



Utilizing the IP Multimedia Subsystem to create an extensible service-oriented architecture

Ahmed Hasswa*, Hossam Hassanein¹

Telecommunications Research Lab, School of Computing, Queen's University, Kingston, Ontario, K7L 3N6 Canada

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ABSTRACT

Smart Spaces provide very promising means of creating context-aware environments. Unfortunately, a lack of information about users within Smart Spaces limits their usefulness. We propose a novel solution that involves integrating Smart Spaces with social networks through the IP Multimedia Subsystem. To create truly context-aware and adaptive spaces. By utilizing the wealth of user information present within social networks, smarter and more adaptive spaces can be created. We therefore propose the design and implementation of “SocioSpace” a Smart Spaces framework that utilizes the social context. We design and implement all components of SocioSpace, including the central server, the location management system, social network interfacing components, service delivery server and user agents. We then run various scenarios to test the reliability of the system. The results show the effectiveness of our framework in successfully creating Smart Spaces that can truly utilize social networks to deliver adaptive services that enhance the users' experiences and make the environment more beneficial to them.

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1. Introduction

There has been a huge interest in social networks; Facebook [1], for example, has been the second most-visited website in many countries [2,3] right behind Google.com. Social networks contain a wealth of information about users' interests, preferences, education, careers, hobbies, and so on that can build spaces that are more knowledgeable and smarter. By exploiting the fact that most users carry a mobile device wherever they go, and by utilizing the reliable wireless infrastructure and the wealth of information available through social networking, we believe that we can design a truly ubiquitous, intelligent and adaptive environment that can significantly enhance the user's experience [4].

Although many contemporary research projects [5–8] worldwide focus on the collection and dissemination of context information in various applications, it is always assumed that context sources can be easily found, or are stored in a centralized database dedicated to that context-aware system. In reality, users are very reluctant to enter their personal preferences into applications with which they may not be familiar. This may simply be due to their busy schedules, to their lack of understanding

of the benefits of such a context-aware environment, or to their privacy concerns. Consequently, many systems are unable to collect enough context information to provide a realistically practical and adaptive environment for the users. Additionally, due to their non-generic designs, most existing context-aware solutions cannot support non-specific user profiles; consequently, they cannot offer a genuinely autonomous environment. To overcome these constraints, we utilize social network profiles to retrieve relevant user interests and preferences. Most, if not all, social networks provide modules and Application Programming Interfaces (APIs) that allow developers to extract information from a user's profile with his or her permission [9]. The extracted information can then be used by Service Delivery Components within Smart Spaces. The different features can be integrated together via the IP Multimedia Subsystem (IMS). There are several features in IMS that make it an excellent candidate for Transport and Control Layer (TCL) management. Our objective is to create a smart adaptive wireless environment. This environment retrieves social information from social networks about users within its coverage area. It then uses the aggregate of this information to provide services within the domains of the environments that cater to the preferences and interests of these users. The services we shall use to test the system include an adaptive room that changes to meet its occupant's preferences, targeted advertising in the real world, a background music player and other peer-to-peer services. We coined the term SocioSpace for our system due to the utilization of social networks for creating smart spaces.

* Corresponding author.

E-mail addresses: hasswa@cs.queensu.ca (A. Hasswa), hossam@cs.queensu.ca (H. Hassanein).

¹ H. Hassanein is also a visiting professor at King Saud University, Saudi Arabia.

1.1. Organization

The remainder of this paper is organized as follows: [Section 2](#) explains the benefits of using IMS for integration of the different SocioSpace components. In [Section 3](#), an extensible platform is designed. [Section 4](#) describes the SocioSpace architecture. A detailed discussion of the main components of the architecture is included, as well as a discussion of data transfer amongst the different components. [Section 5](#) describes the performance evaluation methods and scenarios tested. Finally, [Section 6](#) presents some concluding remarks.

2. Utilizing the IP Multimedia Subsystem

IMS is used to integrate the different components of SocioSpace, and to manage sessions and services. In this section, we give a quick overview of IMS. We then explain the benefits of using IMS for integration of SocioSpace components.

IMS was developed by the Third Generation Partnership Project (3GPP). It provides a framework that accommodates current and future services in wired and wireless networks. It encompasses mobile, fixed, packet-switching, and traditional circuit-switching communication systems. IMS integrates services such as video, voice and messaging with personal mobility, presence and terminal mobility. It also relies heavily on the Session Initiation Protocol (SIP) to manage and control sessions. SIP is an Internet Engineering Task Force (IETF) standard application layer protocol, which is used for initiating and managing an interactive user multimedia session. SIP can setup, modify or terminate data, video conferencing or Internet telephony sessions.

There are several features of IMS that make it an excellent candidate for the transport and control layers of SocioSpace. IMS provides a central database, the Home Subscriber Server (HSS), which makes it possible for all services to access the information in an easy and standardized way. This allows service providers to offer a coherent set of targeted services to users, regardless of their networking interfaces. It also aids in creating an extensible service-oriented architecture that is independent of other variables such as mobile devices, social networks and locations. Consequently, service providers are able to develop and release services more regularly by using the conventions, modules and libraries provided by IMS.

IMS Application Servers can be openly programmed to create web services that provide access to information stored in the database, such as user and space information. IMS Application Servers can also be used to facilitate connections to social network APIs and retrieval of relevant social network information. The integration of social networks with Smart Spaces and mobile devices through IMS allows the creation of truly smart adaptive environments. These environments consist of ubiquitous applications that utilize the information they have about the entities within the space, including user preferences, physical locations and presence, to deliver more relevant and beneficial services. By making use of these, the users receive new and personalized services such as follow-me services, pervasive mobile games, peer-to-peer capabilities, targeted services, rich multimedia services and more. This context-aware and highly dynamic environment adapts to the changing needs of the user, thus increasing the user's overall level of satisfaction.

3. Design of an extensible IMS platform

In this section we design a fully extensible service-oriented delivery platform that uses the IP Multimedia Subsystem to create personalized adaptive spaces. We identify and define the key

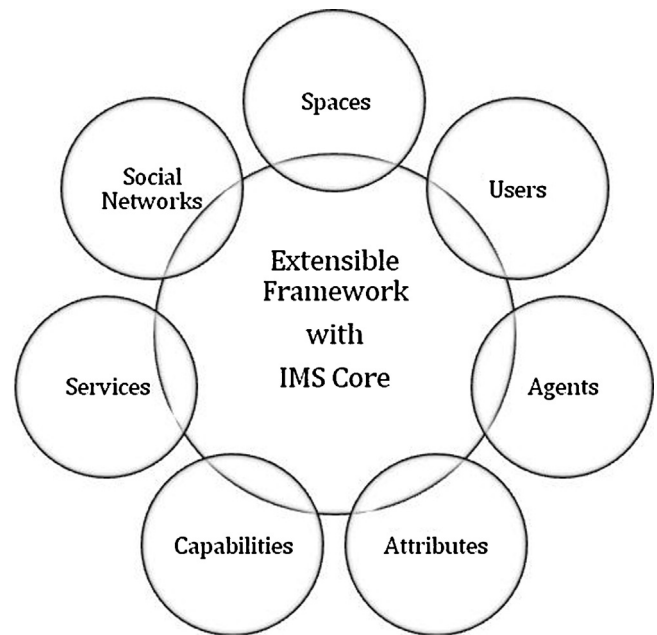


Fig. 1. Core platform components.

entities needed to form the core of SocioSpace. The relationships between different entities are then defined and the methods for making the system scalable and extensible are explored.

3.1. Platform concept

IMS has become an industry standard and has been adopted by many telecom and service providers. IMS, however, does not provide all the services, features and capabilities that are required to create a pervasive service delivery platform. Nonetheless, IMS can provide a solid core for such a platform. Using IMS Application Servers, building blocks can be added on top of the basic IMS system to create a pervasive computing environment. In this section, we propose a conceptual platform and introduce the major building blocks that go on top of IMS. We show how these components fit together and interact with IMS to create device, network, social network and service independence.

Fig. 1 shows the main components involved. Spaces are the environments created by the system. Context-Aware services are delivered within the spaces. Users within a space receive targeted services that are meaningful to them. Social contexts consisting of multiple attributes, and are used to provide the services with its “brains”; and social networks are the sources of these social contexts. Agents are mobile devices carried by users, and they are used to let the system know when users are within a space. Agents also allow interaction between users and a space. Every agent has different capabilities and some services are delivered based on the capabilities of these agents.

3.2. Core platform components

In this section we define the following platform entities: spaces, users, attributes (social contexts), social networks, agents, capabilities and services. These entities form the core of SocioSpace's functionality and operate on top of IMS. We drill down into the details and identify the different properties of each entity. We also provide detailed descriptions of the behaviour and functionality of each entity.

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