binder (EPFL), John Breslin (NUIG), Oscar Corcho (UoM), Martin Dzbor (OU), Jérôme Euzenat (INRIA), Fausto Giunchiglia (UniTN), Carole Goble (UoM), Frank van Harmelen (VUA), Alain Leger (FT), Diana Maynard (USFD), Knud Möller (NUIG), Enrico Motta (OU), Lyndon J B Nixon (FU Berlin), Ina O'Murchu (NUIG), Michele Pasin (OU), Marco Pistore (ITC-IRST), Pavel Shvaiko (UniTN), Heiner Stuckenschmidt (University of Mannheim), Arthur Stutt (OU), York Sure (UKARL), Valentina Tamma (UoLiv), Paolo Traverso (ITC-IRST), Anna V. Zhdanova (UIBK).

2.2.2 The results of the questionnaire addressed to practitioners

As described above, an opinion poll has been submitted to forty-five experts, who have been selected in the list of industry board members of the Knowledge Web NoE project. They were asked to fill the questionnaire on line, or download it from the web site (http://fandango.cs.unitn.it/kw/). Notice that the questionnaire is still available on line for anyone who should be interested in contributing to that activity.

The opinion poll was focused in particular on:

- Company profiles: such as ownership, business activity, geographic area, company size, investments in semantic web applications.
- Organizational impacts and problems that should be overcome during the implementation of a semantic web technology. The focus has been on number of projects developed within the firm, foreseen impact on business efficiency and effectiveness, plan of investments in semantic web projects, possible skill shortages, channels of recruitment, etc.

Unfortunately the rate of answers is low. Only eight practitioners filled in the questionnaire and sent it back to us. Even if answers don't allow us to have statistical valuable data, some useful consideration can be made:

- The same percentage of private, public, and no profit firms contributed to the questionnaire.
- Companies are usually big firms, that don't work with affiliates. They are involved mostly in technology sectors. The number of their employees is higher than 1000. Only two companies are medium-small companies, have a small number of employees, and are involved in banking and financing, and media and communications.
- Contributors already know semantic web, and they see useful applications.
- Half of the companies already have adopted at least a semantic based application and believe that this technology will increase efficiency and effectiveness in the next future. All the companies are planning to adopt semantic web technologies within the next 3 years.
- Organizations are not using specific channels of human resources recruitment, they prefer to support employees to acquire or improve semantic web related competences.

2.2.3 The hype cycle analysis

The hype cycle (figure 1) is a widely accepted graphic representation of the maturity, adoption and business application of specific technologies. Since 1995, Gartner has used hype cycles to characterize the over-enthusiasm and subsequent disappointment that typically happens with the introduction of new technologies (see Understanding Gartner's Hype Cycles).
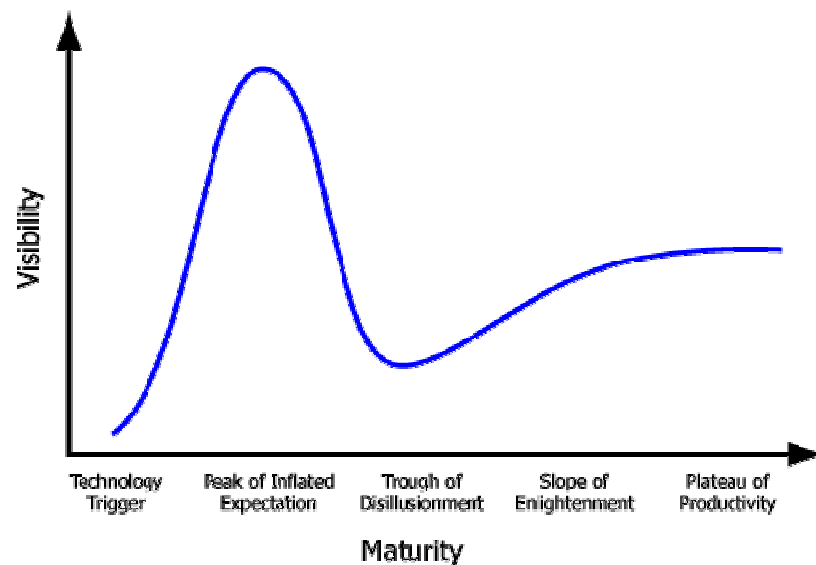
Figure 1. The Technology Hype Cycle of Gartner Group

As depicted in Figure 1. the hype cycle presents five phases:

1. Technology trigger: is the first phase, called also breakthrough, and refers to the product launch process or other event that generates significant interest in the market and in the society.

2. Peak of inflated expectations: the second phase is characterized by a frenzy of publicity that typically generates over-enthusiasm and unrealistic expectations. There may be some successful applications of a technology, but there are typically more failures.

3. Trough of disillusionment: in the third phase technologies enter the "trough of disillusionment" because they fail to meet expectations and quickly become unfashionable. Consequently, the press usually abandons the topic and the technology, and only experts and some other passionate individuals work with that technology improving methods and theories.

4. Slope of enlightenment: although the press may have stopped covering the technology, some actors experiment to understand the benefits and practical application of the technology.

5. Plateau of productivity: in the fifth phase, the technology benefits become widely demonstrated and accepted in the market and in the society. The technology becomes increasingly stable and evolves in second and third generations. The final height of the plateau varies according to whether the technology is broadly applicable or benefits only a niche market.

In the analysis symbols should be used to show the productivity plateau's timeframe of technologies. These are:

O   less than 2 years to achieve the productivity plateau's timeframe;

●   2 to 5 years to achieve the productivity plateau's timeframe;

       5 to 10 years to achieve the productivity plateau's timeframe;

Δ more than 10 years to achieve the productivity plateau's timeframe;

$\otimes$ obsolete before the productivity plateau's timeframe.

KWTR teamwork has decided to submit the hype cycle to a panel of experts in semantic web applications, involved in a workshop entitled "Formal Ontologies Meet Industry" and organized in Trento (Italy) in December 2006. The number of contributors is not very high, but of very good quality, from various nations (USA, France, Italy, UK, Austria), and industries such as oil and gas, automotive, neuro-imaging elaboration, mobile communications, and aero industry.

Participants have been asked to locate semantic based technologies and applications in the hype curve, using the appropriate signs (that indicates years to mainstream adoption). A list of semantic based technologies and applications has been proposed:

1. Semantic web services;
2. Grid computing and semantic web;
3. P2P and semantic web;
4. Semantic web and blogging;
5. Semantic wikis;
6. Corporate semantic based technologies;
7. Semantic based e-commerce and e-procurement;
8. Semantic based e-government;
9. Semantic based e-learning;
10. Semantic based Bioinformatics;
11. Semantic based Multimedia;
12. Semantics in Mobile Communications;
13. Agents and Semantic Web;
14. Security / Trust / Privacy in the Semantic Web;
15. Benchmarking and Scalability;
16. Others (if relevant, other topics will be provided).

The results, deriving form the aggregation of all contributions, are depicted in figure 2.
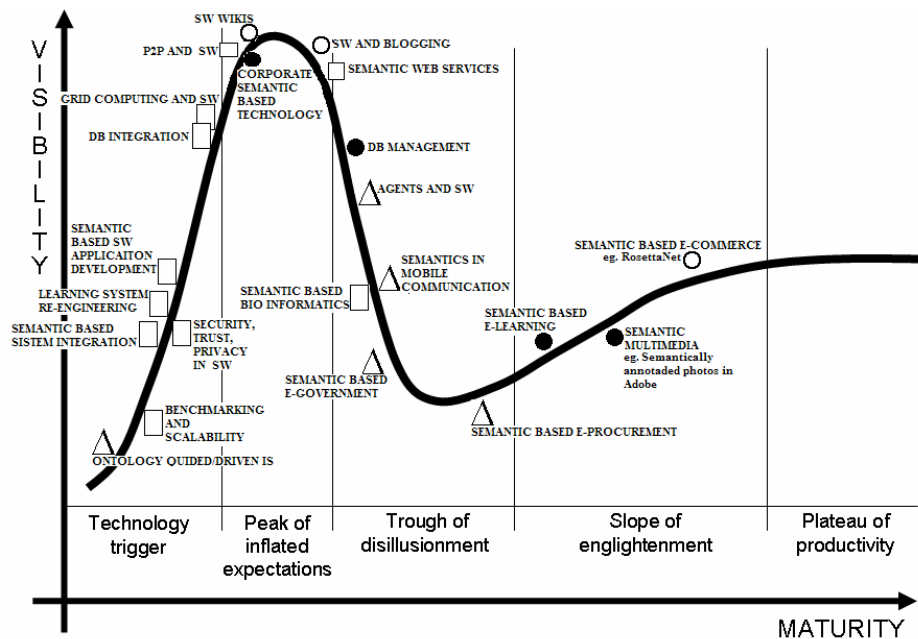
Figure 2. The Hype Cycle Curve for semantic web applications

Some comments should be done about the results depicted in figure 2.

Contributors placed "P2P and semantic web" through three different phases of the hype cycle: the technology trigger, peak of inflated expectations, trough of disillusionment. The KWTR teamwork believes that this is due to the fact that semantic web and P2P can be implemented in various applications and solutions some of them are emerging, some other are well known and failed. Therefore we decided to put this element in the middle position of all the results.

Two experts positioned "semantic wikis" and "semantic blogging" on the slope of enlightenment, focusing their attention in particular on traditional wiki and blogging systems.

Three contributors positioned the element "Corporate semantic based technologies" in the slope of enlightenment. On this matter it is important to notice that, nowadays, only big companies can find semantic based solutions available on the market. A lot of technologies for small and medium enterprises are completely missing.

Some contributors pointed out that a simple example of semantic based multimedia (such as semantically annotated photos in Adobe) should be positioned in the slope of enlightenment, but others argued that a more complex semantic based multimedia technology should be developed and new applications will emerge in 2-5 years.

Even if "semantic/trust/privacy in SW" is positioned in the technology trigger phase, an expert argued that this is not a technology.

Finally, DB integration, DB management, semantic based SW application development, learning system re-engineering, semantic based system integration, and ontology guided/driven information systems are topics of interests added by experts.

4. The future work

In order to conclude this work other new contributions are required to:
- complete the descriptions of some topics described in the wiki system;
- obtain more data from the questionnaire addressed to practitioners;
- make a more in-depth analysis of the semantic web hype cycle.

In line with the content of this deliverable, D1.4.1v4 (the final version at M48) will summarize activities carried on during the 2007 and results presented in the KWTR (final version) and in the wiki system (at December 2007).

The KWTR will be a short paper (20-30 pages) through which industries and research institution can get some useful insights on how semantic web technology will change in the next 10 years. Moreover, people who are interested in a specific topic, can accede to the wiki system in order to obtain more detailed information. There latter will focus on methods and theories (provided by researchers), tools (partially provided by task 1.4.3), applications and success stories (partially provided by task 1.4.2 and WP 1.1). A special link to REASE will be provided in order to provide relevant documents for whom that might be interested.

All these results will be disseminated and findings will be consolidated through the organization of special meeting (in the major semantic web conferences) in which both practitioners and researchers will actively participate. Finally, this work will be linked to the O2I portal which will also be strongly promoted to industry, and be pushed at events where research and industry is present such as ESTC 2007 and the Kweb plenary. FOMI 2007 may be a good opportunity to gather participants before the end of the network and achieve conclusions to all activities.

References

http://knowledgeweb.semanticweb.org/ (Web portal of the Knowledge Web NoE project)

http://fandango.cs.unitn.it/kw/ (Web site of WP1.4)

http://fmsweng.science.unitn.it/wiki/ (KWTR Semantic Web Wiki)

http://fmsweng.science.unitn.it/wiki/index.php/List_of_contributors (List of KWTR contributors)

http://fmsweng.science.unitn.it/wiki/index.php/Topics_of_contribution (Topics of interest related to semantic web research)

http://www.csc.liv.ac.uk/~blacoe/SWtools.html (Semantic based tools and demos analyzed for the task 1.4.3)

http://www.loa-cnr.it/fomi/ (Web site of Formal Onotology Meet Industry 2006 workshop)