Status Messages for the Right Audience with an Ontology-Based Approach

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***Abstract*— In this paper we explore the problems of dedicating status messages to their intended audience on the Web. We present the results of our qualitative user study aimed at revealing the nature of the problem. We then present the existing solutions for directing status messages to their audience and consider their weaknesses. Then, we discuss how Semantic Web technologies can be elegantly used to address the problem and what benefits can be driven from their use. Particularly, we rely on the Online Presence Ontology and a way to semantically describe the intended audience of a status message through the notion of Sharing Space – a group of people bound by a shared property (e.g., a common interest, membership in a certain organization, location, etc.). Apart from ontology extensions, we present a prototype that demonstrates the use of Semantic Web technologies in directing status messages to their intended audiences.**

Index Terms— Status Message Sharing, Intended Audience, Confidentiality, Semantic Web, Online Presence, Online Presence Ontology

I. INTRODUCTION

THE practice of sharing status messages in online communities exists for a long time. First traces of status message sharing might be found in Instant Messaging (IM) platforms where users published short messages along with their name in contact lists to indicate the nature of their availability, or just share something that was on their mind with other people in the IM community. The practice further expanded to Social Microblogging services, like Twitter, 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. Apart from being fun, according to many researchers, this kind of short messages has great importance for detecting presence. Don Norman, for example states that sometimes the possibility to perceive presence from the exchange of short messages is more important than the content that is exchanged [1]. In addition to emotional connecting, perceiving presence can have practical implications. If a user can get acquainted with the current situation of his online contact, he can better choose the moment when to contact him, and contextualize their conversation.

However, with the proliferation of status message sharing in various Social Web sites, some problems that might limit the potential of status messages to enhance presence detection are starting to emerge. Overload of status messages and the lack of appropriate mechanism to extract the most relevant ones for a particular user is one of them. This 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 them. 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.

In order to uncover the true nature of problems in the domain of status message sharing, especially those related to the audience of a status message, we conducted a user study (presented in Section 2) that allowed us to develop understanding of key problems, their origins and explore the space of possible solutions. In Section 3 we present the existing ways of dealing with directing a status message to its intended audience and we discuss their weaknesses. We further present our contribution, a Semantic Web based solution, strongly grounded in the study findings and detail it both from the theoretical and practical point of view. In Section 4 we review the related work and then conclude the paper.

II. THE USER STUDY

The first step of the study was to collect field data. Apart from researcher's observations and introspection based notes, we decided to conduct detailed 30-minute interviews with users in order to collect user stories and critical incident examples. We further analyzed the data 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. It is often used in social sciences and we find it very useful for developing understanding of phenomena on the Social Web. For more information about this methodology we refer the readers to the work of Glaser and Strauss [2].

Interviews were focused on critical incident type questions

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and getting users to provide real life examples of status publishing situations, the type of content published in the status message, and the intended audience whenever applicable. We also inquired about publishing habits including devices used, locations, situation, content types etc. The intended audience was discussed for each example and users were asked to identify the groups of people they are connected to on status sharing services.

Five male and five female users participated in the interviews. They have all been involved in status message sharing for at least six months at the time of the interviews, using either Twitter or Facebook[1] (or both). The subjects' age ranged from 22 to 35, which corresponds well to demography of users of the most active microblogging services, as documented in [3].

A. *Grounded Theory Analysis*

The analysis of interview data was done collaboratively by the researchers involved in the project in order to reduce the impact of subjectivity, inherent to qualitative methods. According to Grounded Theory methodology, data was 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 our findings two major phenomena influence the need for dedicating status messages to a certain audience: **the status messages that represent information noise** to certain users, and the **confidential nature of certain status messages**.

In many scenarios identified by participants of our user study, 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. Information noise mostly occurs as a result of: **gap of understanding** and **lack of significance**.

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** when understanding status messages requires deeper knowledge of the person's background. In other cases the gap of understanding results from **lack of competence** like in cases where users use status messages to ask for advice, or provoke professional discussions. This problem is also present in scenarios of automatic postings of status messages across services (e.g. automatic forwarding from Twitter to Facebook) where mostly different audiences are present on different services. Quite often personal friends from one service (Facebook in our case) don't understand and find irrelevant the profession-related status messages posted on another service (Twitter in our case). This phenomenon can be illustrated on a story of one of our study participants, Alice[2], 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 bear a **socially established meaning**, understood by a small community of people, like those containing internal jokes, or internal aliases and metaphors. This socially defined meaning can also lead to gaps of understanding with people outside of the social circle that defines the meaning. We often collected stories of misunderstandings around status messages, and inappropriate comments that result from misunderstanding.

Some status messages are just insignificant for some users. This lack of significance can be a result of the lack of **interest in the domain** that the status message is about. It is a common case 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 a similar way as the lack of competence issue that we presented previously. 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.

Finally, there is the issue of confidentiality that occurs when a user wants to explicitly restrict access to some groups of contacts for some types of status message or even only for a particular status message. 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 status messages should be kept private from some other (more professional) groups of contacts.

A more detailed overview of the user study is given in the paper [4] that is focused on the study and its implications for creating status message sharing systems.

III. Leveraging Status Messages with Semantics for Intended Audience

As pointed out by our user study, a need to direct a status message to a certain audience, and diffuse different status messages to different audiences is obvious. In this section we present some of the currently existing approaches for solving this problem, discuss their weaknesses and propose a hopefully more complete and flexible solution based on Semantic Web technologies.

A. *Existing Approaches*

Users try to deal with the problem of dedicating a status

[1] http://www.facebook.com

[2] Names of participants are changed in order to protect their anonymity

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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 the groups that should be allowed to see status messages. This approach is incomplete as it actually limits certain persons from seeing all the status message updates of a user. The approach does not take into account the fact that different status messages from the same user might have different audiences; it rather allows to block a group of persons from receiving all the status messages of a user. 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 E"[3] 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 SN – the one she uses to connect only with her personal friends. Several solutions for niche microblogging and microbroadcasting exist (like Shoutem[4] and Static[5]) to allow status message publishing in closed 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 fatigue, 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, and user is, in this case, left with little opportunity to post something in a status message. The user is actually focused only at posting status messages meant for general public, which inhibits their full participation in status message sharing on the Social Web.

B. *The Semantic Web Solution*

The existing approaches either bound a user to a specific Social Network or social service in general, require her to explicitly group her contacts or otherwise limit the possibilities to dedicate a status message to a specific group of contacts. In pursuit of a solution that would overcome those problems, we turn to Semantic Web technologies believing that they can provide a flexible enough, Web wide solution for dedicating a status message to its intended audience. In designing our solution we will inspire from the user study results and the unveiled problem nature. Furthermore, we will favor more general solutions that could address dedicating other presence-related information to its audience as well (like, for example, showing different availability to different groups of contacts).

1) *Online Presence Ontology Extension*

Our approach consists in extending the Online Presence Ontology (OPO)[6] to provide a way to associate intended audience semantics to a status message. The Online Presence Ontology presented in [5] 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.

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 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 [6] 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.

In order to provide a way to dedicate a status message to a certain audience we introduced the concept of a `SharingSpace` into the new version of the ontology[7]. A sharing space will represent 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, we decided to bind our new notion of `SharingSpace` directly to the concept of `OnlinePresence` from the OPO ontology using the property `intendedFor` (see Fig. 1).

A sharing space represents a group of people bound by a shared property. 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 we have attached a number of properties to the `SharingSpace` concept. They allow to represent a place where people are based, or are

[3] http://www.mynameise.com/
[4] http://www.shoutem.com/
[5] http://www.static.com/

[6] http://www.milanstankovic.org/opo/specs/
[7] For information about other properties and classes relevant to Sharing Spaces, please see the Ontology specification

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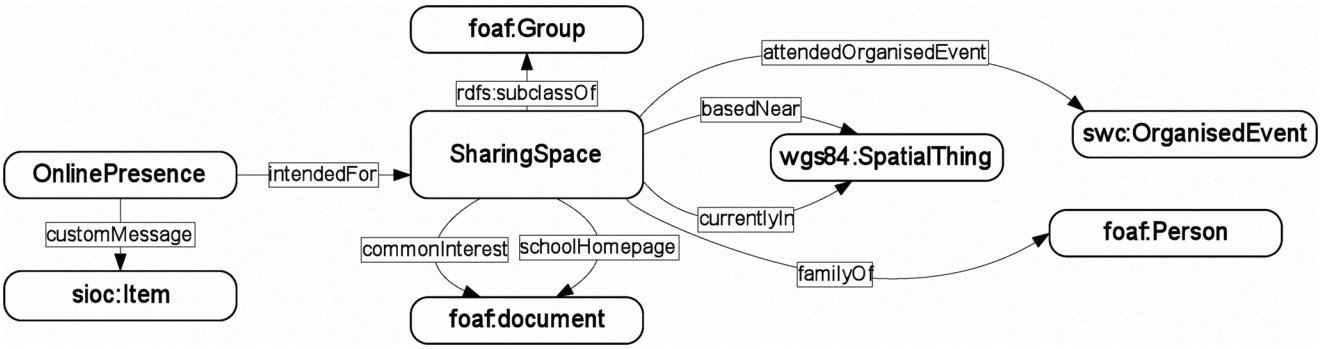

Fig. 1. An excerpt from the Online Presence Ontology

currently present through the concept of `SpatialThing` from WGS84 Ontology[8]; this allows to rely on the huge geographical database of Geonames[9]. 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 (we use the FOAF[10] ontology to refer to persons and documents). It is also possible to point to events that members of a Sharing Space attended together (we rely on Semantic Web Conference Ontology[11] 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. Ontologies for the Social Web like FOAF, Relationship vocabulary[12], and OPO are already used around the web to describe some of those data, expose them in RDF[13] and make them part of already existing interlinked data on the Web (usually referred to as Linked Data[14]). In our definitions of sharing spaces we will heavily rely on the data about users, already made available on the Web using those ontologies.

Once a status message is connected (through `opo:intendedFor` property) to its intended audience (embodied in a sharing space) we need a way to specify who the members of the sharing space are. As shown in our user study, there are many different properties that 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 we have chosen to use SPARQL[15] queries to collect information about persons satisfying a certain property across the Web, and declare them to be members of the corresponding sharing space. This declaration is achieved using the `member` relation from the FOAF vocabulary.

The Fig. 2 gives an example of a Sharing Space definition created using a SPARQL query. This query can collect the actual Sharing Space members information 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 Geonames 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://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/> .
}
```

Fig. 2. Example SPARQL definition of a Sharing Space

Apart from specifying Sharing Space members using SPARQL we believe that the emerging Rule Interchange Format[16] (RIF) will, once it gets better support in tools, be a useful way to define and exchange Sharing Space definition rules across different systems that may use different rule languages internally. Fig. 3 shows how the Sharing Space from previous example would look like in RIF.

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. Application of the SPARQL queries that define the sharing spaces at the time of serving the status messages to a consumer 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, applying the SPARQL queries will identify exactly those people that satisfy the query constraints at the given time. The need for this dynamic sharing space membership was obvious in the case in our example where

[8] World Geodetic System ontology http://www.w3.org/2003/01/geo/
[9] http://www.geonames.org/ is a service providing semantic descriptions of geographical locations
[10] Friend-of-a-Friend vocabulary specification http://xmlns.com/foaf/spec/
[11] http://data.semanticweb.org/ns/swc/swc_2009-05-09.html
[12] http://vocab.org/relationship/.html
[13] Resource Description Framework http://www.w3.org/RDF/
[14] http://www.w3.org/DesignIssues/LinkedData.html
[15] http://www.w3.org/TR/rdf-sparql-query/
[16] http://www.w3.org/TR/rif-core/

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```
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/>]
  )
 )
)
```

Fig. 3. Sharing Space in Object-Oriented Representation in RIF Core presentation syntax

current location was defining whether a user was or was not in the 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 of the irrelevant status messages and reducing information overload on the Social Web, our ontology-based intended audience specifications 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 [7]. 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) [8] a phenomenon that some researchers call "object-centric sociality"[17]. Thus commenting on someone's blog can, in a certain way, increase the user's closeness with the blog author. Similarly, we argue that being frequently in intended audience of somebody's status message makes one closer, in a way, to the author of the message, and therefore having semantic descriptions of intended audiences can facilitate the calculation of closeness measures based on this criterion.

2) A Prototype – SMOB 2.0

In order to demonstrate a part of the possibilities of our solution we extended the Semantic Microblogging Platform – SMOB[18], described in [9] to enable publishing of intended audience information in RDF on the publisher's side and the use it to filter status messages on the viewer's side.

Fig. 4 illustrates a typical use scenario of SMOB 2.0 (we 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 user has the option to disclose his current location by browsing for locations from the Geonames data store. If the user has a Last.fm[19] 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 spaces 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) for the status message, online presence, sharing space and online account resources and make them available in RDF. URIs for current location and currently played music will be fetched from Geonames and DBTune[20] RDF stores and referenced in the published data.

In case the user needs to define a new sharing space, SMOB 2.0 provides a special interface for this, 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).

Once the status message is published along with SPARQL definitions of sharing spaces, the SMOB 2.0 client will ping SMOB 2.0 servers it knows about, to inform them of the newly published data (and 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

[17] http://www.zengestrom.com/blog/2005/04/why_some_social.html
[18] http://smob.sioc-project.org/

[19] http://last.fm is a Social Music service that keeps track of users' recently played songs
[20] http://dbtune.org is a data store containing vast amounts of music related data in RDF

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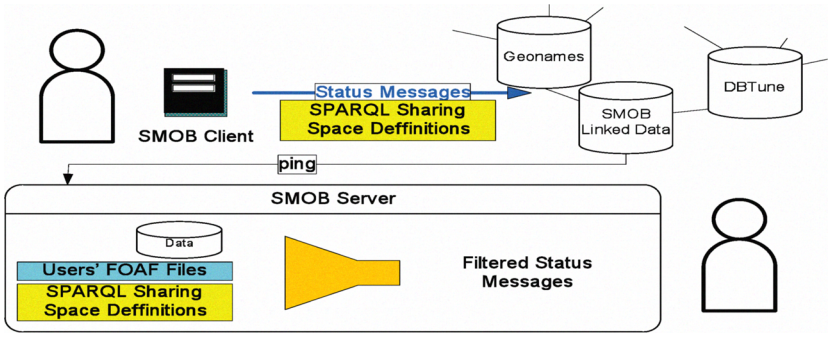

Fig. 4. Publishing Status Messages using SMOB 2.0

Semantic Web[21] and Sindice[22].

SMOB 2.0 aggregating servers are also capable to receive pings from any other service and actually gather any RDF data (not just status messages). SMOB 2.0 servers will further use aggregated data (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 currently observing user (whose properties are declared in her FOAF file) showing only status messages where the currently observing 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.

Hopefully the observing user will be relieved from the abundance of status messages, and the status messages really intended for her might reach her more easily. All those improvements are aimed at enhancing her interaction with the Social Web.

C. *First Impressions about SMOB 2.0*

We have let several users try the first prototype in order to get first impressions on the overhead that choosing sharing spaces might present in status message publishing. Our first users mostly agree that checking a sharing space to direct a status message is easy and convenient. However they think that defining new Sharing Spaces can be a demanding task. This is compensated by the fact most Sharing Spaces, once created, get reused frequently. 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 we believe that some way to query distributed datasets, like DARQ [10] - an engine for federated SPARQL queries, might lead to better performance and more up to date data. We intend to try out those ways in the future.

[21] http://pingthesemanticweb.com/
[22] http://sindice.com/

IV. Related Work

Similar to our use of SPARQL to define sharing spaces i.e. intended audience groups, Alessandra Toninelli et al. [11] use RDF and SPARQL triple patterns to build socially-aware policies. Using triple patterns, policies can be created to grant access to user's attention (e.g., ring her phone). Policies are called "socially-aware" because they rely on user's social graph that can be accessed through Linked Data sources on the Web. However this work is more related to mobile devices as it strongly reflects the specifics of communication using a mobile device, and in this sense it is complementary to our 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. As another difference, socially-aware policy model is more concerned at granting/restricting access than directing presence information to a certain audience.

The MyCampus project [12] is another related work. Researchers from this project propose a way to deliver different granularity and different accuracy of contextual data to different audiences (mostly in university campus). Although this approach is quite useful for user's location and more structured data, in our case it is difficult to apply it because of the unstructured nature of status messages published as text.

V. Conclusions and Future Work

In this paper we presented the user study about status messages and the need to direct them to a certain audience. The study revealed that problems like information noise in status messages and confidential nature of status messages are the main driving forces of this need, and explored the origins of the problem of status message directing.

After exploring existing solutions for dedicating status messages to their intended audiences, we analyzed their weaknesses and proposed a Semantic Web solution to overcome them. More precisely we relied on ontologies to provide a universal vocabulary for expressing status message and intended audience semantics on the Web, and enable different services to exchange that semantics and reuse it. Our solution is based on extending the Online Presence Ontology to enable declarations of intended audience through the notion of a Sharing Space – a group of people bound by a shared property (e.g., shared interest, workplace, school, location, etc.). The members of such sharing spaces can be defined

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dynamically (by specifying a value of their shared property) using SPARQL queries. This way is especially convenient for the Social Web, since it allows collecting sharing space members across different social data sources that expose their data as Linked Data. This solution can be applied all across the Web, regardless of the system that users use to publish and retrieve status messages. What is also special is that our solution is strongly inspired by the findings from the user study and the unveiled nature of the problem. Therefore our model design is driven by the needs of real life scenarios, rather than purely theoretical conceptualizations.

In our future work we will further explore how the notion of sharing space can be applied to other aspects of online presence (e.g., availability information, current activities, etc.) to better reflect faceted nature of presence in online communities. We will also investigate how enabling faceted presence (different appearances for different audiences) using semantic technologies influences the interaction with the Social Web.

Although our approach allows to dedicate a status message to its audience it is not sufficient to enforce the confidential exchange of status messages. Therefore, in our future work we will consider various social access control mechanisms to complement Sharing Space definitions. One direction could be to extend SMOB 2.0 to enforce privacy (in case of confidential status messages), by relying on a lightweight FOAF + SSL protocol [13] for authentication allowing not only to identify the user but also to retrieve her social graph across the Linked Data sources. We will also investigate if the OAuth[23] protocol can be applied for the secure exchange of confidential messages and sharing space definitions across status message publishing systems, by implementing it into our prototype.

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