MOSS: Mobile Social Spaces

Anna V. Zhdanova[1], Marcin Davies[1], Oliver Jorns[1], Vera Stavroulaki[2], Panagiotis Demestichas[2], Marta Gonzalez[3], Klaus Moessner[4], Francois Carrez[4], Hariharan Rajasekaran[5] and Luigi Lo Iacono[5]

[1] ftw. Telecommunications Research Center Vienna, Austria
<zhdanova, davies, jorns@ftw.at>
[2] University of Piraeus Research Center (UPRC), Greece <veras, pdemest@unipi.gr>
[3] Robotiker-Tecnalia, Spain <marta@robotiker.es>
[4] University of Surrey, UK <k.moessner, f.carrez@surrey.ac.uk>
[5] NEC Laboratories Europe, Germany <rajasekaran, lo_iacono@it.neclab.eu>

Abstract. We present an emerging approach of Mobile Social Spaces (MOSS) that intends to improve the ways in which people communicate in the modern world. Pervasive content and service creation and provisioning, in particular for dynamically changing social groups, is a complex task and subject to varying locations of individuals, of the complete group and its context. MOSS tries to remove some of the obstacles in this area and defines a range of functionalities that will support dynamic ubiquitous creation and instantiation of community content and services.

1 Introduction

With the introduction of smartphones, advances in mobile and sensor technologies, ubiquitous computing as it was envisioned by Mark Weiser [7] gets closer to realization. In tandem with the Internet and the Web, it enables a kaleidoscopic view on information reflecting the anywhere-anytime paradigm which influences not only communication but also the way people are working and socializing. Today's cheap wireless access facilitates production, provisioning and usage of more complex and powerful mobile services and enables implementation of complex interaction patterns. Chips and RFID technologies become ubiquitously spread, allowing devices to communicate with each other with minimum human involvement. Humans, in their turn, have more time to focus on what is more important for them, i.e., managing their social spaces instead of software on their mobile devices.

In this paper we present the requirements and design for an infrastructure called Mobile Social Spaces (MOSS) which aims to enhance the user experience when communicating in highly dynamic social spaces. More specifically, MOSS targets integration of various mobile and social network services, simplification of configuring and sharing social information in a mobile space, efficient utilisation of the available network infrastructure, dynamic personalisation of services, anytime, anywhere, through any mobile device, and is thus envisaged to significantly increase the satisfaction of a user. One important prerequisite is that the components of a user's mobile social space are self-managed and configure themselves not only in a

reactive but also proactive manner, taking into account various different aspects such as the users' preferences, communities, policies, the current context the user is situated in, and also the device and network capabilities that inherently influence the communication capabilities. The realization of such self-management capabilities calls for mechanisms for modelling, accessing, learning and updating user and context information in a transparent manner.

The proposed approach for such realization is the subject of this paper, which is structured as follows. Section 2 delivers two exemplifying scenarios for typical MOSS infrastructure usage, and the main derived requirements to the MOSS infrastructure are listed in Section 3. In Section 4, an overview and technical approach towards creation of MOSS infrastructure are provided. The main areas targeted by MOSS and the related progress beyond the state of the art are described in Section 5. Existing related work is outlined in Section 6. Finally, the potential exploitation and evaluation principles of the approach are discussed in Section 7.

2 Sample scenes and use cases

In this section we describe possible scenarios highlighting features of service provisioning in mobile social spaces when various factors (such as the user profile, context and policies) are taken into account in a dynamic fashion. The aim is to present a vision of how the MOSS system could operate and provides a starting point for the derivation of technical requirements for the MOSS services/functionalities.

2.1 Busy working mum

Patricia is mother of three children and she is working at the office and at home. She has to organize all the supplies acquisition, appointments and immediate actions for the wellbeing of the whole family. Patricia uses her mobile phone to set up a service to draw up the list for the ”supplies” (e.g. food) and ”suppliers” (shops she usually goes to) as new necessities arise at home (e.g. no sugar at home), she uses another service to manage the different appointments she has (labor and personal), another for periodic events (e.g., children's private classes) and the last one for immediate actions. People in Patricia's social space, e.g. her husband, her mother, a sister and her domestic help, share some of the services according to different policies indicated by Patricia. Also these people can in turn share their own services with her. Triggering an immediate action implies that a person goes to a certain place. The service created to manage immediate actions will choose the person that belongs to Patricia's social space and that is nearest to the destination place. That person receives a notification indicating the task to be carried out (e.g., to pick some clothes up at a concrete dry-cleaner's establishment, to buy a product at a particular shop). This person can refuse the task; then the service will again select the most appropriate person to fulfill the task until the task is performed or postponed by Patricia.

In two days, Patricia has to make a business travel and therefore wants to organize the home. So during her absence all the supplies have been bought and the different menus scheduled. As she shares the periodic events service with her husband, in her absence, he will take care of children to attend private classes. The service for supplies purchase is shared by her domestic help, as medical appointments service is

shared by Patricia's mother. For her peace of mind, she can monitor and re-schedule all the activity at home while she is traveling. The different services will notice the appropriate people according to Patricia's scheduling or she can delegate that responsibility to her husband.

During her business trip, Patricia has to share her social space with partners of the project consortium, because she is attending a Consortium Plenary Meeting, but the services will be different (presentations interchange, flights scheduling, etc.).

2.2 Living and working in Greece

Ann is a Key Account Manager at a large beer producing company. The clients she deals with are mainly managers of hotels or big restaurant chains. Part of her work is to organize promotion events such as parties at various client premises. With the help of MOSS, Ann builds a professional social network. All she has to do is to provide her business profile and the initial criteria that people should meet to fit to her professional interests. Every time a new subscriber fits these criteria, and if policies allow it, MOSS automatically adds her/him to a suggested members list. If and when Ann wants to, she can check the information on new suggested members and accept or decline a new member.

Ann has an appointment with the manager of a large hotel which is located at the coast of Athens. She is organizing a beach party to promote the latest beer brand at the hotel's new beach bar. After the meeting, Ann steps into her car to drive to the next client. On the way she uses a voice-dictation service in her mobile device to update her professional calendar with the details of her event. A notification message with the details of the event is send to all the subscribed members of Ann's professional network. Between her last two appointments for the day, Ann has some spare time. MOSS has information regarding the time and location of these two appointments. Based on the available traffic information, calculations indicate that there is not enough time to drive back to the office in between. MOSS also detects that one of Ann's favorite cafe is on the route from the location of the first meeting to the second. Since Ann is driving, MOSS plays an audio message asking her whether she would like to try to arrange a meeting with one of her friends for a quick coffee. Ann agrees. MOSS retrieves information that indicates that Alice's friend Ellie will be near the cafe at a suitable time. Ann dictates a message that is send to Ellie. Ellie agrees and they meet at the cafe. Ann arrives at the location of her final meeting for the day.

3 MOSS technical requirements

In order to be able to successfully meet the technical requirements, stemming from the sample use cases presented in the previous, MOSS should facilitate the creation of a mobile social network infrastructure that includes the following innovative aspects:

- Acquiring and managing information on user profiles, preferences, behaviour and constraints, as well as data related to the capabilities of the current user device. This includes collecting user feedback so as to appropriately update.
- Gathering and maintaining updated user context as he/she changes the localization and activity.

- Acquiring and managing location and presence data as well as this information sharing with the members of the networks a certain user belongs to, taking into account specific privacy constraints defined by the user.
- Defining and imposing privacy policies indicated by user: what to share with whom.
- Ability to create services, in an easy and friendly way, to be shared with the rest of the members of a user's networks.
- Access to sensors data or other data sources for services functionality, e.g. RFID for goods at shops, airport services for flights scheduling, etc.
- Reasoning capabilities for rendering personalised content and services to users, such as tasks scheduling inside a user's networks.
- Knowledge management functionality so as to create and exploit experience related to user preferences and requirements, as well as contextual situations.
- Searching mobile social spaces content and forming mobile social spaces based on user preferences and goals.
- User Rating of MOSS services so as to obtain feedback from the user side and refine aspects of service provisioning if necessary.

4 Overview of Mobile Social Spaces

The infrastructure for MOSS comprises a solution enabling end users to be accompanied and to take benefit from their social knowledge-based spaces, adapting to their location, policies, available devices, services and modalities. Core parts of such spaces include different localization technologies, policy management, dynamicity and interoperability. Furthermore, this altogether overcomes existing search and access barriers.

In Figure 1, the generic MOSS infrastructure is shown. In order to dynamically create and publish community services, issues like business models, location and context as well as user-obtained or generated content need to be provided to the knowledge base. There, a range of functions such as policy based inference, semantic search engines, etc. are used to predict user behaviour and to generate customised services for a particular community. Basic mechanisms for achieving this goal include community driven ontology management, reasoning and the linking of the service data/content to protocols and data formats that are understood by the devices used to interface with the actual user.

MOSS enables user generated community services facilitating "mobile social spaces". The four main concepts within the MOSS architecture are "create", "publish", "interoperate" and "access". Many of the mechanisms to instantiate these concepts are available but are restricted to applications in fixed spaces – MOSS exploits these mechanisms by adapting them, where possible, or extending them (where necessary) to support mobile social spaces.

- "create": create content on the go enriched or driven by sensor / context information, decide the rules to share this content, decide what the users' "mobile social space" consists of;
- "access": ubiquitous access not only to the user's social space and its related available content, but also access/retrieve context information relating to the user;

- "publish": rule and context based publishing of content/knowledge, using tags and underlying community-evolved ontologies;
- "interoperate": Community-driven ontology building, matching, management, recommendations, social networking as techniques maximizing the discovery process and guaranteeing the appropriate result.

Figure 2 goes further and provides an architectural view of MOSS highlighting the main building blocks, which are distributed between the users' terminals and a knowledge warehouse in the network supporting ontologies, a knowledge base (excluding the user's knowledge/content), community building, and management.

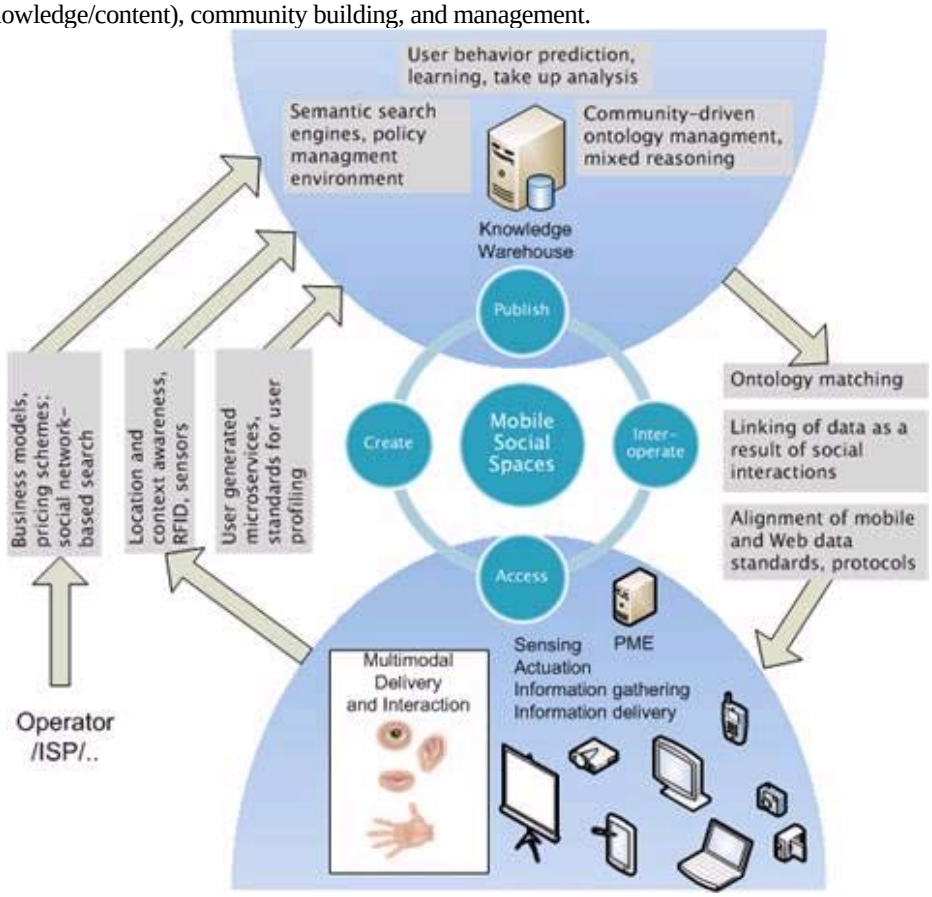

Fig. 1. MOSS Infrastructure

The user terminal requires only few functions like profile/preferences, user rules and policies that dictate the way Mobile Social Space should be built, taking into account people met or surrounding the user as she moves. Context information that is gathered by the user's terminal/devices sensors enrich the whole set of information used during the building of the social space. In addition, two very important blocks, namely publishing/discovery and content management, are responsible for the handling of content/knowledge at the user side. It is worth noting that no piece of user's content or knowledge is stored or handled at the central server. Only tools (counterpart of the

publishing/discovery blocks) for discovering and accessing this knowledge are provided in there. The knowledge warehouse (KWH) is the central place where users' policies and rules are applied, taking into account context information like people presence and profiles, events, places, etc. While the social space is clearly created and proposed to the user at the KWH side, it is nevertheless rendered and managed at the user terminal side. All aspects relating to ontology management are handled at the KWH side as well.

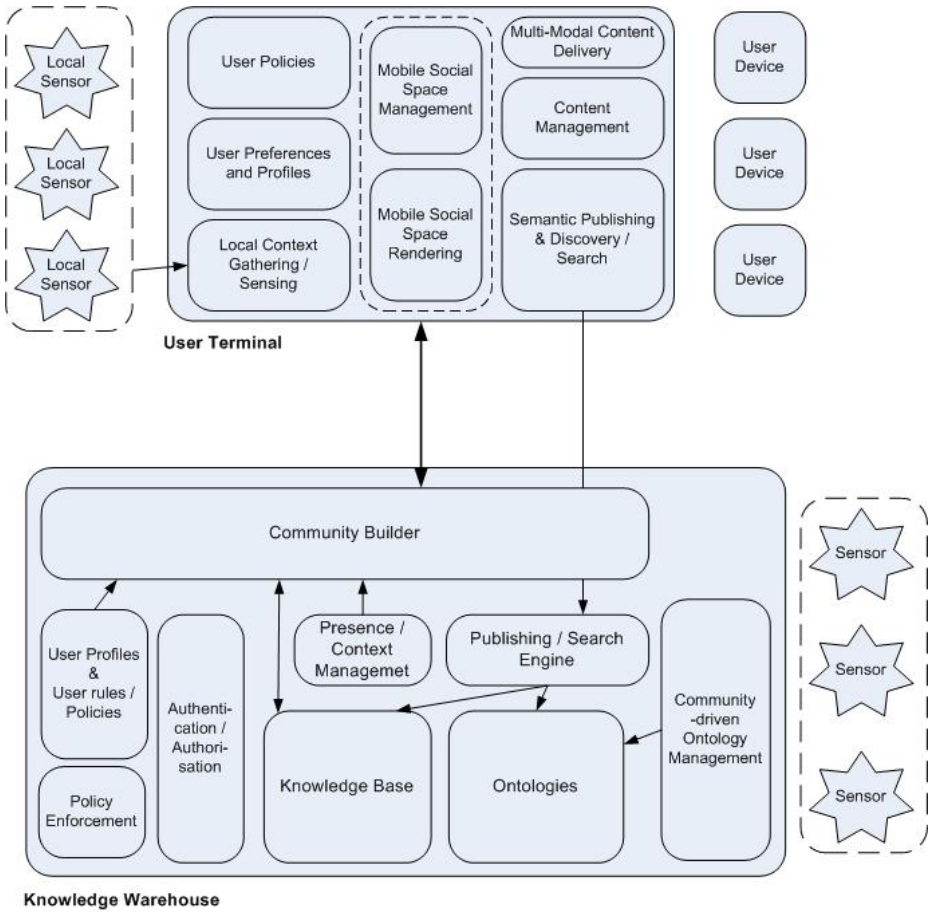

Fig. 2. MOSS Architecture

5 Main areas and progress beyond the state-of-the-art

In this section we conceptualize main research and development areas of MOSS and accordingly indicate the plausible progress beyond the state-of-the-art.

5.1 Location-based social services

The notion of Location-Based Services (LBS) is in fact difficult to capture and there are various definitions such as the one proposed by Junglas et al. [4]: “Location-Based Services are services that take into account the geographic location of a user”. In contrast to that very brief definition Adusei et al. [1] are more specific: “Location Based Services are business and customer services that give users a set of services starting from the geographic location of the client”. Both definitions are valid, but it is not that easy as it seems to be at first glance. As Küpper [5] alludes there is no common definition or terminology for the term “Location-Based Service”. Confusingly, the term itself is often used interchangeably with Location-Aware Service, Location-Related Service or Location Service.

However, it is obvious that location is – amongst others such as time – perhaps the most important context information. From this follows another possible explanation of LBS that subsumes all services where information about the location of the user is needed [4] and as such represents the combined use of wireless communication, location determination, geo-information systems and mobile devices for creation of services such as traffic information, shopping services and location-based gaming. Most mobile services and traditional LBS services do not take into account the users social context and the social network, forgetting that the mobile phone is a social tool that can be used to connect people with each other [2]. LBS must take the next step and avoid being solely based on a pair of geographical coordinates. Users position is indicative of an activity, intention, or goal, but it can be further refined by using the rest of context information about the user, especially their social network: “Are my friends near here?”, “Are all these people also attending the event?”, “Can anyone around inform me about traffic conditions?”. By integrating localization with context, MOSS allows LBS to achieve a higher level of intelligence as it is perceived by users.

Location-Based Social Services (LBSS) enrich traditional LBS by adding the interaction inside a personal and social context. In LBS users act rather passively, mostly as consumers and mobile terminals as download-only devices whereas LBSS are user-centric, that is, the user is contributing to the community, being cared for by the community. No matter if reactive or proactive LBS functions are used, with LBSS the users are in the role of content creators and providers from a mobile device [6].

The traditional business model of LBS is based on a closed model where only the network operator provides services to its subscribers. During the last years it turned out that this model does not meet the expectations, nor does it cope with the requirements of new emerging technologies and the subsequent implications. With LBSS, which is fundamentally user-centric, it is possible to integrate location as a kind of user-generated content. This can be published and integrated with any other information or content. Thus, next generation LBS complement with the Web 2.0 paradigm and allow MOSS to move towards an open model, where the operator acts as an open link between the subscriber and third-party content providers, expanding the range of services users have access to.

5.2 Semantic, pervasive, user-oriented policies

The concept of social networks is currently booming on the internet with applications such as Facebook, MySpace, Orkut, etc. Such applications and platforms are currently attracting millions of users. In addition to these social networking applications, professional networking sites such as LinkedIn and Xing provide a platform for professionals to publish and share professional information to help in industry networking. However, most of the current social networking applications on the internet are currently "static", in the sense that content and user details are updated by the user only when they explicitly visit these applications either through their mobile device or PC. In contrast, mobile social networks are more "dynamic" as they have access to more information about the user such as location, surrounding environment, context, etc. that can be continuously updated. Therefore it is imperative that access to and especially dissemination of such information is granted only to authorized contacts to ensure that the privacy of the user is still preserved. In MOSS privacy issues will be operated via user-generated, machine-processable and sharable policies. The effectiveness of methods for pre-selection, search and sharing of mobile content and components, their advertisement and personalized delivery will be evaluated by user tests. Aspects of service controlling and personalization should be achieved in an unobtrusive manner as required in the scope of pervasive systems.

Policy-based and fine-grained access control. With such a vast amount of information about a user presently online, privacy is a huge concern followed by the need to sort through this information overload and find content that is relevant for a particular user. MOSS addresses the privacy issue by developing a content access framework that deals with fine-grained access control to content controlled by user specified policies. Today's web-based social networks feature access control models that are too coarse and not suited for very fine-grained access control to a user's content. Some of the options available today are:

- Private / Public model – Photo sharing sites such as Flickr use such a model for controlling access to user's pictures. Private pictures can be viewed by "invited" friends while "public" tagged pictures can be viewed by all.
- "Friends" model – Most social networking sites use this model where it is possible to restrict content to users who are classified as friends. Though this makes the access control enforcement easier, it is not entirely efficient from a privacy point of view, since the "degree of intimacy" varies among friends. Some social applications offer the choice of creating sub-groups among friends, but even this is not enough to apply fine-grained access control on user's content.

Some of the methods currently investigated in the research community to implement such access control solutions include ReBAC (Relationship Based Access Control) [8], where a user's relationship with another user determines the access to content, social attestations from social networks confirming a user's relationship to another user, and social access control lists [9].

MOSS will investigate existing methods and adapt them to the mobile social networking context with enhancements to enable fine grained access control to user's content. In MOSS privacy issues will be operated via user-generated, machine-processable and sharable policies. Effectiveness of methods for pre-selection, search

and sharing of mobile content and components, their advertisement and personalized delivery will be evaluated by user tests.

Reasoning with Policies. The type of reasoning solution operated on user-generated policies in MOSS will manage situations not typically considered in the reasoning field so far, but still representative for communications in various ubiquitous settings where communities may be found: appearing and disappearing people and resources in the vicinity, limited availability, strong context dependency and social/communication context.

Usability Mechanisms for Security. Even the most comprehensive security infrastructure will fail if users of the system are not provided with effective tools to configure and test their security settings. The need for such tools is highly desirable in social networks where the majority of the users are young adults who are unaware of the privacy implications that might arise out of faulty access control policies set by themselves. The options available in current social networks are coarse grained options that hardly fit the privacy needs of a highly mobile social space. MOSS' policy management environment (PME) [3] addresses this problem by providing an easy to use tool for end users to compose, manage and enforce machine readable and fine grained access control policies.

5.3 Management of location and presence information

Another goal is to implement a concept for policy-based sharing of location and presence information between end users. Users are able to define the ways the location and presence information is shared with the others and to retrieve information about other users employing the presence and location service in conjunction with other context-aware systems. In particular, such a system may locate the user's buddy-list contacts on an interactive map. Social software and social networking websites providing users' location and presence information have gained high usage over the last several years. Spread of applications like Google Maps and Virtual Earth increasingly facilitate awareness about the surrounding objects, streets and directions. As an increasing number of users have mobile devices, mobility aspects become more relevant. Policies on sharing user data are also gaining more importance as the data becomes to appear in structured or semantic formats that are easy to process and combine. Therefore MOSS aims to integrate aspects of semantic policies, location and presence services, mobility and visualization.

6 Selected related work

MOSS is to advance the developments of the following projects' efforts as well as typical state-of-the-art commercial initiatives:

- eSense (http://www.ist-esense.org): this project provides an extensive study on different types of sensors, in particular, delivering detailed characteristics of the information that can be collected with state-of-the-art sensor technology. However, the domain has not been modeled semantically (i.e., with an ontology or via semantic services) which makes reuse of the project interfaces very difficult.
- m:Ciudad (www.mciudad-fp7.org): the goal of this ongoing project is to enable users to create micro services using mobile devices. One of the outcomes of the

project is an ontology for defining such mobile micro-services. In MOSS, this ontology work is to be adapted together with the semantic policy technology to enable the users to make and employ micro-services at their social spaces.

- SPICE (http://www.ist-spice.org): introduces a service platform for the next generation mobile services. One part of the platform provides the mobile ontology [10] which is a higher-level comprehensive ontology designed for the mobile communications domain. Furthermore, it is a machine readable schema intended for sharing knowledge and exchanging information both across people and across services/applications in mobile ubiquitous environments. However, the ontology framework would be applicable to MOSS when accompanied by a management environment and thus being subject to an easy update on the fly as well as to plugging-in new mobile sub-ontologies arising from the changing context.
- Commercial mobile services for social networking (such as Dodgeball, Loopt, Kaliloc, Jaiku, Aka-Aki) comprise functionality addressing specific user's needs for sharing information (e.g., photos, activities, locations) in mobile settings. Services are not interconnected, and no common knowledge-based infrastructure to develop, deploy and use such services in a unified manner is available. Knowledge management facilities for such services are at the moment highly restricted: information processed and transferred by them is typically created by the users for each individual service from scratch and is not reusable in different contexts and applications.

7 Potential exploitation and evaluation

Any company which has to do with communication within distributed (groups of) people and accessing and managing data coming from heterogeneous platforms/sources can be a potential MOSS user. Furthermore, the presented infrastructure is of interest for advertisement enterprises who can employ MOSS social characteristics to deliver products and services directly to communities and via "word-of-mouth" marketing supported by modern technology. Examples of direct industrial end users include companies producing robots, intelligent TV and radio, web-based systems supporting communication of people who want to extend to the mobile world, physical ubiquitous environment (e.g., for fitness centers, ski resorts, nightclubs, lecture rooms, hospitals), providers who want their users to have enhanced social experience, collaborative work environment producers addressing needs of nomadic working groups, environments for finding experts/specialists/objects, and integrators of existing social networking or communities data.

The evaluation of the MOSS success is deemed as primarily user-oriented, in particular, decreased costs for the mobile social services and increase in quality of experience (overall user satisfaction, larger choice, easiness of usage, etc.). For the industries, acquisition and maintenance of permanent customer user communities as well as new more competitive and facilitating infrastructures and models of service provisioning will be the adding value aspects.

Acknowledgments. The Telecommunications Research Center Vienna (ftw.) is supported by the Austrian Government and the City of Vienna within the competence center program COMET.

References

1. K. Adusei, I. K. Kaymakya and F. Erbas. ”Location-based services: Advances and challenges”, In CCECE 2004, CCGEI 2004. IEEE, May 2004.
2. S. Consolvo, I. Smith, T. Matthews, A. LaMarca, J. Tabert, P. Powledge. ”Location Disclosure to Social Relations: Why, When, & What people want to share”, In Proc. of the SIGCHI Conference on Human Factors in Computing Systems, ACM Press, New York, 8190, 2005.
3. J. Zeiss, R. Gabner, A.V. Zhdanova, S. Bessler, 2008. ”A Semantic Policy Management Environment For End-Users”, In Proceedings of International Conference on Semantic Systems (I-SEMANTICS’08), Graz, Austria, September 3-5, 2008.
4. I.A. Junglas and C. Spitzmüller. ”A research model for studying privacy concerns pertaining to location-based services”. In Proceedings of the 38th Hawaii International Conference on System Sciences, HICSS 05, 2005.
5. A. Küpper. ”Location-based Services Fundamentals and Operation”, John Wiley and Sons, 2005.
6. A. Küpper and G. Treu. ”Next Generation Location-based Services - Merging Positioning and Web 2.0.”, John Wiley & Sons, March 2008.
7. M. Weiser. ”The computer for the twenty-first century”, Scientific American, pp. 94-100, September 1991.
8. C. E. Gates, “Access Control Requirements for Web 2.0 Security and Privacy”, Proc. of Workshop on Web 2.0 Security & Privacy (W2SP 2007), Oakland, California, May 2007.
9. K. K. Gollu, S. Saroiu, A. Wolman, “A Social Networking-Based Access Control Scheme for Personal Content”, Proc. 21st ACM Symposium on Operating Systems Principles (SOSP '07), Stevenson, Washington, October 2007.
10. C. Villalonga, M. Strohbach, N. Snoeck, M. Sutterer, M. Belaunde, E. Kovacs, A.V., Zhdanova, L.W. Goix, O. Droegehorn, O. ”Mobile Ontology: Towards a Standardized Semantic Model for the Mobile Domain”. In Proc. of the 1st International Workshop on Telecom Service Oriented Architectures (TSOA 2007) at the 5th International Conference on Service-Oriented Computing, 17 September 2007, Vienna, Austria.