

Université Paris-Sud, Orsay, France

Master's Thesis

Faceted Online Presence - A Semantic Web Approach

Milan Stankovic

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supervised by

Philippe Laublet, LaLIC, Université Paris-Sorbonne IV, Paris, France

So, so you think you can tell Heaven from Hell,
blue skies from pain.
Can you tell a green field from a cold steel rail?
A smile from a veil?
Do you think you can tell?
And did they get you to trade your heroes for ghosts?
Hot ashes for trees?
Hot air for a cool breeze?
Cold comfort for change?
And did you exchange a walk on part in the war for a lead role in a cage?
How I wish, how I wish you were here.
We're just two lost souls swimming in a fish bowl, year after year,
Running over the same old ground.
What have you found? The same old fears.
Wish you were here.

Pink Floyd

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Even though today, our discussions and link exchanges have become a part of our everyday life and turned into almost unnoticeable experience, the continuous contact with Jelena Jovanovic provides a fundamental basis for my work and represents a valuable source of my ideas and irreplaceable support for the realization of those ideas.

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ABSTRACT

In this Master's thesis I treat the question of online presence – a phenomenon of phatic communication that emerged on the Social Web. Online presence relates to the possibility of users in online communities to express the nature of their presence and possibilities of others to perceive them as “being there”. The infrastructure for such presence detection is present in many forms of Social Web sites, like Social Networks that allow users to post status messages, textually describing their current state; location-sharing services that facilitate localizing a particular user in the world; availability statuses that can be set on instant messaging platforms, etc. Especially interesting are recently emerged microblogging services, like Twitter, that are primarily focused on exchange of status messages, for mostly phatic purpose.

However, despite the great number of possibilities to express presence, many problems emerge when presence data is broadcasted for wide audience without selection, and exchanged over different services. In this thesis I present a qualitative user study that reveals some of those problems and investigates their nature. According to Grounded Theory analysis of the interviews done with users, I have isolated the problem of intended audience of status messages in online communities. User stories and real life scenarios point out to the need to diffuse status messages (as one of the elements of presence data) to particular audiences and sometimes limit the possibilities of others to access them. Those smaller ad-hoc communities are formed around particular interests, affiliations with particular organizations, current locations, etc. I present the findings of the study in detail in the form of a hierarchy of problems and their apparent causes. I also present possible workarounds that users have found with available Social Web tools and discuss the incompleteness of those workarounds.

As the core of the thesis I propose a Semantic Web based solution for the discovered problems. I present an ontology, the Online Presence Ontology, that is capable of capturing the semantics of major presence indicators in the online world (status messages, availability statuses, current locations, current activities, etc.). To this model I add a way to represent the semantics of intended audiences (called Sharing Spaces) and connect them with the presence data in question. The way to specify the members of intended audience of a status message is especially flexible. In order to cover all the real-life scenarios it is based on the Semantic Web querying specifications, most notably SPARQL. Not only that this standard way allows for intended audience specifications to be shared over heterogeneous services, it allows as well to take into account the increasing amount of semantically exposed data about users and their social graphs. I take a view of the Semantic Web as an interconnected distributed network of semantically exposed data (Linked Data) on top of it I build a way for targeting a specific audience with a particular custom message. On one detailed scenario I show how this solution is particularly suited for the nature of the problem.

In the end I give an overview of other existing presence models, both formal and theoretical. I also present related systems that tried to resolve similar problems or tried to use similar techniques and approaches.

I end the thesis with a vision on how the world of online presence could evolve and what place could the formal models for online presence have in this evolved world. I also list the open problems in the field and the research challenges that the domain of online presence research will be faced in the future.

RESUME

Dans ce mémoire de Master, je traite la question de la présence en ligne - un phénomène de communication phatique qui a émergé sur le Web Social. Par présence en ligne on comprend la possibilité des utilisateurs dans les communautés en ligne d'exprimer la nature de leur présence ; aussi que la possibilité des autres à les percevoir comme étant "là". Effectivement, dans le Web Social d'aujourd'hui il existe des nombreuses façons d'exprimer sa présence. Dans les réseaux sociaux les utilisateurs peuvent publier des messages de statut, afin de décrire textuellement leur état actuel. Il y a de plus en plus des services où ils peuvent déclarer leur localisation ou bien déclarer sa disponibilité pour interaction. Particulièrement intéressantes sont des services comme Twitter, dédiés principalement à la publication des messages de statut, dont l'objectif est très souvent une communication phatique.

Toutefois, malgré le grand nombre de possibilités d'exprimer la présence, nombreux problèmes apparaissent lorsque des données de présence sont diffusées pour un public large, sans sélection. Dans ce mémoire, je présente une étude utilisateurs qui révèle certains de ces problèmes en étudiant leurs causes en profondeur. Les techniques d'interviews et de "Grounded Theory Analysis" ont été appliqué afin d'isoler le problème de la publique cible de messages de statut dans les communautés en ligne. Nombreuses témoignages des utilisateurs et nombreuses scénarios de la vie réelle signalaient la nécessité de diffuser des messages de statut (comme l'un des éléments de données de présence) à un public particulier et parfois limiter les possibilités des autres d'y accéder. Je présente les conclusions de l'étude en détail sous forme d'une hiérarchie des problèmes et leurs causes apparentes. Je présente aussi des solutions que les utilisateurs ont trouvées pour contourner ces problèmes et j'argumente le caractère incomplet de ces solutions.

Comme la contribution la plus importante du mémoire je propose une solution pour les problèmes découverts, qui est basée sur le Web Sémantique. Je présente une ontologie de la présence en ligne, qui est capable de capturer la sémantique des indicateurs de présence majeures dans le monde en ligne (messages de statut, les statuts des disponibilités, la localisation actuelle, des activités en cours, etc.) Ce modèle de base est enrichi par une façon de représenter la sémantique des publics visés (appelé Sharing Spaces). Le mécanisme nécessaire pour relier ces descriptions des publics avec les données de présence en question est également prévu. Afin de soutenir tous les scénarios réels, découvertes lors de l'étude utilisateurs, on a besoin d'une flexibilité très grande dans les définitions de membres des Sharing Spaces. En ce raison on tourne vers les standards du Web Sémantique pour l'interrogation des données, notamment vers SPARQL. Non seulement que cette façon standard permet de partager les définitions des Sharing Spaces entre des différentes services hétérogènes, il permet ainsi de prendre en compte la quantité croissante de données sur les utilisateurs et leurs graphes sociaux qui existent déjà partout dans le Web. Sur un scénario détaillé, je montre comment cette solution basée sur les standards du Web Sémantique est particulièrement adaptée à la nature du problème. Je présente également une application (SMOB 2.0) qui a été fait pour mettre en œuvre l'approche générale présente dans le scénario.

Après avoir présenté la solution général et l'application concrète je donne une récapitulation des travaux liées : d'autres modèles de présence, certaines formelles et certaines purement théoriques. Je présente également des systèmes qui ont essayé de résoudre des problèmes similaires ou tenté d'utiliser des techniques et des approches similaires, afin de les comparer avec mon système.

À la fin du mémoire je donne une vision sur la possibilité de l'évolution de la présence en ligne et sur la place que les modèles formels de la présence en ligne pourraient avoir dans ce monde évolué. Je présente aussi une liste des problèmes ouverts et des défis avec lesquelles la recherche sur la présence en ligne devra être confrontée dans l'avenir.

NOTICE

Part of the work presented in this Master thesis was published in the following peer-reviewed scientific publications:

- Stankovic, M., Passant, A. and Laublet, P., Directing Status Messages to their Audiences in Online Communities. In Pre-proceedings of Coordination, Organization, Institutions and Norms Workshop (COIN @ MALLOW) 7th–11th September, 2009, Torino, Italy
- Stankovic, M. and Jovanovic, J. (2008). Online presence in social networks, W3C Workshop on the Future of Social Networking - Position Papers. URL: <http://www.w3.org/2008/09/msnws/papers/w3c-workshop-opo.pdf>

The work was mostly inspired by my earlier work on online presence, presented in:

- Stankovic, M. Modeling Online Presence. In: Proceedings of the First Social Data on the Web Workshop, Karlsruhe, Germany, October 27, 2008, CEUR Workshop Proceedings, ISSN 1613-0073, URL <http://sunsite.informatik.rwth-aachen.de/Publications/CEUR-WS/Vol-405/paper9.pdf>

Parts of the work were also presented in the Digital Enterprise Research Institute, National University of Ireland in April 2009. The presentation slides are available at <http://www.slideshare.net/milstan/online-presence>.

The final results were presented in INRIA, Sophia-Antipolis, France, in August 2009. The presentation slides are available at <http://www.slideshare.net/milstan/faceted-online-presence>.

A poster presenting some of the ideas that this Master thesis is based upon was presented on the Semantic Web Summer School in Cercedilla, near Madrid, in July 2009. The poster is available at <http://www.milanstankovic.org/blog/?p=66>.

You can refer to this Master thesis as:

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1 INTRODUCTION

This is a story about online presence; about the way we interact, and the way we feel each other out there in the realm of the World Wide Web. It is about small but highly important things that are so inherent to human interaction that they easily get unnoticed, and neglected by technology. It is also a story about the technology that acknowledges the importance of these small things and treats them right.

If you use instant messaging (IM) applications you must have felt moments of loneliness, when you were working up to late hours, alone, and then when you looked at your contact list on the IM application, you could see some of your friends still there, in the online world. Although they were physically away you could feel they were somehow together with you. You might have even visited Twitter¹ where people broadcast short messages “in the air”, like birds in Amazon rain forest, announcing that they are alive, sending a message about their mood and thoughts. You might have followed your friends’ lifestreams², to keep track of their current activities.

There is actually a whole web of phatic³ communication underneath today’s communication tools. It is not a coincidence that such forms of phatic communication, interactions not meant for information exchange but for a social or emotional purpose, have emerged. Phatic communication is inherent to human everyday conversations. When we pass by a friend on the street, we usually exchange some words bearing no informational content, just to acknowledge the presence of another person. Our appearance in the real world is full of clues of whether we are approachable or not, whether we are busy or just waiting for someone to stop by and have a chat. No wonder there is a need for similar clues in the online world where communication is getting more and more immersive, and more and more frequent.

Many researchers point out to the importance of such forms of communication in information technologies. In the field of cognitive science, a renowned researcher, Don Norman acknowledged [1] that some forms of exchange of short messages are actually performed to maintain an emotional bond with our peers and that their informational content can be of low importance. The e-learning research community also acknowledges the importance of presence detection for learning performance. For example, studies of Russo and Benson [2] confirm that presence detection is equally important for learning outcome in online learning environments as well as in the physical world. Garisson, Anderson and Archer [3] emphasize different aspects of presence in their model of educational transactions. A whole series of conferences exist to gather researchers from different fields, investigating the phenomenon of presence in different ways⁴.

Apart from research, the state of practice in Social Web application development demonstrates a certain consciousness of the phenomenon of presence, since many services on the Web allow users

¹ <http://twitter.com/>

² lifestreams are information streams assembling a diary of a user’s electronic life and making a timescale of his activities on the Web (published comments, shared bookmarks, uploaded photos, listened songs, reviewed movies, etc.)

³ phatic communication refers to interactions not meant for information exchange but for a social or emotional purpose

⁴ <http://ispr.info/conference>

to publish some short forms of phatic content (e.g., status messages, moods, etc.). A good overview of current practices can be found in the repository of Social Design Patterns⁵, which, among other things, keeps track of the ways that presence can be communicated on the Web.

However, something is obviously not working well in the online world. At least not well enough as in the physical world. We can still interrupt someone while he is obviously busy performing an engaging activity that takes his full attention. We can still get frustrated trying to reach someone who is away. We can still be unaware of phatic expressions posted in communities where we do not participate. Something is clearly standing in the way of phatic expressions on the Web to reach the potential they have reached in the physical world. Apart from the most obvious problems, researchers like danah boyd [4] point out to problems in computer interfaces that do not allow for distinguishing the announcement of presence from a call for communication.

In this Master thesis, I dive into the space of problems surrounding the perception of presence on the Web. More precisely, I focus on a particular way of declaring presence online, which is the publishing of status messages. I investigate the space of possible solutions, and finally present a proposal for a solution that fits the needs of real-life problems. The proposed solution is based on ontologies and other Semantic Web technologies that are used to enable the meaningful presence data flow across the Web. I also present a proof of concept application that I have developed to demonstrate the feasibility of the proposed solution. The created application is a distributed Web application for publishing status messages and dedicating them to their intended audience.

In Section 2, I introduce the concept of Social Web and present the ways presence is perceived on it. I define status message sharing as the focus of this Master thesis and give a preliminary introduction into problems related to the domain of status message broadcasting. Section 3 presents a deeper understanding of those problems achieved through a qualitative user study. I present the methodology used, the results obtained, and other related studies. Some useful conceptualizations that emerged during the study process, as well as their implications for building advanced status message sharing systems are also detailed in this section. Section 4 presents a Semantic Web based solution for the identified problems, based on a specific ontology for Online Presence. The concept of Sharing Space, meant to capture the semantics of intended audience of presence data is also presented, along with various ways the intended audiences could be defined using different Semantic Web standards. This solution should address the requirements established during the user study process. I also present the proof-of-concept application that implements the proposed Semantic Web solution and tries to uncover issues that might arise with its wide use. In Section 5, I present related presence models as well as related systems/applications that have applied similar techniques or tried to resolve similar problems. I also discuss the differences of those approaches with regard to the solution presented here. Section 6 concludes the thesis and presents perspectives for future work.

⁵ <http://www.designingsocialinterfaces.com/patterns.wiki/index.php?title=Presence>

2 THE SENSE OF PRESENCE ON THE SOCIAL WEB

When Tim O'Reilly coined the term "Web 2.0" in 2004⁶, it brought up a lot of controversy. Many researchers did not agree with the introduced numbering scheme (2.0); many questioned the definition of such an advanced Web, and argued about what is and what is not the Web 2.0. Regardless of the term, a shift in the way people used the Web was evident even in that time.

In its early beginnings, the Web was conceived as a network of interlinked documents that humans could put on the Web and browse. The links between documents represented the key force of coherence keeping the network together and making it browsable.

At first, it was easy for end-users to consume the Web content, but putting something on the Web required some programming and technical skills. Because of this, most end users were just content consumers. They used the Web to search and browse for information put by a smaller number of Web publishers (some of them being commercial companies). Although conceived as a social creation, as Tim Berners-Lee defined it in his book [5], the early Web was largely used as a read only medium.

Following some technical advancements in Web programming techniques, a new breed of online applications emerged – applications that facilitated the creation of content by end users. Blogging tools for maintaining personal diaries and publishing texts on the Web emerged, as well as wikis – tools for collaborative content creation. Commenting on other people's content (e.g., blog posts) became equally easy as publishing the content itself. It was a beginning of the expansion of tools for socialization on the Web. The ease of creating content and posting comments bound people together in different forms of conversations and social endeavors. Online discussion forums flourished as well to support this kind of discussions.

The emerging social nature of the Web was made most evident in the increasing popularity of online Social Networks - websites primarily made for socialization. Social Networks allow their users to maintain their social graph and keep in touch with their contacts through various forms of interaction (e.g., exchanging messages, chatting, sharing photos, sharing links, publically commenting on content submitted by others, etc.). According to recent internet traffic studies, Social Networks are becoming an important driving force of internet traffic⁷.

When we follow the evolution of Social Web applications and the emerging forms of social interactions on the Web it becomes obvious that the Web turned into a global platform for socialization. It is no more just a place to search for information and services, it is a place where one can search for friends.

In this Master thesis I focus on a particular aspect of the Social Web - on its ability to support the perception of presence of other people. A lot has changed since 1980 when Marvin Minsky [6] introduced the concept of *being there* in mediated environments; it is mostly because of the Social

⁶ The Web 2.0 conference held in San Francisco in 2004 is considered to be the first event that promoted the term <http://conferences.oreillynet.com/web2con/>

⁷ <http://blogs.zdnet.com/social/?p=114>

Web that pushes the concept of presence to its limits. In this social space that the Web is today, we are often able to perceive the presence of other people in an online community. Sometimes we become aware of our friends' actions on a Social Network and we can imagine what they are doing at a particular moment. Sometimes we can see their status messages and thus enter into the context of their current thoughts and/or activities. On many social services it is possible to share locations (like FireEagle⁸, BrightKite⁹ etc.) so we can also know where our friends are. We can even be granted access to the music that our friends are currently listening and project ourselves even further into their online experience. Apart from being a giant platform for socialization, the Social Web is at the same time a giant space of perceived presence - a space of many social applications that give us the insight into other people's current context and the nature of their current presence (Figure 1).

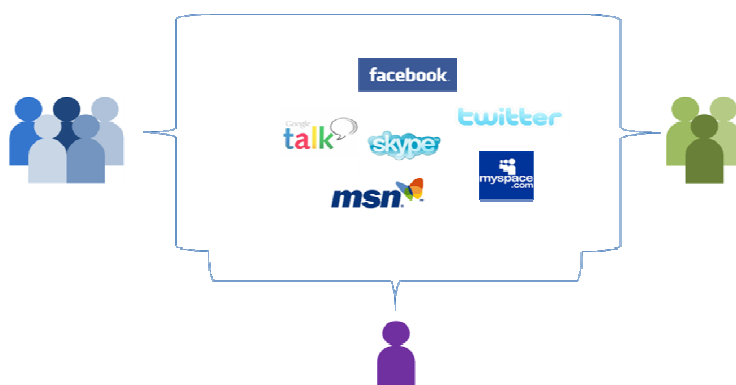


Figure 1 A Space of Perceived Presence. Various Social Web Applications allow us to perceive different aspects of presence of our contacts (like their custom message, current location, activities, etc.)

2.1 COMMON PROBLEMS RELATED TO PRESENCE ON THE SOCIAL WEB

Despite the fact that a great number of services on the Social Web allow us to perceive some aspects of presence of our friends in the online world, many problems exist that make such a presence detection difficult or limited.

First of all, most of the Social Web services act as isolated islands. They collect huge quantities of data (some of which are related to users' presence) and keep them 'locked', obliging anyone who wants to access the data to become a user of a particular service. The consequence of this practice from the perspective of presence detection is the inability of users of one Social Web service to perceive the presence of their contacts on another Social Web service. This problem is well known in the Social Web literature and often referred to as "The Walled Gardens problem" (as in [7]). One of the major obstacles for the resolution of the Walled Gardens Problem is the lack of interoperability standards that would support the meaningful data exchange between services. Political and legal issues stand in the way of full interoperability as well.

⁸ <http://fireeagle.yahoo.net/>

⁹ <http://brightkite.com/>

The problem of interoperability between Social Web services further reflects on the possibility of data integration. Due to the lack of interoperability, it is impossible to integrate the information about someone's presence from different purpose Social Web services (e.g., status message sharing, location sharing, etc.) and create a coherent global image of his presence in the online world. Once integrated, the presence data has a huge potential to provide a more powerful way for people to maintain this form of emotional bond. Unfortunately, this potential remains largely unused on today's Web.

Finally, data about users' presence should help improve their interaction on the Web. The elements of a user's context that constitute his online presence influence in a great way the user's ability to interact with other people and with applications. For example, the fact that a user is giving a talk prohibits him from having chats, receiving calls and notifications from applications. Similar elements of context can be considered as constraints for human computer interfaces and can help reduce frustrations by, for example, informing a user that his contact is currently in a situation that will not allow her to answer a call or reply to a chat message.



Figure 2 The i³ problem that the modeling of presence should resolve [8]

Since the identified problems (Figure 2) are of large scale, in this Master thesis I focus on a particular aspect of online presence, which is the status message sharing.

2.1.1 DIFFICULTIES IN STATUS MESSAGE SHARING

In this section, I introduce the concept of status message sharing, which is the focus of study in this Master thesis. I also give a brief introduction in the problems related to status message sharing, that are in scope of the presented work.

2.1.1.1 Status Message Sharing

First traces of status message sharing might be found in Instant Messaging (IM) platforms where users tend to publish short messages along with their name in contact lists to indicate the nature of their availability, or just to share something that was on their mind with other members of the IM community. Sometimes it was even used to promote some links – personal homepages, events, etc.

The practice further expanded to Social Networks where status messages became an integral part of users' profiles, revealing their current thoughts, activities, and in general disclosing parts of their context to their contacts from the online world. Apart from being an integral part of user profiles, currently status messages often appear in search results on Social Networks, together with person's name and basic data. Recently Social Networks, like Facebook¹⁰, allowed users even to "like" and

¹⁰ <http://www.facebook.com>

comment other people's status messages, which brought them from mere presence announcements to the level of conversation elements.

As Social Web progressed, online and offline worlds continued to merge, and Web started to get a shape of a giant online community, the need for sharing status messages on the Web widely rose. This need was quickly endorsed by the emerging services like Twitter, dedicated exclusively to diffusion of status messages. Microblogging services, like Twitter, dedicated to publishing of short messages, turned out to be a convenient way for users to share their current activities, thoughts, and even feelings, and give their online peers an idea of their current situation.

2.1.1.2 Emerging Problems

However, with the proliferation of status message sharing on various Social Web sites, some problems have started to emerge threatening to reduce the potential of status messages for enhancing online presence detection. Overload of status messages and the lack of appropriate mechanism to extract the most relevant ones for a particular user are among these problems. This message overload stands in the way of a status message to reach its intended audience. Other problems concern the unintended use of statuses, taking advantage of information exposed in status messages, or misinterpreting them¹¹. Because of this, many users are hesitant to share some parts of their current context, thus limiting the possibility of others to perceive their presence.

Those and similar problems that I had a chance to observe, motivated me to conduct a qualitative user study and expand the understanding of their true nature. I believe that this understanding will show the way for advanced technological solutions that could support users better in their practice of status message sharing. The study is presented in the next section.

3 THE USER STUDY

In this section, I present the details of the user study that was aimed at identifying the intended audience of status messages in online communities. The section includes the description of the methodology that was used, the data collection process, and the study findings. I conclude the study overview by presenting related user studies and deriving implications for the development of status message sharing applications. The understanding of the phenomenon of status message publishing will directly shape the technical solution that is proposed in further sections.

3.1 COLLECTING DATA: INTERVIEWS

The first step of the study was to collect field data. Apart from researcher's observations and introspection based notes, I decided to conduct interviews with users in order to collect user stories and real life examples. Interviews were focused on critical incident type questions [9] and getting users to provide real life examples of status publishing situations, the type of content published in status messages, and the intended audience whenever applicable. The users were first asked to answer some specific questions on their background (age, profession, how long have they

¹¹ Those problems are identified in the interviews with users that are presented later in the thesis.

been sharing statuses, etc.). Then the conversation was led towards collecting examples of status message publishing, by inquiring them about their publishing habits including devices used, locations, situations, content types etc. The intended audience was also discussed for each example and users were asked to identify the group(s) of people they are connected to on status sharing services.

Special attention was paid to the analysis of recent status messages together with users, using them as real-life examples and trying to understand the context, motivation and outcome of their publishing.

Each interview lasted around 30 minutes and was audio recorded with explicit consent of the subject.

3.1.1 SUBJECTS

Ten subjects participated in the interviews. Three of them were interviewed in Paris, France and the others in DERI institute in Galway, Ireland. They were all chosen because of their use of statuses on either Twitter or Facebook (or both). The subjects' age ranged from 22 to 35, having both 22 and 35 as extreme values and concentrating around 26-27. This choice proved to correspond well to demographics of users of the most active microblogging services, as documented in [10]. Equal number of male and female subjects participated in the study.

At the time of the interviews, all users were using Facebook to share updates. Six of them were using Twitter in addition to Facebook, and one user was using Skype to publish status updates in addition to Facebook. The frequency of status message posting varied from several times a day to once a week.

All the users have been involved in status message sharing for at least six months at the time of the interviews, while some were early adopters with more than two years of status sharing experience.

3.2 DATA ANALYSIS: GROUNDED THEORY

Once the data was collected, I analyzed them using the Grounded Theory method. Grounded Theory is a systematic qualitative research methodology used to analyze data collected from the field (e.g., interviews) and generate a theory that explains the underlying phenomenon [11]. It is often used in social sciences and I find it very useful for developing an understanding of phenomena on the Social Web. .

The analysis of interview data was done collaboratively by the researchers involved in the Online Presence project in order to reduce the impact of subjectivity, inherent to Grounded Theory analysis. Following the Grounded Theory methodology, data were processed to derive the codes from each user story, in the process called Open Coding. Codes derived in this phase represent first level abstractions over field data. Categories further emerged from those codes in iterations of grouping efforts. In this section, we present the survey findings in a top-down fashion, starting from the most general categories.

According to my findings, there are two major reasons for dedicating status messages to a certain audience:

- The status messages that represent information noise to certain users
- The confidential nature of certain status messages.

In the following subsections, we will unveil the nature of those two problems in more details.

3.2.1 INFORMATION NOISE

In many scenarios identified by the study participants, information noise emerged as a problem, either while browsing other people's status messages and having to process many irrelevant ones, or while publishing a status message and worrying who might care to read it. In most cases, the information noise problem occurred due to the following two reasons: **gap of understanding** and **lack of significance**.

3.2.1.1 Gap of Understanding

Gap of understanding occurs when users are not able to properly interpret the content of a status message. Sometimes the inability to understand arises from **shallow acquaintance**, like in cases where the user who is publishing a status messages knows a certain group of people for a short time. The shallowness of acquaintance can be an obstacle for a group of people to understand jokes, metaphors and in general to properly interpret the intended meanings of custom messages. Similar phenomenon arises with people who are occasional peers, and the people with whom the user has lost touch (ex-school friends, ex-work colleagues).

Sometimes the gap of understanding results from the **lack of competence** like in cases where users use status messages to ask for advice, or provoke professional discussions. It occurs as well in cases of bilingual users who post status messages in two (or sometimes even more) languages. In such cases, the language speaking competence determines the intended audience of a status message, whereas the message represents a noise for the rest of the world. This problem is also present in scenarios of automatic postings of custom messages across services (e.g. automatic forwarding from Twitter to Facebook) where mostly different audiences are present on different services. Quite often close friends from one service (e.g., Facebook) do not understand and find irrelevant the profession-related status messages posted on another service (e.g., Twitter). This phenomenon can be illustrated on a story of one of our study participants, Alice¹², who tweeted about Semantic Web, RDF and similar professional related topics. She had her tweets automatically shown in Facebook as status messages, and her personal friends were often confused. They even posted comments to ask for clarifications about unintelligible terms and inquired why she was posting such "awkward" content.

Some status messages bare a **socially established meaning**, only understood by a small community of people, like those containing internal jokes, or internal aliases and metaphors. Such status messages may be misinterpreted by people outside that small community and may be source of misunderstandings, inappropriate comments and other inconveniences. One of the most illustrating example is a story of our user Dorothy, who worked at a medical laboratory. Once she had a status message "in love..." and received a comment from one of her work colleagues who

¹² Names of participants are changed in order to protect their anonymity

added "...with Joshua". For the group of her work colleagues, Joshua was an experimental mouse, but for Dorothy's family (especially her sister in law) he might have been a potential lover.

3.2.1.2 Lack of Significance

In other cases, a custom message is not intended for some people simply because they have no interest in it. This is the case when a custom message relates to a certain domain and thus can be of significance only to people with an **interest in the domain**. This case is common when people make connections based on a shared interest, stay in touch and then use status messages to spread domain related news, announce events and provoke discussions. Quite naturally, announcements of professional events, intended to reach a user's professional contacts might represent information noise to his personal friends.

In some cases it is the interest in the domain that makes a certain group of people not interested in other non domain-related status messages of a user. The story of our study participant, Azrael, could illustrate this phenomenon. Azrael subscribed to status message updates of a well-known Semantic Web evangelist. However apart from a couple of highly useful domain related links a day, tens of other status messages of the evangelist are related to details of his private life, that flood Azrael's status sharing client.

In other cases some groups of people might not be able to **make use of the information** in the status message which has an informative purpose. This is the case with status messages highly dependent on location – like those containing invitations to local parties and announcements of local events. In both cases such status messages are irrelevant to people from other locations who could not make use of the announcement.

3.2.2 CONFIDENTIALITY

Confidentiality in status message sharing is an issue that occurs when a user wants to explicitly restrict access to some groups of contacts for some types of status messages or even only for a particular status message. It is usually related to groups of higher granularity, like in the case of separating custom messages for work and private contacts. People tend to perceive some content types (like feelings and moods or travel experiences) to be suitable only for closer contacts or contacts of a more private nature, while those custom messages should be kept private from some other (more professional) groups of contacts.

Some users, on the other hand express concern about the **possibilities to track** their status messages to the past and draw conclusions about their personality, which would be out of their control. The concern is expressed about the uncontrolled data integration possibilities across services and attempts to integrate status messages with other content about the user and thus perform some spy-like behavior.

3.3 SUMMARY OF THE STUDY

Our user study underlines the fact that many status messages circulating on the Social Web have their intended audience, and seeks to develop further understanding of this phenomenon. Figure 3, summarizes the study findings. As shown on the figure, primary reasons for a status message to have its particular audience are its confidential nature and the possibility that it represents

information noise for some users. Information noise is further a result of either the gap of understanding or the insignificance for the receiver. Contextual conditions that influence the phenomenon (like content type, granularity of audiences, etc.) are shown in the clouds on the figure.

Users try to deal with the problem of dedicating a status message to a certain audience in different ways. The following ways are the most common.

The first approach is to use existing mechanisms for creating groups of contacts (e.g., on Facebook) and then to specify some restrictions on which groups are allowed to see the status messages. This approach is incomplete as it actually limits certain persons from seeing status updates that might be sharable with them. Furthermore, it does not allow for defining the types of messages that are shared with a certain group; it rather prohibits the group from receiving status updates in general. This incompleteness results in the users' need to focus on sharing statuses with only one group (the one to which the access to status messages is granted) and therefore adapt the status sharing behavior to this purpose.

Additionally, many users find it difficult to explicitly categorize their contacts into groups (especially if the number of contacts is large), so this feature of creating contact groups and restricting access remains largely unused in real life scenarios.

The second approach is to connect with different people on different services (e.g., using Facebook for personal friends, and Twitter for professional contacts). This approach is supported by some new services on the Social Web, like My Name is E¹³ that allows users to easily connect on various Social Networks, with a person they meet. Users can associate social networks with a profile (e.g, business or private) and then, depending on currently active profile, connect with their new friend only on specific social networks. However, it is likely that some people will simply not be present on some Social Networks which will be a limitation for this approach, e.g., in case a user wants to connect with a business contact who is using only one Social Network – the one she uses to connect only with her personal friends.

Several solutions for niche microblogging and microbroadcasting¹⁴ exist (like Shoutem¹⁵ and Static¹⁶) to allow for status message publishing in closed or interest-based communities. However, those services require all the members of a status sharing community to have an account on the service, inevitably leading to social network fatigue¹⁷, a phenomenon related to creating more and more accounts on different Social Web sites.

Finally, one of the most common approaches is just a user's effort to be more careful of what he/she publishes in a status message. This effort takes into account at least the identified problems of confidentiality and gap of understanding. However, in this case, a user is left with little opportunity to post something in a status message. The user is actually focused only at posting custom messages

¹³ <http://www.mynamewise.com/>

¹⁴ I refer to microbroadcasting as to the practice of publishing microblogging post in closed, predefined communities.

¹⁵ <http://www.shoutem.com/>

¹⁶ <http://www.static.com/>

¹⁷ <http://slashdot.org/articles/07/01/02/237223.shtml>

meant for general public, which inhibits his/her full participation in status message sharing on the Social Web.

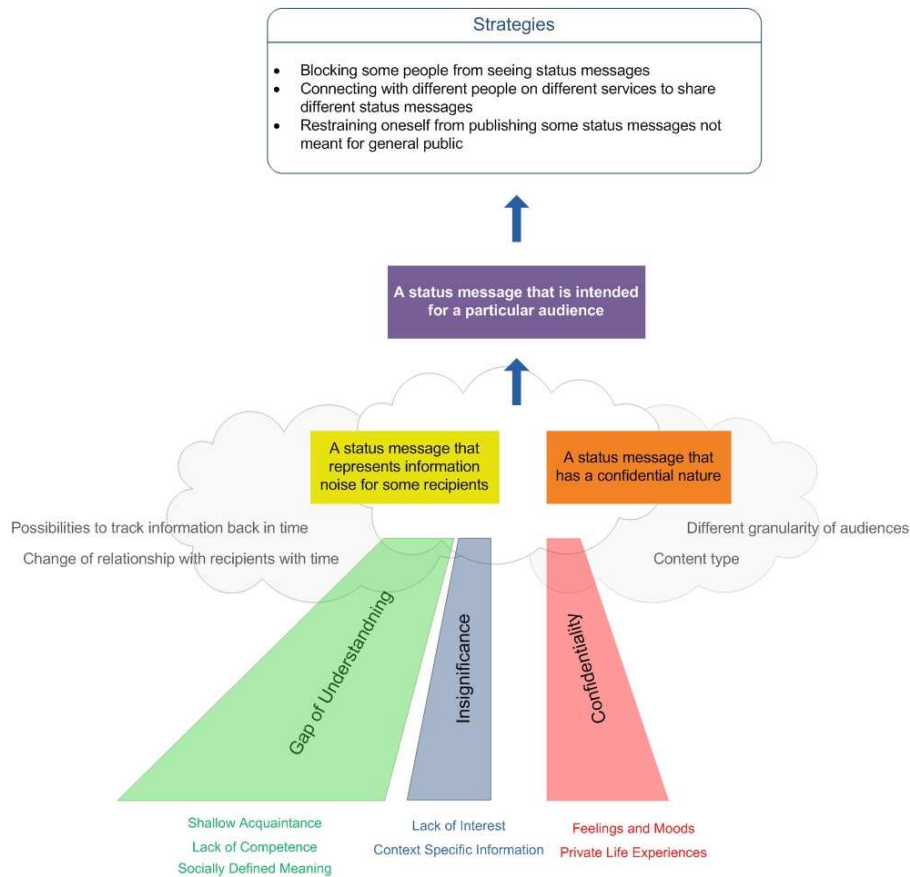


Figure. 3. Grounded Theory Diagram: Status Messages Intended for a Particular Audience

An interesting observation is that in most cases it was very difficult to draw a parallel between the user’s current context and the audience that the message is dedicated to. Contrary to what I have expected, users were not able to name recurring context-audience couples (like “whenever I am at work, I post messages for my work mates”, or “when I am using the home computer, I post messages for personal friends”).

3.4 RELATED STUDIES

With the rapid emergence of Twitter and the growth of its user base, status message sharing on this service began to draw attention of many researchers. Studies have been conducted to explain phenomena specifically related to Twitter. Having in mind the purpose of Twitter, those phenomena are highly related to status message sharing, and thus to the focus of our work. One of those studies done by boyd, Golder and Lotan [12] investigates the nature of conversations that form out of status messages through the practice of re-tweeting. Re-tweeting is a practice performed Twitter users who decide to republish status messages of other user. In their study, Boyd et al.

unveil the motivations for such a practice, among which they identify cases of re-tweeting for a particular audience. They share a finding that the intended audience plays a role in choosing what to republish in a status message on Twitter. More precisely, since the practice of re-tweeting is highly related to information sharing, users tend to worry about the interest of their intended audience.

Another interesting study related to status sharing on Twitter, presented in [13], investigates the intentions of Twitter users and motivations for status message sharing on this service. They identify different motivations, some of which (e.g., sharing information, and reporting news) appear in our user study as descriptors of reasons that focus a message to its audience. The study however does not deal with the nature of intended audience of specific status messages, neither it considers status message sharing on other kinds of tools (other than microblogging).

There are other studies that investigate different practices related to status message sharing on Twitter, or, more generally, on social networking services (like [14]). However, to our knowledge, none of them has done a comprehensive investigation of intended audiences of status messages, and the issues that arise from the fact that users may have a particular audience in mind when publishing a status message – an intention not well supported by currently existing status message publishing facilities on the Social Web.

3.5 IMPLICATIONS OF THE STUDY

In this section, I present the implications of the user study. First, the study allowed for developing a good understanding of the need to dedicate a status message to a certain audience. This need is captured by the theoretical notion of the Presence Diamond [15] that can be useful for further research of the phenomenon. Apart from this notion, concrete requirements for status message sharing systems are derived from the real life scenarios discussed in the user study.

3.5.1 *THE PRESENCE DIAMOND*

When we acknowledge that many status messages have their intended audience and that access to them should in some cases be restricted to that particular audience (especially in cases of confidential messages), it becomes clear that one user might have different status messages for different audiences at the same time.

In fact, emitting different information (appearances) to different groups of observers is not restricted to status messages, but spans over the whole notion of online presence. By the term online presence we refer to totality of information that allows perceiving one's presence in online communities [16]. Apart from status messages, availability for interaction, as an element of online presence, might also have a faceted nature and be different for different groups at different times. One can easily imagine a working situation where a user is available for interaction only with his work colleagues and busy for all others. Access to different online presence information might also be given only to specific groups of contacts (like in the case of sharing the current location only with the closest friends).

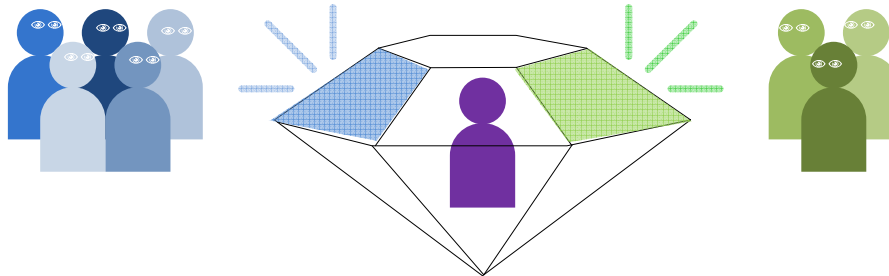


Figure 4 The Presence Diamond¹⁸

The notion of presence diamond allows us to look at a person's online presence as a diamond: different observers are introduced to different facets of the diamond. Facets differ among themselves in:

- **different types of presence data** that are accessible by observers of a facet (like in cases where one group of observers can access a person's location, availability and a status message, and another group can access only the status message),
- **different granularity of data** (like in the case of sharing the exact location with the closest friends and only the current city/country with strangers), and in
- **different data** that are emitted to different observers (like having different status messages and different availability for different groups of contacts).

Even though the focus of this thesis are status messages, I will look at the problem of directing status messages to their intended audience as a sub-problem of enabling faceted online presence. Accordingly, I will favor solutions general enough to address the faceted nature of the presence as a whole.

The notion of faceted presence (and the presence diamond) is highly related to the notion of faceted online identity that already drew the attention of research community [17]. While this notion is more concerned with static aspects of identity, the faceted presence allows studying the transient aspect of a person's appearance in the online world.

3.5.2 REQUIREMENTS FOR AN ADVANCED STATUS MESSAGE PUBLISHING SERVICE

To overcome the limitations of user workarounds presented in the user study, as well as the incomplete technical solutions that exist on the Web, I propose a set of requirements that an advanced status message publishing service should satisfy in order to respond to the needs discovered in the user study. A more adequate service should:

¹⁸ The figure and the notion of the Presence Diamond are strongly inspired by the notion of the diamond of digital identity, that Mike Roch, Director of IT Services at University of Reading, introduced at the Eduserv Digital Identity Workshop in London, January 08, 2009

- Support users in dedicating status messages to people based on their social graph (their relationships with other users)
- Support users in dedicating status messages to people affiliated with a certain institution (e.g., school or workplace) as well as with people who are members of a certain online community (e.g., an online forum).
- Support users in dedicating status messages to people based on their interests and competences (including languages spoken and knowledge about locations visited).
- Support users in dedicating status messages to people based on the intensity of relationship between the status message publisher and the observer.
- Support users in dedicating status messages to a certain group of people regardless of the status sharing service they use (i.e., allowing the target audience to be dispersed all over the Social Web).
- Take into account the dynamic and ever changing nature of user properties (for example their current location, interest, etc.).
- Allow users to publish status messages confidentially – in a way that only certain people can get access to the status message.

In the following sections I investigate the possibilities of Semantic Web technologies to help establish a system capable of fulfilling these requirements.

4 CONTRIBUTIONS OF SEMANTIC WEB TECHNOLOGIES TO THE MANAGEMENT OF ONLINE PRESENCE

The major interest of the scientific community in the Semantic Web starts in 2001, the time when Scientific American published the article entitled “The Semantic Web” [18] by Tim Berners-Lee, Jim Hendler and Ora Lassila. The article presented a revolutionary vision of a better Web, capable of supporting humans entirely in their everyday lives. This vision will later inspire a large community of researchers to investigate and develop different methods and technologies to approach this attractive vision.

In a nutshell, the Semantic Web is a Web more accessible to machines. As a difference to human readable documents available and interlinked on the original Web, the Semantic Web should enable people to expose machine processable semantics. With the ability to “understand” Web content, computers should be able to perform more automated tasks on behalf of humans, preprocess the ever increasing amount of content on the Web, and execute more sophisticated tasks. The original Semantic Web vision article [18] predicts even the emergence of intelligent agents capable of sophisticated planning, taking into account many sources of information, user’s context, preferences, and trust in specific data sources. The exposed semantics of Web data is seen as the enabling factor of those advanced applications that should turn the Web into a more powerful tool to serve humanity.

One of the key elements that support the publishing of semantic content on the Semantic Web is the use of ontologies. Ontologies are defined as explicit and formal specifications of a shared

conceptualization [19]. They represent formal models, agreed upon by a community of experts/users that define the meaning of data exposed on the Semantic Web.

The World Wide Web Consortium¹⁹ has developed many standards to enable defining and publishing of ontologies and semantically described data, including Web Ontology Language (OWL)²⁰ and Resource Description Framework (RDF²¹) for representing statements in the form of object-property-value triples. The query language for semantic data – SPARQL²² is also one of the vital tools for Semantic Web practitioners. These standards allow for creating a network of interlinked data similar to the network of documents that constituted the original Web – it is what we call the Linked Data Web or the Web of Data.

The development of the Semantic Web today takes place in the larger context of the Web Science [20], emerged from the understanding that the Web, and therefore the Semantic Web as well, does not depend merely on technical aspects studied in Computer Science, but reaches the scopes of other disciplines like Social Science, Law, etc. This understanding helps to contextualize the Web-related research and make it more aware of real problems that technology should resolve. This very approach motivated me to conduct a qualitative user study before developing a technical solution for the chosen problem.

What is especially interesting for the topic of this Master thesis is the joining of the Semantic and the Social Web, called the Social Semantic Web [21]. It is a discipline that explores the ways in which Semantic Web technologies can help improve Social Web sites, and address some of the key problems in the area, such as interoperability, lack of data portability, privacy, etc. The most prominent examples of Social Semantic Web initiatives are FOAF²³ and SIOC²⁴ projects. FOAF (Friend-Of-A-Friend) is a project aimed at providing a socially agreed upon ontology for representing user profile data [22]. Many exporters have already been created to transform data from Social Networks to RDF using FOAF²⁵. SIOC (Semantically Interlinked Online Communities) [23] provides the same functionality for the content created by users in online communities, thus allowing one to reuse the user-generated content and track down replies and comments posted over different systems and communities [24]. These possibilities are built upon the concept of Social Semantic Information Spaces [25] – conceptualizations spanning the Social Web in order to realize the ideas of Vannevar Bush [26] and Doug Engelbart [27] on distributed collaboration infrastructures.

¹⁹ <http://w3.org>

²⁰ <http://www.w3.org/2004/OWL/>

²¹ <http://www.w3.org/RDF/>

²² <http://www.w3.org/TR/rdf-sparql-query/>

²³ <http://www.foaf-project.org/>

²⁴ <http://www.sioc-project.org/>

²⁵ like <http://semantictweet.com/> that creates a social graph in FOAF using data from [Twitter.com](https://twitter.com/); or FlickrRDF (<http://apassant.net/home/2007/12/flickrdf/>) that semantifies the data from [Flickr.com](https://www.flickr.com/) using FOAF and SIOC

4.1 THE SEMANTIC WEB SOLUTION FOR DIRECTING STATUS MESSAGES TO THEIR AUDIENCE

In this section I investigate concrete ways how the Semantic Web could be used to deal with the problems discovered in the user study (most notably the problem of directing a status message to its audience) and build a system for status message exchange according to the proposed requirements. I propose a technical solution, based on Semantic Web technologies. Finally, I present a proof of concept microblogging tool – SMOB 2.0 that implements the proposed Semantic Web solution in order to bring the status message directing functionality to the end users.

4.1.1 THE GENERAL IDEA

In order to use Semantic Web technologies for dedicating a status message to its audience we need a way to semantically describe a status message and uniquely identify it over different services on the Web. If we remember the Presence Diamond and the evident need to dedicate other presence information to its audience as well, it becomes clear that we first have to adopt a solution for semantic descriptions of online presence information. In my approach I decided to rely on the Online Presence Ontology (OPO)²⁶ that I have created earlier as a vocabulary for describing online presence information, and extend it to better support the newly discovered needs.

To enable dedications of presence information to a specific audience I extended the OPO vocabulary with appropriate concepts and relations allowing for the representation of the bond between a status message (or other presence data) and the group of users intended to see them. The proposed extensions allow for selecting the intended audience members by a shared property (e.g. current location, interest, social graph) which was one of the requirements derived from the user study.

Finally, I rely on SPARQL query language to express the conditions that make one person a part of the status message audience. This is quite convenient as it facilitates the reuse of data about users available in Linked Data [28] sources across the Web.

In the following sections, I present the basic elements of the Online Presence Ontology, the extensions that have been added to enable dedications to a certain audience, as well as a way to specify the intended audience members with a rule-based approach using SPARQL query language.

4.1.2 ONLINE PRESENCE ONTOLOGY

The Online Presence Ontology (OPO) presented in [29] provides a way to describe a user's current state of presence in the online world, including his availability for interaction, current status message, location and other elements of context. This section gives a brief overview of the basic elements of OPO.

`OnlinePresence`, the core class in OPO, represents a placeholder for all the aspects of a user's presence in the online world. Having in mind possible development of new, currently unpredictable, aspects of presence in the online world, I defined a class, `OnlinePresenceComponent`, to represent an abstract component of `OnlinePresence`. This design decision introduces flexibility

²⁶ <http://www.milanstankovic.org/opo/specs/>

in modeling the building blocks of `OnlinePresence`. Relying on the current state of practice in the area of online social interactions I have defined three components of `OnlinePresence`: `OnlineStatus`, `Notifiability` and `Findability` (Figure 5). These are modeled as subclasses of the `OnlinePresenceComponent` class. First, we perceived the need to distinguish the attitude towards the possibility of interaction with humans (represented with `Online Status`) from the attitude towards the possibility of being contacted/interrupted by a machine. By a contact from a machine we mean the practice of IM programs to pop-up notifications. Many IM programs allow users to specify whether to allow this type of disturbance or not. This particularity is modeled with the `Notifiability` component, by assigning one of the different `Notifiability` instances (e.g., `AllNotificationsPass`, `NotificationsProhibited`) to `Online Presence`. `Findability` is a component meant to describe the possibility of other users to access a person's contact details and online presence data. In most systems this property is defined by users in some form of settings. The approach for defining `Findability` is the same as with `Notifiability`. Different predefined instances are used to denote various states of `Findability` (e.g., `PubliclyFindable` and `ConstrainedFindability`). Finally, `Online Status` represents what one may call availability for chat – the status used by IM platforms.

While analyzing different status scales used by different IM platforms I concluded that the complexity created by all the differences between them could be best resolved by introducing different `Online Status Components` whose combination would permit all existing IM scales to be mapped into one single model – the one used in OPO. I have defined the following components of the `Online Status`:

- `Activity` – denotes whether a user is present or away from the service;
- `Disturbability` – denotes whether a user wants to be contacted or declares himself/herself as busy;
- `Visibility` – denotes the possibility of others to view a user's actual state of presence;
- `Contactability` – denotes whether the possibility to contact a user is restricted.

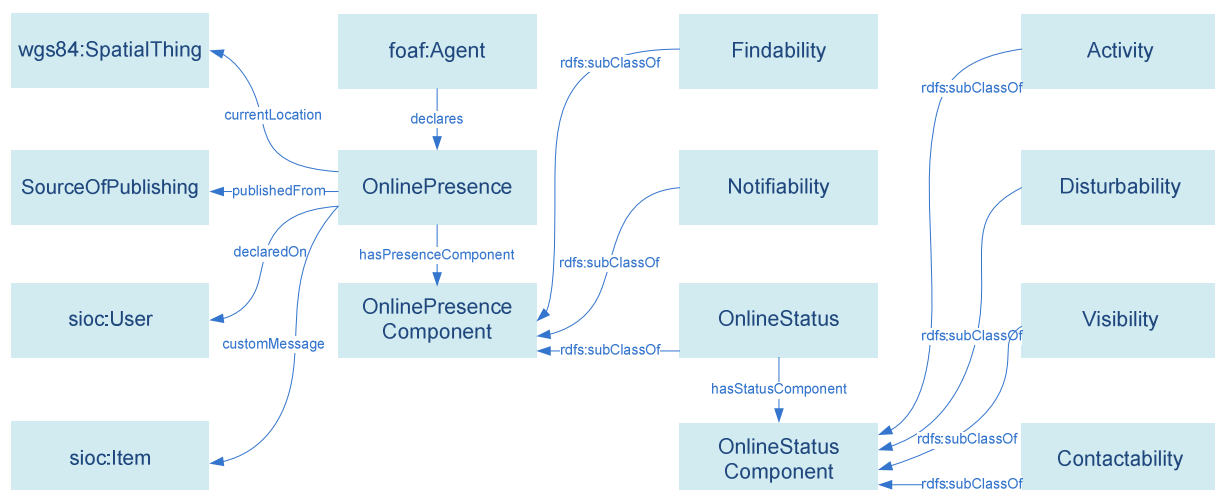


Figure 5 An excerpt of the basic OPO model

The concept of Online Presence itself is connected to the class `Agent` from the FOAF vocabulary using the property `declares` (see Figure 5).

In OPO, status messages are one of the elements that form an image of someone's presence online. Since on the Social Web sites there is a common practice of replying to status messages, there is a need to look at status messages both from the perspective of their initial use for declaring presence, but also as triggers for conversations. Therefore, we decided to represent them using the `Item` concept from the SIOC ontology, described in [23] and widely used for semantically describing user generated content in online communities. Representing status messages as Items can support even a scenario when a status message of one user is a reply to the status message of another.

Since I will focus on status messages in the further text, it is useful to take a moment to explain an example status messages description, specified using OPO. The examples in this thesis will be given using the Turtle RDF syntax²⁷.

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>.
@prefix opo: <http://ggg.milanstankovic.org/opo/ns#>.
@prefix foaf: <http://xmlns.com/foaf/0.1/>.
@prefix sioc: <http://rdfs.org/sioc/ns#>.
@prefix : <http://example/org>

:Milstan rdf:type foaf:Agent;
foaf:mbox <mailto:milan.stankovic@gmail.com>.

:myCustomMessage rdf:type sioc:Post;
sioc:content "going to have fun".

:MyCurrentPresence rdf:type opo:OnlinePresence;
opo:customMessage :myCustomMessage;
opo:startTime "2008-03-01T18:51:19".

:Milstan opo:declaresOnlinePresence :MyCurrentPresence.
```

Figure 6 An example Online Presence description using OPO

In the example on Figure 6 I first create a `foaf:Agent` to represent the user himself. The Agent is uniquely identified by his e-mail address (`foaf:mbox` property). I then create a `sioc:Post` (a subclass of the `sioc:Item` class) to represent the content of the status message (which is “going to have fun” in our example). Subsequently, I create an instance of `opo:OnlinePresence` to gather all presence data and I attach the status message to it using the `opo:customMessage` property. Finally, I connect the Online Presence instance (`:MyCurrentPresence`) with the user who declared it.

One might wander about the reasons for such an indirection in the model, but the necessity to treat the content of status messages separately from the fact that they represent a status message of the user at a certain point in time, is evident on the Social Web. There are applications that treat the content of users' postings as microblogs and focus on the content itself and the emerging conversations. On the other hand, there are applications that take the same postings and present them as the users' status messages. This practice imposes the necessity to treat the dual nature of

²⁷ <http://www.w3.org/TeamSubmission/turtle/>

status messages (as status of a user and as user generated content). While OPO provides the status perspective of a status message, SIOC model provides a way to look at status messages from the perspective of user-generated content. Therefore, this marriage of OPO and SIOC should provide a semantic support for a wide range of real life scenarios on the Social Web applications.

Following the changes in the area of Social Web sites and the improved understanding of the ways how presence can be declared, I have enhanced the original model of OPO, by building a new version during my Master studies. Apart from those basic components, the new version supports expressing the current location of the user and declaring user's actions.

Emerging trends like travel-blogging, travel-tweeting and the constantly increasing usage of mobile devices for engaging in online social interactions, make the need to include the location data in the Online Presence Ontology obvious. When people are on the move, permanent locations specified in their user profiles do not help much to position a user in the time of writing a post. On the other hand there are more and more GPS enabled devices that can automatically generate location metadata. Thus, I found it useful to extend the concept of Online Presence with location data and then connect posts to instances of Online Presence. Other potential use of current location data would be in enabling complex contact restrictions in Instant Messaging, like "the user can be contacted by anyone from the same town". If we want to enable those restrictions (in the form of rules or policies) at some point in the future, it would be useful to define the user's current location. For specifying location data we use the SpatialThing concept from the WGS84 Ontology²⁸. This concept is compatible with the vocabulary used to semantically represent millions of geographic places on the service Geonames.org.

Another improvement was the possibility to represent user's actions, like reading something, listening to music, etc. Actions are an important part of user's current context while being online, and they can give important clues about his state of mind to his peers. As a result of the analysis of real Social Web applications and real life presence publishing scenarios, different action types are included in the ontology specification. Furthermore actions are organized in an extensible hierarchy that could support the emergence of new online behaviors. A special module of the ontology covers the domain of user actions.²⁹

By capturing the semantics of the presence in the online world in a way that is flexible enough to cover the needs of many real-life scenarios, OPO offers an element of solution to the i³ (interoperability-integration-interaction) problem presented at the beginning of this thesis.

More detailed information about OPO classes and properties, as well as instructions on how to use the ontology can be found at <http://www.milanstankovic.org/opo>. Moreover, the Online Presence project is conceived as an open process of building a universally agreed upon ontology and it is constantly evolving, so everyone is invited to post comments and contribute to its development.

²⁸ World Geodetic System ontology <http://www.w3.org/2003/01/geo/>

²⁹ <http://milanstankovic.org/opo-actions/specs/>

ONLINE PRESENCE ONTOLOGY EXTENSION: THE NOTION OF SHARING SPACE

Although OPO is useful for explicating the semantics of online presence data, it lacks a way to dedicate the online presence data to their intended audience. My approach consists in extending OPO to provide this possibility.

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In order to provide a way to dedicate a status message to a certain audience I introduced the concept of `SharingSpace` into the new version of the ontology³⁰. A sharing space represents all the persons that a status message is intended for. However, since a need for faceted appearance in online communities does not concern only status messages but the whole notion of online presence, I decided to bound the new notion of `SharingSpace` directly to the concept of `OnlinePresence` from the OPO ontology using the property `intendedFor` (see Figure 7). If we recall the notion of the Presence Diamond, the concept of `SharingSpace` would correspond exactly to the facet of the Presence Diamond.

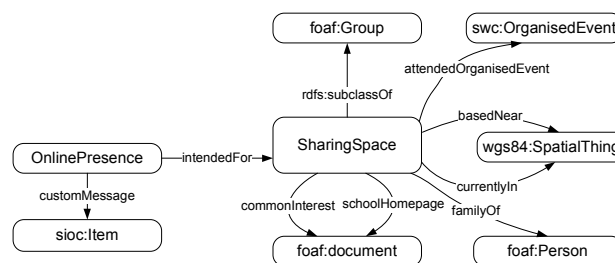


Figure 7 An excerpt from the Online Presence Ontology

A sharing space represents a group of people bound by shared properties. As we identified in our user study, it is usually a certain property of a person that makes a status message suitable or not for her. In some cases those are more stable properties, like hometown, workplace, and school being attended, nature of relationship with the status message publisher, interests etc. In other cases more dynamic properties can determine if a user belongs to the status message audience or not, like his current location for example. In order to preserve the semantics of the shared property that bounds people together in the sharing space I have attached a number of properties to the `SharingSpace` concept. They allow to represent a place where people are based, or are currently present through the concept of `SpatialThing` from WGS84 Ontology; this allows to rely on the huge geographical database of Geonames³¹. Using those properties one can also represent documents that identify common interests or homepages of schools of Sharing Space members, as well as their common relation with a certain person (I use the FOAF ontology to refer to persons and documents). It is also possible to point to events that members of a Sharing Space attended together (I rely on Semantic Web Conference Ontology³² to capture the semantics of those events). In a way those properties allow to specify the criteria for belonging to a particular Sharing Space.

Quite conveniently, the data about users that might be relevant for Sharing Space membership is already present on the Social Web on various social network profiles and location sharing services.

³⁰ For information about other properties and classes relevant to Sharing Spaces, please see the Ontology specification (<http://www.milanstankovic.org/opo/specs/>)

³¹ <http://www.geonames.org/> is a service providing semantic descriptions of geographical locations

³² http://data.semanticweb.org/ns/swc/swc_2009-05-09.html

Ontologies for the Social Web like FOAF, Relationship vocabulary³³, and OPO are already used around the web to describe some of those data, expose them in RDF and make them part of already existing interlinked data on the Web (usually referred to as Linked Data). In the definitions of sharing spaces I will heavily rely on the data about users, already made available on the Web using those ontologies.

Once a status message is connected to its intended audience (embodied in a sharing space) we need a way to specify the members of the sharing space. As shown in the user study, many different properties can bind a group of people in a sharing space, so our solution to identifying sharing space members must be flexible enough to support all those ways. For this reason, I have chosen to use SPARQL queries³⁴ to collect across the Web the information about persons satisfying a certain criteria, and declare them as members of the corresponding sharing space. This declaration is achieved using the `member` relation from the FOAF vocabulary (`foaf:member`).

Figure 8 gives an example of a Sharing Space definition expressed as a SPARQL query. This query can collect information about the actual members of a Sharing Space across available repositories of FOAF and OPO data. In this case, the Sharing Space encompasses all the persons interested in Semantic Web that are currently in Paris (we rely on Geonames³⁵ URIs to uniquely identify Paris). One could easily imagine a scenario of publishing a status message about a Semantic Web related event in Paris that could serve as an invitation/reminder to all interested people from the neighborhood.

```
PREFIX opo: <http://ggg.milanstankovic.org/opo/ns#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>

CONSTRUCT
{
  <http://example.org/ns#CurrentlyInParis> rdf:type opo:SharingSpace;
    foaf:member ?person.
}
WHERE
{
  ?person foaf:topic_interest <http://dbpedia.org/resource/Semantic_Web>.
  ?person opo:declaresOnlinePresence ?presence .
  ?presence opo:currentLocation <http://sws.geonames.org/2988507/> .
}
```

Figure 8 Example definition of a Sharing Space using SPARQL

Apart from specifying Sharing Space members using SPARQL, the new version of the OWL language³⁶, currently available as OWL 2 Working Draft [30] will provide a way to define Sharing Spaces through richer restriction axioms such as property chains. Property chains would allow to state that if a user satisfies a certain property then he is automatically a member of a Sharing Space.

The OWL 2 code presented on Figure 9 is an axiom defining Sharing Space members through their interest. To connect people with their Sharing Spaces we rely on two properties `foaf:interest` as a property of a person, and `opo:commonInterest` that identifies the common interest of Sharing Space members. Whenever those properties have the same range, a person should be declared a member of the respective Sharing Space. It is what the code states -the `foaf:member` property between a person and a Sharing Space will be established whenever a person has a `foaf:interest` that is a

³³ <http://vocab.org/relationship/html>

³⁴ This choice emerged in a discussion with Alexandre Passant in DERI, Galway, Ireland

³⁵ <http://www.geonames.org/> is a service providing semantic descriptions of geographical locations

³⁶ <http://www.w3.org/2004/OWL/>

opo:commonInterest of people in a particular Sharing Space. It establishes a property chain between the foaf:interest property of a person and opo:commonInterest property of a Sharing Space, in order to specify that the foaf:member relation emerges from such a chain of properties.

```
SubPropertyOf (
  PropertyChain(
    foaf:interest ObjectInverseOf( opo:commonInterest )
  )
  ex:member37
)
```

Figure 9 Example definition of criteria for Sharing Space membership using OWL 2

Apart from OWL 2 property chains, I also believe that the emerging Rule Interchange Format [31] (currently a working draft) will be a useful way to define and exchange Sharing Space definition rules across different systems that may use different rule languages internally.

```
Document (
  Prefix(dbpedia http://dbpedia.org/resource/)
  Prefix(ex http://example.org/ns#)
  Prefix(opo http://ggg.milanstankovic.org/opo/ns#)
  Prefix(foaf http://xmlns.com/foaf/0.1/)
  Group (
    Forall ?person ?presence (
      ?person[foaf:memberOf -> ex:currentlyInParis] :-
      ?person[foaf:topic_interest -> dbpedia:Semantic_Web opo:declaresOnlinePresence ->
?presence]
      ?presence[opo:currentLocation -> <http://sws.geonames.org/2988507/>]
    )
  )
)
```

Figure 10 Example Sharing Space defined using RIF

Figure 10 presents an Object-Oriented Representation in RIF Core presentation syntax using frames. It states that every person interested in Semantic Web, who declared current presence in Paris (represented by the Geonames URI <http://sws.geonames.org/2988507/>) is a member of the Sharing Space ex:currentlyInParis.

Although flexible and powerful, the RIF rule language is not yet widely supported by tools, since it is an early draft. Similar situation is with OWL 2. Therefore it is the best to rely on SPARQL to provide Sharing Space definitions while we wait for other technologies to take off.

4.1.2.1 Advantages of Sharing Spaces

One of the advantages of relying on data describing users and their presence, that reside in distributed data stores is that membership of a sharing space does not have to be static. The application of SPARQL queries that define the sharing spaces at run-time can support even the scenarios where membership of a sharing space is dynamically changing. Since the properties of users are described in different Linked Data sources around the Web, SPARQL queries will identify exactly those people that satisfy the query constrains at the given time. The need for this dynamic sharing space membership is obvious in cases in where current location (or any other less persistent property) defines whether a user is or is not in the

³⁷ ex:member is a subproperty of foaf:member. It is introduced since statements made directly about the foaf:member property (that is created and maintained by other people) might redefine its original meaning and thus be considered as vocabulary hijacking. This subproperty introduced only for the purpose of this example makes the impact of the statement to the semantics of foaf:member property more genuine.

intended audience of the status message. Moreover, one can decide to publish these formal representations of Sharing Spaces on the Web, if he wants to share them so that other people can apply the same policies in their system.

Apart from indentifying the intended audience of a status message for the purposes of filtering the irrelevant status messages and reducing information overload on the Social Web, the ontology-based intended audience specification can serve as a ground for enforcing privacy. The idea that ensuring trust and privacy on the future Web can be grounded on the interlinked graph of data (i.e. Linked Data) and policies that take advantage of existing data sources is already presented in [32]. When applied to status message sharing, the realization of this idea demands semantic description of status messages (provided by SIOC) as well as their intended audiences (provided now by OPO) as a prerequisite. On top of those semantic descriptions, some access control mechanisms could be applied to enforce the actual policies.

Another benefit of having semantic descriptions of intended audience might be for calculating social proximity of users of the Social Web. Some researchers argue that on the Social Web, users are not only connected by acquaintance but also by a piece of information they interact with together (e.g., a blog posts and its comments) [33] – a phenomenon they call “object-centric sociality”³⁸. Thus commenting on someone’s blog can, in a certain way, increase the user’s closeness with the blog author. Similarly, I argue that being frequently in intended audience of somebody’s status messages makes one closer, in a way, to the author of the messages. Therefore having semantic descriptions of intended audiences can facilitate the calculation of closeness measures.

Although my approach allows one to direct a status message to its audience, it should be noted that it is not sufficient to enforce the confidential exchange of status messages. Therefore, in case of private data this approach should be complemented with a privacy enforcement mechanism. One way to do it might be to rely on the lightweight FOAF + SSL protocol [34] for authentication. This protocol allows not only to identify the user but also to retrieve her social graph across the Linked Data sources, which can then be used to apply Sharing Spaces and adapt the view of status message to the eyes of a particular user. Another possible way would be the use of OpenID³⁹ protocol for user authentication. The OAuth⁴⁰ protocol can also be helpful for secure exchange of confidential messages and sharing space definitions across status message publishing systems. It allows a service to access user’s data from another service with explicit user’s permission. This is extremely practical for data reuse and can be helpful in transferring sharing space definitions from one service to another.

4.1.3 A SCENARIO OF USE OF SHARING SPACES

In this section I present a scenario where semantic descriptions of status messages are used together with Sharing Space definitions to direct status messages to their audience. The scenario is taking place in a heterogeneous world of several different status message publishing applications, and one application for aggregating status messages of other people.

³⁸ http://www.zengestrom.com/blog/2005/04/why_some_social.html

³⁹ <http://openid.net/>

⁴⁰ <http://oauth.net/>

In this scenario three users exchange status messages to achieve a certain level of presence detection and maintain a sort of emotional bond. Betty is using a mobile device and a specific mobile application to publish her status messages. While she is participating in the International Semantic Web Conference (ISWC), Betty posts a custom message “enjoying a great talk about SPARQL at ISWC”. Since this message would have no meaning for her personal friends who do not know what SPARQL and ISWC mean, she decides to dedicate the message to people interested in Semantic Web and to people currently in the Washington DC area, where the conference is taking place. At the same time, Betty want to keep in touch with her personal friends, so she posts another custom message “having great time in Washington DC, eating the marvelous chicken wings in the conference breaks” dedicated to her close friends.



Figure 11 Betty's status message in RDF and a corresponding Sharing Space in SPARQL

Semantic descriptions of the first status message and the corresponding Sharing Spaces are given on Figure 11. As explained earlier, in the general solution proposal, the content of the status message is described using the SIOC vocabulary in order to enable replies. The status message is then declared as Betty's current status message using the OPO vocabulary, and it is directed to its audience using `opo:intendedFor` property. The audience is declared through the URI of the Sharing Space `http://example.org/SemWebPeopleInDC`. The SPARQL query presented below can then be used to retrieve all the people satisfying the conditions for the membership in the Sharing Space

and attach to the Sharing Space using the same URI. In this particular case, all the people interested in Semantic Web, that are currently declared to be in Washington DC (the Geonames URI in the query corresponds to Washington DC) will be named as members of the `http://example.org/SemWebPeopleInDC` Sharing Space.

On the other part of the world Fred⁴¹ is working, and dreaming of a drink after work, so he decides to post a custom message “anybody in for a drink tonight?”. He does not want a drink with his boss and workmates, neither he wants to talk about Semantic Web, so he decided to pick the “friends and family from Bedrock” sharing space that he has defined earlier.

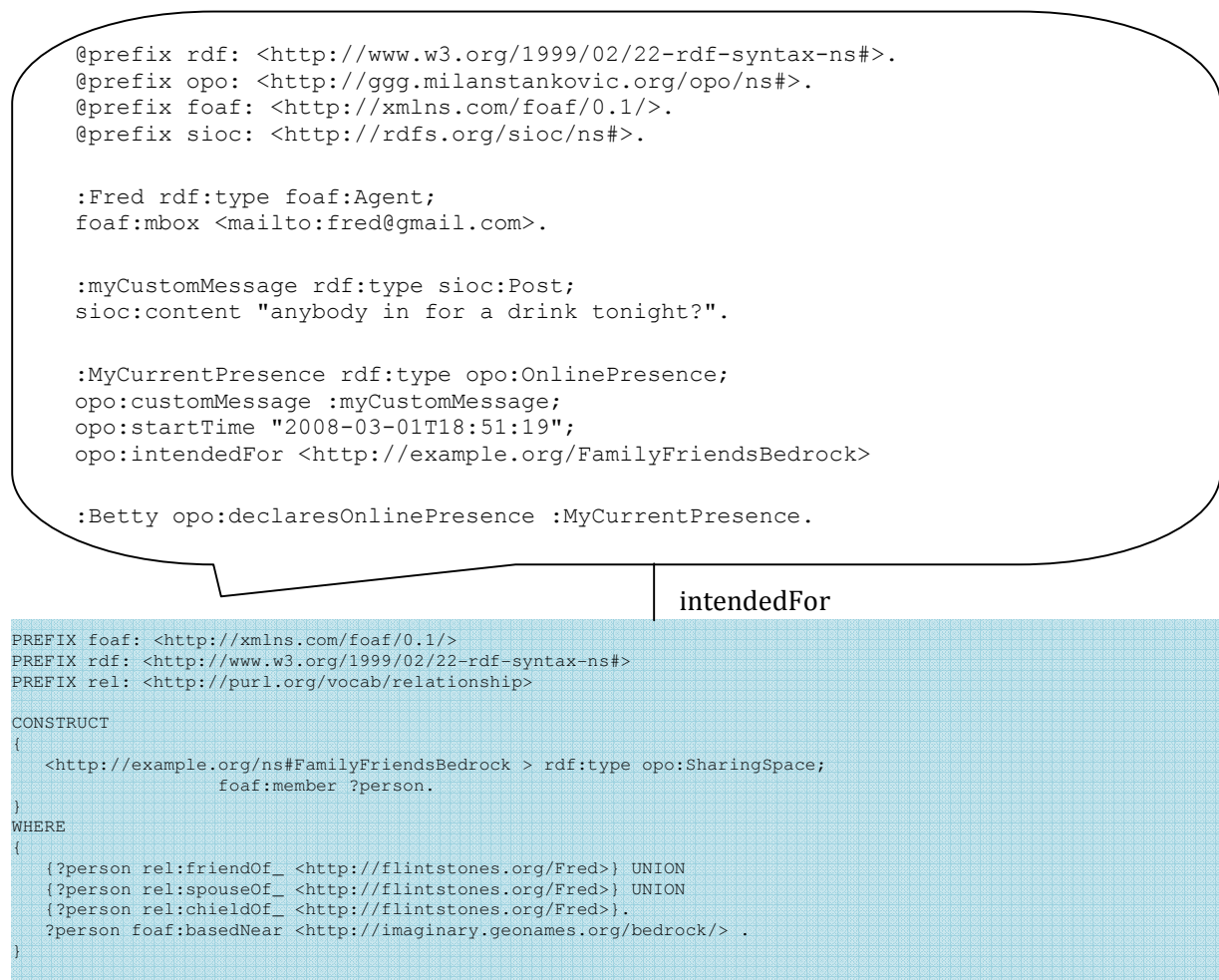


Figure 12 Fred’s status message in RDF and a corresponding Sharing Space in SPARQL

Semantic descriptions of his status message and the corresponding Sharing Spaces are presented on Figure 12. They are quite similar to the status message published by Betty, except that this time, the message is directed to Fred’s `http://example.org/FamilyFriendsBedrock` Sharing Space. The SPARQL query defining this Sharing Space is made to capture Fred’s friends, his wife, and children,

⁴¹ Any similarity of names used in scenario with the names of characters from Flintstones TV show is not a pure coincidence. The intention was to allude that the interoperability potential of Semantic Web technologies is so great that we could even imagine interoperating with prehistoric-like devices as long as they can publish and consume RDF and SPARQL.

all of them living close to Bedrock. To describe those interpersonal relations we rely on the Relationship vocabulary [35].

Wilma is a Semantic Web researcher. She works with Betty, and she is married to Fred. She uses a status message aggregating service to retrieve relevant status messages of her contacts and see how they are doing. Her aggregating service retrieves status messages of her contacts together with corresponding Sharing Space definitions in order to filter them out for Wilma. The service can also access Wilma's FOAF file⁴² where the following information can be found:

- Wilma is a family member of Fred, and
- Wilma is interested in Semantic Web.

The aggregator service could also use Semantic Web indexing services (like Sindice⁴³) and search engines (like SWSE⁴⁴) to retrieve more information about Wilma, Fred and Betty. With this basic information from the FOAF file (and possibly more from Sindice) the service can easily apply Sharing Space definition queries and obtain the fact that Wilma is in the intended audience of Fred's message, and in the intended audience of Wilma's first message (the one related to Semantic Web).

```
PREFIX sioc: <http://rdfs.org/sioc/ns#>
PREFIX sioct: <http://rdfs.org/sioc/types#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX dct: <http://purl.org/dc/terms/>
PREFIX opo: <http://ggg.milanstankovic.org/opo/ns#>
PREFIX opo-actions: <http://ggg.milanstankovic.org/opo-actions/ns#>
SELECT ?post ?date ?content ?maker ?name ?depiction ?presence
where {

    ?presence rdf:type opo:OnlinePresence.
    ?presence opo:customMessage ?post.

    ?presence opo:intendedFor ?audience.
    ?audience foaf:member <http://flintstones.org/Wilma>.

    ?post rdf:type sioct:MicroBlogPost;
        foaf:maker ?maker ;
        sioc:content ?content ;
        dct:created ?date .
    ?maker foaf:name ?name.
    ?maker foaf:img ?depiction.
}
```

Figure 13 SPARQL Query that can retrieve status messages intended for Wilma

With the assumption that the aggregating service is storing all the status messages and other user data in some kind of RDF triple store, the query presented in Figure 13 could be used to retrieve all the status messages intended for Wilma. The query searches for resources of type `opo:OnlinePresence` that are intended for a certain `opo:SharingSpace`. Then it focuses only on those

⁴² By FOAF file I refer to any form of personal profile described using FOAF vocabulary, either in form of a simple RDF file or an embedded RDF descriptions in Web pages.

⁴³ <http://www.sindice.com>

⁴⁴ <http://www.swse.org/>

resources where Wilma is a member of the `opo:SharingSpace` in question. For those presence descriptions, it retrieves all the relevant data related to custom message, together with sender's name and picture for the purpose of presentation in the user interface.

Figure 14 summarizes the scenario graphically. As we can see, using semantic descriptions of status messages, their intended audience as Sharing Spaces, and other available data, a status message aggregating service can make a choice of relevant status messages to show to Wilma.

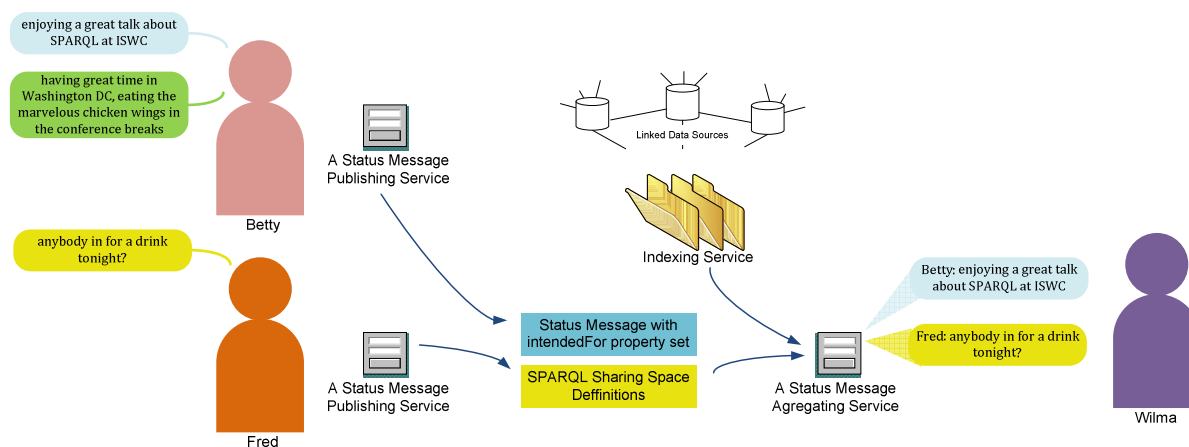


Figure 14 Graphical summary of the Flintstones scenario

In this example scenario it is easy to notice how elegantly and gracefully the Semantic Web technologies allow virtually any service to participate in status message exchange and take advantage of intended audience definitions using Sharing Spaces. Even more, since Sharing Space definitions are designed to be compatible with widely used vocabularies like FOAF and SIOC, the services that collect and present status messages to the user, can benefit from data from virtually any data source on the Web that uses those vocabularies. Inference and querying possibilities with such semantic data and Semantic Web standards are significant, and they will allow user applications to gather significant data from heterogeneous data sources and achieve important data filtering possibilities.

4.2 EXTENSIONS OF THE TOOL SMOB

In order to verify the correctness of the suggested approach I have extended microblogging tool (namely the Semantic Microblogging platform - SMOB [36]) to allow users to define Sharing Spaces and direct their status messages using them. In this section, I present the original SMOB architecture, the extensions that I have made to improve it and enable the publishing of Sharing Space Descriptions, as well as the impressions and feedback of beta-testers.

4.2.1 DISTRIBUTED ARCHITECTURE OF SMOB

SMOB is a distributed semantic microblogging architecture. It consists of a PHP tool for publishing microblogging posts⁴⁵ called the SMOB Client and a tool aggregating microblogging posts called SMOB Server. SMOB Client can be installed on a Web server and serve as personal status message

⁴⁵ Microblogging posts are short (mostly up to 140 characters long) messages broadcasted on the Social Web

publisher. Although the installation demands more knowledge from a user than the usual sign-on procedure on commercial tools, the user gains a greater independency and stays in control of his own data. Microblogging posts are published as files containing semantic descriptions, mostly relying on FOAF and SIOC vocabularies. Apart from local copies, user can choose to broadcast a microblogging post on various SMOB Servers (or other services capable of reading semantic descriptions). SMOB Servers collect RDF descriptions of microblogging posts and aggregate them in an RDF triple store. Together with these descriptions, SMOB service can collect FOAF descriptions of user profiles and other data in RDF.

As a distributed architecture that mimics the way information is shared on the Web, SMOB is a perfect ground for building a tool for status message directing using Sharing Spaces. In the following section, I describe the extensions that have been made to achieve this.

4.2.2 SMOB 2.0 – FUNCTIONALITIES OF THE EXTENDED VERSION

In order to demonstrate a part of the possibilities of the proposed solution, I extended SMOB to enable publishing of intended audience information in RDF on the publisher's side, as well as using that information for filtering status messages on the viewer's side.

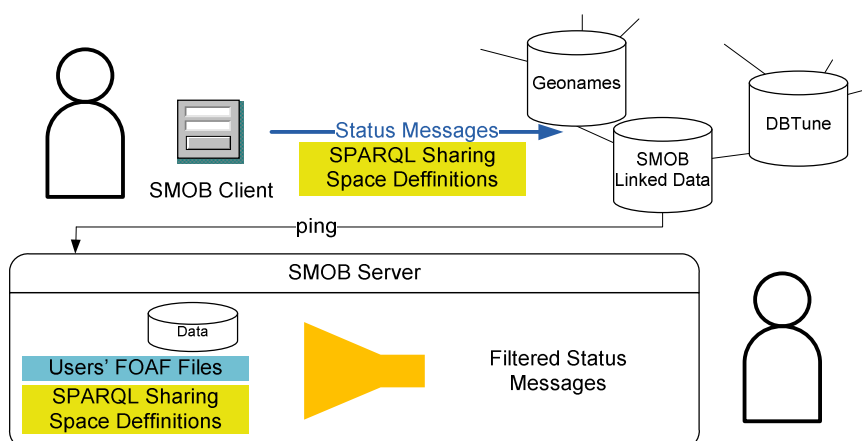


Figure 15 Publishing Status Messages using SMOB 2.0

Figure 15 illustrates a typical use scenario of SMOB 2.0 (I refer to the extended version of SMOB with the version suffix 2.0). The user first enters his status message in a Web form, responding to the typical question “What are you doing right now”. Along with the status message, the user has the option to disclose his current location by browsing for locations from the Geonames data store. If the user has a Last.fm⁴⁶ account, the SMOB 2.0 client will provide him with an option to associate his current music information to the status message and thus allow a more profound perception of his presence online. Finally, the user can choose the sharing space(s) to which he wants to dedicate the status message. Once he is done, SMOB 2.0 will create dereferencable URIs (in the Linked Data sense)⁴⁷ for the status message, online presence, sharing space and online account resources, and

⁴⁶ <http://last.fm> is a Social Music service that keeps track of users' recently played songs

⁴⁷ Web server is configured to return an RDF description of a resource when the URI of that resource is asked for over the HTTP protocol

make them available in RDF. URIs for current location and currently played music will be fetched from Geonames and DBTune⁴⁸ RDF stores and referenced in the published data.

SMOB The Linked Data Microblogging Client

What are you doing right now?

writing my master thesis

Your Location:

Place/Town

Listened to:

Share With:

based-in-Paris Interested-in-the-Web SemWeb knowsMe sorbonne + [New Sharing Space](#)

Announce On:

<http://www.milanstankovic.org/smob/server/>
 <http://microplanet.sioc-project.org/>

Figure 16 The SMOB 2.0 Client Interface

The created RDF descriptions are persisted in files with convenient URLs that favor easy dereferenciation of resource URIs.

In case the user needs to define a new sharing space, SMOB 2.0 provides a special interface for this (Figure 17), trying to hide as much as possible, the complexity of the underlying semantic technology. The user only has to choose the properties by which he wants to constrain the sharing space membership (for example, place of residence, workplace homepage, school homepage, relationship with the user, etc.) and SMOB 2.0 will create the needed SPARQL query (fetching the necessary URIs from external sources as well).

⁴⁸ <http://dbtune.org> is a data store containing vast amounts of music related data in RDF

Create a new Sharing Space

Sharing Space Name

Friends of (URI)

People Interested in (Wikipedia page)

People having account on (social website URL)

People based near(Geonames URI) ▼

People currently in(Geonames URI)

People having a [=select=] ▼ relationship with me

People working for (workplace homepage)

People going to (school homepage)

Figure 18 Interface for defining new Sharing Spaces

In case the user is experienced, he can edit the SPARQL query created by the system and customize it according to his needs. Figure 18 presents the SPARQL definition of a Sharing Space that the system has created from the user's input (shown on Figure 17). The user is able to change the query and save it for further use.

SPARQL Query

This is the generated SPARQL Query for creating the Sharing Space. Please do not change it if you don't know what you are doing.

```

PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX opo: <http://ggg.milanstankovic.org/opo/ns#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>

CONSTRUCT
{
  <http://milanstankovic.org/smob/publish/data/sharingspaces
/2009-08-06T10-07-24.rdf#SharingSpace> foaf:member ?person.
}
WHERE
{
  ?person foaf:basedNear <http://sws.geonames.org/5551752/>.
}

```

Figure 19 Form for editing SPARQL query created by the system

Once the status message is published along with SPARQL definitions of sharing spaces, the SMOB 2.0 client pings SMOB 2.0 servers it knows about, to inform them of the newly published data (end eventual new SPARQL sharing space definitions). It is important to note that SMOB 2.0 data publishers can be configured to ping, not just SMOB 2.0 aggregating servers but any service on the

Web that is capable of dealing with RDF data. It can also be configured to ping the general purpose Semantic Web indexing services like Ping the Semantic Web⁴⁹ and Sindice⁵⁰.

SMOB 2.0 aggregating servers are also capable of receiving pings from any other service and actually gathering any RDF data (not just status messages). SMOB 2.0 servers will further use the aggregated data (e.g., status messages, FOAF data about user properties and social graph, etc.) and SPARQL sharing space definitions to adapt the view of status messages to the current user showing only status messages where the user belongs to the intended audience. In particular, servers put all the RDF data they receive in a local RDF store, identify the members of sharing spaces by running SPARQL sharing space definitions over the data store, and finally query their RDF store for status messages that are intended for a sharing space that the current user belongs to.

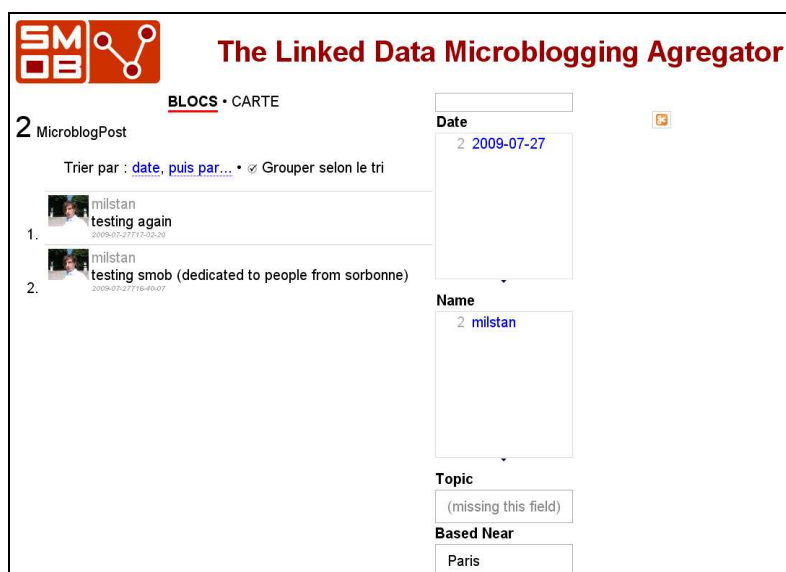


Figure 110 The interface of SMOB 2.0 Server

The user of the SMOB 2.0 server identifies himself by entering his FOAF URI, thus allowing the system to access his (FOAF-based) user profile available anywhere on the Web. By leveraging data from the user's profile, the system customizes the status message view in the way that was described earlier. Hopefully the user will be relieved from the abundance of status messages, and the status messages really intended for him might reach him more easily. All these improvements are aimed at enhancing the user's interaction with the Social Web.

4.2.3 FIRST IMPRESSIONS ABOUT SMOB 2.0

Several users have tried the first beta version of SMOB 2.0 in order to get the first impressions on the overhead that the introduction of sharing spaces might present in status message publishing. The first users mostly agree that selecting a sharing space for a status message is easy and convenient. However, they think that defining new Sharing Spaces can be a demanding task. This is

⁴⁹ <http://pingthesemanticweb.com/>

⁵⁰ <http://sindice.com/>

compensated by the fact that most Sharing Spaces, once created, are frequently reused. All these preliminary impressions are to be verified in the future work on a quantitative user evaluation.

Apart from user interaction issues, some technical issues emerged during development. SMOB 2.0 servers use local RDF stores to aggregate status messages, but also FOAF files and potentially other relevant data from Linked Data Cloud. Having to store them in local copies raises many issues: from time/storage efficiency, over accuracy due to change in data, to data ownership. In some practical cases it also slows down the system. Therefore, I believe that some way to query distributed datasets, like DARQ [37] - an engine for federated SPARQL queries, might lead to better performance and more up to date data. I intend to try out these approaches in the future.

It is also important to mention how SMOB servers deal with the possibility of data changes in the Linked Data world. Currently there is a simple solution to replace and retrieve the data about a user (her FOAF file) and replace the old data in the data store every time the user logs to the system. However, this solution imposes a lot of unnecessary work since the data does not change every time the user logs in. It is evident that some form of protocol for notifying data consumers about the change in data is critical for the efficiency of online presence related systems. Either a more general solution for pushing notifications of data changes on the Semantic Web (Gnip⁵¹, a general data pushing service, could be considered to be one possible solution), or some kind of specialized protocol for presence notifications like the one presented in [38] should be considered.

5 RELATED WORK

With the increasing awareness of the importance of online presence in information and communication technologies, several efforts emerged with the aim to create a useful model for representing online presence. In this section, I give an overview of those models and discuss the different perspectives that they undertake.

I also give an overview of related systems that try to solve the problem of dedicating status messages to a certain audience, as well as the systems that use the Semantic Web technologies in a way similar to the solution proposed in this Master thesis.

5.1 RELATED PRESENCE MODELS

In this section, I present related models for capturing the semantics of online presence. Out of four presented models, three are formal models and one (Ontology of Presence) is theoretical.

5.1.1 MENOW SCHEMA

MeNow Schema⁵², created by Christopher Schmidt, is a simple formal model for treating the phenomenon of Online Presence. The motivation for creating this schema was to be able to describe a variety of aspects of a person's current status, either online or offline, in a way that allows for seamless aggregation or retrieval of status data. This schema looks at statuses of people in terms of

⁵¹ <http://www.gnip.com/>

⁵² <http://crschmidt.net/foaf/menow/menow.rdf>

their activities, so the key feature is the possibility to describe different activities (like reading, listening, etc.). It is also interesting that the schema allows for declaring companions of a user at a certain point in time – people possibly involved in the same activities. This can be especially useful for the analysis of social proximity between people.

However, the MeNow Schema is relatively poor in capturing the semantics of status messages and states of availability – areas where the Online Presence Ontology can provide a richer support. For example, the fact that one status message is posted as a reply to someone else's status message, cannot be captured by the MeNow Schema. The same applies for various qualitative aspects of availability statuses in instant messaging (like Busy, Available, Idle, etc.).

5.1.2 XMPP

The Extensible Messaging and Presence Protocol (XMPP)⁵³ is a widely accepted protocol for the exchange of instant messages and buddy lists, used by many IM applications. An integral part of the protocol is a formal representation of status message and online status. While status message is represented as a string, to represent the online status one can choose between four predefined statuses (Chat, Away, Extended Away, and Do Not Disturb). The protocol is extensible so many extensions have been made to enable representation and sharing of other context elements, e.g., current location and user activities. Unfortunately, most of the extensions are unsupported by the majority of IM tools.

Since the protocol is primarily made for instant messaging, it does not take into account the scenarios of exchange of presence data in other social applications. It is therefore quite understandable that its underlying model does not support replies to custom messages, since such a practice is not common in IMs (it is more common for microblogging).

On the side of online statuses, the expressivity of the XMPP model is quite poor as well, not allowing to capture the differences of many heterogeneous status scales used by different IM applications.

5.1.3 IETF SIMPLE

Internet Engineering Task Force has created a number of specifications for Instant Messaging and Presence as a part of their work on Session Invocation protocol (SIP). This set of specifications is called SIMPLE⁵⁴.

These specifications provides a vocabulary for representing user activities, locations, moods, characteristics of a place, and many other context elements. However, it does not take advantage of the Semantic Web technologies and is therefore limited when it comes to uniquely identifying resources across various sources and integrating data about one user that may be scattered across the Web.

5.1.4 ONTOLOGY OF PRESENCE

⁵³ <http://xmpp.org/>

⁵⁴ <http://www.ietf.org/id/draft-ietf-simple-simple-05.txt>

In his book chapter, entitled “Presence in Social Networks” Scot Wilson published a theoretical model to capture the semantics of Presence in Social Networks [39]. As a difference from other available models, this model does not represent just the phenomenon of presence but takes into account the whole process of publishing of presence information. The model emphasizes the presence data publishing and consumption aspects, as well as the purpose of the presence data. It is also possible to specify what kind of cue about presence is explicated in the presence data exchange.

However, there is no information about the formal specification of this model and its richness in expressing the semantics of status message and online statuses.

5.2 OTHER SYSTEMS

In this section, I present different systems, some of them Semantic Web based, that could be used to direct online presence data to a certain audience.

5.2.1 *SOCIALLY AWARE POLICIES*

Similar to our use of SPARQL to define sharing spaces (i.e. intended audience groups), Alessandra Toninelli et al. [40] use RDF and SPARQL triple patterns to build social graph aware policies. Using triple patterns, different policies can be created to grant access to user’s attention (e.g., ring her phone). However, this work is more related to mobile devices as it strongly reflects the specifics of communication using a mobile device. In this sense it is complementary to my work in effort to make use of social data available in Linked Data sources to enhance user’s interaction with devices and make her communications more adapted to her current situation. Another point of difference is that socially-aware policy model is more concerned with granting/restricting access to a certain resource than dedicating/directing presence information to a certain audience.

5.2.2 *MYCAMPUS PROJECT*

MyCampus project was aimed at developing a Semantic Web based platform to support social interactions of students in university campuses [41]. Apart from other aspects of socialization, it deals with presence as well. When it comes to the problem of different audiences of different data, researchers from the MyCampus project proposed a mechanism for providing different granularity and different accuracy of contextual data to different audiences. For example, depending on the presence data consumer, the user’s location could be obfuscated or provided in a less precise form (e.g., like saying that the user is on the campus and not disclosing the exact building where she is). Although this approach is quite useful for user’s location and more structured data, in case of status messages it is difficult to apply it because of unstructured nature of status messages published as text.

5.2.3 *SEMANTIC EMAIL ADDRESSING*

Researchers from Stanford University have noticed the difficulties in keeping track of many e-mail addresses of our contacts, and have designed a system for directing e-mail messages to people who satisfy a certain criteria [42]. Their system allows a user to specify the characteristics of persons that should receive the message, and then uses various Semantic Web data sources (most notably

personal data described using FOAF) to select the actual recipients and find their e-mail addresses. Although the approach is similar in nature, there is no indication how the semantic descriptions of targets for e-mail messages are persisted/published and how can they be reused over different systems (as opposed to Sharing Spaces exposed using a standardized language).

5.2.4 SMESHER

Smesher⁵⁵ is a semantic microblogging application made by Benjamin Nowack. It uses Semantic Web vocabularies to enrich microblogging posts published by its users. Although built on top of semantic technologies, the application does not provide a convenient functionality to dedicate microblogging posts to their intended audience.

6 CONCLUSIONS AND PERSPECTIVES

By this Master thesis I wanted to underline the importance of presence perception in human communication, and to emphasize how equally important it must be on the Web as it is in real-life interactions. The Web has become a social thing to the great extent, thanks to the proliferation of different Social Web sites. Today's Web is closer to its original purpose – to connect people. In order to succeed in this mission, the Web must support some kind of presence detection and pathic communication that will make technology-aided interactions more realistic and more adapted to the user's current situation. As the evolution of the Web is headed towards the Semantic Web, a way to make online presence information a part of the Semantic Web is needed. Moreover, a way to make that information flow in the right directions through the space of interlinked semantic data is a necessity as well, in order to deal with the growing quantities of data and information overload.

In this thesis, I have presented an ontology – the Online Presence Ontology capable of representing many types of presence data on the Semantic Web and I have contrasted its design with various different models made for a similar purpose. The main contribution of this work is however a solution for directing presence information (most notably status messages) to its intended audience. This solution is based on Semantic Web technologies and is deeply grounded in the analysis of real life scenarios and user needs explored through a qualitative user study. It relies on semantic descriptions of users' presence information and their personal characteristics, combined with dynamic descriptions of audiences – groups of people that share certain characteristics. Those audiences, called Sharing Spaces make a key component of the approach for directing status messages. They are defined not by enumerating users who make the audience, but by defining the characteristics that members of one audience group have in common. In this way Sharing Spaces are dynamic, and capable of being changed whenever users change, and whenever their context changes. The possibility to react to those changes and become aware of them is grounded in Linked Data that helps integrate the data about users and their current context from various sources on the (mostly Social) Web.

In this thesis I relate this notion of Sharing Spaces mostly to a particular aspect of Online Presence, which is a status message, and I present a system that supports status message sharing with a

⁵⁵ <http://smasher.org>

particular audience (powered by SPARQL definitions of Sharing Spaces). This system, SMOB 2.0 shows only one way how Semantic Web definitions of intended audience could be used; but the potential of this technique is far greater than that. The concept of presence begins to take its rightful place in advanced interfaces, most notably in augmented reality – the effort to augment real life objects with additional information and features coming from the digital world. One interesting idea is Glowing Places⁵⁶ from Philips, a project that bring to life a sort of furniture capable of feeling the presence of people who sit on it. Another one is Aura [43] – a remote awareness system trying to build emotional presence detection over spatially distant people based on their sleep patterns. Once such projects are ready for taking their systems to a further level and make them cooperate with other systems and devices, they will face the i³ problem, and the Semantic Web technologies could come to rescue in a way similar to the one presented in this work.

Semantic models of presence and intended audience could even make advanced imagination mockups, like TAT Augmented ID⁵⁷, a reality. TAT Augmented ID is an augmented reality concept that pushes the possibilities of online presence data together with identity management to their limits. It offers a vision of the world where users can use augmented reality applications on their mobile phones to browse for social media content of a person in front of them. The mobile device should be capable of scanning the person's face and finding the presence information (activities, moods, etc.) on the Social Web. This information is shown on the mobile device screen as a form of augmented reality around a person. Even more, in this vision, the scanned person is able to choose which social media sources he likes to share in which situation, and the system can adapt the augmented reality view according to the characteristics of the observer and his eligibility to see certain information types. This scenario calls loudly to the application of Semantic Web representations of presence and intended audience of presence information, almost as if it was made to emphasize their need.

Semantic representations of presence could as well find their use in advanced technologies, like Reality Mining⁵⁸, based on sensors data that enable tracking humans and their interactions in order to derive their needs and habits, and improve the way they interact with systems. Presence derived from sensors data could also be represented using semantic representations like OPO, and be further used integrated with social media sources to provide a complete image of a user's state of presence and his current context. The final goal is to make the user's interactions with other people and devices more intuitive and appropriate to his current situation.

Nevertheless, the research challenges do not end there. Confidentiality and respect of user rights are domains where a lot still has to be done to enable the proper treatment of presence information. Once a certain level of interoperability and possibility to integrate presence data is achieved, legal issues will arise. There should be a way for users to restrict the flow and misuse of their semantically represented presence data. Making inference on presence data and gaining additional knowledge might not always be exactly what users want other people to do with their data. Semantic technologies should be able to answer to this issue as well.

⁵⁶ <http://www.we-make-money-not-art.com/archives/2005/03/glowing-places-1.php>

⁵⁷ <http://www.youtube.com/watch?v=tb0pMeg1UN0>

⁵⁸ http://www.technologyreview.com/read_article.aspx?ch=specialsections&sc=emerging08&id=20247

With the emergence of the real-time Web [44] as a form of interaction with the Web where information is delivered to the users at the time of content creation, and even pushed to them wherever they are; many challenges for the domain of Online Presence arise. As the presence data is frequently changing one can expect it to be an important driving force for the real-time Web, but this phenomenon will inevitably lead to more and more information being pushed to users frequently. The challenge for research is to find a way for presence data to flow over the real-time Web and still remain relevant and desired by users, never becoming obtrusive and annoying.

Temporal aspects of Semantic Web data are also an important issue when it comes to presence, as presence data is subject to constant changes. A lot of ideas exist already on the question how should one be able to identify which triples are true at which point of time [45]. Indeed this question is of great importance if Semantic Web tries to reflect the ever-changing nature of the world. One of the possible solutions – to include time in the formal model – is applied in OPO, but this is not enough, since the semantic data store does not have to contain complete information. Many research questions still remain. How can a system know that the presence data it possesses about a user is the most accurate and the most recent one? How can it know that somewhere on the World Wide Web, there is no other source with more recent data about a user?

How can a system use presence data to improve interaction without exposing too much of a user's privacy? How can it seamlessly integrate presence detection into everyday interfaces and make it part of everyday interaction?

The research of Online Presence in the future should give answers to all those questions, and many more that will come along the way of making the presence detection an integral part of our virtual lives.

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