5-2009

Two Emerging Technologies: A Comparative Analysis of Web 2.0 and the Semantic Web

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Abstract
In this paper we investigate the development and outcome of two emerging technologies, that is the Semantic Web and the Web 2.0. Our research question is; how do we explain the surprising success of Web 2.0 and the equally surprising non-fulfillment of the Semantic Web.

Building on a case study approach we conducted a in depth comparative analysis of the two emerging technologies. We propose two conclusions. First; traditional top-down management of an emerging global technology has proved not to be effective in the case of the Semantic Web and Web 2.0, and second; the success for such global technologies is mainly associated with bootstrapping an already installed base. We discuss the implications of these findings.

Keywords
Web 2.0, Semantic Web, standards, case study

1 Introduction
During the late 1990s and early 2000s the Internet and the World Wide Web (WWW) redefined how we are relating to technology and how it is applied in the network. Two of the most exciting examples are the Semantic Web and what we have come to know as the Web 2.0. The Semantic Web was initiated by Tim Berners-Lee (TBL) and the World Wide Web Concortium, and publicly announced in the Scientific American in 2001(Berners-Lee et al. 2001). It was described as a further evolvement of the Web into 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" (W3C 2008). The Web 2.0 is a term used to label a collection of technologies and applications, such as wikis, blogs and social networks.

The development of these two technologies has strikingly different trajectories. While the Semantic Web was developed by a large body of interconnected committees and work groups, the Web 2.0 emerged through various academic and industrial initiatives which were hardly coordinated at all.

Looking at the results of these two initiatives, there really is a striking difference, illustrated in figure 1 below. The figure shows how trends in search volume, and amount of News reference have evolved in the period early-2005–mid-2008.

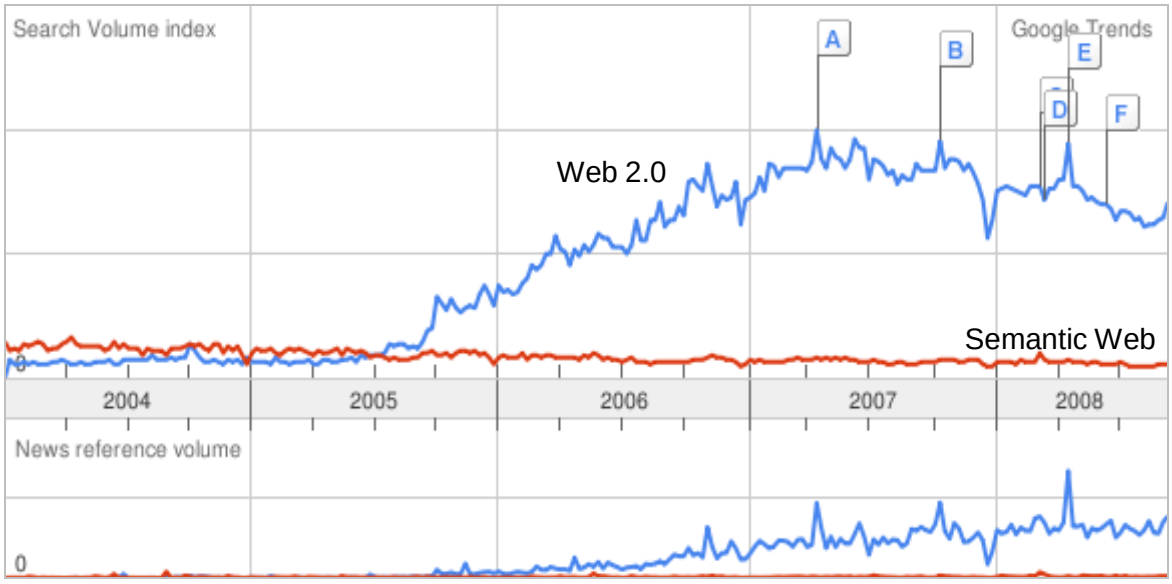

Figure 1. Search trends: Web 2.0 vs. Semantic Web. (http://www.google.com/trends[1])

From a humble beginning the graph shows a dramatic increase regarding Web 2.0 from 2005 and onward. While Google Trends is certainly not a scientific instrument, it shows nevertheless a remarkable surge of interest in Web 2.0, and correspondingly a low interest for the Semantic Web. The radical shift in the Web 2.0 graph corresponds quite well with the first Web 2.0 conference in Oct. 2004. The lettered flags correspond with specific news references[2].

This represents a puzzle. Why should a scientifically sound initiative as the Semantic Web fail to raise interest while a relatively arbitrary collection of technologies experience wide interest and extensive use? One possible answer to this question is rather easily found. The Semantic Web has to date not managed to spur applications that has succeeded in reaching a wider public. On the other hand most of the internet users of today are quite familiar with web applications such as wikis, blogs and Social Networking Software, like ie. Wikipedia and Facebook.

[1] http://www.google.com/trends?q=web+2.0%2C+Semantic+Web&ctab=0&geo=all&date=all&sort=0. [Accessed: 15.11. 2008]

[2] A "Web 2.0 : What Participation" – PC World, Apr 18 2007. B "Web 2.0 Summit: Tidbits" – Guardian Unlimited, Oct 18 2007. C "BT Integrates Telphony with Web Services to Enable "Web 2.9"" – PR Inside (Pressemitteilung), Mar 10 2008. D "Betting on Web 2.0" – CIO Insight, Mar 18 2008. E IBM unveils Web 2.0 Server" – InternetNews.com, Apr 23 2008. F "Getting Found Out, Web 2.0 Style" – WTOV9.com, Jun 18 2008.

In this paper about standards and technological development we try to analyse the reasons for this somewhat surprising outcome. Our research question is: How do we explain the surprising success of Web 2.0 and the equally surprising shortcomings of the Semantic Web?

We proceed by briefly describing our method in section two. Then, in section three, we give an overview of the development of the Semantic Web and the Web 2.0. In section four we present our detailed comparative analysis, and discuss our findings in section five. In the last section we offer conclusions and points to further research.

2 Method

Building on a case study approach (Yin, 1994) we conducted a comparative analysis (Rihoux, 2006) of the two emerging technologies as they are presented at the time of study. Due to the nature of the case object of study, the field research has been carried out as a qualitative study of online material. The key materials were the documents from the different working groups at the W3C, the relationship between them and the standards and core technologies they have been responsible for developing. In addition we have researched the central technologies and the best practices that have been established within the Web 2.0 paradigm. Finally, we have analysed the latest related research efforts working on combining technology from ”both sides”.

One of the main online sources has been the W3C’s own website[3]. This includes the standards, or parts of standards, (*Recommendations*), within the field of study. Other online sources have been what we would regard as main knowledge centres, like conference websites, scientific publisher web sites and academic online journals, and commercial web sites maintained by acknowledged and trusted resources within the web community.

Data analysis was conducted in the following steps. First we established a set of criteria, drawn from the literature. Then, for each criterion, we compared the two technologies in detail. Finally, we analysed and discussed our findings in relation to earlier research.

3 Background

In this section we will describe the development of the Semantic Web and the Web 2.0. In doing this we will not focus on technical issues, but on development processes and the involved actors.

3.1 Semantic Web

The Semantic Web identifies what its initiators Tim Berners-Lee and the W3C regard as the next step in the evolution of the World Wide Web. The first paper 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 was aimed primarily at scientists (Fensel et al. 2003)[4]. Since then it has been mainly scientists, through a vast amount of W3C-work groups, who have worked on developing the standards and protocols that would elevate the web to the next level of services, without really managing to reach the common public.

[3] http://www.w3.org
[4] Reference from Tim Berners-Lee’s foreword p. xi – xxiii.

The Semantic Web strategy aims 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" (W3C 2008). The evolution of the Semantic Web is, like all other web standards development projects governed by the W3C, and managed by the *W3C Process Document* which is written by the W3C Advisory Board and peer reviewed by the W3C members and teams. The structure of the document itself reveals the structure of a quite large and bureaucratic standardization body, which adds a fair amount of complexity, not only to the Semantic Web development project but to the general W3C Recommendation process. 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. It is implicitly the process guideline for all research governed by the Consortium (W3C 2005), and reflects the organisational structure of the W3C.

The group structure within W3C is divided into three; *Working-*, *Interest-*, and *Coordination* groups, where Coordination groups manages the communication between the groups and how their roles of participation are organised. A Coordination group also manages communication between W3C groups and research and development groups outside W3C. An *Interest Group* is mainly responsible for gathering and processing ideas and bringing together people who wish to contribute with evaluation and ideas, while *Working Groups* are producing the actual material such as Recommendation Track reports, reviews of other Working Group's material, software, and validation technology (W3C 2005). This organisational structure is shown in figure 2.

3.2 Web 2.0

The somewhat controversial term Web 2.0 has, in short, become a name for a set of descriptions regarding user generated content, shareability and usability on the Web. In the following we will present the beginning and the characteristics of this bottom-up develop paradigm.

According to Tim O'Reilly, the Web 2.0 term, coined by Dale Dougherty in conjunction with the Web 2.0 Conference in 2004, was originally meant to describe what was thought to be a "reboot" of the Web after the dot-com decline. The question at the time was if the Web 2.0-term could make sense, being what we might call a rethorical black-box[5] encompassing both the notion of being a turning point and a call to action. The basic idea was to support a process of evolution of the Web from being mainly a one-way information publishing device to become a platform for a wide array of services that would present more possibilities for a two-way communication and user-participation. (O'Riley 2007)

The main strategy was to establish the Web as Platform in order to "harness the Collective Intelligence" (O'Reilly 2007). This implicates not only core technological developments and practices such as AJAX, but also business aspects, design elements, and social aspects. O'Reilly describes the *Web as platform* as the cause of a business revolution, in that a new understanding of this new set of rules is needed; of which the main aspect is to build applications that are able to take advantage of and utilize network effects (O'Reilly 2006).

[5] 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. (Latour, 1999:304).

Network effects refer to a self-reinforcing process where the value of services or applications increases as more people are attracted to it and using it (Katz and Shapiro 1994). This could translate as *the network as platform*, where regular users is supposed to be able to run applications through the browser, turning the web site into an application where the users could run required tasks, saving their data in a database in connection with a web application such as Google Apps. Another characteristic Web 2.0 task would be participating and contributing in the practise of *crowdsourcing*, described by Howe (2006) like for example Wikipedia, MySpace or YouTube, adding value to the application while using it.

The Web 2.0 tech-paradigm has increasingly been adopted in the enterprise market. According to The McKinsey Quarterly survey regarding how businesses are using Web 2.0, more than 75% of the executives who responded planned to either maintain or increase investments in typical Web 2.0 technology ie. P2P networking, social networks, and Web services[6].

4 A Comparative Analysis

In this section we will present the comparative analysis. To structure our analysis we will present our main dimensions in Table 1.

Criteria	**Web 2.0**	**Semantic Web**
Technology and standards	Javascript, XML	RDF, OWL
Development approach	Bottom-up, GUI-oriented, ease of use	Top-down, developing standards
Managerial mechanisms	ad-hocracy"[7], rough consensus and running code"[8]	"professional bureaucracy"[7], large organisation, large body of work groups, consensus
Development dynamics	No organisation, standards adhering	bureaucratic, standards-drivven
Applications	Wikis, Blogs, mash-ups, SNS	K/IM[9], MM[10], Mozilla[11], RSS[12], SW user agents, etc

Table 1. Comparative aspects: Semantic Web vs. Web 2.0
Sources: W3C[13], O'Reilly (2006, 2007)

4.1 Technology and standards

The most important distinction between the Semantic Web and the Web 2.0 is that the Web 2.0, in addition to focusing on graphical user interfaces, usability and user-centered development, utilizes known technologies and standards leading to new applications and

[6] http://www.mckinseyquarterly.com/How_businesses_are_using_Web_20_A_McKinsey_Global_Survey_1913
[7] see Henry Mintzberg (1992), Structure in Fives: Designing Effective Organizations. Prentice Hall.
[8] "We reject: kings, presidents, and voting. We believe in: rough consensus and running code." David Clarke, presentation, 24th IETF conference 1992.
[9] Knowledge and Information Management applications, such as Helpdesk support, and other cataloging and classification systems like ie. the Simple Knowledge Organization System (SKOS).
[10] Media metadata management, such Adobe XMP [http://www.adobe.com/products/xmp/main.html].
[11] Firefox, or Mozilla-based browsers use RDF internally as a format for the representation of heterogenous data.
[12] RDF Site Summary: XML-protocol for syndication of content.
[13] http://www.w3c.org/2001/sw

patterns of use, while the Semantic Web proposes a set of completely new technical solutions, for example; Web 2.0 utilize Javascript and XML which are well established technologies while the W3C had to invent ie. RDF and OWL in order to get the Semantic Web to work.

In most cases it is easier to build on the installed base of a technology, than developing a new set of standards, than building new technologies. 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 difference in complexity we recognise today regarding standards and flexibility, that is Semantic Web and Web 2.0.

4.2 Development approach

As described in the previous section the Semantic Web was developed in a sophisticated system of standardisation bodies and work groups. In contrast the Web 2.0 was the somewhat unintended result of various industrial and individual initiatives. For example the development of the wiki-application was done by one person, Ward Cunningham[14], in 1995 for the Portland Pattern Repository as a collaboration software for publishing pattern languages and pattern related information.

The main advantage with the Web 2.0 approach is that development is done as an extension of an already installed base and infrastructure. This is in contrast to the Semantic Web, which mainly is developed by introducing a set of completely new standards and protocols within the very same working solution; the World Wide Web as we know it.

The Web 2.0 development trajectory is build from a series of modest achievements as opposed to the Semantic Web's monolithic stature.

[14] http://c2.com/cgi/wiki?WikiWikiWeb. [Accessed: 30/11/2008]

4.3 Managerial mechanisms

As illustrated in figure 2 the governing mechanisms ruling the development of the Semantic Web consists of a carefully designed structure of activities and groups:

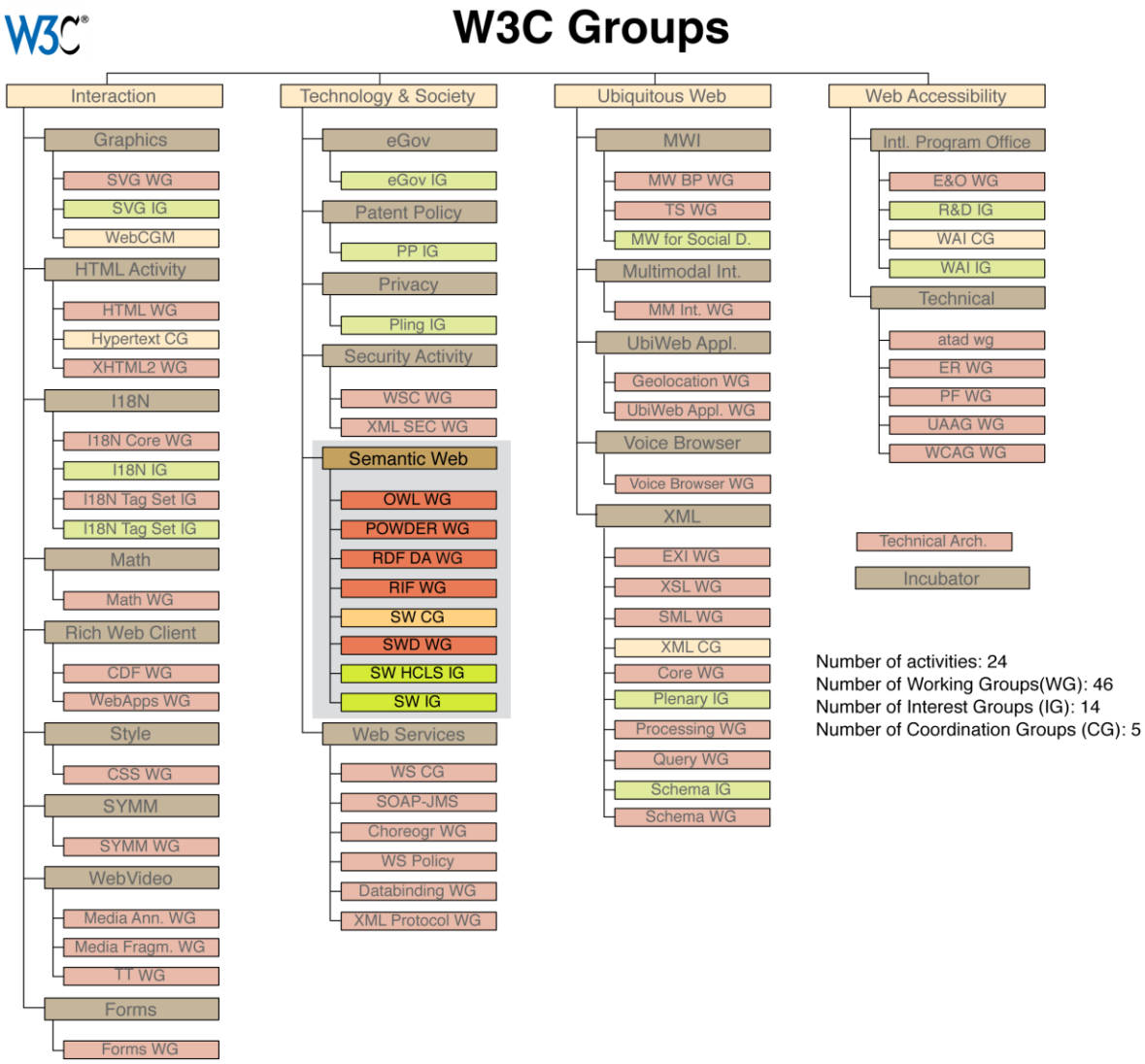

Figure 2. The W3C activity and group map with the Semantic Web Activity highlighted. Source: W3C. (http://www.w3.org/2003/02/W3COrg.png)

A large bureaucratic governing body works rather well in order to control and maintain a large infrastructure such as the WWW, but could hamper or completely halt innovation processes within the same infrastructure (Hanseth and Aanestad 2002). This could possibly contribute to explain why the Semantic Web has run into trouble as the next level of Web evolution.

In contrast to this working practice, the managerial mechanisms of web 2.0 are entirely different. The main actors are industrial and individual actors offering solutions for an installed base of users in communication with the market doing what Law describes as *heterogenous engineering* (1987). Akrich calls this the process of multilateral *negotiation*; when technology is being shaped by back and forth negotiation and translated into a technological form (Akrich 1992). Hanseth and Monteiro describes this as patterns of use

being *inscribed* into an artefact (1998). The main argument here is that these patterns of technological use are not decided by commites, but evolve as a result of "collaborative negotiation."

4.4 Development dynamics

The notion of the Semantic Web as a groundbreaking technology that would spread itself because of its utility value, like many innovators believe, does not stand. There are, unfortunately, little or no evidence of this spreading, at least not on a sufficiently large scale.

The main developing dynamics for the Web 2.0 is the self reinforcing mechanism described by Grindley as Dynamics of standardization, where the number of complimentary services depends on the size of the installed base, which in turn controls the credibility of the standard. A large installed base leads to more services produced, gives greater credibility, which in turn makes the standard more attractive to new users and further adoptions, as shown in figure 3 (1995).

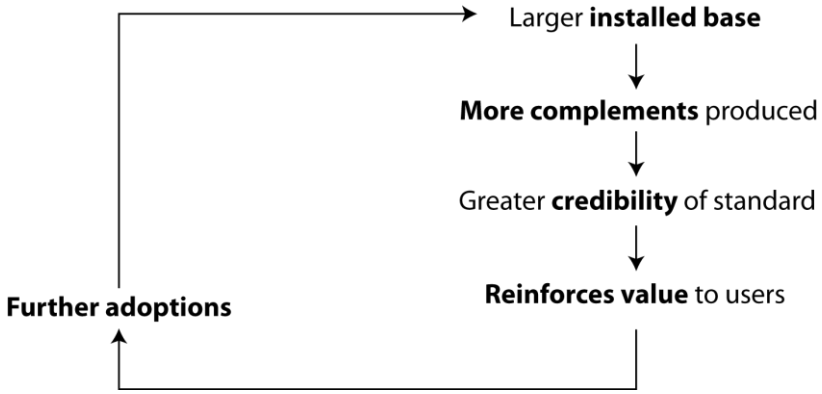

Figure 3. Standards reinforcments mechanism
Source: (Grindley 1995:27)

4.5 Applications

The most archetypical applications of Web 2.0 are wiki software, blog software, and Social Networking Software, for example MediaWiki[15], WordPress[16] and Facebook[17]. These applications are used by hundreds of millions of people all over the globe every day. Semantic Web applications include ie. ontology bases, databases, knowledge management systems and so on, and are mainly, with a few exceptions, used to to do specific tasks. There exists a rather significant number of specific Semantic Web applications. There is however difficult to find any significant signs of public acceptance or adoption among common users on a large scale. However, the first Semantic Web application intended directly at the common user, could possibly be Twine by Radar Networks[18], which is a knowledge networking application that has attracted some attention since its release late 2008.

Summing up, this analysis has shown that on six central criteria it is easy to explain the success of the Web 2.0 in contrast to the Semantic Web. We do not claim that this is the end

[15] http://www.mediawiki.org/wiki/MediaWiki
[16] http://wordpress.org/
[17] http://www.facebook.com.
[18] http://www.twine.com. See also ch. 6.1

of the story, as there is certainly a possibility that the Semantic Web at some point will go into a take-off phase, for example in a joint venture with the Web 2.0 stack of technologies. There are, however, important management aspects of the two development stories, which we will discuss in the next section.

5 Managerial implications

We may identify two different traditions. The mainstream research school has argued that large scale tech development should be managed with top-down planning and coordinated execution. Weill and Broadbent argues that "technology-dependent business will never be easy and will need constant management attention" (Weill & Broadbent 1998:231), and Jakobs and Mora describe the problems in standards setting regarding increasing complexity connected to top down coordinaton of ICT standards. (2008).

Another research school has pointed out that standards are not necessarily an easy way to solve this problem. Hanseth et al. argues that technical standards might intertwine with heterogeneous work practices leading to an increased level of complexity that traditional standardisation approaches is not capable of dealing with. Leaning on Beck (1994) they argue that complexity must be related to reflexivity, and under certain circumstances a traditional standardisation process might increase complexity instead of reducing it (Hanseth et al. 2006). According to Hanseth et al. one possibility of reducing socio-technical complexity is to reduce the organisational complexity stemming from a large number of actors and their interdependencies (2006:16). Also, according to Hanseth, Monteiro and Hatling (1996) a standard should be flexible enough to absorb change.

What does this analysis tell us of managerial challenges of large scale technological development projects in an internet context?

We suggest two major challenges:

- The problem with top-down management of global technology
- Bootstrapping the installed base

5.1 The problem with top-down management of global technology

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 management 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).

Semantic Web technologies and development can be said to, at least initially, be a somewhat top-down based project. It was initiated by Tim Berners-Lee himself, and the organization he leads, the W3C, is responsible for a better 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 problem with top-down management becomes evident as the rather remarkable difference in common adoption regarding these two technological directions is brought to the surface.

The foundation for technological development seems to be, not universalistic, clean and straightforward, but complex, messy and chaotic; a balance of heterogeneity based on what kind of technology we need, think that we need, or demand. A rigorous top-down traditional development strategy for example by defining the system-specifications first, and then implementing the software that is built before deploying the system, presents a set of problems that, according to Hanseth, Monteiro and Hatling (1996) is based on the notion that a standardisation process is frequently interrupted and intertwined with events that requires that standards need to be flexible and changeable. This problem area is also presented in a 2007 McKinsey Quarterly[19] survey regarding the adoption of Web 2.0 technologies in enterprises, where the advantages of "grassroots" level initiative is enhanced, and it is even argued, in some cases, that "top-down management would have been a hindrance".

5.2 Bootstrapping the installed base

Abbate (1999) emphasizes the importance of having users within the network, shaping the technology. This is in line with Akrich's (1992) argument about needing mediators to create connections between technical content and user, which could be regarded as the main essence of bootstrapping.

A key to understand the success of Web 2.0 is the notion of bootstrapping an installed base, which is described by Hanseth and Aanestad as a "pseudo-coded" six-step process:

1. Start by design the first, 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.
2. use the technology and repeat as long as possible: enrol more users
3. if possible: explore, identify and adopt more innovative (and beneficial) ways of using the solution, go to 2
4. use the solution in more critical tasks, go to 2
5. use the solution in more complex tasks, go to 2
6. improve the solution so new tasks can be supported, go to 2

(Hanseth and Aanestad 2002)

Returning to our comparative analysis it is fairly obvious that bootstrapping tactics is very different within the two technological development strategies. In the case of Web 2.0 we have shown that there are several bootstrapping mechanisms. A prime example would be the emergence of Social Networking software which, in fact, adhere to all of the six steps above.

On the other hand, the W3C had no bootstrapping strategies/mechanisms for the Semantic Web, which is remarkable when we look back at how well the initial Web evolved. It is somewhat of a paradox that the original World Wide Web, which alongside Linux, is the very epitome, of a bottom-up, bootstrapped, bazaar-like[20] developed technology, now are being evolved by utilizing a quite opposite development strategy.

[19] http://www.mckinseyquarterly.com/How_businesses_are_using_Web_20_A_McKinsey_Global_Survey_1913
[20] As in the Open Source essay "The Cathedral and the Bazaar" by Eric S. Raymond.

5.3 Limitations

We acknowledge that what we have presented here is only one interpretation of a very complex phenomenon, among several possible. We would, for instance, like to look closer into the possible impact that front-end issues like GUI's, User-Centered development, and Usability, aspects that are quite central within th Web 2.0 paradigm, could have on the further development of the Semantic Web, and not only the fact that it is the result of a top-down development project. We would also like to delve deeper into the dawning integration of typical Web 2.0 services and Semantic Web technologies where the trajectory with the standards oriented Semantic Web serves as an underlying infrastructure for the user-centered Web 2.0. Someone has already coined this integration Web 3.0, and we think that this term or entity could very well fill its own papers, blogs, wikis, and books.

6 Conclusion and further research

In this paper we have investigated the development and outcome of the two emerging technologies; the Semantic Web and the Web 2.0. Our research question is; How do we explain the surprising success of Web 2.0 and the equally surprising failure of the Semantic Web. Building on the analysis, we offer two conclusions:

- traditional top-down management of emerging global technology has proved not to be effective in the case of Web 2.0 and the Semantic Web

- success for such global technologies is mainly associated with bootstrapping an already installed base

Semantic Web technologies are not necessarily 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. But how do we bootstrap an installed base using a technology that is hidden? Leaning on Latour's concept of black-boxing (1999: 304), we might regard the collection of Semantic Web technologies as an aligned underlying infrastructure for a publicly known and settled Web 2.0, which means that the public user would not have to learn a completely new user-interface paradigm.

6.1 Further research

One quite interesting question is, could the Web 2.0, utilizing practises that are described in the literature of Information Infrastructure research, bootstrap the Semantic Web from laboratorial obscurity to common deployment?

It is at the crossroad where technology meets 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 is possible 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. The first public web service that seems to have been able to do this in a way that the regular consumer might relate to is Twine, a web based personal information/knowledge management agent that shows how network economics

could work within a Web 2.0/Semantic Web discourse. Also, the UK-based company Talis[21] has developed a Semantic Web application platform that according to the company provides an infrastructure for building Semantic Web applications. It would also be interesting to follow the further development of this technological approach.

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