UNIVERSITY OF OSLO
Department of Informatics

Waiting for the Semantic Web

Some comparative and sociotechnical aspects regarding the evolvement of the World Wide Web

Master thesis

Sturla Bakke

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“ I said ‘ I think they might also be what are called “hopeful monsters”.’

She said ‘What are hopeful monsters?’

I said ‘They are things born perhaps slightly before their time; when it’s not known if the environment are ready for them.’

Nicholas Mosley, Hopeful Monsters, 1990

1 Abstract

The aim of this thesis is to discuss some sociotechnical aspects of the Semantic Web's somewhat, at least so far, seemingly failure to materialize on a larger scale, by using the methodology of Actor-Network Theory and Information Infrastructure theory, and in the light of other socio-technical developments within the Web paradigm, which is, rather controversially, coined as Web 2.0. There is a disagreement within the Web-community about this term, its definition, and whether it has any relevant meaning. I will present a kind of definition or rather a set a of characteristics, related to the term, in ch. 7.2 , as it is described by the group of web professionals and leading innovators that coined the term, but it is outside the scope of this thesis to discuss the linguistic significance of the term (O'Riley, 2005).

It might seem that most of the research done in the Semantic Web field is technologically deterministic; that, apart from Tim Berners-Lee's initial filantropic vision, the research work done in this field seems to be mainly based on solving technological challenges in the making of new web standards, that the development of heavy, formal standards that would elevate the Web of today into an almost "autonomous artificial intelligence" is done in a highly meritocratic environment that could resemble that of the Open Source movement.

The kind of silent development work, with its emphasis on standards, done in the Semantic Web paradigm is contrasted by the so-called Web 2.0 revolution and its more fly-by-the-seat-of-your-pants attitude towards flexibility (Hanseth et al., 1996, O'Riley, 2005) and, because of its more socially deterministic character, which has lead to new web-services directed towards a broader scope of users and field of usage [ch. 8.3.1] which in turn leads to more people utlizing web services. According to Hanseth and Monteiro (1998) this is a key factor in cultivating an installed base, in addition to the fact that a growing popularity among the public also captures the attention of both media and accesible venture capital, and it might not be unthinkable that this also will contribute in the process of cultivating the installed base.

A relevant question is whether the collection of technologies that constitutes the Web 2.0 paradigm, that mainly includes a set of technologies we already possess, see ch. 7.2, will be able to exploit or utlilize Semantic Web standards and gain momentum from

integrating them, and by that contributing to the Web 2.0 paradigm evolving into a front-end for the Semantic Web.

This thesis is divided into four main sections.
The thesis first gives an account of a selection of the relevant literature within the field of Actor-Network Theory, and Information Infrastructures as a methodological foundation, although ANT, according to Latour only is useful when it does not 'apply' to anything (Latour, 2005:141). Then I describe the background for these well connected theories leaning heavily on the writings of Bruno Latour, John Law, Michel Callon, Madeleine Akrich, Ole Hanseth and Eric Monteiro.

Second I describe the actants as standards, protocols and languages within the Semantic Web field developed by the working groups in, and issued by the W3C, consisting of a wide variety of computer scientists around the world, and how these actors have related to each other in the development process, along with the characteristics of the Web 2.0 paradigm as they are presented by the Web community that first coined the term, the O'Reilly 2004 Web Conference, and some examples of Web 2.0 instances. The main body of literature about the Semantic Web and the Web 2.0 paradigm exists, largely due to the area of interest, mainly online. I therefore present a set of critiques connected to the method of net research along with a brief description of the set of methods used in the research study.

Finally I present a comparative description and analysis of some of the socio-technical aspects of integrating these two technologies, and the actor network that is developed through this process, before I conclude from the findings in the study to the extent that conclusions are possible to reach at all in this "work in progress". Because of the volatile nature of the object of study, it is rather difficult to give a definite set of conclusions. What I present is merely one possible conclusion among several.

2 Acknowledgements

First I must thank my supervisor, Professor Ole Hanseth, for his patience with a struggling student's hopeless and somewhat peculiar relation to deadlines*, and asking me questions I could not initially answer, which brought some core focus into the set of problems that I wanted to investigate. Wherever I still wander out of focus and into the academic and thematic mist, it is purely my own stubborn responsibility.

I need to thank my employer Westerdals School of Communication, for looking the other way when I, on more than one occasion, obviously did something else than regular work.

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A special thank you to Tone, who took care of me in periods when the going got tough, who made dinners and took me out for an occasional walk and a bit of fresh air when my complexion started to look like Procol Harum's famous hit song.

And finally, I must thank my Mom, for her perpetual stoicism and love. The fact that she did not give up on me years ago is an incomprehensible fact that would baffle even the most maternal among mothers.

In the end, when the lights are out, and all is quiet on the domestic front, one should not underestimate the inspirational and soothing impact music may have on a fragile soul. Although this thesis, even with the help and support from all of the above, turned out to be a rather arduous journey; without the music of Bach, Mozart, Joni Mitchell and Gino Vannelli, it could quite possibly, have turned out to be an almost insurmountable task to overcome, indeed.

Thank you.

Sturla Bakke
Oslo, 8 November 2007

* I like deadlines. I love the whooshing sound they make as they fly by

- Douglas Adams

3 Table of contents

3.1 List of Figures

4 Introduction

While we wait for the Semantic Web to publicly happen, a more immediate and directly socially constructed technological approach to the reuse of data on the Web has emerged. The question is whether this pushes the development of the Semantic Web back, or could the Web 2.0 paradigm be the killer application for the Semantic Web, much the same way Mosaic was the killer application for the World Wide Web? Mosaic was the first browser with a graphical user interface that ran on regular desktop machines, that is, not only on expensive UNIX workstations but Windows PCs and Macintoshes as well. This made it, and as a consequence, the Web, more available and accessible to a larger public. Which lead to an exponential growth in both web servers and users (Naughton, 2000:211, 246-247).

In order to come closer to something that could give an explanation as to why the Semantic Web still has not materialized as something that could resemble what was described in its original vision (Berners-Lee et al., 2001), and numerous ideal descriptions since it was conseptualized, I have chosen to discuss what, in the Web community, has emerged as the next natural development of online communication, the Web 2.0 paradigm, and to what extent it has adopted, deployed, and simply influenced or being influenced by Semantic Web technologies, and how these mechanisms in evolving an information infrastructure are described in the literature.

In the period that has passed since 1990, when the Web was invented, the amount of Web-pages has increased at an exponential rate. From the first server[1] and the first page[2] in November 1990, the number of websites had grown to 130 in June 1993 and it exploded, as Mosaic, the first user-friendly browser with a graphical user interface, was released in the spring of 1993 (Naughton, 2000:245). In January 1996 the number of web sites had increased to 100.000. By January the following year, the number of web sites had increased to approximately 650.000[3]. In their October 2007 Web Server Survey, Netcraft[4] recieved responses from 142.805.398 web sites, which was an 7.6 million increase since the previous month[5].

[1] nxoc01.cern.ch, later renamed info.cern.ch. Souce: http://www.w3.org/History.html
[2] http://nxoc01.cern.ch/hypertext/WWW/TheProject.html. This page does no longer exist. The oldest known page, http://www.w3.org/History/19921103-hypertext/hypertext/WWW/Link.html, last changed Tuesday, 13 November 1990 15:17:00 GMT. Source: http://www.w3.org/History.html
[3] Source: Matthew Gray, MIT. http://www.mit.edu/people/mkgray/net/web-growth-summary.html [Accessed: 20/06/2007]
[4] See Appendix 11.1
[5] Source: http://news.netcraft.com/archives/web_server_survey.html. [Accessed: 25/10/2007]

Data for the period August 1995 – October 2007 presents an exponential growth curve regarding the total amount of sites, globally and across all domains.

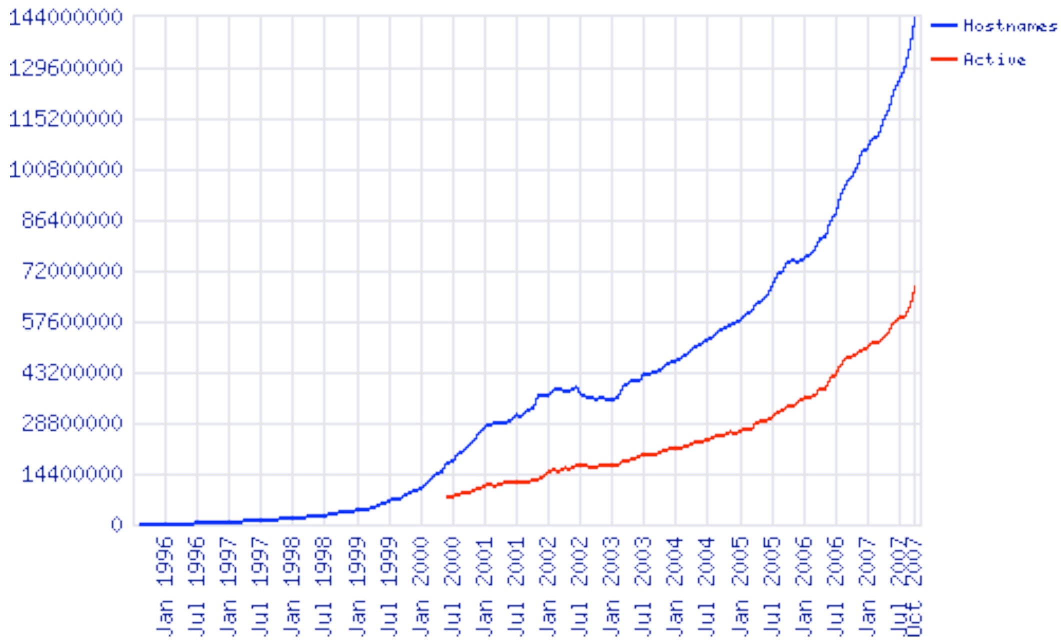

Figure 4-1 Total number of web sites across all domains Aug. 95-Oct. 2007

Source: http://news.netcraft.com/archives/web_server_survey.html.
[Accessed: 25/10/2007]

Changing this installed base of web community members, going from utilizing a regular document web into exploiting a granular semantically rich data web, which is what the Semantic Web is all about, could prove to be difficult, without the help of a *disturbing*, killer application technology that could weave the realm of social human activities with the power of machine comprehension and inference.

> ”The hope is that, in not too many years, human brains and computing machines will be coupled together very tightly, and that the resulting partnership will think as no human brain has ever thought and process data in a way not approached by the information-handling machines we know today”
>
> *J.C.R. Licklider, Man-Computer Symbiosis*
> (Licklider, 2001)

It might seem like J. C. R. Licklider's vision for how humans could transcend into the realm of the almost almighty still has yet to be achieved. However, it seems as it is, at least to a certain extent, echoed in Tim Berners-Lee's vision for the Semantic Web (Berners-Lee et al., 2001). Only this time the computing machines are not that much depending on being coupled with humans in order to process data. Instead of a man-computer symbiotic collaboration, the Semantic Web is based on the interoperability between machines, it might be seen as a computer-computer symbiosis that eventually, the day when or if the vision of the Semantic Web are realized according to Berners-Lee's original ideas, might lead to levels of data processing and Human-Computer Interaction that neither J.C.R. Licklider nor we, the generation that probably have come closest to his 1960-vision, could possibly dream of. By that it could very well become just as profound a socio-technical change as the invention of the Internet and World Wide Web initially was. It could save the Web from collapsing under its own weight and size. It could possibly do all sorts of things, if we could just manage to overcome the state of lock-in that is growing tighter as the exponential growth in online information continues

Brian Carpenter, among several scientists, gives a rather precise description of the development work on the Internet as an evolving infrastructure: ”A good analogy for the development of the Internet is that of constantly renewing the individual streets and buildings of a city, rather than razing the city and rebuilding it. The architectural principles therefore aim to provide a framework for creating cooperation and standards, as a small "spanning set" of rules that generates a large, varied and evolving space of technology” (Carpenter, 1996).

5 Literature and theory

In this chapter I present a selection of the relevant literature, both curricular and extra-curricular, in order to discuss the part of the Semantic Web and the Web 2.0 discourse in a comparative perspective that is relevant for this thesis. First I present some basic isms relevant to the field of social construction of technology. Then I describe and lightly discuss the chosen main body of literature regarding Actor-Network Theory, in addition to give a brief introduction to Information Infrastructure theory, mainly in the form of the writings of prof. Claudio Ciborra, prof. Ole Hanseth, University of Oslo and prof. Eric Monteiro, Norwegian University of Science and Technology. Finally I will present what I regard as a relevant excerpt of the body of literature about and current practices within the Semantic Web and the so-called Web 2.0 paradigm, both regarding the technologies that make it work and, that has been published in the period 2001-2007, with a focus on the period 2005-2007, and the criticism that has occurred both within the Semantic Web discourse, and the ongoing debate about definitions and practices related to the Web 2.0 paradigm. Whether Web 2.0 might be regarded a paradigm within the Web-community can be debated. I have chosen to use the term 'paradigm' because it represents a shift in how people may relate to web services, from one to many, one-way, server-side based communication to many to many, two-way communication, with many of the services based on execution on the client side, diminishing the divide between web-services and desktop-services.

5.1 Isms – rethorical semantic black boxes

An ism might come in handy when explaining a, more or less, complex set of beliefs, a settled doctrine or ideology that, when explained once and for all, in one word, or two, could describe a rather complex structure of actors and their semiotics. An ism could therefore fit rather adequately the definitions of a black box, see ch. 5.2.2.5

5.1.1 Technological determinism

This view describes a scenario where the development process of technology is adhering to its own set of logic, in that technology itself determines its deployment and design as this is described by Winner 1977 (referenced in (Hanseth and Monteiro, 1998), and that it is "autonomous and independent of social influnces"(Misa, 1994).

Which, according to Johnsen and Fyhn(1998) leads us to investigate only what is the result of technological production, not the technology itself.

5.1.2 Social constructivism

With social constructivism we understand that it is the social institutions, people, groups and others that define meaning to and also are responsible for the design of technological artefacts by determining and selecting which technological artefact that is to survive and gain further development, as this is outlined by Pinch and Bijker (1984). In this manner the technology that best suits the user community will be constructed, indicating that the technology itself does not represent a significant part.

Theories about information infrastructures being an enabling, open, shared, evolving, heterogenous, installed base lies somewhere between these two extremes (Hanseth and Monteiro, 1998), in that it both shapes and is shaped by the community that surrounds it.

5.1.3 Universalism

Universalism is all about the ultimate omnipresent, all-inclusive solution. Within web research, universalism could very well describe the border-transcending web "where everything fits together perfectly and where any information may be exchanged between anybody connected, without any loss of meaning or other obstacles" (Hanseth and Monteiro, 1998:128). Universalism could be the perfect rethorical black-box[6] for the Semantic Web. Following Universalism in the process of explaining the vision of the Semantic Web, and the process of trying to implement it, it conforms to the original vision of the Semantic Web as the universal final web where everyone and everything in the mother of all actor networks fits elegantly together, and where meaning is not just inscribed in the actors and actants, but just *are* in some celestial existence of order and beauty. [Un]fortunately, this is not how the world is put together. The world, as most people know it, is a rather messy and unpredictable place, constantly trying to overcome chaos, broken dreams and disappointments.

5.2 Actor-Network Theory

New aspects of communication arises when communication practices are increasingly done in a computer mediated manner. I can choose to be anonymous in order to maintain privacy and security, or just because I wish to conceal my identity. I might

[6] See ch. 5.2.2.5

communicate with others through technologies that demand we are all online at the same time, like various chat progams. In return, this channel of communication is not very persistent. Unless we are using some sort of ”recording” software, the content disappears at the same moment the software’s user interface is closed. This, again, is different from e-mail or discussion forums, where it is not necessary with a high degree of synchronicity, but where the content is saved, giving a high degree of persistence. In this [actor]network of [actor]networks, it is not only a technological issue, even if it is an important part and a huge actor network of its own. It is as much of a sociotechnical issue, which in an ANT perspective includes testing of standards’ strength, enrolling of “friends” and layers upon layers of technical inscriptions. Using Actor-Network Theory gives us a quite precise understanding of the underlying infrastructure, as ANT is a tool for explaining technological-semiotic networks, and since an entity in most cases can be both a network and an actor, it will also give us the opportunity of granularity or scaling, which might be useful when looking at technology in a social constructionistic perspective upon which we might measure the success, or rejection, of technological artefacts.

5.2.1 Background

The classic Actor-Network Theory came out of the research work by Michel Callon, Bruno Latour and John Law within the field of science and technology studies, STS, and is characterized with its lack of differentiating between technical and non-technical, human and non-human elements (Hanseth and Monteiro, 1998, Law, 1992).
The study of the basic foundation and parts of an information infrastructure shows how the introduction, development, and actual deployment of various information infrastructures is a socio-technological cooperation, where non-technological interests through negotiation of compromises is endowed with a touch of technology. ANT is an example of the analytical tools we would need in order to extract and comprehend the information that is the result of processes like these.

ANT provides us with a set of terms that help us characterize information infrastructures, and a vocabulary to describe how, in what circumstances, and to what extent technology affects patterns of human behaviour. This is beneficial in order to identify the magnitude of influences from seemingly anonymous technical actors, like for instance standards that already have been deployed, or whole systems as actors in a larger infrastructure. This allows us to regulate the magnification of the set of problems we are to investigate, and by that the granularity of details we wish to include in the case description, which is significant when analyzing information infrastructures.

According to Law (1999: 3) ANT is a ”ruthless application of semiotics”; it may be understood as a ”semiotics of materiality” in that it facilitates semiotic understanding of relational contexts and entities, and does not differentiate between them. It is also a theory that has gained some controversy and criticism, and even the name ANT is, according to Law (1999: 4) an oxymoron, with the tension between the centered ’actor’, and the decentered and technically metaphorical ’network’. Latour went even further in his ”On recalling ANT” (1999a: 15), describing the four difficulties of Actor-Network theory as ”the word actor, the word network, the word theory and the hyphen!” Latour also mentions the changes in the meaning of the word network, from *transformations* that could not be grasped by any of the social theories in a traditional sense, through the evolvement of online technologies and popularizing of the word into meaning ”instantaneous, unmediated access to every piece of information” (1999a: 15). ANT, in the minimalistic version described by Monteiro (2000), has evolved into a method for describing change and complexity of a sociotechnical character, to describe the socio-technical processes involved in the introduction, development and evolvement of information infrastructures and how such infrastructures might influence human and societal behaviour (Monteiro, 2000). The theory gained momentum from the beginning of the nineties, and has, according to Law (1999) spread to cover more areas of scientific research beyond STS, and is now as of 2007 used in a rather extensive area of scientific research, and has become maybe too transportable, ”tolerant” and ”simple” according to Law, who claims that this simplification of the theory has made it loose its ”capacity to apprehend complexity”, and that the theory not necessarily should be ”simple, clear, transparent” (Law, 1999: 8-9), referencing Marilyn Strathern[7] in that it sometimes is good to be puzzled and uncertain about the clarity of a topic or purpose of a topic. According to Law it is in the very resistance against simplicity that a possible succesful outcome of ANT exists.

5.2.2 Main concepts and vocabulary

In spite of Latour’s commments on ’the ridiculous poverty of the ANT vocabulary’ (1999a: 20), I nevertheless present the terms and concepts that after all do exist.

[7] Marilyn Strathern, *Improving Rating: audit in the British University system*, European Review, 5: 305-321. Referenced in Law, 1999:8

5.2.2.1 Actor / actant

Actors are "entities that do things" (Latour, 1992: 241). According to Latour, what actors are is less emphasized, it is the 'doing' bit, the character of action, that is the most important aspect. With the concept of 'actor' we understand specifically conscious beings, while the term 'actant' may comprise of all other worldly things of more or less autonomous nature. An actant is an entity without competence in itself, while an actor is "an actant endowed with a character" and competences (Akrich and Latour, 1992: 259), which are negotiated in processes of translation (see 5.2.2.3). This leads to the emergence of a heterogenous network with connected actors and actants that strengthen, influence and enhance, and depends on each other, through what John Law describes as 'heterogenous engineering' (Law, 1987: 113, Law, 1992) Callon describes this as a process where actor and network continuously redefine each other:

> "The actor network is reducible neither to an actor alone nor to a network. Like networks it is composed of a series of heterogenous elements, animate and inanimate, that have been linked to one another for a certain period of time [...] An actor network is simultaneously an actor whose activity is networking heterogenous elements and a network that is able to redefine and transform what it is made of" (Callon, 1987: 93)

Within the context of development work in computer science, for instance, an approved standard, ie. a programming language, is an actant that has an attributed competence in that it works as a common value among developers that work together, and so becomes an actor. An accepted standard has the capacity of mobilizing a network of heterogenous proponents to take action and be a starter or a maintainer of processes. Through a commonly accepted standard this network of aligned actors becomes settled. Everyone knows what to do according to standards, the only thing to consider are the processes of input and output, making the standard, in principle, a black box.

The second term or concept is 'network', which might be described as a group of actors and artefacts, and the relationship between them, and is decribed by Callon as "a group of unspecified relationships among entities of which the nature itself is undetermined" (Callon, 1993, p. 263, cited in (Stalder, 1997))

5.2.2.2 Network

In centre of Actor-Network Theory we find the idea of heterogenous networks, and according to Callon an actor network is at the same time an actor that networks, describes and translates the different heterogenous elements or entities, and a network that has the capability to change and transform its content (Callon, 1987: 93). This is also concurred by Law, who, in 'Notes on the Theory of the Actor-Network' (1992) writes that "an actor is a patterned network of heterogeneous relations, or an effect produced by such a network. The argument is that thinking, acting, writing, loving, earning -- all the attributes that we normally ascribe to human beings, are generated in networks that pass through and ramify both within and beyond the body. Hence the term, actor-network -- an actor is also, always, a network." (Law, 1992)

When using Actor-Network Theory as the theoretical foundation to analyze the social implications on the *further* evolvement of what must be considered as a fairly Large Technical System: the World Wide Web and its evolvement into an informationscape that also computers may 'comprehend', we ought to regard the society as a whole, and, as such, an entity of heterogenous links, aligning a network of humans and non-humans, and all the sub-networks, all in a relationship of dependency towards each other (Law, 1992). He claims that actors and actants exist in a mutually dependency, and that it is this relationship of dependency that shapes the social structures that come out of the exchange process between them.

5.2.2.3 Translation

Translation is the main occupation of an actor-network. The network translates ie. tools, experiences, observations, interests, skills, inscriptions, wishes and other artefacts of a social and technological nature into statements according to a specific argument. This is a procedure where 'heterogenous engineers" pick out, identify, and through the considering of the possibility of interaction, enrol other actors, thus making a forum for support, turning them into allies and, hopefully, constructing relevance in the process (Latour, 1997: 126, Law, 1987, Law, 1992, Callon, 1986: 6), making the actors interested in building and, maintaining, and also defending the network. Translations is thus progressive and negotiating process where both the actors' identities, the possibillities, and space of action are discussed and regulated (Callon, 1986: 8). Translations, as such, can therefore never be omitted, only hidden or diguised. According to Callon this translation process has four stages: problematisation, interessement, enrolment and mobilisation that in reality may overlap (1986: 6).

Problematization

The first stage in the translation process, problematization, describes a system of allies and relations between actors and actants of different value. Their identities and directions are defined by the 'joined forces' in the network in order to obtain a common goal. This part of the process centres around problem definition and how to construct actors that can be capable of attaining more powerful positions within the network, and thus might become more and more important until they obtain indispensability(Callon, 1986).

Regarding the Semantic Web, the problematization process has so far been centered around founding governing and standards issuing bodies, and the issue of defining a set of problems that many actors would gain from solving, and create a framework of common goals. The Semantic Web discourse, with all its complexity of groups of proponents and opponents, would demand a bit more than just a scientific framework. Interest must also be created in order to overcome the state of lock-in that the infrastructure has reached after years of exponential growth.

Interessement

The second stage in the translation process is interessement, which is the process of inducing and stabilizing the identity of the other actors that was originally picked out in the problematization stage. The process of interessement will seek to obstruct all probable rivaling associations and design a system of allies (Callon, 1986: 10). In order to bring ie. Semantic Web technologies to the world (or market), networks and alliances must be formed and ideas, values and possible prosperity for everyone that get enrolled into the network in contrast to those who choose to remain on the outside. The process of interessement means to distribute values, characteristics and tasks among the actors in the network. According to Tourain[8] the actor does not exist outside the network in which he enters. The actor's identity varies in relation with the relationships within the network. An interesting aspect of the Semantic Web, in this regard, is the technological specification of the URI[9], which might identify and link to not only an online hyperlink or artefact, but also a physical artefact or places, like ie. a restaurant or a dentist (W3C, 2006e). Does it reside outside the network or will it become an actor within the network through its URI-connection? The nature and inscriptions of URIs (ch. 7.1.4.1) leads me

[8] A. Tourain (1974), *Production de la Société*, Seuil, Paris. Referenced in note 30 in Callon, 1986.
[9] URI: Unified Resource Identifier

to the conclusion that the inscriptions of the URI will cause an actor to enter the network through the URI, which is in line with Tourain.

Enrolment

Enrolment, as the definition and coordination of the roles within the network, and how they are connected, is the third stage in Callon's model of translation and should ideally be the result of interessement, that is, alliances. However, according to Callon, "No matter how constraining the trapping device, no matter how convincing the argument, success is never assured", meaning that successful alliances not necessarily are the result of the interessement-process (1986: 10). In order to circumvent this possibility of a potential failure, Callon claims that "The issue here is to transform a question into a series of statements which are more certain", and he defines enrolment as an achievement of successful interessement, and "To describe enrolment is thus to describe the group of multilateral negotiations, trials of strength and tricks that accompany the interessements and enable them to succeed" (1986: 10).

Mobilization

The fourth and last stage of Callon's four stages of translation circles around the issue of who represents whom, and if the actors that act as spokespersons really are representative for the network (Callon, 1986: 12). This is analogue to the term 'competence' within the field of law, ie. not necessarily meaning the *knowledge* sense of the word, but the *mandate* to represent the network, even though knowledge probably would be the initial reason for being allowed to represent the network in the first place. This act of legitimization is important, since new actors from outside are being mobilized and attempted enrolled into the network. Actors that, ie. in the process of implementing Semantic Web standards and technologies into the set of standards and protocols of the existing Web, may sanction the technology and strengthen the network further, making it more difficult for opposing views to be heard, which might be difficult because of the Web's very open and heterogenous nature. The evolvement of the Web, and the technologies it is placed upon, has to a large extent been based on a meritocratic, open source-set of ethics. The new allied actors could be users, or companies that see the advantage of reusing their data in new and cost-effective ways possible only while making datasets semantically comprehendable by machines. The defining of the Obligatory Passage Point is part of the mobilization process. The Obligatory Passage Point may be actors, like ie. W3C and research and development communities that are in control of the technological resources. Within the World Wide Web discourse the OPP could be the internet governing bodies like W3C – World Wide Web Consortium, ISOC – Internet Society[10], IETF – Internet Engineering Task Force, IAB – Internet Architecture Board, and IANA – Internet Assigned Numbers Authority, or the joint venture entity of WSRI[11] as a research facility, to name some of them.

5.2.2.4 Inscriptions

Inscriptions describes how technical artefacts are endowed with specific patterns of future use. *Endowed* in this case does not necessarily refer to the artefact being physically inscribed by a physical action. Patterns of use are a result of negotiation and interpretation of anticipation, which is a significant part of development and deployment of technology. According to Akrich, it is in the process of negotiation that patterns of use are translated into a technological form, since we, methodologically, can not accept the view of only one side, the inventor or the user, alone. We must establish a back-and-forth communication ”between the designer's projected user and the real user”, in order to access the user's response and then, through negotiations and translations, acceptance. (Akrich, 1992:205-209, Hanseth and Monteiro, 1998)
According to Akrich, designers:

> ”define actors with specific tastes, competences, motives, aspirations, political prejudices, and the rest, and they assume that morality, technology, science, and economy will evolve in particular ways. A large part of the work of innovators is that of ”inscribing” this vision of (or prediction about) the world in the technical content of the new object.
>
> The technical realization of the innovators beliefs about the relationships between an object and its surrounding actors is thus an attempt to predetermine the settings that users are asked to imagine for a particular piece of technology and the pre-scriptions (notices, contracts, advice, etc.) that accompany it. (Akrich, 1992:208)

5.2.2.5 Black-boxing and complexities

According to Latour, the concept of blackboxing might be defined like: 'An expression from the sociology of science that refers to the way scientific and technical work is made invisible by its own success. When a machine runs efficiently, when a matter of fact is

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[10] ”The Internet Society (ISOC) is a professional membership society with more than 100 organization and over 20,000 individual members in over 180 countries. It provides leadership in addressing issues that confront the future of the Internet, and is the organization home for the groups responsible for Internet infrastructure standards, including the Internet Engineering Task Force (IETF) and the Internet Architecture Board (IAB)” http://www.isoc.org/isoc/index.shtml. Last updated: 11th July 2007. Accessed: 12th July 2007.
[11] WSRI: The Web Science Research Initiative is a collaboration between the Computer Science and Artificial Intelligence Laboratory at MIT and the School of Electronics and Computer Science at the University of Southampton. Source: http://www.webscience.org/about/

settled, one needs to focus only on its inputs and outputs and not on its internal complexity. Thus, paradoxically, the more science and technology succeed, the more opaque and obscure they become' (Latour, 1999b: 304).

Regarding development work in computer science this might seem slightly oxymoronic when working with standards. According to this, an accepted standard could very well be a settled actant, a routine blackbox, since the containment of a black box no longer needs reflections and translations. The metaphor itself stems from cybernetic science indicating a piece of technology that is self contained, that "runs by itself", and that mainly is too complicated to continously be reflected upon. A TV is such a black box. We don't have to know how the TV works, or the vast complexity in network of actors and actants needed for it to work, in order to watch the programs that are broadcasted. The vast majority does not have a clue, they just push the ON-button. Almost *everyone*, in the literal sense of the word, can in one way or another, relate to the television, while the technology itself is, to a large extent, incomprehensible for most people. It is beyond the scope of this thesis to present scientific material or literature about the television as a cultural artefact, but we will probably not need that much scientific material in order to get a notion of the penetrational forces of the television as a cultural medium within the western modernity. We might say that while television has completely penetrated the western society, and most other societys that have access to electric power as well, the science and technology that made it happen, and which appear stable and secure, is incomprehensible by most people. This is in line with Latour's claims from the paragraph above about successful technology becoming opaque and obscure (1999b: 304) and therefore makes a black box difficult to redefine, and subsequently hard to change.

There is however exceptions, and one of them is software programming. A piece of software, that in principle is a black box, and as such should be settled, is opened and negotiated over and over during bugfixing, and after upgrading it once again becomes a sealed black box. The user interface of a software is another example of a black box, as it is hiding a network of actors and actants of logical complexities.

We might conclude that the strength and stability of a black box depends on the level of complexity it conceals, and on the amount of work and costs of reopening or redefining it.

Complexity

According to Mol and Law (2002) a simple definition of complexity could be: "There is complexity if things don't add up, if events occur but not within the progress of linear time, and if phenomena share a space but cannot be mapped in terms of a single set of three-dimensional coordinates"

The blackboxing feature of ANT facilitates the ability to pack and unpack complexities (Monteiro, 2000: 82) in and out of indifference or comprehension, ie. to describe granularity in networks in that an actor can also be a network in itself, whether it is a machine or a group of scientists that, as a group, is regarded as one entity, and unpacking this actor reveals a network of individual actors. This technique offers an assumably high degree of precision when describing processes of socio-technical change, ie. like the introduction of new ways of relating to online material as the Semantic Web undoubtedly will lead to.

Another, and perhaps more important, aspect of blackboxing, when it comes to the evolvement of the Semantic Web, is the development of user interfaces. As I will later discuss, the possibility that the rather slow evolvement of the Semantic Web, and its related applications comes from the the fact that most of the work hitherto done on technologies related to the Semantic Web comes mainly from academic institutions, and are directed towards not even early adopters, but experts, especially experts within the field of knowledge representation.

5.2.2.6 Critique of ANT

One of the criticisms against actor network theory is that proposes equaltiy between all actors in the network, human and non-humans alike, without regarding already existing structures in the network, instead seeing these as consequences of ongoing processes among the actors in the network.

As mentioned in chapter 5.2.1, Law (1999: 4) describes the term itself as an oxymoron, with the tension between the centered 'actor', and the decentered and technically metaphorical 'network'. As of 2007 it is used in a rather extensive area of scientific research, and Law (1999) describes the theory as having become maybe too transportable, 'tolerant' and 'simple' and that this simplification of the theory has made it loose its "capacity to apprehend complexity".

5.3 Information Infrastructures – key definitions

The concepts of Information Infrastructure as conceptualised by Ciborra (Ciborra, 2000), and Hanseth and Monteiro (1997, 1998) is comprised of components of a socio-technical character that make it a shared, evolving, open, standardized and heterogenous installed base (Hanseth, 2002a). According to Hanseth and Monteiro (1998) the historical conceptualisation of information infrastructure may be regarded as a combination of information and infrastructure technologies, and as a result, an evolutionary step for both, in that it was originally introduced in order to separate an actual underlying network/infrastructure from the applied services utilizing them, while computer use in organisations grew more and more complex. An information infrastructure differs from an organizational or interorganizational distributed information system in that it is larger and more complex, in addition to also being more diverse because of its evolving nature and heterogeneity. According to Monteiro "An information infrastructure is an aligned actor network." (2000:79)

In ch. 5.2.2.5 I argue that also software, that has become more and more integrated, might be regarded as a network, and thus also an infrastructure, although there also might be software that is small and not participate as an actor in the network (Hanseth, 2002a).

5.3.1 Shared

As cited in Hanseth (2002a) the Webster dictionary defines an infrastructure as "a substructure or underlying foundation; esp. the basic installations and facilities on which the continuance and growth of a community, state, etc. depends as roads, schools, power plants, transportation and communication systems, etc." (Guralnik[12] in (Hanseth, 2002a)). This definition underlines the aspect of shared resources, and as such, the Internet match this definition. Hanseth also describes large collections of applications or information systems that would fit this description of a shared resource, but it would be somewhat outside the scope of this thesis to discuss these.

5.3.2 Evolving

Since another key characteristic of an information infrastructure is that it never starts from scratch, but always are built upon existing infrastructures, one main feature of an information infrastructure, is its continuous evolving (Hanseth, 2002a). A new and useful web-service, that become included and integrated in the network, would improve the

[12] Guralnik, D. B. (ed.) (1970) Webster's New World Dictionary of the American Language. New York, The World Publishing Company, referenced in Hanseth, 2002a.

value of the already existing infrastructure. The Semantic Web would be an example of such an evolvement. It is not developed from scratch, but build on top of the infrastructures of the Internet and the World Wide Web as a natural continuity.

5.3.3 Open

According to Hanseth, there should be no limits to an information infrastructure as to the number of elements that may be incorporated in the infrastructure, whether these are users utilizing the infrastructure in a potentially unlimited number of ways, the infrastructure should also be open in the sense that there should be no limits regarding the number of participants or contributors to the actual design and take advantage of the infrastructure. In accordance with its evolving nature an information indfrastructure should have no beginning nor end, leading to an open-ended development period (Hanseth, 2002a). Again the Semantic Web comes forward as the epitome of a no-border openness in that it ideally stretches from the "virtual" into the "real", not only as it is thought to do so, but technologically it facilitates the possibility to directly link from a specific place on the Web to a specific artefact in the world of bricks and mortars (IETF, 2005).

5.3.4 Standardized

According to Hanseth and Monteiro we need to understand the role of standards as a "highly complex socio-technical negotiation process", and how we must be able to categorize and systematize in order to understand the role of standards in order to develop information infrastructures (1998:55). Citing Hawkins they boil it down to "Communication systems cannot function without standards"[13], and describe the need for classification and conceptualization in order to perceive the degree of importance that standards play in the development of information infrastructures (1998:55). I will connect this to the establishment of the different Semantic Web work groups within the W3C (ch. 7.1.1.1) and the foundation of the Web Science Research Initiative (see 7.1.2). The process of black-boxing, mentioned in ch. 5.2.2.5, could greatly benefit from the implementation of standards, since this includes a simplification of what else would be complex implementation processes (Hanseth and Monteiro, 1998:56).

5.3.4.1 Internet standards

The Internet, which in RFC 2026 is described as "a loosely-organized international collaboration of autonomous, interconnected networks" that "supports host-to-host

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[13] Hawkins, 1996 referenced in Hanseth and Monteiro, 1998:55

communication through voluntary adherence to open protocols and procedures defined by Internet Standards" [14] materialized as a "public communications medium" during the 1990s (Abbate, 1999:180). The most noted standards are TCP (RFC 675), IP (RFC 791), HTTP (RFC 2616), FTP (RFC 969), URL (RFC 1738), URI (RFC 3986), DHCP (RFC 2131) among many. As of 29 th. August 2007 there were 1040 proposed Internet standards[15]. An Internet standard may be described as a set of guidelines, specifications and methodologies, that, after a period of innovation and development within a working group or community initiated by the Internet Engineering Steering Group (IESG) is approved as an open standard by the Internet Engineering Task Force (IETF) or another relevant actor or body. The development process of a new Internet standard goes through several stages and is in a universalistically manner fairly simple. Experience has shown, once again that, in practice, the process is a bit more complicated. According to RFC 2026 (p. 3) the reasons for this are "due to (1) the difficulty of creating specifications of high technical quality; (2) the need to consider the interests of all of the affected parties; (3) the importance of establishing widespread community consensus; and (4) the difficulty of evaluating the utility of a particular specification for the Internet community."

Internet Draft

Before a possible new Internet Standard can enter the so-called *standards track* as a proposed standard, initial versions are made available among the Internet community in the IETF's "Internet-Drafts" directory on a number of hosted servers, for informal comments and reviews. This distribution facilitates the peer-review process that could lead to the publication of an Internet draft as an RFC. If the proposed Internet-Draft is left uncommented and unchanged in the IETF's "Internet-Drafts" directory and its mirrors for more than six months, the draft is retracted. An Internet-Draft may be replaced by a more recent version, prolonging the six month period. At this stage the proposed standard is regarded as a work in progress, and should not be referenced by papers, reports, or be the target of compliance.[16]

Proposed Standard

After a six-month period with peer-review, the entry level for an RFC as a possible Internet Standard is as a *proposed standard* which already is regarded as a stable technology that has been sufficiently commented and reviewed by the actors in the

[14] http://www.ietf.org/rfc/rfc2026.txt. [Accessed: 28/08/2007]
[15] Source: http://www.rfc-editor.org/rfcxx00.html#Proposed. [Accessed: 29/08/2007]
[16] RFC 2026, p. 8. http://www.ietf.org/rfc/rfc2026.txt.

developing network to be considered as a constructive and advantageous specification, but still liable to change or maybe also withdrawal. Although a proposed standard is regarded as stable, well-understood and a valuable specification that formally do not require implementation or operational experience, it is recommendable that a process of implementation and experience are carried out in order to test and validate the specification, and that the proposed standard, initially, is to be regarded as immature until it is either retracted, or advances further through the set of maturity levels, also known as ”standards track”. At this stage it is not recommended to deploy an implementation based on this standard.

Draft Standard

To become a *draft standard*, a proposition has to be well understood, represent stable meaningfulness, and be regarded as a foundation for a further development towards an implementation. The basis for this level of maturity rests on the fact that it is required that at least two independent and interoperable implementations from different sets of codes have been developed. Although a Draft Standard is regarded as a final specification, it can be required that it undergoes additional field testing, even if changes at this stage are presumably carried out mainly to solve and work out late encountered problems. According to the RFC 2026, it would, in most circumstances, be ”reasonable for vendors to deploy implementations of Draft Standards into a disruption sensitive environment” [17].

Internet Standard

Having gained ”significant implementation and successful operational experience”, and reached a high level of technological maturity in addition to be regarded as a significant contribution and benefit to the Internet community, a Draft Standard may advance to become an Internet Standard, and will be assigned a number in the STD-series in addition to the RFC number that is retained[18].

5.3.4.2 W3C Recommendations

The process of releasing Recommendation from the World Wide Web Consortium complies with the following track[19] and is constructed to reach consensus about every

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[17] RFC 2026, p. 13. http://www.ietf.org/rfc/rfc2026.txt.
[18] RFC 2026, p. 14. http://www.ietf.org/rfc/rfc2026.txt.
[19] Source: http:// http://www.w3.org/2003/06/Process-20030618/tr.html#maturity-levels.
[Accessed: 24/10/2007]

aspect and contents about a technical report, secure "high technical and editorial quality, and to earn endorsement by W3C and the broader community:
[Procedure: (Source: see note 19)]

Working Draft (WD)

A Working Draft is a document that W3C has published for review by the community, including W3C Members, the public, and other technical organizations.

Candidate Recommendation (CR)

A Candidate Recommendation is a document that W3C believes has been widely reviewed and satisfies the Working Group's technical requirements. W3C publishes a Candidate Recommendation to gather implementation experience.

Proposed Recommendation (PR)

A Proposed Recommendation is a mature technical report that, after wide review for technical soundness and implementability, W3C has sent to the W3C Advisory Committee for final endorsement.

W3C Recommendation (REC)

A W3C Recommendation is a specification or set of guidelines that, after extensive consensus-building, has received the endorsement of W3C Members and the Director. W3C recommends the wide deployment of its Recommendations. Note: W3C Recommendations are similar to the standards published by other organizations.

5.3.5 Heterogeneity

In the article "From systems and tools to networks and infrastructures - from design to cultivation", Hanseth (2002) defines heterogeneity in an information infrastructure as comprised of many elements of different characters, human as well as non-human, technical as well as non-technical, and also social and organizational, making them into a socio-technical network rather than just a technological one. This is also described in the National Information Infrastructure white paper by the Clinton/Gore administration from 1993[20], as encompassing all media-recording, -transmitting, -processing and -displaying artefacts, both hardware and software, together with the information itself and relevant media, describing infrastructures as "connected and interrelated, constituting *ecologies of networks*", and "layered upon each other just as software components are layered upon each other in all kinds of information systems" (Hanseth and Monteiro, 1998):43-44. I will discuss this type of layered infrastructure in the decription of the Semantic Web infrastructure in ch. 8.2.

[20] http://www.ibiblio.org/nii. [Accessed: 20/06/2007]

Part of its heterogeneity is founded in its evolving nature; infrastructural layers are built on top of each other. An information infrastructure will therefore, according to Hanseth, also include subinfrastructures for instance in the form of different versions of a standard during [long] periods of change, or standards that may overlap one another.

5.3.6 Installed base

According to Hanseth, infrastructures in terms of an installed base can never be developed from scratch, it is a key characteristic that they are always being developed as an extension of an already existing one. This means that all changes and improvements to an infrastructure has to comply with the existing standards of that infrastructure. This implies that an existing infrastructure to a very large extent decides how a new addition to the infrastructure might be designed, and by that also how it may evolve over time (Hanseth, 2002a). The time factor is an important aspect in the construction of large infrastructures. As mentioned by Hanseth and Monteiro (1998), all elements and artefacts within an infrastructure are linked together, implying that in order to facilitate evolvement of an infrastructure, the installed base must be cultivated, which in turn implicitly considers an infrastructure as already existing.

5.3.6.1 Standardisation vs. flexibility

In order to develop existing information infrastructures, the development work has to comply with the already existing installed base of hardware, software, protocols and standards to ensure backward compatibility (Ruhleder and Star, 1996). The different actants are mutually dependent of each other to a varying degree, and would necessarily be a target for change from time to time. That means that there must be some degree of flexibility among these actants within the infrastructure. Hanseth, Monteiro and Hatling present a scenario where it is necessary, when designing an information infrastructure, to prepare for the infrastructure to change, in that most of the components that comprise the information infrastructure fluctuate between stability and change (Hanseth et al., 1996).

This is a rather important aspect regarding the further evolution of the WorldWideWeb into the Semantic Web, where the mark-up language has developed from HTML to XHTML to XML which had a sufficiently strong specification to become the foundation for the core semantic protocol for the Semantic Web; RDF (ch. 7.1.4.4)[21] In order to ensure some kind of compatibility with aleady existing protocols and languages, the

[21] RDF info page, W3C: http://www.w3.org/RDF/. [Accessed: 01/05 – 31/08/2007]

W3C has released other recommendations like SPARQL (7.1.4.7) and GRDDL (7.1.4.8)

5.3.6.2 Bootstrapping

Bootstrapping is characterized by an evolutionary design method, building an infrastructure or network bit by bit, one module after another, starting with the simplest one, enroling early adopters before the rest of the community, and little by little letting basic network economics work (Hanseth, 2002a, Hanseth and Aanestad, 2002).

5.3.7 Network externalities

This notion of network externalities, based on the implementation of standards, which means that an added value is being contributed to the network or installed base as it grows in the way that the larger the installed base gets, the more attractive it becomes to both join, and to offer new services to it, which in turn will reinforce the installed base making it grow even further (Katz and Shapiro in (Liebowitz and Margolis, 1994)), as illustrated in figure 5-1. Positive network externalities would lead to increasing returns, for instance would the value of Semantic Web technologies increase as larger parts of the Web community would invest in deploying the technology, producing more ontologies and mark up more of the information with RDF tags. When more people are involved in this, the level of service, and by that the returns, would increase proportionally, leading to a situation where an already large installed base becomes even larger, in a self-reinforcing process of cultivation, while a smaller installed base, because of the same proportionality therefore experience a weaker, or non-existing reinforcing value, becomes smaller.

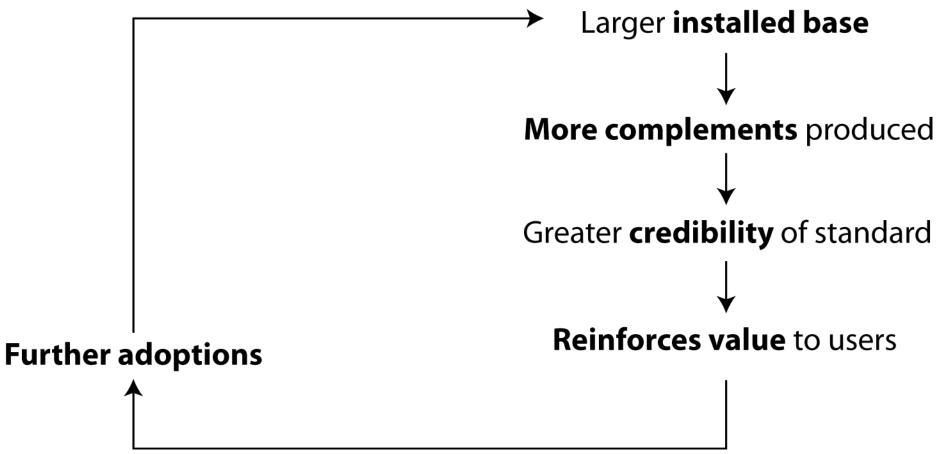

Figure 5-1 Standards reinforcements mechanism

Source: Grindley (1995) as referenced in Hanseth (2001:62)

5.3.8 Irreversibility and lock-in

Information infrastructures are, as pointed out by Hanseth and Monteiro, large actor-networks, that is "systems architectures, message definitions, individual data elements, standardisation bodies, existing implementations of the technology being included in a standard, users and user organisations, software vendors, text books and specifications" (Hanseth and Monteiro, 1998:148).

6 Method

Due to the nature of the case objective, the field research has been carried out as a qualitative study of online material, and the gathering of emprical material about the different working groups at W3C and the standards and core technologies they have been responsible for developing, in addition to central technologies and the best practices that has been established within the Web 2.0 paradigm. The goal has been to look at aspects attached to the development work within the Semantic Web paradigm, that could explain why it has not yet really become the "next big thing", as Tim Berners-Lee and the proponents maybe had hoped for, even if much has happened the last few years. During this process I discovered that what had instead taken the lead, not only in the media but also among a fairly large part of the web community, was a collection of technologies that compared to Semantic Web research and standards development, looked rather quick and dirty: the so-called Web 2.0 as mentioned in the previous chapter. Since the term Web 2.0 has caused some controversy in regards to how it is to be defined, I have gone to what I regard as the sources of the term, which is O'Reilly Media.[22]

Delimitations

The field of interest is huge, and it has been difficult but necessary to delimit the area of study to where these paradigms meet and interact.

The sources and references used in this thesis follows this typical pattern: most references that are connected to the field of information infrastructure and Actor-Network Theory are gathered from printed resources, that is printed articles and books, while most of the references connected to the actual field of study, that is Semantic Web, Web 2.0 and the infrastructure they might have in common, are gathered from online material.

Problem

This is problematic largely due to the very amount of information that is available, which makes information management difficult, but also the volatile nature of the medium itself, which is in line with Hanseth and Monteiro's (1998) description of an information infrastructure as, among other things, a shared, open, evolving, heterogenous actor network. This, of course, makes it hard to stay focused, and maybe an online

[22] http://www.oreilly.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html.

research study has to evolve with the medium it is supposed to study. The fact that both the actual field of study, socio-technical aspects in the junction between Semantic Web and Web 2.0, seeks to describe some of the fastest evolving infrastructures on the World Wide Web today while it is happening, and the medium that had to be used in order to do so, also is changing character extremely fast, has made this research study into something almost like chasing air, chasing something that is all around you.

One of the main online sources, has been the W3C's own website[23], where all of the standards, or parts of standards, or more correctly Recommendations, within the field of study have originated, and are being maintained, in addition to being the main collaboration space for the many working groups within the organization.

Other online sources have been what I would regard as main knowledge centres, like conference websites, scientific publisher web sites, academic online journals and smaller web sites maintained by acknowledged resource persons within the web community.

[23] http://www.w3.org

7 Empirical material

7.1 Semantic Web

Semantic points to the *meaning of*, that the *semantic* of a given something is the *meaning* of that something, ie. describing things and their properties for instance like Martha is 31 years old, weighs 65 kg, is 1,79 m tall and has red hair, and the relation between them, like Martha is a member of Apple's European Software Alliance team which in turn is a part of BSA, Business Software Alliance which in turn is a global organisation that works against software piracy, in a way that computers might comprehend, and is not focusing on hyperlinks between different places on the Web, but may rather link between resources that are categorized with the help of ontologies.
In the following, I will describe the different technologies as different interoperable standards, and the difficulties with which we attempt to accomplish the interoperability they give, from an information infrastructure point of view as this is described by Ciborra and Hanseth (Ciborra, 2001, Hanseth, 2001) and through the vocabulary of ANT describe the interdependencies between vision, strategy and infrastructure as this is presented by Callon; Hanseth, Aanestad and Berg; Latour; and Monteiro (Callon, 1986, Callon, 1991, Hanseth et al., 2004, Latour, 1997, Latour, 1999b, Monteiro, 2000).

The Semantic Web represent a common foundation in order to allow the sharing and reusing of data across both application and network boundaries. The research and development work that is endeavored by a large group of research facilities and partners is managed by the W3C. The Semantic Web is based on the Resouce Description Framework (RDF), (W3C, 2001-2007b).

After a rather slow and almost reluctant beginning, the amount of research, publishing of papers and semantic web conferences is now, and has been since early 2005, steadily increasing. One of the reasons for initial the slow start could be that there were few relevant standards to adhere to in the beginning. The W3C released the main formats for the Semantic Web, RDF and OWL, in February 2004 (see Appendix 11.3, W3C Press release[24]). In the press release, the W3C annonunced that the release of the two Semantic Web standards, which would provide:

[24] Source: http://www.w3.org/2004/01/sws-pressrelease.html.en. [Accessed: 20/09/2007]

> ”a framework for asset management, enterprise integration and the sharing and reuse of data on the Web. These standard formats for data sharing span application, enterprise, and community boundaries - all of these different types of "user" can share the same information, even if they don't share the same software.

Which would mark the start of the Semantic Web as also a commercial platform for the Web as a data oriented Web, and according to the W3C it also signals:

> ”transition of Semantic Web technology from what was largely a research and advanced development project over the last five years, to more practical technology deployed in mass market tools that enables more flexible access to structured data on the Web.”

(Press release URL: http://www.w3.org/2004/01/sws-pressrelease.html.en. [Accessed: 20/09/2007]

A visible sign of an increased activity among the developer community is the trend reflected in the amount of activity in the Semantic Web mailing list. If we look at the number of postings at the W3C Semantic Web mailing list from 2000 and up until present where, as of 31th July 2007, there have been a total of 5.527 postings, of which only 145 messages were posted between March 2000 and February 2005, which means that the list had an average *monthly* posting rate at 3,5 messages, where many of the postings were not about Semantic Web topics but invitations to various conferences, not all connected to the Semantic Web discourse. In February 2005, this had increased to 132, and in March the number of postings was 266. As we can see in the figure, the activity suddenly multiplicated many times and became unstable higher, and the highest activity so far seems to be *right now*.

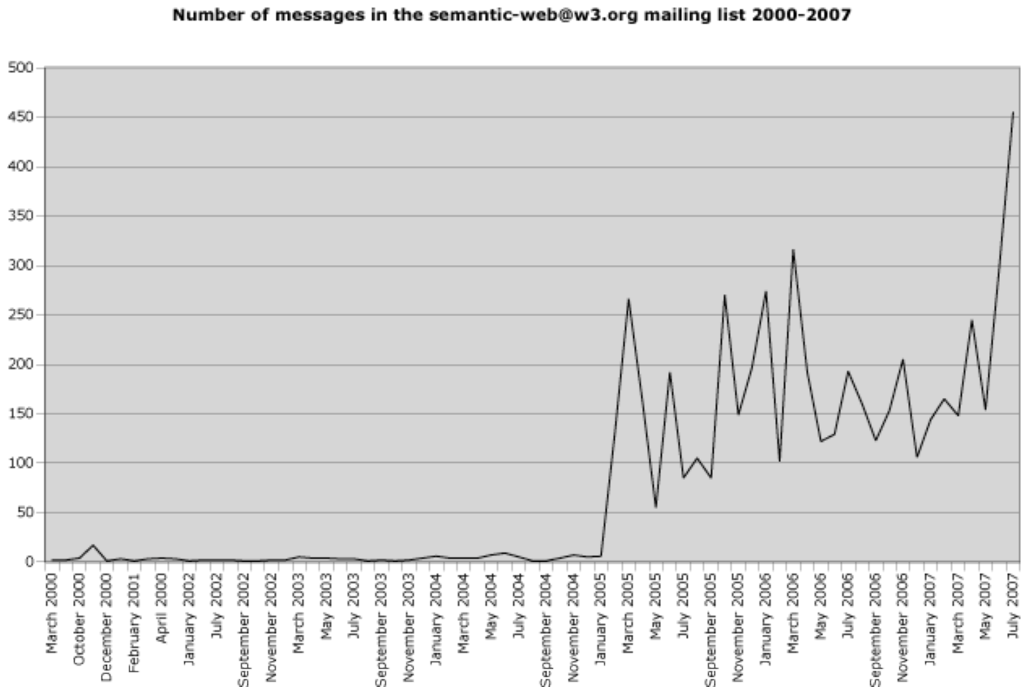

Figure 7-1. Number of postings on the W3C's Semantic Web mailing list

The figure shows a graphical representation of how the mailing list activity on the W3C mailing list has evolved from 2000 to 2007, with a distinctive shift in beginning of 2005, when the RDF and OWL specifications had been W3C standards for about a year.

7.1.1 Central actors

In following sub-chapters I will describe the main organizational actors within the Semantic Web discourse, how they are problematized, their main activities, and, where relevant, how they are related to each other and other R&D environments

7.1.1.1 W3C

The W3C is mainly occupied with the production of Web standards, which is not called standards but recommendations. The organization is also developing software, and acts as an open discussion forum about all things Web. On the Consortium's "About"-page it says that: " The World Wide Web Consortium achieves its mission by bringing diverse stake-holders together, under a clear and effective consensus-based process to develop high-quality standards based on contributions from the Membership, Team, Offices, and public. [...]

The W3C Team includes more than sixty researchers and engineers from around the world who lead the technical Activities at W3C and manage the operations of the Consortium."[25]

7.1.1.2 Semantic Web Activity

In its Semantic Web Activity Statement the W3C declares the goal of the Semantic Web initiative as:

> "… to create a universal medium for the exchange of data. It is envisaged to smoothly interconnect personal information management, enterprise application integration, and the global sharing of commercial, scientific and cultural data. Facilities to put machine-understandable data on the Web are quickly becoming a high priority for many organizations, individuals and communities.
>
> The Web can reach its full potential only if it becomes a place where data can be shared and processed by automated tools as well as by people. For the Web to scale, tomorrow's programs must be able to share and process data even when these programs have been designed totally independently. The Semantic Web Activity is an initiative of the World Wide Web Consortium (W3C) designed to provide a leadership role in defining this Web. The Activity develops open specifications for those technologies that are ready for large scale deployment, and identifies, through open source advanced development, the infrastructure components that will be necessary to scale in the Web in the future." (W3C, 2001-2007c)

7.1.1.3 Technical Architecture Group (TAG)

The TAG group was founded in order to establish and document consensus regarding patterns and principles of Web architecture, and to be a resource group in defining and interpreting these when necessary, and give assistance in the coordination work regarding developments within architectural cross-technology that span several work groups, both within the W3C and external(W3C, 2004).

The TAG coordinates its work with both external groups and groups within W3C. According to the groups charter all "W3C Working Groups are expected to follow the Architectural Recommendations. If a Working Group intends to contradict an established Architectural Recommendation in a technical report, the group is expected to identify which principles are being contradicted and to provide technical rationale for the decision (e.g., the principle is wrong or conformance is impossible)" (W3C, 2004).

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[25] http://www.w3.org/Consortium/org. [Accessed: 30/10/2007]

7.1.1.4 The W3C Process Document

The W3C Process Document is written by the W3C Advisory Board and "peer-reviewed" by the W3C members and teams. The document presents the structure of W3C and the specification driven processes that are related to the organization's work and responsibilities as a governing body.

An expanded table of contents (See Appendix 11.2) reveal a quite large standardization body, which, as discussed in ch. 8, add a certain amount of complexity, as this is described by Hanseth and Aanestad (2002), to the Semantic Web development project.

7.1.1.5 Semantic Web Coordination Group

In order to control the Semantic Web Activity which includes the work done by the groups described in the following sub-chapters, the W3C has founded the Semantic Web Coordination Group. In its charter the intention and the area of relevance of the group is described to be an "advisory forum for the Semantic Web Activity", to serve as a coordinator and facilitator of the work done by the W3C work groups in order to steer clear of overlapping efforts and of possible forking of Semantic Web technology, avoiding the development of incompatible standards, and to maintain a place for organizing and controlling the relations and connections in this network, that not only consists of W3C work groups, but also organizations outside the W3C that are working on Semantic Web and related technologies although the predominant focus is on maintaining contacts with the groups within the W3C. (W3C, 2006d).

7.1.1.6 Semantic Web Deployment Group (SWDWG)

"The Semantic Web Deployment Working Group provides "consensus-based guidance in the form of W3C Technical Reports on issues of practical RDF development and deployment practices in the areas of publishing vocabularies, OWL usage, and integrating RDF with HTML documents" (W3C, 2006c). This means that the main purpose of the SWDWG is to provide practical directions for Semantic Web users in how to publish their data and meta-data utilizing the standard protocols and formats that comprises the Semantic Web.

The communication and ongoing work done by the members of the group is carried out by the use of a mailing list public-swd-wg@w3.org, teleconferences and face-to-face conferences, which are publicly available through the list itself and associated web-archives, although the conferences themselves are not. Observers and experts[26] may be invited to attend. In addition the group has its own irc-channel, #swd. The public may also participate in the mailing list discussions. The group may split into special parallel working ”task forces”. The group is collectively responsible for the work done by the task forces (W3C, 2006c). The fact that the public has the ability to directly participate in the mailing list discussion follows the the open tradition that has been one of the characteristics of the work done, both by the working groups involved in the development of the Internet, and later the World Wide Web. The archives are made available through the group's homes page[27] which gives updated information about membership lists, meetings, schedule and status of recommendations, and other resources.

7.1.1.7 RDF Data Access Working Group

The RDF Data Access Working Group's main task is to examine the needs for a query language and networking standards for RDF in addition to define formal and validated specifications and cases for the support of these underlying demands. The group was formed in February 2004, and arranged their first face-to-face meeting in April the same year[28]. This work has so far led to the release of the SPARQL query language for RDF 14th June 2007, after having published the first draft of this protocol the 12th October 2004.

7.1.1.8 Web Ontology Language Working Group

The group was formed September 2007. The group has so far communicated via weekly teleconferences. Their first face-to-face meeting is scheduled for December 6-7, 2007.

According the the group's charter, the group is to develop a W3C Recommendation that further extends and refines the Web Ontology Language.

Relations to other groups, as this is presented on the groups charter web site:[29]

- Semantic Web Coordination Group.
  To ensure synchronization with all other Working and Interest Groups in the Semantic Web Activity
- Rule Interchange Format (RIF) Working Group.
  To help produce the RIF Working Group deliverable on using RIF with OWL

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[26] The W3C has its own policy for the approval of Invited Experts, which can be found here: http://www.w3.org/2004/08/invexp.html. See also appendix 11.6

[27] http://www.w3.org/2006/07/SWD/. Accessed: [28/08/2007]

[28] The agenda for the first meeting, held in Amsterdam can be obtained here: http://www.w3.org/2001/sw/DataAccess/ftf1. [Accessed: 11/10/2007]

[29] http://www.w3.org/2007/06/OWLCharter.html. [Accessed: 1/10/2007]

and generally avoid unnecessary difficulties for users working with RIF and OWL in combination

- Semantic Web Deployment Working Group.
  To assist with questions concerning the interactions between OWL and Simple Knowledge Organisation System (SKOS)
- Semantic Web Education and Outreach Interest Group.
  To synchronize possible OWL 1.1 outreach issues
- Semantic Web Health Care and Life Sciences Interest Group.
  To consider the use case requirements possibly raised by the HCLS community when defining the various OWL 1.1 extensions
- XML Schema Working Group.
  To ensure that the possible datatype support of OWL 1.1 is not incompatible with the XML Schema datatypes
- Technical Architecture Group.
  To work with the group to ensure that the design is consistent with general Web architectural principles

Point 6, about decision policy, in the group's charter says:

> **Decision Policy**
> As explained in the Process Document (section 3.3), this group will seek to make decisions when there is consensus. When the Chair puts a question and observes dissent, after due consideration of different opinions, the Chair should record a decision (possibly after a formal vote) and any objections, and move on.

- When deciding a substantive technical issue, the Chair may put a question before the group. The Chair must only do so during a group meeting for which the agenda indicated the possibility that a decision on that particular issue might be made. When the Chair conducts a formal vote to reach a decision on a substantive technical issue, eligible voters may vote on a proposal one of three ways: for a proposal, against a proposal, or abstain. For the proposal to pass there must be more votes for the proposal than against. In case of a tie, the Chair will decide the outcome of the proposal.
- This charter is written in accordance with Section 3.4, Votes of the W3C Process Document and includes no voting procedures beyond what the Process Document requires.

7.1.1.9 Semantic Web Interest Group

This Group is mainly concerned about how the Semantic Web is going to be developed and utilized, and supersedes the RDF Interest Group. This group is formed to offer support to both users and developers of Semantic Web technologies, and both members and non-members of the W3C, with an emphasize on offering a supportive framework for developers in creating "vocabularies and applications to support a Web data marketplace combining harvesting, syndication, metadata and Web Service techniques" (W3C, 2004-2006). The Semantic Web technologies that are of a particular focus is

RDF, OWL and SPARQL. The group's web page was last updated the 23rd May 2007. Since then the W3C has released the GRDDL specification as an official W3C Recommendation, on the 11th September 2007, which is a mechanism for extracting data from existing web documents [30].

The framework offered by the group to help developers cooperate consists of spaces for email discussions mainly through the group's public mailing list, but also the IRC-channel #swig via the Freenode network[31], which is a provider of discussion and communication facilities for the developer communities within the Free Software and Open Source paradigm, and for non-profit organizations and the like[32].

7.1.1.10 Rules Interchange Working Group

This group's main task is to determine a standard for rules format in order for them to be aligned across various systems. This format will work as a gateway between old and new rule languages, making it possible for rules written for various applications to shared and re-used by other rule based artefacts, ie. other applications and rule implementations.

Information from the group's web site[33] describes this group's mission as a part of W3C's broader intention of making information sharing more suited for machine processing. This was presented as:

- Rules themselves represent a valuable form of information for which there is not yet a standard interchange format, although significant progress has been made within the RuleML Initiative and elsewhere. Rules provide a powerful business logic representation, as business rules, in many modern information systems.
- Rules are often the technology of choice for creating maintainable adapters between information systems.
- As part of the Semantic Web architecture, rules can extend or complement the OWL Web Ontology Language to more thoroughly cover a broader set of applications, with knowledge being encoded in OWL or rules or both.
  (Source: http://www.w3.org/2005/rules/wg/charter.html
  [Accessed: [29/08/2007]

[30] Sources: http://www.w3.org/2001/sw/interest/ and http://www.w3.org/TR/grddl/. [Accessed: 18/10/2007]
[31] irc://irc.freenode.net/swig. [Accessed: 18/10/2007]
[32] Source: http://freenode.net/ [Accessed: 18/10/2007]
[33] http://www.w3.org/2005/rules/wg/charter.html [Accessed: 20/10/2007]

7.1.1.11 Gleaning Resource Descriptions from Dialects of Languages Working Group (GRDDL)

The GRDDL Working Group is a part of the Semantic Web Activity, and released the first draft of the GRDDL specification in October 2006. The specification was officially released on September 11th 2007.

The group's goal is to add a process of relating different XHTML syntaxes in documents to RDF syntax, by extracting resource data from the documents.

The group's charter states that: "The Gleaning Resource Descriptions from Dialects of Languages (GRDDL) specification aims to supplement the RDF/XML concrete syntax with a flexible mechanism for using other XML syntaxes with the Resource Description Framework. It binds XML documents, especially XHTML documents, XHTML profiles and XML namespace documents, to transformations (typically in XSLT) that relate their syntax to RDF/XML. A body of supporting software is developing, as well as a community of users" (W3C, 2006b)

7.1.2 WSRI

Web Science Research Institute[34] is a the result of the research collaboration between MIT CSAIL[35] and University of Southampton, and according to Tim Berners-Lee "The Web Science Research Initiative will allow researchers to take the web seriously as an object of scientific inquiry"[36] The institute is founded in order to generate a forum for web research and for comprehending the social, technical and scientific mechanisms regarding the evolution of the Web.

7.1.3 Data about data - Metadata

Within the Semantic Web discourse, metadata is information that describes resources on the web. A key notion concerning the definition of metadata, within the Semantic Web discourse is that it is machine readable, and may refer to any page or resource that has a URI[37]. This implies that metadata will be crucial in building semantically rich applications on the web (Berners-Lee, 1997). It is also rather understandable that there has to be a standardized format for how we are to express information about data for the

[34] http://webscience.org/node/35. [Accessed: 10/08/2007]
[35] MIT CSAIL: MIT Computer Science and Artificial Intelligendce Laboratory
[36] http://web.mit.edu/newsoffice/2006/wsri.html. [Accessed: 10/08/2008]
[37] URI: Universal Resource Identifier

many different areas that require it. The Dublin Core Metadata Initiative is one of the organizations occupied with making metadata standards available for a wider community, in addition of developing vocabularies of standardized, interoperable, specific metadata with the goal of being able support "more intelligent information discovery systems" [38].

7.1.4 Standards

At the core of the Semantic Web concept lies the prospect of machin-to-machine-interoperability. In order to realize this, one needs to develop the tools for using and reusing (publish and republish) data in a dynamic, interoperable manner in order for an information infrastructure like this to evolve. To achieve this, the dynamics and continued heterogeneity and interoperability require a set of standards, languages/protocols and rules for the sharing of information, knowledge and meaning. In the following sub-chapters I will give a brief description of the core specifications related to the development within the present Semantic Web discourse.

7.1.4.1 URI

The Uniform Resource Identifier (URIs, by some regarded as URLs, Uniform Resource Locator) is the technology for naming or addressing web-spaces. An URI identifies images, email, web-documents and other resources, and should ideally be persistent, ie. not change.

7.1.4.2 n-ary relations

Specifically regarding guidelines in how to express so-called n-ary relations. A binary relation, which in Semantic Web languages decribes a property as a binary relation in that it is an instance that link two actors or actors/actants, where the second of the two is a value or argument, while an n-ary relation, describes a relation that links an actor to more than just one other actor or value. This provides the possibillity to also describe relevance, relational strength, purpose, and more. In many circumstances a relation with many participants, the primary participant is often unclear (W3C, 2006a).

7.1.4.3 Ontologies

Ontologies are shared, categorized, renditions of knowledge and one of the cornerstone technologies within the Semantic Web discourse. The concept of ontology-based metadata is fundamental in achieving the degree of interoperability that lies at core of the Semantic Web vision. To let people generate ontologies which characterize specific

[38] http://dublincore.org/about/. [Accessed: 23/08/2007]

metadata, and make these ontologies reusable, the W3C has developed RDF[39], RDFs[40], and OWL[41].

Ontologies represent W3C's formal standards for the support of sharing and reusing of data and knowledge. An ontology, in computer science terms, "is a formal, explisit specification of a shared conceptualization" (Gruber, referenced in (Fensel et al., 2003). An ontology may therefore represent a category within a domain, and be specified by a catalog of artefacts that are thougt to exist within that actual domain (Sowa, 1999)

According to Fensel *conceptualization* should be interpreted as an abstract model which is connected to a real world circumstance, while *explicit* should be interpreted as the type of concepts that are deployed and the limitation of these concept's use are clearly defined, and *formal* indicates that that ontology ought to be machine readable (Fensel, 2004).

There is a need for developing mechanisms to integrate and make compatible overlapping and inconsistent onotology areas. According to Gil (2005) a solution to this problem could be in hyperlinking these to their knowledge bases, and by that creating something that would resemble the idea of namespaces in XML-technology, allthough it could potentially be rather hazardous and lead to a complexity greater than the one we originally wished to overcome.
I would argue that the sphere of ontologies in itself is an open, shared, heterogenous and above all evolving information infrastructure.

7.1.4.4 RDF and RDF Schema - Resource Description Framework

RDF came out of work done by R.V. Guha at Apple on MCF (the Meta Content Framework), which was later turned into an XML application and taken up by the W3C. The W3C turned it into what we today know as RDF, which was published as a W3C Recommendation in early 1999. [http://www.w3.org/TR/1999/REC-rdf-syntax-19990222/]

The metadata protocol that W3C has recommended and developed as a resource description model, and one of the working standards that constitutes the Semantic Web efforts is RDF, Resource Decription Framework, which is an application of XML. The development of what was going to be RDF was originally started by started by

[39] Resource Description Framework
[40] Resource Description Framework schema
[41] Ontology Web Language

Ramanathan V. Guha's work on MCF, Meta Content Framework, in 1997 while working at Apple(Andreesen, 1999). This protocol was later turned into an XML application, as RDF, and was released as a W3C recommendation in 2004 (See Appendix 11.3). RDF is capable of desbribing any resource on the Web, and will supply the web-infrastructure with interoperability and exchange of semantic content(Lassila and McGuinness, 2001).

The RDF standard protocol is a tool for modeling knowledge, and not as useful in terms of organizing it.

RDF Vocabulary conforms to W3C Recommendation

RDF is a W3C Recommendation. RDF is a graphical language used for representing information about resources on the web. It's a basic ontology language. Resources are described in terms of properties and property values using RDF statements. Statements are represented as triples, consisting of a subject, predicate and object (S, P, O). RDF is written in XML and uses URIs - Unique Resource Identifiers to identify resources. Relatively to his weakest points, RDF uses only binary properties. This restriction seems quite serious because often we use predicates with more than two arguments. Another problem with RDF has to do with the handling of properties. RDF Schema "semantically extends" RDF to enable us to talk about classes of resources, and the properties that will be used with them. RDF and RDF Schema provide basic capabilities for describing vocabularies that describe resources. However, certain other capabilities are desirable like cardinality constraints, specifying that properties are transitive, specifying inverse properties, specifying the "local" range and/or cardinality for property when used with a given class, the ability to describe new classes by combining existing classes (using intersections and unions), negation (using "not").

Source: http://www.w3.org/TR/rdf-schema/. [Accessed 22/08/2007]

7.1.4.5 OWL - Web Ontology Language

OWL is the W3C recommendation for explicitly describe meaning of categories and the relationship between those categories. By utilizing OWL authors may be able to obtain a broader integration and interoperability in a cross-application environment. OWL is a language for processing content rather than presenting it, and by that promotes machine interpretability by providing a supplemental vocabulary together with regular semantics[42].

[42] http://www.w3.org/TR/2004/REC-owl-guide-20040210/. [Accessed: 22/09/2007]

OWL has more powerful features than XML and RDF for representing meaning and machine interpretable material on the Web[43].

7.1.4.6 FOAF – Friend Of A Friend

FOAF is an ontology, authored by Dan Brickley and Libby Miller with contributors from the FOAF mailing list (foaf-dev@lists.foaf-project.org) and the RDF and Semantic Web developer community, that helps users to both publish and discover social network information in a machine-processable form. The FOAF project is initiated outside W3C, but is linked to the Semantic Web Deployment Group[44]. The FOAF vocabulary is identified through the namespace URI 'http://xmlns.com/foaf/0.1/' but does not adhere to a W3C standard, even though it is an application of RDF.

7.1.4.7 SPARQL

Query language for RDF, released 14 th June 2007.
The RDF specification sets the semantics and the syntax of the SPARQL language. This query language have capabilities to formulate queries within heterogenous data sources, both data stored as RDF, or other types of data that are filtered through gateways in order to come through as RDF. The query language matches graph patterns that consists of triple patterns.

7.1.4.8 GRDDL

GRDDL, Gleaning Resource Descriptions from Dialects of Languages, is a mechanism that lets authors of web content reproduce data automatically, and add semantic richness to the material by linking Semantic Web and microformats. Utilizing GRDDLE, applications can extract data from structured Web pages and turn it into Semantic Web data.[45]

GRDDL is a specification for extracting RDF triplets from existing documents. According to W3C, the GRDDL specification[46] does this by introducing "markup for declaring that an XML document includes gleanable data and for linking to an algorithm, typically represented in XSLT, for gleaning the resource descriptions from the document."

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[43] http://xml.coverpages.org/owl.html. [Accessed: 22/09/2007]
[44] Source: htpp://www.w3.org/2001/sw/interest/. [Accessed: 29/09/2007]
[45] Source: http://xml.coverpages.org/GRDDL-REC-Announce.html. [Accessed: 20/10/2007]
[46] Source: http://www.w3.org/TR/grddl/ [Accessed: 20/10/2007]

7.1.5 Microformats

Microformats are small pieces of HTML, XHTML, CSS, XML, RSS feeds etc. that represents the actants in the network, ie. tags, people, events and so on, that can be utilized in order to embed semantic markup[47].

7.1.6 Inference

Inference on the Semantic Web is related to recognizing new relations between abstractions, and being able to reach conclusions on the basis of the discovery of these relations. Inference within the Semantic Web discourse is described as ”automatic procedures” that” can generate new relationships based on the data and based on some additional information in the form of an ontology or a set of rules”[48].

A type of example is given at the W3C website for the Semantic Web, in the form of syllogisms: Peter hasA Football named Kenny, while a relevant ontology might state that all Footballs are Round. A Semantic Web software that recognises the understanding of statements like ”P is also Q” could then increase the set of statements with ”Kenny is Round”, even though this statement was not present in the original set of data. Of this follows the notion that a new relationship was recognized.

7.2 Web 2.0

The somewhat controversial term Web 2.0 is, in short, a name for a set of descriptions regarding user generated content, shareability and usability on the Web. In the following sub-chapters I will first give a brief presentation of the core technologies and how they are related, and present some of the areas to which they are used.

7.2.1 AJAX

The term AJAX[49], Asynchronous JavaScript + XML, represents a set of technologies and a technological approach to how web applications are to behave on a web page. Even though the term is rather new, the technology behind it, which is XHTML, CSS and JavaScript, is not. AJAX includes:

- standards-based presentation using XHTML and CSS;
- dynamic display and interaction using the Document Object Model;
- data interchange and manipulation using XML and XSLT;

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[47] Source: http://microformats.org/wiki/what-are-microformats. [Accessed: 20/10/2007]
[48] Source: http://www.w3.org/2001/sw/SW-FAQ. [Accessed: 15-20/08/2007]
[49] The term was coined by Jesse James Garrett of adaptivepath.com in February 2005

- asynchronous data retrieval using XMLHttpRequest;
- and JavaScript binding everything together.

7.2.2 Web 2.0 – applied

7.2.2.1 Wikis

The wiki-technology was originally developed by Ward Cunningham in 1995, and the first wiki-site was named the Wiki Wiki Web[50]. A wiki is collaboration tool, where everyone can create content, either by making new pages, or editing existing ones. It is the epitome of user generated content and sharing, that is a central idea within the Web 2.0 paradigm, letting users become participants and producers, increasing online interactivity.

Figure 7-2 Wikipedia, the mother of all wikis

7.2.2.2 Blogs

A blog is a personal diary, a log of a person's activities published on the web as a chronological list; a web log. This makes, again, regular users into publishers, in that a blog, regarding technical content, publish the same type of artefacts, like text, images and links. Readers of blogs may leave comments, but not edit what is already written. Blogs can relate to any human activity, and as such be a part of a social network. Blogs

[50] http://c2.com/cgi/wiki?WikiWikiWeb. [Accessed: 7/11/2007]

can link to each other through a blogroll, which is a list of favourite blogs, and by that advertise for each other, increasing the number of visits, in a viral marketing kind of fashion. Blogs can also be more than just a personal published log, it can take on many forms like ie. group blogs, which resembles a news forum, but with options for leaving comments, blurring the borders to the existing mass media. The comment option has been picked up by many, if not almost all, regular newspapers' online editions, and give the public the opportunity to comment regular news postings on regular news web sites. This leads in an increasing way to user generated content in regular mass media.

7.2.2.3 Folksonomies/tagging

Tags are describing keywords connected to digital artefacts like audio files, pictures, movie clips and so on. Originally tagging was a feature that came with the social bookmarking web site del.icio.us, where users could upload a list of their favourite web sites, and share this with other users that did the same. The bookmarks in the list could be tagged with keywords, and by that belong to several categories. A picture of J.S. Bach could then be tagged with ”classical music”, ”baroque”, ”fugue”, ”organist” among others. This way of categorising artefacts differs significantly from the traditional desktop styled folder-based organization. Later tags have evolved from categorising bookmark listings, to also include photos (www.flickr.com) , books (www.librarything.com) , web content (www.digg.com) and academic papers(www.citeulike.org) among many.

7.2.2.4 *Mashups*

A mashup is a web site that gathers and combines some or most of its content and functionality from other online sources. Mash-up sites are usually developed utilizing AJAX. An example of a mashup is doggdot.us [http://doggdot.us], which is an aggregate of digg [http://digg.com], slashdot [http://slashdot.org], and del.icio.us [http://del.icio.us]

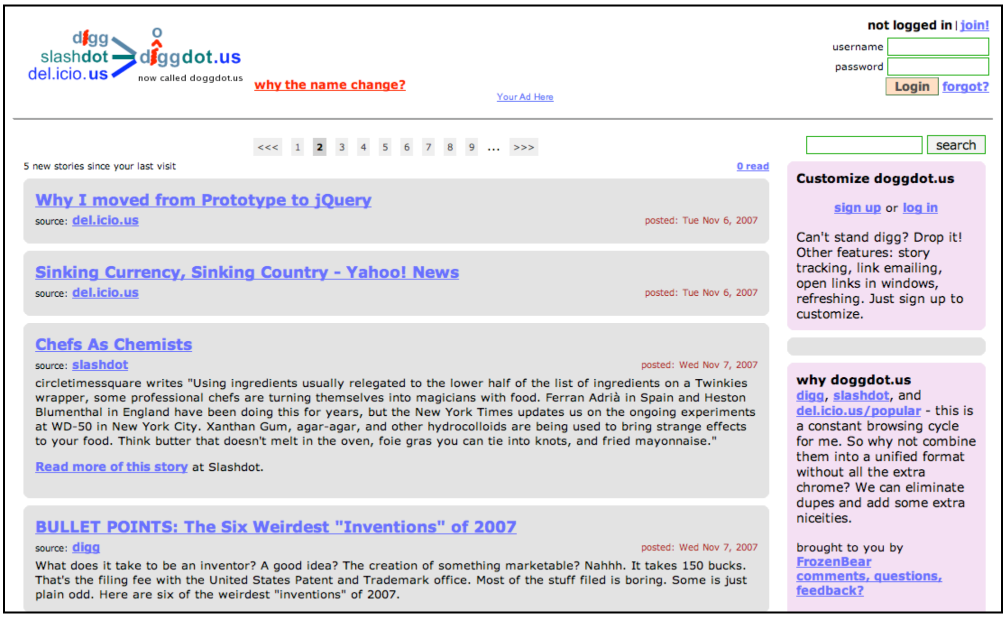

Figure 7-3. User interface, doggdot.us

The figure shows the mashup interface of doggdot.us, and how it is aggregating content from del.icio.us, slashdot.org and digg.com.

7.2.2.5 *Social Networking Sites*

Social networking sites, sometimes also referred to as friend-of-a-friend-sites, are web sites that through memberships offerings provide user in the web community possibilities for online social interaction, integrating technologies like instant messaging, chat, sharing photos, videos and music, discussion groups, blogs, discovering and exchanging friends. At present the best known social networking sites are places like MySpace, Facebook and Orkut, with many millions of users.

7.3 Semantic Web and Web 2.0

There are numerous research projects that try to combine the powerful standards of the Semantic Web with the easy accesible interface of Web 2.0.

In the following I am going to describe two of these as they appear in research- and journal material.

7.3.1 OntoWiki

This is not included as a case study, merely as an example of research and development wthin the area of Semantic Web meets Web 2.0. OntoWiki is an application, that provides support for "agile, distributed knowledge engineering scenarios"[51], which basically mean that it can manage several, ie. heterogenous, knowledge bases simultaneously, where *knowledge bases* in this case means RDF Models.

The developer community has looked to the Web 2.0 paradigm and implemented a fairly simple, familiar and easy to comprehend, facet-based, graphical user interface that is presented as an information map, which is divided into a quite common three-coloumn lay out; left navigation coloumn [1] for choosing knowledge resources, main middle coloumn [2] which is the target coloumn, and right coloumn [3] which incorporates additional information, properties, and filtering opportunities of the chosen data. A demo screencast of OntoWiki can be seen here: http://3ba.se/screencast/OntoWiki-Tutorial.swf.

As we can see in some of the screenshots obtained from the OntoWiki web site[52], the graphical user interface shows a familiarity with the Web 2.0 paradim of the regular wiki in that it allows users to create and edit while using it, but with semantic technology like OWL and RDF, and semantically improved search facilities implemented. According to the developer community behind OntoWiki "It fosters social collaboration aspects by keeping track of changes, allowing to comment and discuss every single part of a knowledge base, enabling to rate and measure the popularity of content and honoring the activity of users"(Auer et al., 2006). With its links to the the Web 2.0 graphical user interface paradigm, it follows the pattern of a ready translated technology, making it easier to enrol new actors.

[51] http://ontowiki.net/Projects/OntoWiki. [Accessed: 24/10/2007]
[52] http://ontowiki.net/Projects/OntoWiki/Screenshots. [Accessed: 25/10/2007]

Screenshots from the OntoWiki application:

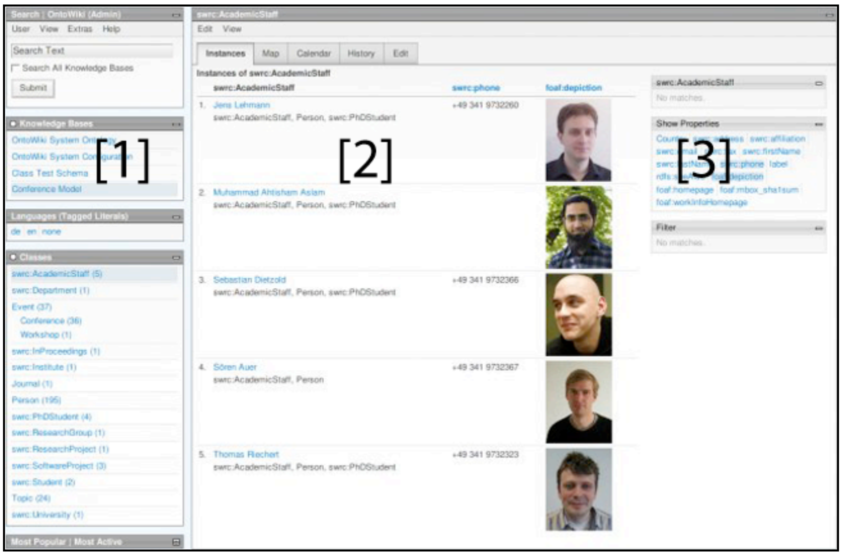

Figure 7-4 Contact management in the OntoWiki application

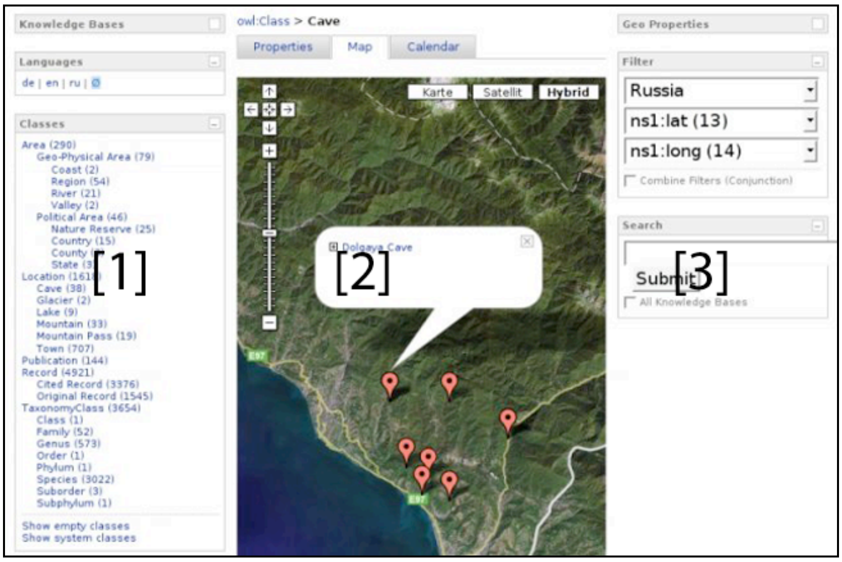

Figure 7-5 OntoWiki - Mashup view

Clicking the Map pane gives us the Map mashup-view, which shows us the geo-spatial data of the instances

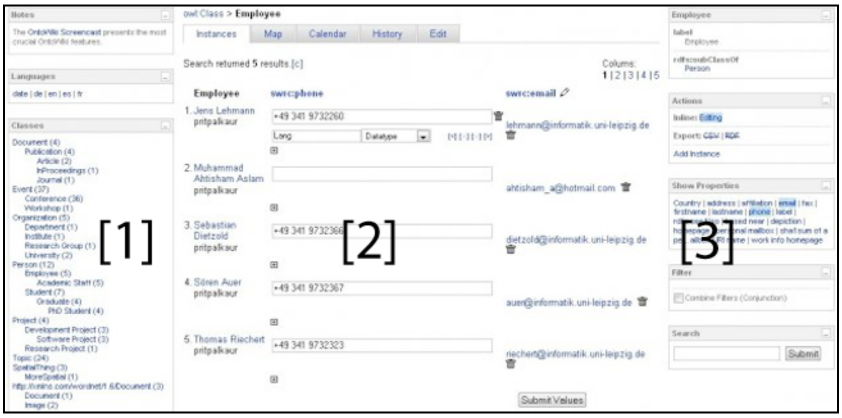

Figure 7-6 OntoWiki - multiple editing

Clicking the Instances pane facilitates multiple editing of instances, in this case employees, and if we want to edit the details,

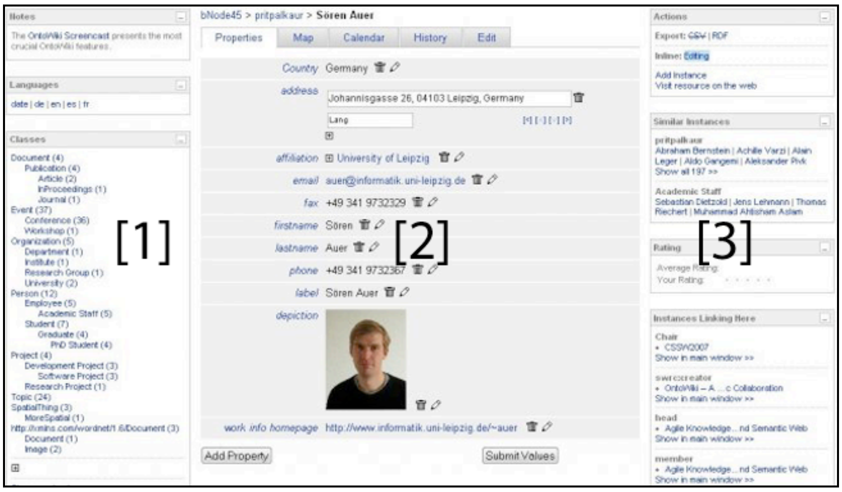

Figure 7-7 OntoWiki - inline editing, single instances

we can do inline editing of single instance data. If a semantic social system like this should succeed in order to attract other actors, and eventually cultivate the installed base, mechanisms for bootstrapping it must be in place(Hanseth, 2002a). In this case the users, ie. actors, must be given the possibility of creating categorization entrances in an ontology and editing them afterwards, which is done in the OntoWiki POWL user interface

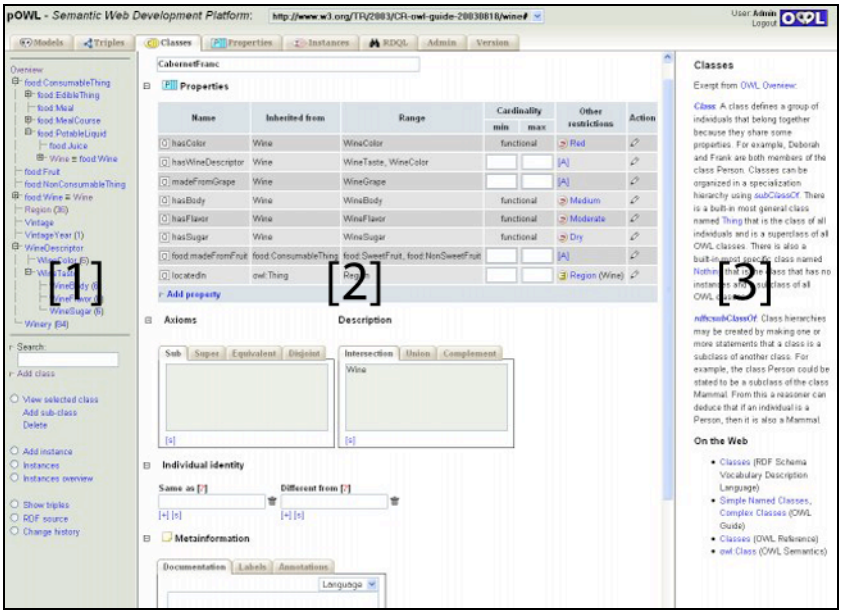

Figure 7-8 OntoWiki - POWL, ontology management interface

7.3.2 SIMILE

Another research project within this discourse is SIMILE - Semantic Interoperability of Metadata and Information in unLike Environments. [53]

SIMILE is a project-suite, conducted by the MIT Libraries[54] and MIT CSAIL[55] that includes several sub-projects where Web 2.0 and Semantic Web technologies are combined.

The project aims to strengthen the interoperability between "digital assets, schemata/vocabularies/ontologies, metadata, and services", and directed towards end-user services, and is based on open source technology[56].

The project consists of many sub-projects, of which the Longwell Semantic Web browser and the Piggy Bank browser extension for Firefox is of particular interest. Longwell, with its configurable faceted user interface, which gives the user the ability to visually browse complex RDF-sets.

From the project's user guide web page the faceted user paradigm is described as follows: [57]

> A facet is a particular metadata field that is considered important for the dataset you are browsing. Longwell can be configured to prioritize which facets are 'open' when the page loads and in what order, an/or it can analyze facets and choose heuristically which are most important and should be 'opened.'
>
> Once the facets are selected for a specific dataset, Longwell starts processing the dataset and extracts a list of facets, their values, and the number of times each facet value occurs in the dataset. This is shown in the right hand side, where each facet is boxed independently. Clicking on the facet's title will toggle it open or closed.

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53 http://simile.mit.edu
54 http://libraries.mit.edu/
55 http://csail.mit.edu/
56 http://simile.mit.edu/wiki/SIMILE:About
57 http://simile.mit.edu/wiki/Longwell_User_Guide#Where_can_I_find_examples_of_Longwell_configurations_to_start_from.3F. [Accessed: 30/10/2007]

Longwell

Figure 7-9 SIMILE: Longwell faceted user interface

Piggy Bank

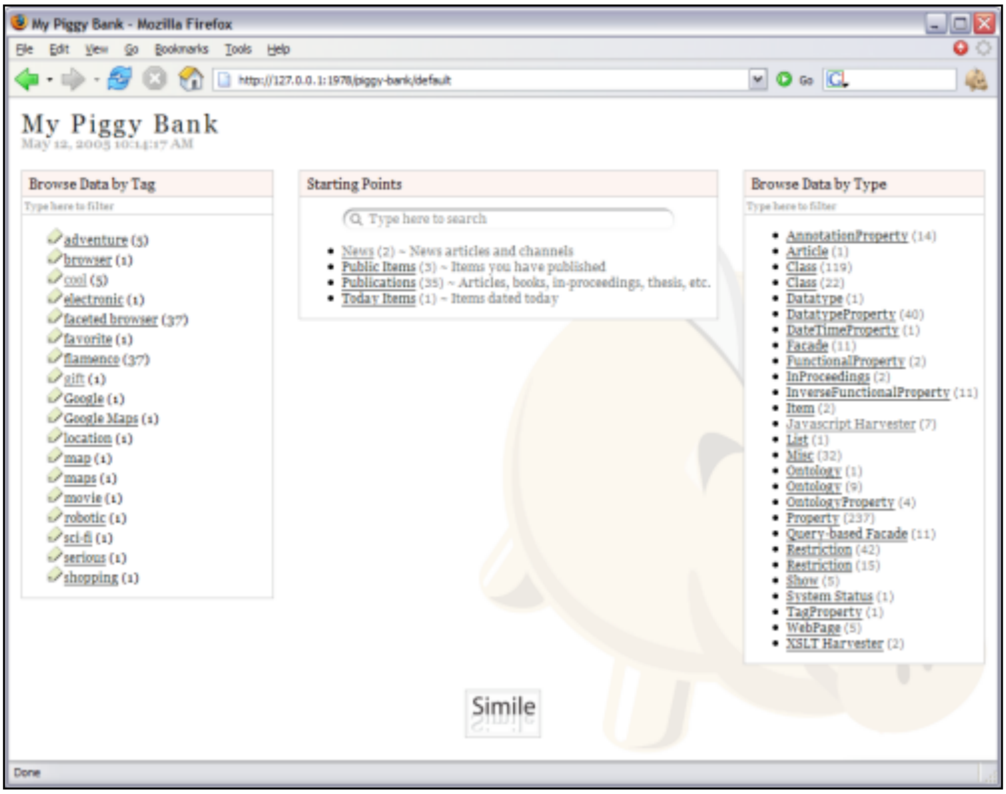

Figure 7-10 SIMILE Piggy Bank browsing interface

Piggy Bank, which is a Firefox extension that turns the browser into a mashup generator, allowing users to collect and save data from heterogenous sources and put the data together. The information can be tagged with keywords for later searching, browsing and retrieving. The information a user has collected can be saved in a Semantic Bank, which is also a project in the SIMILE software suite, and published, sharing it with others.

Other sub-projects in this suite include:

Babel, web service for translation between various semantic web file formats and also Excel and BibTex formats.

Crowbar (not released yet), application that, in short, turns a web browser into a web server giving the user the ability to remotely control the browser.

Exhibit, application that may create interactive dynamic web-gallery pages. Supports faceted browsing.

Gadget, application that extract summaries of XML data

Semantic Bank, the storage application server partner of Piggy Bank.

Timeline, an AJAX-like widget for visualizing time-based events. Based in DHTML. Can be combined with Timeplot.

(Source:http://simile.mit.edu.timeline. [Accessed: 01/11/2007])

Timeplot, an AJAX-like time plotting widget based in DHTML, can be combined with Timeline event data.

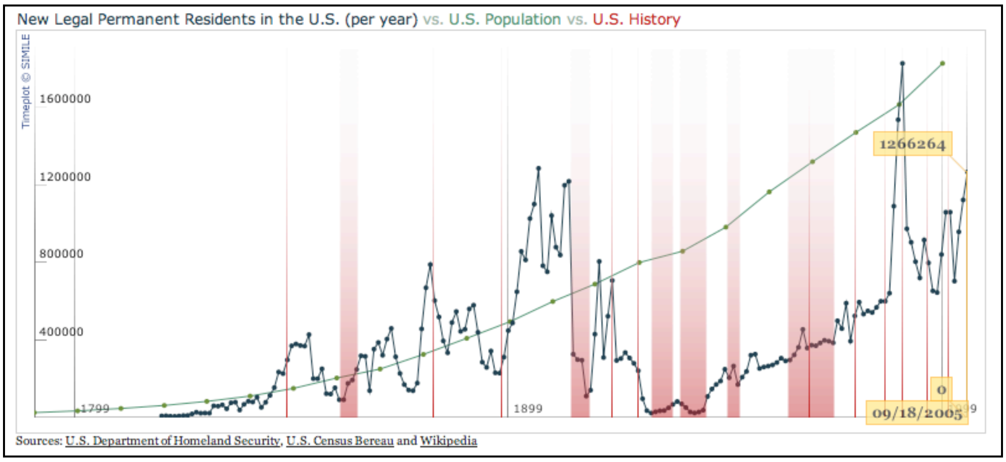

Figure 7-11 SIMILE: Timeplot

Welkin, a graphical RDF-visualizer

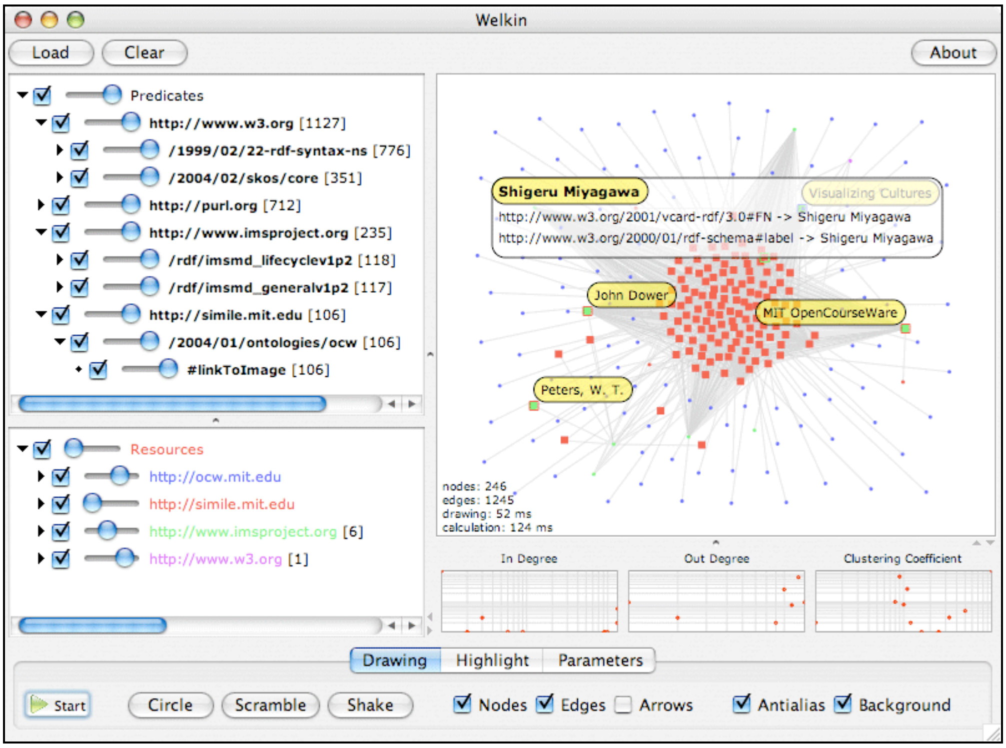

Figure 7-12 SIMILE: Welkin RDF visualizer

Source for the SIMILE project: http://simile.mit.edu. All screenshots have been extracted from the sub-projects web pages, which follows the pattern: http://simile.mit.edu/<project_name> Where the project title contains more than one word, they are separated with an underscore. The project sites have been accessed in the period: 25/10 – 4/11/2007.

8 Discussion

In this chapter I will discuss how the presented parts of this actor network do or may interact as this is decribed within the present discourse and in the literature of Actor-Network Theory and Information Infrastructure theory, as a comparative study of the state of Semantic Web technologies implementation viewed in relation to the development and deployment of the Web 2.0 paradigm.

I will describe the Semantic Web as a complex and specification driven technology that in the meeting with instances of the Web 2.0 bundle of technology that has seen a rather noticeable growth both in the number of services and size of the installed base of users, in a shorter period of time, comes forward as top-down and formal.

I will discuss some aspects of the integration of these two directions within Web science and its possible impact on the evolvement of the Web, in that it has the possibility of fusing the lightness and availability of an easy accessible and flexible Web 2.0 technology with the formal and standards-based languages of the Semantic Web, as tension between standardization and flexibility, as this is described by Hanseth, Monteiro and Hatling (1996), and Tuomi (2002).

In order to come closer to something that could resemble an explanation as to why the Semantic Web still has not materialized as something that could echo what was described in its original vision (Berners-Lee et al., 2001), and numerous ideal descriptions since the Semantic Web was conseptualized, I have chosen to discuss what, in the Web community, seems to have become the next *natural* evolvement of online communication, the Web 2.0 and the different development style it represent, and to what extent it has adopted and also deployed Semantic Web technologies, in comparison to the Semantic Web itself according to the main concepts in the literature of ANT.

On the World Wide Web Consortium's web site they describe themselves as:
"The World Wide Web Consortium (W3C) develops interoperable technologies (specifications, guidelines, software, and tools) to lead the Web to its full potential. W3C is a forum for information, commerce, communication, and collective understanding"[58].

[58] http://www.w3.org

I will discuss some socio-technical aspects of the two different approaches of web evolvement, and at the same time discuss the process of development the new standards, or recommendations as the correct term would be[59], given by the W3C, undergo during the development period within the W3C, in comparison with the bootstrapping, evolutionary design method that is recognized regarding the Web 2.0 paradigm. I will use the vocabulary, method and theory[60] of ANT to discuss the different technical and non-technical solutions that the developers have chosen, both the intended, and the unintended where they are to be found. I will discuss on the basis of Actor-Network Theory, where a network, with the distinction between actors and actants, doers and those who make them do, quite possibly could dissappear, or become transparent (Denning, 2002), or through modularization as this is described by Hanseth, Monteiro and Hatling (1996).

8.1 Background and short historical overview

Although I am trying to look a bit forward in this thesis, one can not really, by using qualitative research methods, say anything fundamental about the future without a glimpse or two at the historical events that has lead to the present, and also the present visions and hopes of what to come (Berners-Lee et al., 2001).

Since the time of the separation between the humanities and science within the academic field, the amount of information, especially since the second world war, has seen a dramatic and exponential growth. We might say that the problems regarding the enormous amount of information production combined with the paradigm of archive-, search- and managing knowledge within the academic field, eventually has led to the invention of the global, almost autonomous, hypertextual information infrastructure, today known as the World Wide Web. Built on top of an already existing infrastructure, the Internet, which came to be not only from the envisions of Vannevar Bush, but from a group of scientists and visionaries, like J.C.R. Licklider, Douglas Engelbart, and Ted Nelson among others, the Web represents, in its present state, the utmost example of an evolutionary, iterative development process. Particularly the ideas of J.C.R. Licklider,

[59] Officially the W3C does not define standards. The correct term in W3C lingua is 'Recommendation', as they state on their website: " A W3C Recommendation is a specification or set of guidelines that, after extensive consensus-building, has received the endorsement of W3C Members and the Director. W3C recommends the wide deployment of its Recommendations. Note: W3C Recommendations are similar to the standards published by other organizations." (http://www.w3.org/TR/#Recommendations)

[60] There are divergent opinions of the correct description of what ANT really is, as mentioned in chapter 5.2.1. This thesis is not an adequate medium for that debate, which has been going on since the inception of the theory from the very beginning, and will probably continue until the end of time, or at least as long as ANT is being used doing research.

the head of the behavioural science programme within ARPA(Naughton, 2000), would prove fruitful. Licklider channeled funds in the direction af Douglas Engelbart and his research project "A strategic framework for the augmentation of the human intellect"[61], and the hypertextual concepts first coined by Ted Nelson (Nelson, 1965), all directly inspired by the groundbreaking article "As we may think" by Vannevar Bush in Athlantic Monthly in 1945 which, by many, is regarded as the visionary foundation for the technological development and inventions that constitutes what today is recognized as the World Wide Web. In this article Bush envisions what he thinks is the ideal solution to the exponential growth problem in information and knowledge handling, and that it must be based on the way human beings mentally store and retrieve information from recollection, which is based on principles of association and immediacy, crossing thematic boundaries and segmentation in a non-linear way, literary as we think (Bush, 2001).

> "With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain. It has other characteristics, of course; trails that are not frequently followed are prone to fade, items are not fully permanent, memory is transitory. Yet the speed of action, the intricacy of trails, the detail of mental pictures, is awe-inspiring beyond all else in nature.
>
> *Excerpt from "As we may think", Vannevar Bush*

Without coining the actual concept of hypertextuality, he described the notion of how it had to be done in order to work. In 1946 this must be regarded as rather revolutionizing although he failed to foresee the digital computer as the tool, and had a huge, profound, and a quite determinable impact on the works of both Douglas C. Engelbart and Tim Berners-Lee, in addition to the impact it must be said to have had on the development of digital media in general. Another visionary that may not have gotten as much credit as he probably should, at least not outside the computer science community, is J.C.R. Licklider. Also strongly influenced by Bush he wrote his "Man-Computer Symbiosis" article in 1960, predicting how humans using keyboards and screens, in a time when there were no such things, could communicate with computers (Bush, 2001, Levy, 1995, Licklider, 2001, Naughton, 2000).

[61] In 1968 this research prosject ended in NLS (oN Line System), a system that included features that were to become prototypes for all hypermedia systems present today, like the mouse, overlapping windows, electronic mail, text processing and hypertext. (NAUGHTON, J., 2000, LEVY S., 1995)

When Tim Berners-Lee started to work on a hypertextual information retrieval system at CERN[62], it was as a result of the many problems at the laboratory regarding the handling of research material from the many scientists, especially the many visiting scientist[63] that came to CERN doing research, and worked for a certain period of time, using different and often uncompatible equipment on different platforms, and then left. A problem caused by this high turnover of people was that information was constantly being lost, meaning, in turn, that the transfer of knowledge at such a huge place would prove rather difficult and cumbersome. The result of this was, according to Berners-Lee, that due to the very structure at CERN, as a miniature world, the problem was at the time "particularly acute" (Berners-Lee, 2000). Berners-Lee developed a system based on hypertextuality, enabling scientists to unite, research, store, archive, and access research material and sharing documents and programs in an open and almost associative manner. In order to be that "universal space of information" where everyone should be able to link to any piece of information, making the use of hypertextuality crucial. Computing technology changed dramatically between the 1960s and the 1980s going from being just calculating devices to become tools of communication (Abbate, 1999). In order to keep his system as simple as possible so that as many as possible would, not only grasp what the Web was and what it could do, but also to get others to contribute to the actual development, he had to sacrifice the second part of his original vision of hypertextual interoperability. This includes interoperability between machines, software, and software agents – a World Wide Web comprehendable by machines, making machines and software become communication devices with an inbuilt semantic, reciprocal comprehension, and by that possibly realise the Web's intended and full potential, which was not only to be a place for humans to find information, but turn it into a global online database, which could be accessed by different types of applications, both browsers and non-browser applications alike, increasing the possibilities for inference based on interaction and interoperability between different online resources (Berners-Lee, 2000, Berners-Lee, 2001, Fensel et al., 2003, Tuomi, 2002).

This was all part of the original vision of World Wide Web (Berners-Lee, 2000), but also something that would add significantly to the complexity of the network, and that was put on hold in order to keep the system as simple as possible as to being able to mobilize

[62] Conseil Européen pour la Recherche Nucléaire. European Council for Nuclear Research, founded 1954. Since the research work done at the insitute goes beyond the study of the atomic nucleus, and is mainly concerned with the study of interactions between sub atomic particles the laboratory is commonly referred to as the "European laboratory for particles physics". Online: http://www.cern.ch. [Accessed: 15/06/2007]
[63] At present there are about 6500 visiting scientists, which, according to CERN, is half of the world's particle physicists, representing 500 universities and over 80 countries.

resources. This is in line with Hanseth and Aanestad's description of bootstrapping as design method, which basically suggest that creating and cultivating a network should start by implementing the "simplest, cheapest solution we can imagine and which satisfy the needs of the most motivated users in their least critical and simplest practices and which may be beneficial by supporting communication and collaboration between just a few users", and then use this technology to enrol more users, inventing more complex and beneficial solutions bit by bit, and repeat this process as long as it takes to gain momentum (Hanseth and Aanestad, 2002).

In order to attract resources at CERN, Berners-Lee did just that, by starting with a cheap, simple solution that would satisfy users in the simple and not so critical practice of looking up telephone numbers. The World Wide Web started out at CERN as an application that could be used to find telephone numbers, even though it was clear from the very beginning that Berners-Lee and Cailliau had a quite bigger vision for the system, basing it on existing technology[64] (Tuomi, 2002).

I will describe, based on Hanseth and Monteiro's definitions of what constitutes an information infrastructure (Hanseth, 2002a, Hanseth and Monteiro, 1998, Monteiro, 2000), the Semantic Web, as an extension of the World Wide Web within the present infrastructure that constitutes the WWW, and becoming an infrastructure in itself for the new wave of web services, by O'Reilly Media, coined the Web 2.0, much the way the Internet was the infrastructural underpinnings for the World Wide Web. The difference this time is that, while the Internet and the World Wide Web grew out of modest beginnings as a bottom-up construction (Berners-Lee, 2000), the Semantic Web although evolutionary, develops from or within an infrastructure that already has surpassed all other infrastructures in size and ubiquitousness and, it seems, from a much more *grand plan* than the former (Berners-Lee et al., 2001). The Semantic Web discourse is still to a great extent connected to research labs and work groups developing the standards on which it rests, and in a sense, still quite young and new. A consequence of this is that the translations and negotiations of the different standards and protocoles that together are intended to comprise this discourse are just recently set, and the different working groups of the Semantic Web's governing body, the World Wide Web Consortium, are still issuing RFCs (Request for Comments). Therefore it seems judicious to base the analysis on the definitions and key aspects of modern

[64] The World Wide Web application utilized the Internet host name resolution system, and was written on a NeXT computer that had hypertext functionality build in the operating system (BERNERS-LEE, T., 2000, TUOMI, I, 2002)

Information Infrastructure theory as described by Ciborra, Hanseth, Monteiro and others, and ground this in the discourse of Actor-Network Theory, as adequate tools to describe an open, evolving, heterogenous installed base, that just recently has started to gain some sort of momentum, and is, although slowly, approaching a kind of closure in the information infrastructure-sense of the concept. The last two to three years the research and development activity within the Semantic Web field has increased significantly also outside the W3C, but without being recognized among the greater web community, as the graphical overview regarding search trends shows in Figure 8-4. In February 2004[65] the RDF and the OWL was released by the W3C as recommended standard formats after years of research and development among the different working groups within the W3C (see Appendix 11.3).

In the same period of time we've seen another line of evolutionary process within web development, one which is not founded on a specification and standards driven evolution process as the Semantic Web, but more based on the web community's assumed needs. And while the Semantic Web, because of the formal approached, top-down, standards concentric, evolvement process has taken years, the Web 2.0 with its "rough consensus and running code" kind of rapid evolution that resembles earlier periods of Internet development (Russell, 2006) has enroled a large part of the community in a shorter period time.

This is an echo from the Internet-OSI standards battle (Hanseth et al., 1996, Russell, 2006). Looking at the multi-layered protocol of OSI and the simpler protocol of the Internet as these are presented by Hanseth, Monteiro and Hatling (1996), they resemble remarkable similarities to the different levels of complexity we recognise today regarding Semantic Web and Web 2.0.

8.2 Semantic Web – "formal"

The term Semantic Web, identifies what has largely been regarded as the next step in the evolution of the World Wide Web. The fundamental purpose of the Semantic Web is, as mentioned earlier, to make the information and knowledge accessible as *data*, shareable and comprehendable by machines in the same distributed manner as the Web utilizes today in the publication of regular Web-*documents*. By annotating content through layers of meaning or comprehension at a machine level, as seen in figure 8-1,

[65] http://www.w3.org/2004/01/sws-pressrelease [Accessed: 12/09/2007]

this should intentionally lead to more sophisticated web services that are interoperable in a more profound manner than what has been possible in the traditional *human-only* readable document-Web, even with the Web 2.0 technologies and its increased co-operational level of services, with a technological framework that supports more well-founded and efficient conditions for both the developers and users of the Web's many resources, in allowing the sharing and redistribution of *data*, aggregated by different actors, such as applications and databases, companies, organizations and consumers alike, in both an automatic and manual fashion. This allows information to appear as pure data, and the relationship between different sets of data, utilizing fileformats that can be read by a variety of application areas, as mentioned by the W3C: "for example: in data integration, whereby data in various locations and various formats can be seamlessly integrated in one, application; in resource discovery and classification to provide better, domain specific search engine capabilities; in cataloging for describing the content and content relationships available at a particular Web site, page, or digital library; by intelligent software agents to facilitate knowledge sharing and exchange; in content rating; in describing collections of pages that represent a single logical "document"; for describing intellectual property rights of Web pages (see, eg. the Creative Commons[66]), and in many others (W3C, 2001-2007a).

The Semantic Web was *publicly* presented in the article "The Semantic Web" in Scientific American, and co-written by Tim Berners-Lee, James Hendler and Ora Lassila in 2001 (Berners-Lee et al., 2001), while the first papers about a machine-readable web, utilizing technologies for the sharing and reuse of data was presented by Berners-Lee at the first WWW conference in 1994 , and aimed primarily at scientists (Fensel et al., 2003)[67].

> To a computer, the Web is a flat, boring world, devoid of meaning. This is a pity, as in fact documents on the Web describe real objects and imaginary concepts, and give particular relationships between them. For example, a document might describe a person. The title document to a house describes a house and also the ownership relation with a person. Adding semantics to the Web involves two things: allowing documents which have information in machine-readable forms, and allowing links to be created with relationship values. Only when we have this extra level of semantics will we be able to use computer power to help us exploit the information to a greater extent than our own reading.
>
> - Tim Berners-Lee "W3 future directions" keynote, 1st World Wide Web Conference Geneva, May 1994

[66] http://creativecommons.org/technology/usingmarkup
[67] Reference from Tim Berners-Lee's foreword p. xi – xxiii.

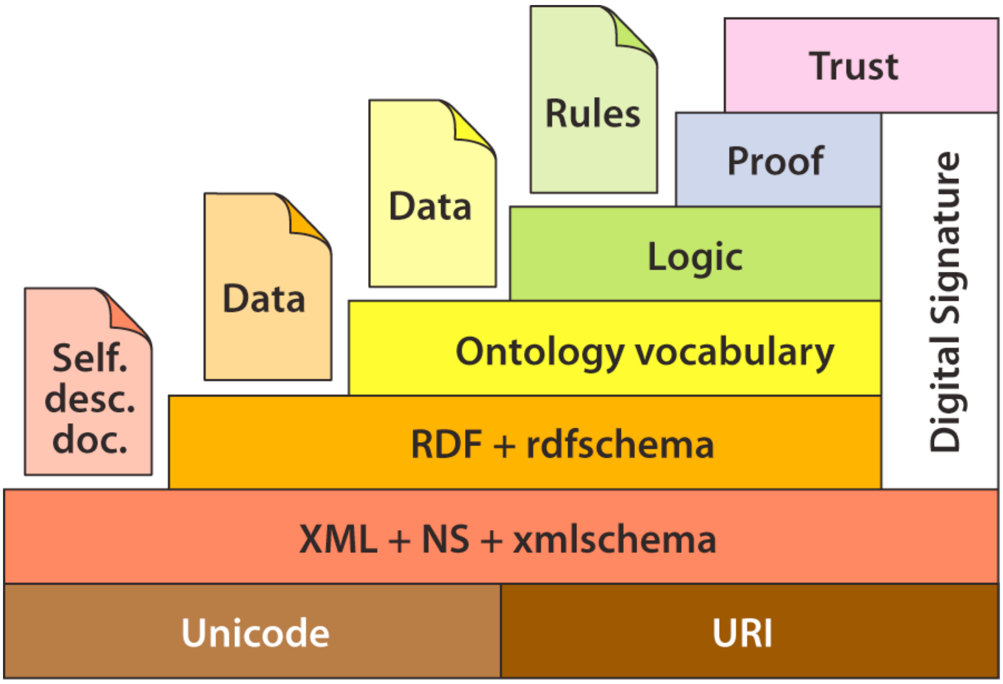

Figure 8-1. An early 'layer cake' model of the Semantic Web

Source: http://www.w3.org/2001/09/06-ecdl/slide17-0.html

The figure shows the the layered construction comprised of the various Semantic Web technologies and standards as languages and rules, and represents a formal, specification driven development process. As we may see, there is no layer where front-end issues like usability ie. through user-interfaces are problematized. This approach would lead to a black-boxing of the protocols, which according to Latour (1999b) should implicate that the complexities (Mol and Law, 2002) have been succesfully enroled. This approach faces the same problem that Jef Raskin critized Ted Nelson for, regarding the lack of user-interface in his hypertext system Xanadu (see p. 78)(Suter, 1995) in that black-boxes the complexities without the interface to approach them. A later version has addressed this shortcoming:

The new Semantic Web layer cake model

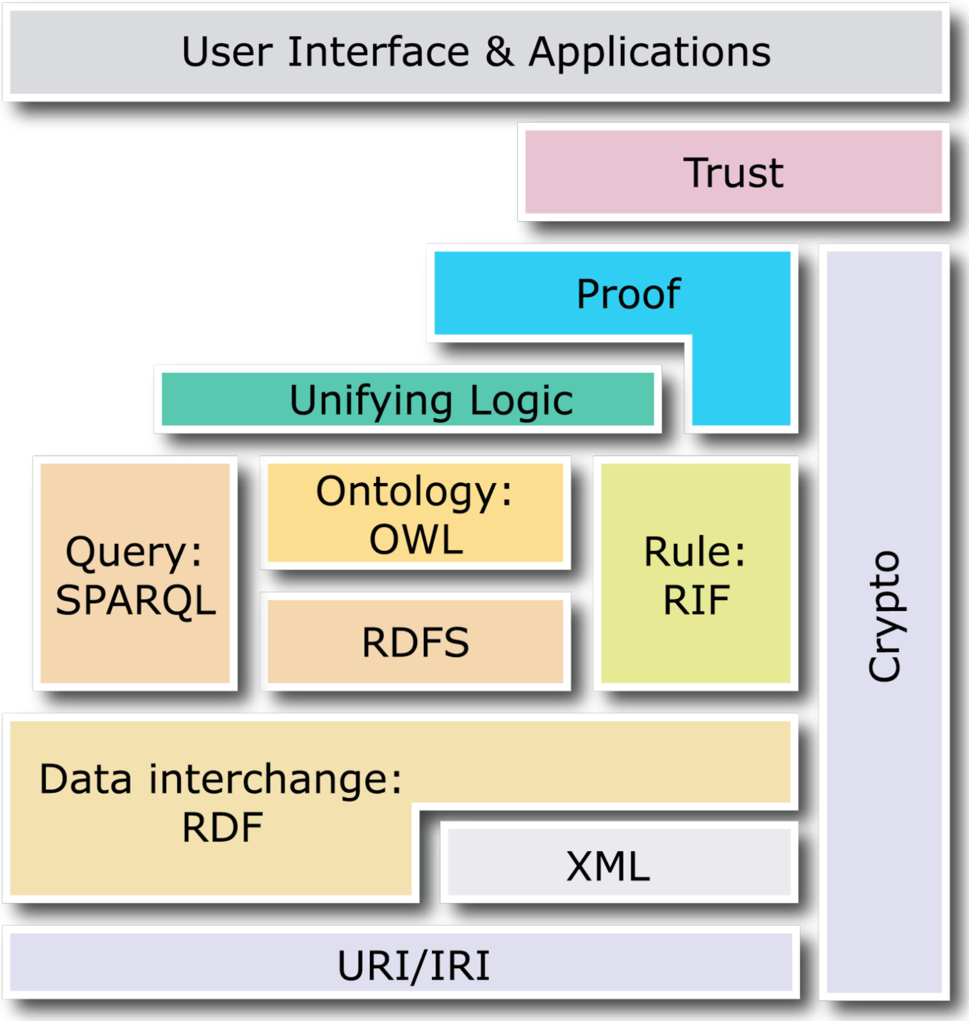

Figure 8-2 The latest 'layer cake' model of the Semantic Web

Source: http://www.w3.org/2007/03/layerCake.svg. [Accessed: 20/09/2007]

The Semantic Web infrastructure layer cake shows the schematic structure of the various languages and protocols as they are related from the bottom basic standards (technological) upwards thorough the layers relating to protocols regarding 'social' interaction, like logic, inference and review:

- URI/IRI – unique identifiers, uniform technology for exposing data sources via RDF
- XML – data format, one of several serialization formats for RDF in addition to ie. N3 and Turtle.
- Data interchange: RDF - resources and their properties
- Query: SPARQL - query language and protocol for RDF. 'SQL' for the Semantic Web
- RDFS - description of properties and relationships, concepts
- Ontology: OWL - sharing meaning, based on categorization
- Rule: RIF - interchange of rules

On top we recognize the logic, proof and trust layers regarding the production of certainty and trust in the inference process. Together these layers present a picture of the

Semantic Web infrastructure, with issues regarding user interface and application now in place as the black-boxing layer, on top.

It might seem that the sort of silent early research work did lack the back-and-forth negotiation that, according to Akrich (1992:208-209) is fundamental in the alignment process in the actor network, and that the negotiations went on primarily within the developer community (see Figure 7-1). That, in addition to the fact that the initial idea of a machine-to-machine semantic data web comes from Tim Berners-Lee himself, which might suggest that it could not possibly become more top-down than that. It is an interesting parallel to observe, that when the Web exploded in 1993 with the development of Mosaic, that was also a flexible bottom-up evolution. Students the US National Center for Super Computer Applications (NCSA) at the University of Illinois at Champaign-Urbana launched a new browser that was easy to use, and had a graphical user interface. Maybe even more important; they modified the HTML-standard by adding the possibilities to handle images, on the reason that it would be cool. Besides they made the program available for regular PCs and Macintoshes, and not only UNIX machines. Suddenly regular users could *design* web pages and spice them up with photos and graphical elements and photographs, easing the process of linking technology and user leading users to become mediators themselves, black-boxing it, which is in line with Akrich's descriptions of the need for mediators in order to link technical content and user, 'rendering the technology as real' (Akrich, 1992). This was certainly a bottom-up development. According to Andreesen (Gillies and Cailliau, 2000) Tim Berners-Lee himself did not think of this as some place the World Wide Web should go. After all the Web was invented as a *serious* tool for researchers. Mixing in pictures and using the HTML-language as a design tool seemed too playish (Naughton, 2000):242. Nevertheless it became clear rather quickly that this modification to the HTML-standard became very popular and was accepted by the users and changed into a tool for increasing the usability and popularity of the Web, transforming it, over time, from a communication tool for scientist, into a identity shaping realm of communication channels and converging media. (Gillies and Cailliau, 2000:240-242, Naughton, 2000).

According to Hanseth and Aanestad the development of large networks need coordinating, governing and standardization bodies, a requirement that changes as the scale of the network change, which means that a small network that is in its very beginning does not require such governing bodies. In fact, they argue, if standardization bodies are involved in the beginning, this could add an unnecessary complexity which could slow the project down or, even worse, make it fail (Hanseth and Aanestad, 2002).

This could present a possible explanation regarding the difficulty the Semantic Web has met in the development process. The network that it is trying to extend, the World Wide Web, has already surpassed all other information infrastructures and is the biggest actor network to date. This requires a governing and standardization body that is big enough to run these processes within the network, whereas the Semantic Web as an extension of the existing Web, is still in its beginning. This could explain why the governing and standardization powers of the W3C could possibly hamper the development process of the Semantic Web, and present the dilemma the W3C faces, as it is supposed to, on one side be a governing body of the world largest actor network, while at the same time be responsible for developing the new standards needed for the information infrastructure to continue to evolve. This is the classic tension between standardization and flexibility as described by Hanseth, Monteiro and Aanestad (Hanseth, 2002b, Hanseth and Aanestad, 2002, Hanseth and Monteiro, 1998, Hanseth et al., 1996) among others.

Ideally, the next development phase of the Web should, according to Tim Berners-Lee, would be the Semantic Web, as it was envisioned that *this* was the technology that in itself should be the ”final”, all encompassing, well-structured, standardized solution. The vision of the Semantic Web described it almost as the GUT[68] of computer sience. In some brilliant universalistic way.

Instead, another approach to web services started to manifest itself. Rather than inventing something from "scratch" in order to achieve a new and higher level of web services, parts of the web developing community evaluated what they wanted and what parts of the technology that already existed that could be used, or combined in a different way, in order to achieve a higher degree of interactivity. Instead of just *reading* published documents, users were given the possibility of *commenting* the published material, either this were blog entries, articles or other forms of self-identifying material. This became the result of the new web software paradigm that was developed, with rich feature sets and with simple graphical user interfaces that most actors within the web

[68] Humorous: Grand Unified Theory – a term used to describe work in theoretical physics on unifying what are considered three "fundamental" gauge symmetries: hypercharge, the weak force, and quantum chromodynamics (QCD), eventually leading to a Theory of Everything. But as we all know, the answer to the big question about Life, Universe and Everything is 42. (Sources: Stephen Hawking, *A brief History of Time*, Wikipedia and Douglas Adams)

community could relate to, and they could therefore also take part in the translations within the actor network, conducting ”heterogenous engineering” (Law, 1987:113), enroling actors across the network, turning other members of the web community into allies.

Possibilities for many-to-many communication emerged as a result, with open, collaborative and since the technological actants unfolded as a result of negotiations between technical actants and non-technical actors (Hanseth and Monteiro, 1998, Law, 1992), technological acceptance was an implicit consequence in the period of evolvement, that still is underway. The new and, in some regards, next level of web services that came of this was coined Web 2.0, and represented a significant change in how the web community relate to online material. From being something slightly similar to the traditional way of one-to-many publishing, only digital and networked, to a dynamic, polylateral informationscape where the web community edit and update content, post, blog, remix and share files, respond, and all things communicative, evolving the Web into being also a social Web, publishing oneself, shaping identity in a social network.

With its emphasis on graphical user interfaces (GUI), it has managed to cultivate the installed base into a larger web community. By hidig the complexities of the infrastructure in a black-box-like GUI in line with Latour’s descriptions of successful technology becoming opaque and obscured by its own success (Latour, 1999b:304) it has reached more people, leading this paradigm into being a clear social construction of technology, and one that could benefit a Semantic Web that so far struggles to inscribe patterns of use among the majority of the Web community. Akrich describes the need for actors mediating the negotiating process: ”If we are to describe technical objects, we need mediators to create the links between technical content and user. In the case of non-stabilized technologies these may be either the innovator or the user” (Akrich, 1992:211). In this case, where two patterns of inscriptions meet, and where one appears to have stabilized more than the other, I would argue that this point of view does not quite fit the complexity of Semantic Web/Web 2.0 paradigm, and that the mediator in this case is neither the innovator nor the user, but the strength of the Web 2.0 inscription on the Semantic Web might be a collection of added software tools of which the installed base in a relatively short period of time has grown significantly mature. The Web 2.0 paradigm has stabilized through its emphasis on graphical user interfaces, at least in relation to its users, and the bootstrapping design method used to cultivate the installed base bit by bit.

Within the Semantic Web community, the problematization has, up until now, to a large extent been concentrated around joining the governing bodies in order to build actors with a position powerful enough to produce and release standards upon the web community that the community would accept.

I would argue that it might seem slightly odd that the web community of developers have not, at least not in a significant manner until now, taken into consideration what happened when Mosaic, with its graphical user interface, was released in 1993. Apparently they did not pay sufficient attention to usability issues, or the rapid cultivation of the installed base within the Web 2.0 community.

8.3 Web 2.0 – "de facto"

Figure 8-3 Web 2.0 Tag cloud

Artwork by Luca Cremonini[69] inspired by the original tag-cloud picture by Markus Angermeier[70] CC Share Alike 2.5 Generic license

[69] Source: http://www.railsonwave.it/railsonwave/2007/1/2/web-2-0-map. [Accessed: 25/10/2007]. CC Share Alike 2.5 Generic license. (Source: http://creativecommons.org/licenses/by-sa/2.5/)
[70] Source: http://kosmar.de/wp-content/web20map.png. [Accessed: 25/10/2007]

8.3.1 Web 2.0 – characterizations and concepts

The term Web 2.0 is somewhat controversial. It does have a group of characteristics attached to it, but because of its shortfall of a certain set of standards that could give the term a definitive meaning, it could have a different significance to different groups of users, and therefore do not have a singular, clearly defined meaning among the user groups. Tim Berners-Lee even thinks it is not that different from Web 1.0. In an podcast-interview for the IBM-website, about the connectivity issue in Web 2.0 services and whether this was different from Web 1.0 he answered:

> Totally not. Web 1.0 was all about connecting people. It was an interactive space, and I think Web 2.0 is of course a piece of jargon, nobody even knows what it means. If Web 2.0 for you is blogs and wikis, then that is people to people. But that was what the Web was supposed to be all along. And in fact, you know, this Web 2.0, quote, it means using the standards which have been produced by all these people working on Web 1.0. [...] So Web 2.0 for some people it means moving some of the thinking client side so making it more immediate, but the idea of the Web as interaction between people is really what the Web is. That was what it was designed to be as a collaborative space where people can interact.[71]

In this sub-chapter I will discuss some of the practices that have become rather common within this part of the Web's infrastructural paradigm. According to Tim O'Reilly, founder of O'Reilly Media, the Web 2.0 term describes a process of evolution of the internet going from being mainly a one-way information device to becoming a *platform* for a wider array of web-services that would present more possibilities for two-way communication and user-participation, how to grasp the essence of how such a platform is put together, and what is necessary for it to prosper (O'Riley, 2005). In an attempt to give a compact explanation of the Web 2.0 he presented this definition[72]:

> Web 2.0 is the network as platform, spanning all connected devices; Web 2.0 applications are those that make the most of the intrinsic advantages of that platform: delivering software as a continually-updated service that gets better the more people use it, consuming and remixing data from multiple sources, including individual users, while providing their own data and services in a form that allows remixing by others, creating network effects through an "architecture of participation," and going beyond the page metaphor of Web 1.0 to deliver rich user experiences.

[71] Interview with Scott Laningham, developer Works, 28/08/2007. Quoted from podcast transcript, available at: http://www-128.ibm.com/developerworks/podcast/dwi/cm-int082206.txt. [Accessed 11/10/2007]
[72] http://radar.oreilly.com/archives/2005/10/web_20_compact_definition.html. [Accessed: 10/10/2007]

The original Web started, at a certain point in time, to grow at an exponential rate, because students at the University of Urbana-Champaign, lead by Marc Andreesen wrote the first web-browser with a graphical user interface called Mosaic. This program quickly became what in computer circles is called a killer application (Naughton, 2000:247), one that made the World Wide Web easily accessible to the public. This is a clear parallel to what has evolved to become the next level in Web services and usability, the so-called Web 2.0, again because of its character of being inclusive towards the public leads them into a higher state of technological acceptance. Which is good, because not only does this evolved state of the web condone user participation, typical Web 2.0 projects like Wikipedia[73], Facebook[74], Flickr[75] and del.icio.us[76] among others show us that it is based on it. It is the user participation and collaboration with real-time feedback, working the social mechanisms done through blogging, wikis, remixability and distributed services, and the possibility of categorize content by tagging, that is some of the characterizing aspects of the Web 2.0 paradigm, in addition to technologies for syndication of content from heterogenous sources mashed together, that makes up a set of principles and best practices. This bears a quite clear connection of the intended best practices of the Semantic Web.

The Web 2.0 paradigm of enroling actors, resembles what Hanseth and Aanestad (2002) describes as 'design through bootstrapping, where it is explained that it is easier to start with knowledgeable and motivated users who possess the adequate resources, and that not need essential changes in the organisation or network, and that could do with 'cheap, simple and flexible technologies'. When, initially, enroling the easiest and simplest, and then the more complex. We might transfer the 'design as bootstrapping' methodology, by looking at the updated and bigger picture, where both the Semantic Web and the Web 2.0 paradigm have started to integrate some of the technologies involved. In this perspective we might regard the Web 2.0 paradigm as the simple, flexible technology that it easy to enrol, and therefore is a natural start in a bootstrapping process, leading further to the enrolment of the Semantic Web.

One has to be careful and alert when turning to Wikipedia for information that should be capable to stand trial within the academic world, but I have nevertheless chosen to quote

[73] http://en.wikipedia.org - user grenerated encyclopedia
[74] http://www.facebook.com - Social Networking Site (SNS) – application for linking together friends and groups of interests online
[75] http://www.flickr.com - sharing and tagging of pictures – user-generated
[76] http://del.icio.us - social sharing of bookmarks – user-generated

one of the ”best practices” of the Web 2.0 paradigm, Wikipedia itself, as it describe the very same Web 2.0 paradigm like this:

> ”...the phrase "Web 2.0" hints at an improved form of the World Wide Web. Technologies such as weblogs, social bookmarking, wikis, podcasts, RSS feeds (and other forms of many-to-many publishing), social software, web application programming interfaces (APIs), and online web services such as eBay and Gmail provide a significant enhancement over read-only websites. [...] The phrase "Web 2.0" can also refer to the transition of websites from isolated information silos to interlinked computing platforms that act like software to the user. Web 2.0 also includes a social element where users generate and distribute content, often with freedom to share and re-use.” [77]

Public acceptance is a rather crucial aspect regarding the continued evolvement of the installed base of any technological construction. During the period of 2004-2007, the research activity within the Semantic Web discourse increased significantly, although there were a decline in the number of published book titles from 2006 to 2007. At the same time it would seem like the public acceptance of these technologies are far greater regarding Web 2.0 than Semantic Web technologies, as we can see in the figure 8-3.

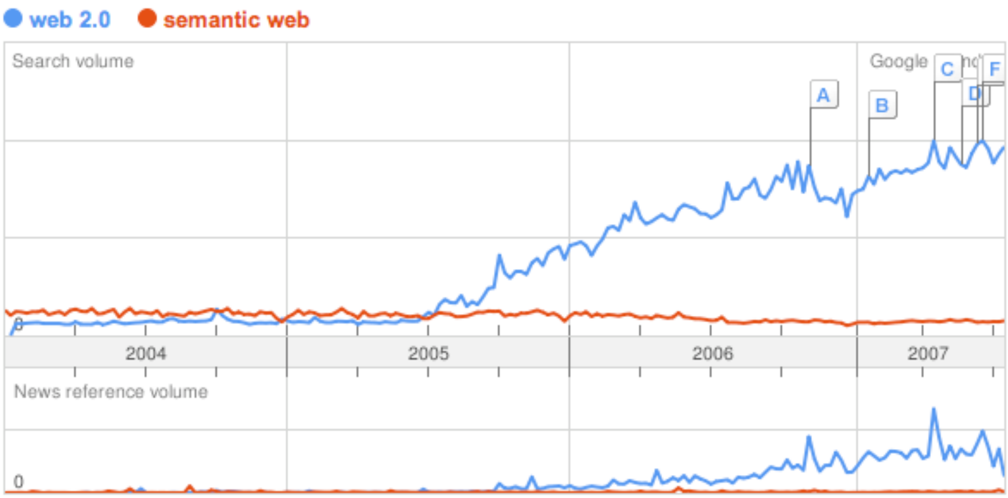

Figure 8-4. Search trends web 2.0 vs. Semantic Web

Source: http://www.google.com/trends[78]

The figure shows how trends in search volume, and amount of News reference have evolved in the period mid-2005–mid-2007. The lettered flags correspond with specific news references[79]. The search trend reflects the accumulated cultivation of an installed

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[77] Source: http://en.wikipedia.org/wiki/Web_2. [Accessed: 20.10.2007]
[78] http://www.google.com/trends?q=web+2.0%2C+Semantic+Web&ctab=0&geo=all&date=all&sort=0. Accessed: August 1st 2007
[79] A ”Web 2.0 Summit: Yahoo’s Web 2.0 Strategy” - Search Newz, Nov 8 2006. B ”Venture Capital Climbs In ’Web 2.0’ Burst” – CBS News, Jan 23 2007. C ”Web 2.0: What participation?” – PC World, Apr 18 2007. D ”Enterprise Web 2.0 – Programming with Levers, Dials and maybe Switches” – SYS-CON Media, May 21 2007. E iPhone to Support Third-party Web 2.0 Applications” – PR Newswire (press release), Jun 12 2007. F ”Web 2.0 Adoption” – Industry Week, June 20 2007.

base, which is also reflected in Grindleys ”Standards reinforcements mechanisms”-figure, referenced in Hanseth (2001:62) (Figure 5-1).

Semantic Web technologies and development can be said to, at least initially, be a somewhat top-down based project, because it was initiated by Tim Berners-Lee himself, and the organization he leads, the W3C, is responsible for main part of the research work done among the various work groups whereas the web paradigm called Web 2.0 with its emphasis on user participation, is driven by the web user community.

The Web was initially a bottom up driven project, in that it was invented out of a presumed specific necessity at a certain moment in time, and not at a mangement level (”top”) but by a member (Tim Berners-Lee) of the supporting staff (”bottom”) at CERN, that saw the need for this technology in order to gain control over the vast amounts of research material produced. The Web grew at a steady pace the first two years, but the growth was not exponential until the Web's first killer application, the Mosaic browser, was released in 1993 (Naughton, 2000, Gillies and Cailliau, 2000).

The democratization of the information control that the Web potentially gave the public a notion about, started when the front-end issues, like graphical user interfaces, and usability were taken seriously. Mosaic was the first web-software with a user interface that most people, that is regular consumers, could understand how to use, and relate to. With Mosaic the growth in the number of users and servers increased at an exponential rate (Naughton, 2000).

The curve in Figure 8-4 resembles, in a way, the technological development of the Web 2.0 paradigm that is bottom-up and user-centric, which shows the velocity and penetrational force of a technology that is a result of social construction, in comparison to the sort of silent development work on Semantic Web standards done within the scientific community. This could in a way also resemble the comparative differences in technological development that Eric Raymond describes in his ”The Cathedral and the Bazaar” (Raymond, 2000), where the Cathedral being the W3C, and the Bazaar being the myriad of Web 2.0 upstarts and developer communities, mashing services together in all their heterogeneity. With regards to the the Semantic Web, since it, after all, is based on open standards, we would probably prefer to recognize this resemblance more like The Bazaar and the Slightly Smaller Bazaar.

Abbate (1999) emphasizes the importance of having users within the network, shaping the technology. This leads to a blurred distinction between users and producers, and she argues that the success of the Internet can be traced back to the users' ability to form the network to satisfy their needs. This is in line with Akrich's argument about needing mediators to create connections "between technical content and user", and she argues further that "in the case of non-stabilized technologies these may be either the innovator or the user" (Akrich, 1992). This argument covers very well the early stages of the development process of ARPANET, where there were no significant distinction between users and developers, since it was ARPA's own computer scientists that built the system to cover their own needs (Akrich, 1992).

A negotiation process through new search technologies that is constantly developing could be a viable solution and seems to be one, of several, possible answer. Another is the newest Semantic Web technologies like SPARQL and GRDDLE, that could perform automatic extraction of semantic data. In my view it is at the crossroad where technology meets most people that the technology proves itself. It is from this meeting original and useful technologies evolve, in the back-and-forth negotiation described by Akrich (1992):208-209) That is why it would not seem unlikely that the fusion between the formal, quite rigid, specification driven and "scientifically" developed technologies that constitutes the Semantic Web and the overall flexible, 'de facto' technologies of the Web 2.0 paradigm could be the synergy that could lift Semantic Web technologies out of the laboratory on a more extended scale. According to Hanseth a gateway might be defined as a "link between different elements", or in a broader perspective "even a standard or a whole network can be seen as a gateway" (Hanseth, 2002b). According to this the Web 2.0 technologies could be seen as the gateway between the traditional Web and web-service saturated Semantic Web and by that be the kind of technology that release the potential of the web that Tim Berners-Lee originally envisioned (Berners-Lee, 2000).

Seeing this development process as building a "Large Technical System" it falls naturally to draw upon Thomas Hughes' influential 'Networks of Power' (Hughes, 1983), about the development of electricity in the period from 1880 to 1930. The seminal event in this process is what is known as the battle between systems (AC vs. DC), and which ended when the AC/DC-converter was developed, working as a gateway between AC and DC networks (Hanseth, 2002b, Hughes, 1983). From this it could be drawn a parallel to describe the traditional Web vs. the new and extended Semantic Web and where the difficulties the developer community has had in enroling actors in order to reach an installed base where the networked economical aspects become apparent, might end when what might seem as a "converter", in the shape of the Web 2.0 paradigm, links the traditional web with the Semantic Web.

Within the Semantic Web itself, we might regard several of the newly released W3C-protocols, like ie. GRDDL, as converters between existing and future information management practises.

9 Concluding analysis

I have described an elected group of actors and actants; networks of users, a grid of technological standards that initially may look like opposites but share several technological practices, in that they gather data from heterogenous sources, and exchange technological actants, like ie. RDF and GRDDL, and projects like ie. FOAF, OntoWiki and SIMILE, among many.

I have discussed the work of deploying certain semantic web technologies which, in all of its convergence, and being an infrastructural melting pot, is all about co-dependent heterogenous networking technologies. In chapter 5 I have given a brief overview of theories and literature, and in chapter 7 I have presented the standards and protocols, concepts and their meanings in addition to a set of empirical findings regarding the main aspects of the infrastructural discourse related to this thesis. Nevertheless, they are only parts of a paradigm, that they are trying to shift or more precisely, evolve, and this thesis is limited to the part of this discourse that is related the socio-technical aspects of the tension between standards and flexibility regarding the development of the Semantic Web and the Web 2.0 paradigm.

The original vision of the Semantic Web is a thing of beauty (Berners-Lee et al., 2001). The idea of having a far more advanced version of the global information landscape that Vannevar Bush envisioned in 1945 is tantalizing, but in terms of translation rather demanding. If succeeding, it could not only realize his visions, but surpass them by making this informationscape into an almost autonomous body, taking care of itself in all its interwoven standards and interoperability; an actor network where the translations among the sub-networks become punctualized into a consolidated entity.

If being realized, this could be a glorious endeavor indeed. However, it seems that the Semantic Web could need a graphical user interface as a front-end. The interoperability that these new protocols should have made possible is not yet fully implemented, although a certain amount of slow progress is being made. The shere manpower needed just in order to make and maintain all of the domain-specific ontologies that are necessary as foundation for the inference engines to work as planned or envisioned seems like an almost overwhelming task to undertake. There is, of course the task force of Wikipedia, with its tens of thousands of knowledgeable volunteers, and then the potent proactivity of Google with its rather adequate financial muscles, but the task of transfering the nature of *being* and the taxonomies of the world into what we might call the *namespace for all things*, do, potentially, seem like a huge enterprise of an omnifarious nature.

The W3C has recently released the GRDDL-specification that enables authors to extract RDF data from XHTML and XML. The consortium has also published a validation service that can do this extraction for you, either by URI, or direct input of document markup[80].

9.1 What works well for people I

I discuss the Semantic Web developer community's initial lack of attention to usability and user-interfaces as a possible explanation for the Semantic Web's hitherto failure to materialize, which is remarkably similar to Ted Nelson and the Xanadu hypertext system. After almost 35 years of development, it still awaits common acceptance. Jef Raskin[81] critized the system because of its lack of user interface: "Nelson's avoidance of what he calls "front end" issues is a major failing of his vision, his priorities, and his understanding of what makes things work well for people" (Suter, 1995). After all, the regular web, that Tim Berners-Lee invented in 1990 (Berners-Lee, 2000), did not appeal to regular consumers until Marc Andreesen and Eric Bina developed Mosaic, the first browser with a graphical user interface in the spring of 1993 (Berners-Lee, 2000, Naughton, 2000). The Web went from being a text based online system used mainly by universities and research organizations, to a consumer communication network in a period of just 3 years.

The Semantic Web is the further evolvement of the World Wide Web, which is largely a document-web comprehendable mainly by human actors, into a data-web not only comprehendable by non-human actors, in that it provides an infrastructure that makes it possible to share and redistribute data across and between the system's borders. This interoperability is mainly made possible through the development of the set of standards described in sub-chapter 7.1.

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[80] Source: http://www.w3.org/2007/08/grddl/ [Accessed: 01/11/2007]

[81] American human-computer interface expert. Best known for having started the Macintosh-project for Apple Computer LEVY, S. (1995) *Insanely great: the life and times of Macintosh, the computer that changed everything*, New York, Penguin Books. HERZFELDT, A. *The Father of Macintosh*, http://folklore.org/StoryView.py?project=Macintosh&story=The_Father_of_The_Macintosh.txt, [Accessed: 3/11/2007]

As humans, we do have limits as to the amount of information we can handle without the help of machines, which is one of the problems related to today's Web: it requires human interference and intelligence. The information overload that Vannevar Bush set out to overcome has grown to such huge proportions that we are simply incapable of relating to all information within such a vast and heterogenous infrastructure. The biggest and, to a large degree, ubiquitous information infrastructure today is the Internet, with its hypertextual application, the World Wide Web, meets a set of what we might consider as "normal" problems, when the time for a change comes into actuality.

The Semantic Web is not an isolated artefact but an evolvement of the existing Web. The extended interoperability that is the whole idea, vision and the very core of the Semantic Web, where the retrieving and semantic integration of heterogenous data gathered from a large or even global network, makes it natural to look at these fairly new standards and the process of implementing them through Actor-Network- and Information Infrastructure theory. Even more so since it seems that the grand idea of an almost autonomous interoperable network on a machine level have shown to be harder to realise and implement than one perhaps first thought it to be, as this bootstrapping process is explained by Hanseth and Aanestad (2002).

It is somewhat of a paradox that the developers of the original World Wide Web, which alongside Linux, is the very epitome, of a bottom-up, bootstrapped, bazaar-like development methodology, now are utilizing the opposite development strategy. This is the Semantic Web-version of the earlier OSI-Internet standards war (Russell, 2006). How can Tim Berners-Lee avoid deploying the design method that proved so extremely successful the last time he tried it? Not only does he avoid it, he does the quite opposite. He utilizes the same method that lost the last time around. Why? Can it be that the shadow of the W3C has grown to big for supporting this kind of innovation in the network? That the Web and its rulers has become too successful and top-down oriented, and now, almost against their own will, resist change?

9.2 Socio-technically constructed determinism?

Reading the 2001-article (Berners-Lee et al., 2001) gives a somewhat peculiar mix of technological determinism and social constructivism. It might look like the authors camouflage the technologically deterministic aspects of the Semantic Web evolution with arguments that it is a technology that will benefit the regular consumer, but is really a specification driven evolution by the wish to further develop the technology for its own sake. Not that this is wrong. Even technologies that are being developed because of scientists wish to excel might work well for people, leading to even further development, and this time driven by societal "needs" and wishes. Can it be that technology can be hermafrodite, going from being technologically driven in a science/technological meritocracy to become socially constructed following societal acceptance? This might be the explanation of the fact that in spite of the rather noticeable increase in research efforts within the Semantic Web discourse, it has met difficulties in catching on among the public. In this lies a paradox. Semantic Web technologies are not neccesarily meant to be flashy and visible, but rather work deeper down in the infrastructure in a 'work, but not be seen' kind of manner. With the technology more or less hidden from the public eye, it does not create the stir as the original web did, because it is only extending the WWW with new sets of services. This is in line with Latour's concept of black-boxing (1999b:304), which would lead us to regard the Semantic Web technologies as an underlying infrastructure, an actant of standards that is increasingly settled in the meeting with Web 2.0

Perhaps it is just how we could regard the Semantic Web? As a black-boxed technology. While discussing the Web as an information infrastructure; to look at the Semantic Web together with Web 2.0 as the evolving aspect of the Web as a renegotiable black box, and not the final goal. In that respect we might say that the term "Semantic Web" is a bit unfortunate, in that it possibly takes away the focus on evolvement and almost gives the impression of Semantic Web as the final destination for the Web. Maybe it would be slightly more pragmatic to view the concept of the Semantic Web as only a name or concept of a certain development process of the worlds largest information infrastructure. Because of the very size of the Web, this evolving process runs into a, at least partial, lock-in, and makes it difficult to deploy these new standards. It might seem like the Web could, to a certain extent, be salvaged by the research work done on the process of implementing the new semantic standards in search engine technology and derivative works based on these standards, that this information infrastructure will continue to evolve as information infrastructures do, and that one of the biggest challenges of todays web. This is in line with Hanseth, Monteiro and Hatling (1996) who argue that a standardisation process, on a regular basis, is interrupted with events that demands that formal standards also have to be flexible enough to absorb change

Among the many critics of the Semantic Web we find Clay Shirky, who has pointed out problematic issues regarding machine inference[82], and Peter Norvig, Director of Research at Google, who has pointed out problematic issues regarding ontologies and metadata, and the questioned competence of regular users needing to relate to more complexity [83]. One main element in this critique is that the standards are too complex, and not sufficiently flexible when it comes to error prone developers.

RDF is far more complex than HTML, and HTML has taken years of browser wars and companies that have had problems with, or lack of will to, release software according to standards. Developers have had difficulties adhering to standards issued by the W3C. Just to watch the huge number of web pages that is titled *untitled.html* shows that even the simplest markup language might give a lot of people with the best of intentions slight problems with following even simplest of standards[84].

> In 'A Sociology of Monsters', John Law quotes Nicholas Mosley's book 'Hopeful Monsters':
> "I said ' I think they might also be what are called "hopeful monsters".'
> She said 'What are hopeful monsters?'
> I said 'They are things born perhaps slightly before their time; when it's not known if the environment are ready for them.' [85]

In a fused actor network where both Web 2.0 and the Semantic Web infrastructures are actors, we problematize the Semantic Web according to Callon(1986), and while it is the formal standards of the Semantic Web that represents the strong technological foundation and, as such, as a strong actor, should have been the leading actor in the powerful position as the new web paradigm the scientists want us to accept, it is the *Web 2.0* with its emphasis on graphical user interfaces and usability, that seems to become the vehicle of translation, making it, seemingly, the powerful actor in the problematization process because of a stronger public position within the network. This is still in line with to Callon's description of a system of allies and relations between actors and actants of different value. According to Callon this is a process where the position is defined by the action of joining forces in the network, one that would construct

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[82]Source: http://www.shirky.com/writings/semantic_syllogism.html. [Accessed: 18/08/2007]
[83] http://blogoscoped.com/archive/2005-01-18.html, and http://www.nodalpoint.org/2006/07/19/aaai_google_and_the_semantic_satanic_romantic_web [Accessed:1808/2007]
[84] A search for documents named untitled.html using the Yahoo! Search engine returned 5.650.000 hits, while untitled.htm returned 2.550.000, 13th July 2007. In total that is 8,2 million webpages with an error as simple as wrong namegiving.
[85] Nicholas Mosley, Hopeful Monsters, p. 71, quoted in John Law, ed. 'A Sociology of Monsters, 1991.

actors of increasing significance, until indispensability (Callon, 1986). In the case of the Semantic Web and the Web 2.0 paradigm utilizing each other, this would lead us to one, of several, possible conclusions that these technologies have come to a necessary co-existence, in order to further cultivate the installed base.

Latour claim in 'Science in Action' that "the only way to keep the dissenters at bay is to link the fate of the claim with so many assembled elements that it resists all trials to break it apart" (1997: 122).

This is a situation also described by Akrich where the "technical realization of the innovator's beliefs about the relationships between an object and its surrounding actors is thus an attempt to predetermine the settings that users are asked to imagine for a particular piece of technology and the pre-scriptions (notices, contracts, advice, etc) that accompany it. To be sure, it may be that no actors will come forward to play the roles envisaged by the designer. Or users may define quite different roles of their own. If this happens, the objects remain a chimera, for it is in the confrontation between technical objects and their users that the latter are rendered real or unreal" (Akrich, 1992:208).

9.3 What works well for people II

There is a saying that you know others through yourself, and what I want is a remote control. I don't need to know *how* it works, as long as it works the way that I have come to believe that it should, and that it continues to do so in an expected period of time. It makes me feel safe. I am a simple man, and I want simplicity. I want a black box. And since I believe that I am not so different from others. I think they want it as well. We want black boxes that are cheap, simple and interactively brilliant, that make our world simpler and at the same time give us more options, and more services.

One such cheap, fast, better black box could be the Web 2.0 paradigm, that according to Tim O'Reilly was coined by Dale Dougherty at a meeting between O'Reilly and MediaLive International in 2003 (O'Riley, 2005), and presented at the first O'Riley Conference in 2004 (O'Riley, 2005).

Because many Web 2.0 – services are based on reusing data, that is also a focal point in the research work done in the the Semantic Web field, an *integration* between the two, seemingly 'opposite' technologies, with Web 2.0 services are mainly about user-experiences while Semantic Web research work is specification driven and mainly is focused on developing standards, rules, languages and framework, could possibly be a solution for both parties. In his arcticle "Is Web 2.0 killing the Semantic Web?", Dan Zambonini (2005) argues that Web 2.0 services has been implemented more quickly and with more immediate benefits, than the more slowly developed and thoroughly founded Semantic Web, and that this has lead to the fact that Web 2.0 services has gained momentum more quickly, and therefore been accepted by the installed base accordingly. This does not necessarily imply that the Semantic Web will not happen on a bigger scale. In the article Zambonini also argues that the Web 2.0 even might need Semantic Web technologies in order to reach its optimal level of service (Zambonini, 2005). One such possible technology that is meant to integrate the rather versatile, open-ended web 2.0 of today with the more rigid Semantic Web is, as mentioned in ch. 7.1.4.8, the newly released GRDDLE-standard for automatic extraction of RDF data from XHTML and XML documents.

Although quite slowly, the Semantic Web *has changed*, from being a slightly obscure and controversial idea of making the traditional Web comprehendable and interoperable by machines, into a far less obscure but still a bit controversial technology, which has made this into a fascinating journey indeed. Even if it still lies beyond the grasp of the regular consumer, it might seem that the Semantic Web, with the help of Web 2.0 paradigm, not only is far less obscure, but after all these years of working on and issuing W3C Recommendations[86] and RFCs[87] the development of the Semantic Web could possibly start to gain acceptance among the Web community, not as *The Semantic Web*, but as an underlying infrastructure for the visible Web, when a new generation Semantic Web technologies (SPARQL, FOAF, GRDDL) is being deployed within the traditional Web and Web 2.0, establishing a link between the old and the new web world, aligning the actor network.

The Web 2.0 services has deployed certain Semantic Web technologies, like ie. the FOAF protocol, which means that people in the web community are using Semantic Web technologies without really being conscious of doing so. This kind of usage is also

[86] The W3C development process, and the description of how it is designed to maximise consensus is available at the W3C web site: http://www.w3.org/2005/10/Process-20051014/tr
[87] Request for Comment. Proposals are published in the form of an RFC memo through the Internet Society, www.isoc.org, on behalf of Internet Engineering Task Force, www.ietf.org, and the RFC Editor, www.rfc-editor.org.

in line with what members of the W3C Semantic Activity Group have envisioned as practical deployment of the Semantic Web, as a technological framework for a higher level and extended range of web services. The Semantic Web was never intended as a replacement of the present Web, but as an underlying "servant" actor.

Could it possibly be that instead of killing the Semantic Web, the Web 2.0 paradigm is becoming the killer application? In both fields of practices, the reuse of data is a significant aspect. In his article, Zambonini argues that Web 2.0 services are deployed more quickly, and therefore get more public attention than the more silent research work done with the more formal Semantic Web technologies, which also is reflected in the graphical representation of search interest of Web 2.0 vs. Semantic Web shown in Figure 8-4. Search trends web 2.0 vs. Semantic Web. Quicker deployment and by that quicker negotiation also leads to a more rapid cultivation of the installed base and by that reaches a momentum more quickly. I will argue that it is the need of the applications in the Web 2.0 paradigm of gathering, ie. mashups, from heterogenous sources in order to deliver the level of web services that might get the Semantic Web technologies out of the research labs and become a useful actor in the web community, that the graphical user interface that the Semantic Web hitherto has been lacking, could be the Web 2.0 paradigm itself. Instead of coming forward as *Semantic Web-services*, the Semantic Web will simply represent the infrastructure being black-boxed through the Web 2.0 interface paradigm leading the Web 2.0 to be something that happened while we were waiting for the Semantic Web, and might turn out to be the killer application it needs, to be an aligned actor network, and that the two could quite possibly melt together, where the Web 2.0 paradigm will become the de-facto, flexible graphical front-end for the formal standardized Semantic Web.

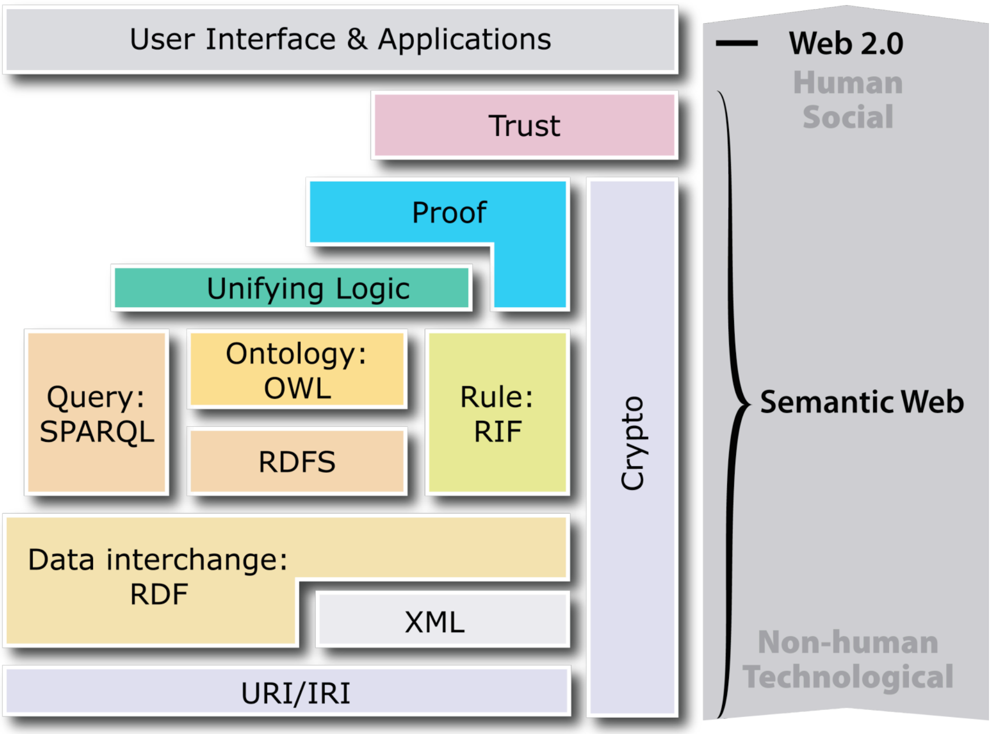

Figure 9-1 Semantic Web / Web 2.0 layered infrastructure

Adapting the latest W3C Semantic Web layer cake by including the Web 2.0 paradigm as a coming de-facto graphical front-end for the Semantic Web infrastructure, and relating it to actor network theory, could possibly give us a picture of the result of these two design methodologies fused together that looks like figure 9-1. In this scenario the core Semantic Web standards like RDF, OWL, GRDDL and SPARQL might also be regarded as gateways between the Semantic Web and Web 2.0 applications.

9.4 Further work

Although it would have been tempting to present a complete picture of all adjacent technologies and research groups and how they interoperate, all the journals that are published and conferences that are attended, but it would have been outside the scope of this thesis. I have limited the area of analysis to parts of the junction between Semantic Web and the Web 2.0 paradigm.

In their special issue on Web 2.0 and the Semantic Web, that are due for release in December 2007, the Journal of Web Semantics are calling for papers in order to discuss the impact of Web 2.0 technologies and what is described as the Web 2.0 revolution related to the work done within the Semantic Web paradigm.

The International Journal of Metadata, Semantics and Ontologies, IJMSO, is at present compiling a special issue containing reports from the latest research done on the search and retrieval of artifacts on the Web, like audiovisual media, documents and other resources. using ontologies, metadata and technologies based on W3C's standards for the Semantic Web. This special issue is due for publication in 2008 and is edited by Jorge Cardoso at the University of Madeira, Portugal, Christoph Bussler, CISCO Systems Inc., USA and Fransesco Guerra at Universitá di Modena e Reggio Emilia, Italy. The area of interests is related to topics like semantic-driven indexing and retrieval, annotation of documents in order to increase search precision, search in RDF databases, Semantic Web information retrieval in terms of searching, querying, and ranking, meta search engines and related technologies[88].

It might be exiting to follow the Semantically–Interlinked Online Communities Project (SIOC), which is conducting research into providing methods for linking communication technologies like forums, blogs and mailing lists to each other[89].

Other topics of possible interest could be a discussion of the impact that a deployment of a possible convergence between Web 2.0 and Semantic Web technologies could have on the newborn practice of Crowdsourcing[90], of how the powerful and somewhat formal and rigorous technologies of the Semantic Web paradigm could increase the significance of the Web 2.0 technologies that make Crowdsourcing possible (Howe, 2006), recognizing that Crowdsourcing is the Web 2.0 version of Eric Raymond's bazaar-model in 'The Cathedral and the Bazaar' of how "Given enough eyeballs, all bugs are shallow" (Raymond, 2000). While Raymond describes a software development model within the open source community, the Web 2.0 is mainly about user contribution and collaboration in the production of text, music, pictures and identity itself.

Another and a more theoretical discussion could be whether there is a connection between the properties of relational strength described in n-ary relations (ch. 7.1.4.2) on the Semantic Web, and the strength of inscriptions in an actor network. This discussion

[88] http://dme.uma.pt/jcardoso/SpecialIssue/IJMSO07/
[89] http://sioc-project.org. [Accessed: 10-15/08/2007]
[90] One of the biggest and most successful examples of Crowdsourcing can be said to be Wikipedia, where tens of thousands of people together make the largest encyclopedia in the world.

could possibly give us information about the stability, and therefore validity over time, of vocabularies, taxonomies and ontologies, which in turn would have an impact on how we relate to various layers in the Semantic Web layered infrastructure (Figure 8-1), and in particular the trust layer, and how we eventually would percieve the data, information or knowledge that is being aggregated, utilizing Semantic Web technologies.

Yet another area of research could regard the attempts at moving from regular desktop services to web applications through AJAX and Semantic Web technologies. One interesting example of this is the web application replacement for Microsoft Exchange, the Zimbra Collaboration Suite[91], which is mainly based on the AJAX suite of technologies. What a user normally would be forced to do in a desktop-based client software, can now be done in a Javascript-enabled browser, which would lead us to think that moving from desktop to webtop is already within reach.

9.5 End Comment

We are used to define ourselves by sharing information with others. By telling others about jobs, interests, and showing skills in a meritocratic network of friends, colleagues, and acquaintances, we paint a picture of ourselves that we want to present to the world around us, and that is what we wish to continue doing. Having become a networked society inscriptioned by the technology we develop, make new inscriptions onto, and use, we continue to communicate, but now increasingly through digital networking technologies. After all, communication is at the very core of human activity.

We might describe technology as an aspect of societal change, but it is not, as technological determinists claim, autonomous, nor is it the sole mover. In a perspective based on social constructionism it is rather a question of definition. If we assume that society changes technology, and that society by that decides the kinds of technology it wants and accepts, it is also necessary to look at the very definitions of technical quality. Who defines the criteria under which technology is judged? Which kinds of technology succeed and which do not, and why not? In the media-saturated [post]modernity this is often connected to computer-mediated communication, and remediating technologies.

[91] http://www.zimbra.com. This is a brilliant suite of office productivity tools, that runs on all platforms, is based on open standards and open source. The software was, in 2006, regarded as one of the top five technological innovations to look for in 2007 by PC World magazine. Source: http://www.pcworld.com/article/id,128176-page,8-c,electronics/article.html. [Accessed: 4/11/2007] The company was acquired by Yahoo! 9/17/2007. Source: http://www.zimbra.com/about/yahoo_acquires_zimbra.html. [Accessed: 4/11/2007]

The foundation for a technological development is not universalistic, clean and straightforward, it is complex, messy and chaotic; a balance of heterogeneity based on what kind of technology we need, think that we need, or demand, based on previous experience, in a somewhat hermeneutic circular process. We might see the level of technological development as a consequence of the balance between technologically deterministic scientists that *invent* new technology because they *can* in a meritocratic fashion, and the more socially deterministic public who demand what we think we need, both in some beautifully unconscious way, ending up in a fragile balance of present adequacy, immersed in converging, ubiquitous, layers of media technologies in which we are both consumers and publishers.

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11 Appendices

11.1 About Netcraft

Netcraft is an Internet services company based in Bath, England. Netcraft is funded through retained profit and derives its revenue in the following ways:

- Providing internet security services, including anti-fraud and anti-phishing services, application testing, code reviews, and automated penetration testing.
- Providing research data and analysis on many aspects of the Internet. Netcraft has explored the Internet since 1995 and is a respected authority on the market share of web servers, operating systems, hosting providers, ISPs, encrypted transactions, electronic commerce, scripting languages and content technologies on the internet.
- Accepting advertising on the Netcraft web sites.

Acknowledgements, according the company's web site:

Bob Metcalfe, inventor of Ethernet, and co-founder of 3com, pronounced Netcraft "cool", while Tim O'Reilly called www.netcraft.com the best known example of a site devoted to tracking technology on the Internet.

Source: http://news.netcraft.com/about-netcraft. [Accessed: 25/10/2007]

11.2 World Wide Web Consortium Process Document

14 October 2005

This version:
  http://www.w3.org/2005/10/Process-20051014/
Latest operative version:
  http://www.w3.org/Consortium/Process/
Previous operative version:
  http://www.w3.org/2004/02/Process-20040205/
Editor:
  Ian Jacobs, W3C

Please refer to the errata for this document, which may include some normative corrections.

This document is also available in these non-normative packages: single HTML file, self-contained gzipped tar archive, self-contained zip archive.

There may be translations of this document.

Abstract

The mission of the World Wide Web Consortium (W3C) is to lead the World Wide Web to its full potential by developing common protocols that promote its evolution and ensure its interoperability. The W3C Process Document describes the organizational structure of the W3C and the processes related to the responsibilities and functions they exercise to enable W3C to accomplish its mission. This document does not describe the internal workings of the Team or W3C's public communication mechanisms.

For more information about the W3C mission and the history of W3C, please refer to About W3C [PUB15].

Status of this Document

This is the 14 October 2005 version of the W3C Process Document. This document has been produced by the W3C Advisory Board and reviewed by the W3C Members and Team.

The list of changes to the public Process Document is available on the Web.

W3C, including all existing chartered groups, follows the most recent operative Process Document announced to the Membership.

Please send comments about this document to process-issues@w3.org (Member-only archive).

Additional Member-only information about the Process Document (e.g., issues lists, Member-only drafts, and changes to Member-only drafts) is available from the Process Plan page. General information about W3C is available on the Web, including information about becoming a W3C Member.

The terms MUST, MUST NOT, SHOULD, SHOULD NOT, REQUIRED, and MAY when highlighted (through style sheets, and in uppercase in the source) are used in accordance with RFC 2119 [RFC2119]. The term NOT REQUIRED (not defined in RFC 2119) indicates exemption.

Some terms have been capitalized in this document (and in other W3C materials) to indicate that they are entities with special relevance to the W3C Process. These terms are defined herein, and readers should be aware that the ordinary (English) definitions are incomplete for purposes of understanding this document.

Relation of Process Document to Patent Policy

W3C Members' attention is called to the fact that provisions of the Process Document are binding on Members per the Membership Agreement [PUB6]. The Patent Policy W3C Patent Policy [PUB33] is incorporated by normative reference as a part of the Process Document, and is thus equally binding.

The Patent Policy places additional obligations on Members, Team, and other participants in W3C. The Process Document does not restate those requirements but includes references to them. The Process Document and Patent Policy have been designed so that they may evolve independently.

In the Process Document, the term "participant" refers to an individual, not an organization.

W3C Process Document - Table of Contents

The ToC of the W3C Process Document, which extends 55+ pages, is included in order to show the size, formality and complexity of the W3C-working process.

11.3 W3C 2004 Press release about RDF and OWL

World Wide Web Consortium Issues RDF and OWL Recommendations Semantic Web emerges as commercial-grade infrastructure for sharing data on the Web

Contact Americas, Australia --

Janet Daly, <janet@w3.org>, +1.617.253.5884 or +1.617.253.2613

Contact Europe --

Marie-Claire Forgue, <mcf@w3.org>, +33.492.38.75.94

Contact Asia --

Yasuyuki Hirakawa <chibao@w3.org>, +81.466.49.1170

(This press release is also available in French and Japanese)

http://www.w3.org/ -- 10 February 2004 -- Today, the World Wide Web Consortium announced final approval of two key Semantic Web technologies, the revised Resource Description Framework (RDF) and the Web Ontology Language (OWL). RDF and OWL are Semantic Web standards that provide a framework for asset management, enterprise integration and the sharing and reuse of data on the Web. These standard formats for data sharing span application, enterprise, and community boundaries - all of these different types of "user" can share the same information, even if they don't share the same software.

Today's announcement marks the emergence of the Semantic Web as a broad-based, commercial-grade platform for data on the Web. The deployment of these standards in commercial products and services signals the transition of Semantic Web technology from what was largely a research and advanced development project over the last five years, to more practical technology deployed in mass market tools that enables more flexible access to structured data on the Web. Testimonials from enterprise-scale implementors and independent developers illustrate current uses of these standards on the Web today.

"RDF and OWL make a strong foundation for Semantic Web applications," said Tim Berners-Lee, W3C Director and inventor of the World Wide Web. "Their approval as W3C Recommendations come at a time when new products spring up in areas as diverse as Enterprise Integration and medical decision support. It's not unlike the early days of the Web, when once people saw how it worked, they understood its power. We're entering that phase now, where people can see the beginnings of the Semantic Web at work."

A World Wide Web Consortium (W3C) Recommendation is understood by industry and the Web community at large as a Web standard. Each Recommendation is a stable specification developed by a W3C Working Group and reviewed by the W3C

Membership. Recommendations promote interoperability of Web technologies of the Web by explicitly conveying the industry consensus formed by the Working Group.

Wide Range of Applications Growing from New Semantic Web Standards

Semantic Web-enabled software using RDF and OWL include:

- Content creation applications: Authors can connect metadata (subject, creator, location, language, copyright status, or any other terms) with documents, making the new enhanced documents searchable
- Tools for Web site management: Large Web sites can be managed dynamically according to content categories customized for the site managers
- Software that takes advantage of both RDF and OWL: Organizations can integrate enterprise applications, publishing and subscriptions using flexible models
- Cross-application data reuse: RDF and OWL formats are standard, not proprietary, allowing data reuse from diverse sources

Many specific examples of commercial applications and enterprise scale implementations of these technologies are detailed in both the testimonial page, and the RDF Implementations and OWL Implementations pages.

How the Semantic Web Pieces Fit Together - XML, RDF and OWL

Much has been written about the Semantic Web, as if it is a replacement technology for the Web we know today. "In reality," countered Eric Miller, W3C Semantic Web Activity Lead, "it's more Web Evolution than Revolution. The Semantic Web is made through incremental changes, by bringing machine-readable descriptions to the data and documents already on the Web. XML, RDF and OWL enable the Web to be a global infrastructure for sharing both documents and data, which make searching and reusing information easier and more reliable as well. "

W3C's Semantic Web Activity builds on work done in other W3C Activities, such as the XML Activity. Its focus is to develop standard technologies, on top of XML, that support the growth of the Semantic Web.

XML Provides Rules, Syntax for Structured Documents

At the foundation, XML provides a set of rules for creating vocabularies that can bring structure to both documents and data on the Web. XML gives clear rules for syntax; XML Schemas then serve as a method for composing XML vocabularies. XML is a powerful, flexible surface syntax for structured documents, but imposes no semantic constraints on the meaning of these documents.

RDF Delivers a Data Framework for the Web

RDF - the Resource Description Framework - is a standard a way for simple descriptions to be made. What XML is for syntax, RDF is for semantics - a clear set of rules for providing simple descriptive information. RDF Schema then provides a way for those descriptions to be combined into a single vocabulary. RDF is integrated into a variety of applications including:

* library catalogs
* world-wide directories
* syndication and aggregation of news, software, and content
* personal collections of music, photos, and events

In these cases, each uses XML as an interchange syntax. The RDF specifications provide a powerful framework for supporting the exchange of knowledge on the Web.

"RDF is part of the foundation of a major advance in the power of the Web. Ultimately, we will see users and applications combining information represented in RDF from multiple sources on the Web in ways that, until now, have been inconceivable," explains Brian McBride, Chair of the RDF Core Working Group, "The RDFCore Working Group has turned the RDF specifications into both a practical and mathematically precise foundation on which OWL and the rest of the Semantic Web can be built."

OWL Delivers Ontologies that Work on the Web

What's needed next is a way to develop subject - or domain - specific vocabularies. That is the role of an ontology. An ontology defines the terms used to describe and represent an area of knowledge. Ontologies are used by people, databases, and applications that need to share subject-specific (domain) information - like medicine, tool manufacturing, real estate, automobile repair, financial management, etc. Ontologies include computer-usable definitions of basic concepts in the domain and the relationships among them. They encode knowledge in a domain and also knowledge that spans domains. In this way, they make that knowledge reusable.

OWL - the Web Ontology Language - provides a language for defining structured, Web-based ontologies which delivers richer integration and interoperability of data among descriptive communities. Where earlier languages have been used to develop tools and ontologies for specific user communities (particularly in the sciences and in company-specific e-commerce applications), they were not defined to be compatible with the architecture of the World Wide Web in general, and the Semantic Web in particular.

OWL uses both URIs for naming and the description framework for the Web provided by RDF to add the following capabilities to ontologies:

* Ability to be distributed across many systems
* Scalability to Web needs
* Compatibility with Web standards for accessibility and internationalization
* Openness and extensibility

OWL builds on RDF and RDF Schema and adds more vocabulary for describing properties and classes: among others, relations between classes (e.g. disjointness), cardinality (e.g. "exactly one"), equality, richer typing of properties, characteristics of properties (e.g. symmetry), and enumerated classes.

"OWL takes a major step forward in representing and organizing knowledge on the World Wide Web. It strikes a sound balance between the needs of industry participants for a language which addresses their current Web use cases, and the restrictions on developing an ontology language that meshed with established scientific principles and research experience," explained Jim Hendler and Guus Schreiber, co-chairs for the Web Ontology Working Group. "Over fifty Working Group members have successfully designed a language that addresses both sets of concerns and is endorsed by academics and practitioners alike."

RDF and OWL Documents Include Primers, Use Cases, Test Suites, to Aid Developers

The W3C RDF Core Group has produced six documents. Each is aimed at different segments of those wishing to learn, use, implement or understand RDF. The RDF Primer is an introduction to, and tutorial on how to use, RDF and RDF Schema. RDF Concepts and Abstract Syntax specifies the fundamental concepts and information model of RDF. The RDF/XML Syntax Specification (Revised) defines how to write RDF in XML syntax. RDF Vocabulary Description Language 1.0: RDF Schema describes how to use RDF to describe application and domain specific vocabularies. RDF Semantics defines the mathematically precise formal semantics of RDF and RDF Schema. RDF Test Cases defines a set of test cases that illustrate aspects of the other specifications and may be used for the automatic testing of implementations.

The W3C Web Ontology Working Group has produced six OWL documents. Each is aimed at different segments of those wishing to learn, use, implement or understand the OWL language. Documents include - a presentation of the use cases and requirements that motivated OWL - an overview document which briefly explains the features of OWL and how they can be used - a comprehensive Guide that walks through the features of OWL with many examples of the use of OWL features - a reference document that provides the details of every OWL feature - a test case document, and test suite, providing over a hundred tests that can be used for making sure that OWL implementations are consistent with the language design - a document presenting the semantics of OWL and details of the mapping from OWL to RDF.

Industrial and Academic Leaders Move Semantic Web Standards Forward

The RDF Core Working Group is comprised of industrial and academic expertise, lending the depth of research and product implementation experience necessary for building a common description framework for the Web. Participants include representatives from Hewlett Packard, Nokia, IBM, AGFA, ILRT Institute for Learning and Research Technology at the University of Bristol, IWA International Webmasters Association and the University of West Florida. The RDF Core Working Group builds on the contributions of many other organization which developed the RDF Model and Syntax (1999 Recommendation) and RDF Schema (1999 Proposed Recommendation).

The W3C Web Ontology Working Group carries a complement of industrial and academic expertise, lending the depth of research and product implementation experience necessary for building a robust ontology language system. Participants include representatives from Agfa-Gevaert N. V; Daimler Chrysler Research and Technology; DARPA; Defense Information Systems Agency (DISA); EDS; Fujitsu; Forschungszentrum Informatik (FZI); Hewlett Packard Company; Ibrow; IBM; INRIA; Ivis Group; Lucent; University of Maryland; Mondeca; Motorola; National Institute of of Standards and Technology (NIST); Network Inference, Nokia; Philips, University of Southampton; Stanford University; Sun Microsystems; Unicorn Solutions along with invited experts from German Research Center for Artificial Intelligence (DFKI) Gmbh; the Interoperability Technology Association for Information Processing, Japan (INTAP); and the University of West Florida.

OWL brings together a number of groups that have been developing Web ontology languages over the past decade. OWL is based the DAML+OIL language, which was developed by an international team funded by the US Defense Advanced Research Projects Agency (DARPA) and the European Commission's Information Science Technologies (IST) program. The documents released today represent the maturation of this work shaped by the members of the the World Wide Web Consortium.

About the World Wide Web Consortium (W3C)

The W3C was created to lead the Web to its full potential by developing common protocols that promote its evolution and ensure its interoperability. It is an international industry consortium jointly run by the MIT Computer Science and Artificial Intelligence Laboratory in the USA, the European Research Consortium for Informatics and Mathematics (ERCIM) headquartered in France and Keio University in Japan. Services provided by the Consortium include: a repository of information about the World Wide Web for developers and users, and various prototype and sample applications to demonstrate use of new technology. To date, nearly 400 organizations are Members of the Consortium. For more information see http://www.w3.org/

11.4 W3C 2007 Press release about GRDDL

W3C Completes Bridge Between HTML/Microformats and Semantic Web
GRDDL Gives Web Content Hooks to Powerful Reuse and Data Integration

Contact Americas, Australia --
Janet Daly, <janet@w3.org>, +1.617.253.5884 or +1.617.253.2613
Contact Europe, Africa and the Middle East --
Marie-Claire Forgue, <mcf@w3.org>, +33.492.38.75.94
Contact Asia --
Yasuyuki Hirakawa <chibao@w3.org>, +81.466.49.1170

(also available in French and Japanese; see also translations in other languages)

http://www.w3.org/ -- 11 September 2007 -- Today, the World Wide Web Consortium completed an important link between Semantic Web and microformats communities. With "Gleaning Resource Descriptions from Dialects of Languages", or GRDDL (pronounced "griddle"), software can automatically extract information from structured Web pages to make it part of the Semantic Web. Those accustomed to expressing structured data with microformats in XHTML can thus increase the value of their existing data by porting it to the Semantic Web, at very low cost.

"Sometimes one line of code can make a world of difference," said Tim Berners-Lee, W3C Director. "Just as stylesheets make Web pages more readable to people, GRDDL makes Web pages, microformat tags, XML documents, and data more readable to Semantic Web applications, opening more data to new possibilities and creative reuse."
Getting Data into and out of the Web; how is it happening today?

One aspect of recent developments some people call "Web 2.0" involves applications based on combining — in "mashups" — various types of data that are spread all around on the Web. A number of active communities innovating on the Web share the goal of sharing data such as calendar information, contact information, and geopositioning information. These communities have developed diverse social practices and technologies that satisfy their particular needs. For instance, search engines have had great success using statistical methods while people who share photos have found it useful to tag their photos manually with short text labels. Much of this work can be captured via "microformats". Microformats refer to sets of simple, open data formats built upon existing and widely adopted standards, including HTML, CSS and XML.

This wave of activity has direct connections to the essence of the Semantic Web. The Semantic Web-based communities have pursued ways to improve the quality and availability of data on the Web, making it possible for more intensive data-integration and more diverse applications that can scale to the size of the Web and allow even more powerful mashups. The Web-based set of standards that supports this work is known as the Semantic Web stack. The foundations of the Semantic Web stack meet the requirements for formality of some applications such as managing bank statements, or combining volumes of medical data.

Each approach to "getting your data out there" has its place. But why limit yourself to just one approach if you can benefit, at low cost, from more than one? As microformats users consider more uses that require data modelling, or validation, how can they take advantage of their existing data in more formal applications?

A Bridge from Flexible Web Applications to the Semantic Web

GRDDL is the bridge for turning data expressed in an XML format (such as XHTML) into Semantic Web data. With GRDDL, authors transform the data they wish to share into a format that can be used and transformed again for more rigorous applications.

GRDDL Use Cases provides insight into why this is useful through a number of real-world scenarios, including scheduling a meeting, comparing information from various retailers before making a purchase, and extracting information from wikis to facilitate e-learning. Once data is part of the Semantic Web, it can be merged with other data (for example, from a relational database, similarly exposed to the Semantic Web) for queries, inferences, and conversion to other formats.

The Working Group has reported on implementation experience, and its members have come forward with statements of support and commitments to implement GRDDL.

GRDDL Test Cases is also published today, which describes and includes test cases for software agents to support GRDDL. The Working Group has produced a GRDDL service that allows users to input a GRDDL'd file and extract the important data.

About the World Wide Web Consortium [W3C]

The World Wide Web Consortium (W3C) is an international consortium where Member organizations, a full-time staff, and the public work together to develop Web standards. W3C primarily pursues its mission through the creation of Web standards and guidelines designed to ensure long-term growth for the Web. Over 400 organizations are Members of the Consortium. W3C is jointly run by the MIT Computer Science and Artificial Intelligence Laboratory (MIT CSAIL) in the USA, the European Research Consortium for Informatics and Mathematics (ERCIM) headquartered in France and Keio University in Japan, and has additional Offices worldwide. For more information see http://www.w3.org/

URL: http://www.w3.org/2007/07/grddl-pressrelease

11.5 Members of the Semantic Web Coordination Groups

Member	**Role**
Phil Archer	POWDER Working Group Chair [http://www.w3.org/2007/powder/]
Thomas Baker	SW Deployment Working Group [http://www.w3.org/2001/sw/SWD/]
Dan Brickley	SW Interest Group Interest Chair [http://www.w3.org/2001/sw/Interest/]
Dan Connolly	GRDDL Working Group Staff Contact [http://www.w3.org/2001/sw/grddl-wg/], Past Data Access Working Group Chair [http://www.w3.org/2001/sw/DataAccess/]
Lee Feigenbaum	Data Access Working Group Chair [http://www.w3.org/2001/sw/DataAccess/]
Brian McBride(*)	GRDDL Working Group Chair [http://www.w3.org/2001/sw/grddl-wg/], Past RDF Core Working Group Chair [http://www.w3.org/2001/sw/RDFCore/]
Guus Schreiber	SW Deployment Working Group Chair [http://www.w3.org/2001/sw/SWD/], Past Best Practicees and Deployment Working Group Chair [http://www.w3.org/2001/sw/BestPractices/], Past Web Ontology Working Group Chair [http://www.w3.org/2001/sw/WebOnt/]
Harry Halpin	GRDDL Working Group Chair [http://www.w3.org/2001/sw/grddl-wg/]
Sandro Hawke	Rules Interchange Working Group and OWL Working Group Staff Contact [http://www.w3.org/2005/rules/]
Ivan Herman	W3C Semantic Web Activity Lead [http://www.w3.org/2001/sw/], Semantic Web Interest Group Staff Contact [http://www.w3.org/2001/sw/Interest/], Education and Outreach Interest Group Staff COntact [http://www.w3.org/2001/sw/sweo/]
Tonya Hongsermeier	Semantic Web Health Care and Life Sciences Interest Group Chair [http://www.w3.org/2001/sw/hcls/]
Ian Horrocks	OWL Working Group Chair [http://www.w3.org/2007/OWL/]
Yves Lafon (*)	Web Services Activity Lead [http://www.w3.org/2002/ws/]
Eric Neumann	Semanic Web Health Care and Life Sciences Interest Group Chair [http://www.w3.org/2001/sw/hcls/]
Liam Quin(*)	XML Activity Lead [http://www.w3.org/XML/]
Alan Ruttenberg(*)	OWL Working Group Chair [http://www.w3.org/2007/OWL/]
Christian de Sainte Marie(*)	Rules Interchange Working Group Chair [http://www.w3.org/2005/rules/]
Susie Stephens	Education and Outreach Interest Group Chair [http://www.w3.org/2001/sw/sweo/]

Ralph Swick	SW Deployment Working Group Staff Contact [http://www.w3.org/2001/sw/SWD/], ActingW3C Technology & Society Domain Lead, Past Best practices and Deployment Working Group Staff Contact [http://www.w3.org/2001/sw/BestPractices/], Past W3C Semantic Web Advanced Development Lead [http://www.w3.org/2000/01/sw/]
Chris Welty	Rules Interchange Working Group Chair [http://www.w3.org/2005/rules/]

(*) Active mailing list members participation only
There is a separate (member-only) scribe duty list
[http://www.w3.org/2001/sw/CG/scribe.html]
Ivan Herman <em@w3.org>, (W3C) Semantic Web Activity Lead
$Id: Overview.html,v 1.276 2007/09/11 11:47:06 ivan Exp $

This appendix is included as an example of the level of interconnectedness between related groups within the W3C.

11.6 W3C Policy for Approval of Invited Experts[92]

This Guidebook is the collected wisdom of the W3C Group Chairs and other collaborators.

Section 6.2.1.3 of the W3C Process Document explains that W3C sometimes invites an individual with particular expertise to become a Invited Expert in a Group. An individual becomes an Invited Expert in a group as follows:

- The Chair and Team Contact hold preliminary discussions with the individual.
- The individual provides the information required of an Invited Expert as follows:
    - If you do not already have a W3C Access Account login and password (check if there is an account associated with your address), complete the Public Access Request Form.
    - After you receive your W3C login name and password, complete the W3C Invited Expert Application (which refers to the Invited Expert and Collaborators Agreement).
- The Team Contact discusses your application with W3C Management following the internal process regarding Invited Experts (Team-only). Note: If your application is for a group that does not require access to the W3C Member Web site, your application does not require review by W3C management.
- If Management approves the request, the Team invites the individual to participate formally in the Group.

Principles Guiding Invitations and Periodic Review

The Team generally follows these principles when considering an application:

1. Invited expert status is normally granted to either independent individuals (i.e., individuals not significantly affiliated with business interests), or to academics affiliated with institutions of higher learning.
2. Invited expert status is not normally granted to individuals employed by organizations which have significant business interest in results from W3C. This might even include some not-for-profit organizations. Such organizations SHOULD join W3C.
3. Under almost no circumstances will invited expert status be granted to an individual whose support comes from an financially solvent organization which has terminated its W3C membership.
4. If the case is made that granting invited expert status to an individual supported by a "membership candidate" organization would enhance the chances that organization would join W3C, then a provisional 6-month invitation might well be issued.

The status of all Invited Experts is reviewed at least once a year, and may be reviewed more frequently, to ensure that information supplied on their application is still current (for instance organizational affiliation, participation commitment, etc.).

[92] http://www.w3.org/2004/08/invexp.html. [Accessed: 02/09/2007.]

Member Access to W3C Site

Only after an individual has accepted an invitation from the Team to participate in a Working Group as an invited expert is that individual granted "Member access" to the W3C Web site.

Ian Jacobs[93]
Created 18 Aug 2004, from information created by Philippe Le Hégaret
last revised $Date: 2006/08/07 17:56:01 $ by $Author: ijacobs $

[93] http://www.w3.org/People/Jacobs/

11.7 W3C Copyright notice

The following copyright notice is used by the W3C on alle written material regarding the different working groups, and thus connected to the appendices related to the W3C.

[94] http://www.csail.mit.edu/
[95] http://www.ercim.org/
[96] http://www.keio.ac.jp/
[97] http://www.w3.org/Consortium/Legal/privacy-statement