Bridging the gap for Next Generation Services: Presence Services on Legacy Devices

Thamsanqa Moyo, Mamello Thinyane, Madeleine Wright, Barry Irwin, Peter Clayton, Alfredo Terzoli
Department of Computer Science
Rhodes University, Grahamstown, South Africa
Tel: 046 6038291 Fax: 046 6361915
g02m1612@campus.ru.ac.za, g00t1153@campus.ru.ac.za, m.wright@ru.ac.za, b.irwin@ru.ac.za, p.clayton@ru.ac.za, a.terzoli@ru.ac.za

***Abstract*— Next generation services are provided by applications that leverage packet-based domains. A challenge faced by such services is the support for multiple devices, including legacy devices. Our paper examines a strategy for the provision of next generation services on legacy cellular network devices. We advocate that the provision of next generation services via applications on the SIM card allows for the deployment of such services on legacy devices. We demonstrate this assertion through a proof of concept application, SIMPre, that resides on a SIM card. SIMPre implements a presence service by leveraging Java Card, the SIM Application Toolkit and the OMA IMPS standard. We show that it is possible to provide a next generation service on the SIM card such that it ubiquitously integrates with the functionality of a legacy device. We conclude through this demonstration that the SIM card is a viable option for providing backward compatibility to legacy devices in the implementation of next generation services.**

***Index Terms*— Next Generation Services, Next Generation Mobile Networks, SIM Card, Java Card, Presence, Service Platform Delivery**

I. INTRODUCTION

Next generation services (NGSs) are provided by applications that leverage packet-based domains on a next generation network [1]. One of the features of NGSs as highlighted by Lui et al [1] is endpoint transparency. Endpoint transparency allows a service to be deployed without adaptation for the terminal that a user employs to access the service, for example a cellular phone. Therefore the challenge is to develop next generation services whose application logic is independent of the technology employed at the terminal that delivers the service to the user.

The Next Generation Mobile Networks (NGMN) Project [2] recommends that legacy[1] mobile devices be supported by NGMNs up to the point that enough NGMN compliant devices exist to viably discontinue legacy services. Therefore an opportunity exists to develop NGSs such that they can be accessed by users with legacy devices during the migration period from legacy devices to NGMN compliant devices. However, legacy devices may not have the technological capabilities needed to consume NGSs.

Our paper motivates utilising the Subscriber Identity Module (SIM) [3] card as a platform on which to provide NGSs on legacy mobile stations. A mobile station is any device that connects to a mobile operator's network and comprises of both a SIM card and mobile equipment, more commonly known as a mobile handset [3], [4], [5].

The NGMN Project recommends that a SIM card should be used on NGMN compatible devices [2]. Since the SIM card is considered to be an independent part of the mobile station, we suggest that SIM applications allow for endpoint transparency in the provision of NGSs as the SIM card may be deployed on both legacy and NGMN compatible mobile stations [2], [4].

We qualify this assertion through a Java Card [6] SIM application, SIMPre, that provides presence services to mobile stations. Our application shows that it is possible to provide such a NGS through an application wholly contained on the SIM card. Our contribution is in demonstrating that NGSs may be provided to legacy mobile terminals via the SIM card.

A. *Scope of the study*

Our paper demonstrates the SIM card as a client side platform on which devices can access next generation services. Therefore, our discussion is limited to the client side aspects of next generation service provision. Non-client side components, such as servers, are mentioned only when they aid the discussion of the client side aspects.

The rest of our paper is organised as follows: Section II gives the background to the SIM card as a platform and available presence protocols; Section III outlines our design of a SIM application providing a presence service; Section IV overviews an implementation of our design in the form of the SIMPre application; Section V provides a brief discussion on the provision of NGSs on SIM cards; we conclude the paper in Section VI.

II. BACKGROUND TO THE STUDY

This section gives some background to using the SIM card as a platform on which to deliver applications and on available presence protocols. We begin by discussing the SIM card.

This work was undertaken in the Distributed Multimedia Centre of Excellence at Rhodes University, with financial support from Telkom SA, Business Connexion, Comverse, Verso Technologies, Tellabs, StorTech, THRIP and the Andrew Mellon Foundation.

[1] In this paper, current 2G and 3G mobile handsets are referred to as legacy devices.

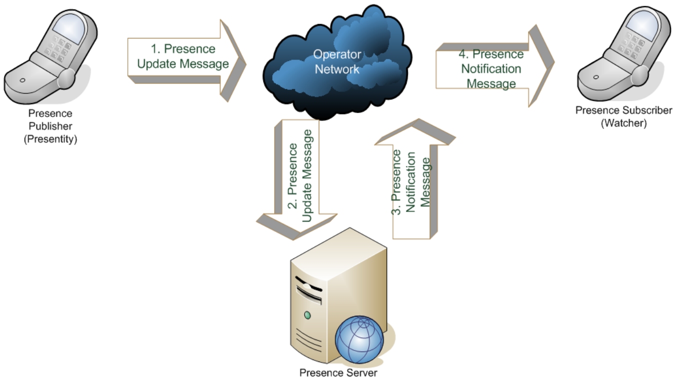

Fig. 1. The publish-and-subscribe interactions of the IETF presence model[11] applied to a mobile network scenario

A. The Subscriber Identity Module

A SIM card is deployed on a Global System for Mobile (GSM) communication network [3] and its equivalent on Universal Mobile Telecommunication System networks is the Universal Subscriber Identity Module (USIM) [4]. In this paper we refer to both types of card as SIM cards as the difference between the two cards does not make a difference to our study.

A SIM card's primary purpose on a mobile network is security, that is, the secure storage of sensitive mobile operator data, authentication and encryption [3]. In addition to security provision, a SIM card may host applications and the SIM Application Toolkit (SIM Toolkit) defines an interface for such applications to access the mobile equipment's functionality, such as the display screen [7]. The Java Card platform also allows for applications to run on a SIM card .

The Java Card platform is an implementation of a virtual machine residing on a SIM card and it provides a limited set of the functionality typically found on the Java Standard Edition platform [8]. The GSM 03.19 standard [9] specifies a Java API that extends the Java Card API to provide Java Card applets the functionality offered by the SIM Toolkit interface and access to the internal components of the SIM card, such as the SIM card file system [10]. Therefore the API specified in the GSM 03.19 standard [9] provides the necessary functionality to develop a ubiquitous Java Card application that can access all the functionality of both the SIM card and the mobile equipment. For this reason we found this API to be best suited to the development of a presence service that runs on the SIM card. The background of presence protocols is overviewed next.

B. Presence Protocols

Presence is a communication enabling technology that allows the sharing of availability information between networked entities that are interested in communicating with each other [12]. An example of presence is information describing whether a mobile station is on or off [13]. Therefore presence services are an important feature of NGSs as they will drive the usage of other NGSs.

Common presence protocols listed in [12] include: the OMA Instant Messaging and Presence Service [14]; the Session Initiation Protocol for Instant Messaging and Presence Leveraging Extensions (SIMPLE) by the Internet Engineering Task Force (IETF) [15]; and the Extensible Messaging and Presence Protocol (XMPP) by the Jabber Software Foundation [16]. The 3rd Generation Partnership Project (3GPP) also specifies presence protocol details for a presence service running on a mobile IP Multimedia Subsystem [17].

All these protocols adhere, to some degree, to the presence model defined by the IETF in RFC 2778 [11]. This model, illustrated in Figure 1, is based on publish-and-subscribe interactions. This entails one user of the presence service publishing presence information and another subscribing to that information. Since this model is the common factor amongst all the common presence protocols, we select this model as the basis on which we discuss presence services in the remainder of this paper.

The actors specified in RFC 2778 [11] and relevant to the remainder of this paper are:

Presentity: This is the entity that presence information refers to, for example, a user who sets their presence status to "Busy".

Watcher: This entity receives presence information from a presentity.

Server: This entity manages the presence information as it travels from a presentity to a watcher.

The goal of our study is to demonstrate that a presence service, utilising any one of the protocols mentioned in this section, can be provided on a SIM card. We aim to demonstrate that a presentity can utilise a SIM application to publish presence information and a watcher can utilise a SIM application to receive presence information. Therefore a design is needed that will provide a generic framework to guide developers in producing such a SIM application. The framework is generic such that any one of the protocols mentioned in this section can be implemented by using it.

The design of our presence service providing application is detailed next.

III. System Design

In this section we provide the design of a SIM application that can be used by both a presentity and watcher . Since our design focuses on the SIM applications it is discussed from the perspective of a presentity and watcher. The server entity will only be mentioned where it is necessary to explain the interactions of the SIM application design components. Therefore, server design issues such as watcher access control are not addressed as our design focuses on the SIM application design.

The goals that this design meets are as follows:

1) The design should be generic such that it can be used to implement a presence protocol based on the IETF presence model [11].
2) The design should meet the NGS goal of endpoint transparency, that is, the logic of the service and that of the endpoint must be independent.

The important components of our design are shown in Figure 2. Our design is split into three loosely coupled components

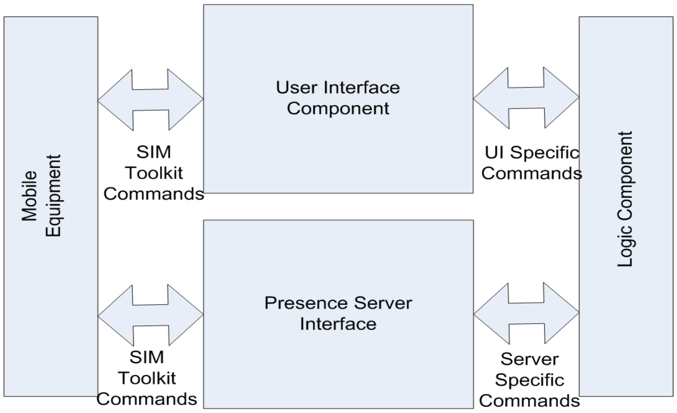

Fig. 2. Design View of System Components

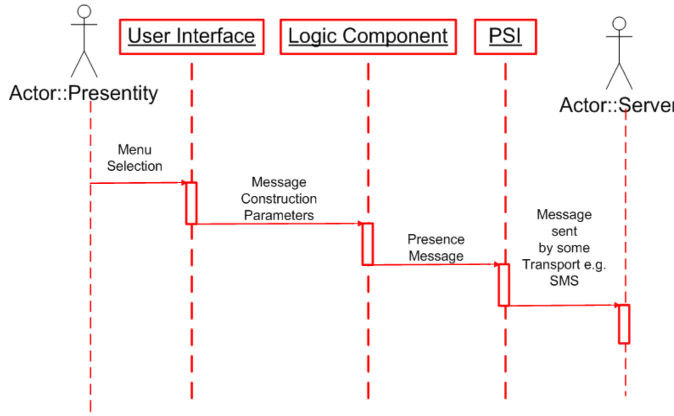

Fig. 3. Sequence diagram showing a presentity updating their presence information

on the SIM card: the User Interface (UI) component; the Logic component ;and the Presence Server Interface component (PSI). The mobile equipment component is external to the SIM card and is included to illustrate the interactions the mobile equipment will have with components on the SIM card. The rest of this section is dedicated to an overview of the whole design and a description of how the three SIM components interact in providing a solution from both the presentity and watcher perspective.

A. Overall Design

The UI component is responsible for providing the mechanisms for interaction that a user will have with the SIM client, for example, displaying presence information on a watcher's mobile equipment screen or allowing a presentity to update its presence information. The PSI component is responsible for implementing the transport mechanisms to send and receive messages between the server and the client. The Logic component is responsible for implementing the application logic required for the presence service.

The UI and PSI components may be platform dependent as their functionality may depend on the type of SIM card, mobile equipment capabilities and network infrastructure. For example, the number of characters that the UI component will be able to display will depend on the number of characters that the screen on the mobile equipment will support. The Logic component must be developed in a platform independent manner. It must be possible to deploy the Logic component across multiple cards working with a heterogeneous collection of mobile equipment regardless of the details of the network infrastructure.

The advantages of structuring our design in this manner are that:

1) Our first goal of a generic design is met as all the application logic required by a specific presence protocol may be provided for in the Logic component.
2) The second goal of endpoint transparency is achieved as the Logic component is separated out from the components that directly interface with the mobile equipment and the SIM card internal structures. This allows the presence service to be deployed across various SIM cards and consequently mobile equipment, without the need for rewriting the core logic of the service. Therefore a NGS developer may develop the Logic component in an endpoint agnostic manner.

The two presence entities that this design is most relevant to are presentities and watchers. We discuss the role that these components play from the perspective of both a presentity and a watcher.

B. Presentity interactions

A presentity's primary role is to provide its presence information for watchers to view [11]. Figure 3 show the interactions between the SIM components when a presentity publishes its presence information to the presence server. In this subsection we outline the roles that each of the SIM components play within this scenario .

The UI component is responsible for providing the means by which a presentity may enter their presence information. Since the mobile equipment is the means of communication that a presentity has with the SIM card, the UI component must utilise mobile equipment capabilities via some interface such as the SIM Toolkit interface. Once the input is received the UI component must send the appropriate parameters to the Logic component to enable the construction of the relevant presence information update commands. An example of the such parameters is the text that a presentity may enter when updating its free flow text presence information.

The Logic component on receipt of message construction parameters from the UI component must create a presence update message based on the parameters received. For example, on the receipt of parameters indicating that a presentity has changed its presence status from "Available" to "Not Available", the Logic component must construct a message that will relay this change to the server. This message must be formatted by the Logic component according the presence protocol implemented by the service in order for the server to process the message. The message constructed by the Logic component is sent to the PSI component.

The PSI component works with lower level protocols that will transport the message to the server. An example of such

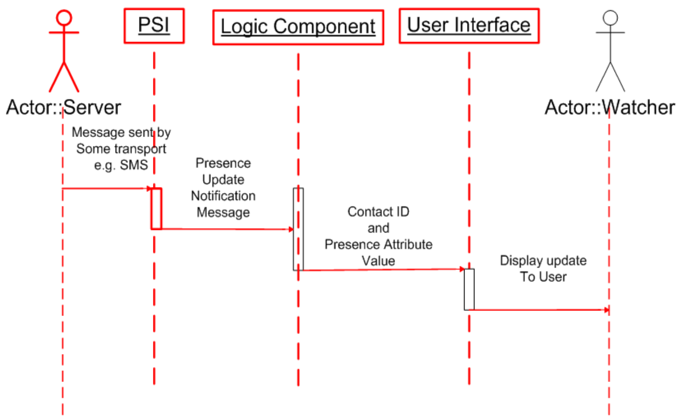

Fig. 4. Sequence diagram showing a presence information update interaction

a lower level protocol existing on current networks is SMS. This component will format this message using the lower level protocol and send it across the appropriate network channel.

Once the server receives this message it will be relayed to the appropriate watchers. The interactions of the SIM components from the perspective of the watcher is given next.

C. Watcher Interactions

A watcher's role is to consume the presence information of a presentity. Figure 4 show the interactions between the SIM components when presence update information has been received from the server. Each component's activities in these interactions are outlined next.

When a presence message arrives at the mobile station of a watcher, it is received by the PSI component. This component is responsible for understanding the lower level protocol in which incoming presence message is formatted. It must extract the presence service information from the incoming message and pass it the Logic component. The PSI component does not need to understand the presence service information, but it must know where the presence service information resides within the incoming message format.

When the Logic component receives the presence service information from the PSI, it will be in the format specified by the presence protocol implemented. The Logic component must process this information and act on the instructions contained within. The scenario in Figure 4 depicts the receipt of a message notifying the watcher's SIM application that a presentity has changed its presence. Therefore the Logic component must identify the presentity and the new of presence information related to that presentity . The Logic component will then send these values to the UI components.

Finally the UI components will receive the new presence information and the identity of the presentity for whom that information is applicable. The UI components will use either the internal structure of the SIM card or the mobile equipment to display this update for the watcher. For example, the UI component may manipulate the standard files on the SIM card such that the new presence information displays in the SIM phone book entry for the relevant presentity.

The next section introduces our SIM application, SIMPre, that is implemented from this generic design.

IV. Implementation

SIMPre is a SIM application developed from the design mentioned in the previous section. The decisions taken during the implementation of the design are detailed in this section. We provide details of the implementation of each of the SIM components shown in Figure 2 and a description implementation decisions made for the entire system. We start by highlighting the overall system implementation.

A. System Implementation Description

The design in Section III may be implemented across multiple cards utilising multiple presence protocols. SIMPre leverages the OMA IMPS standard [14] as a presence protocol and the Gemplus Xpresso card [18] as the host SIM card.

The OMA IMPS Enabler Release 1.2 [14] provides a design architecture for implementing presence services on mobile devices[19]. Although the specification of a concrete presence implementation is beyond the scope of IMPS, it provides generic design guidelines for building a solution that will run on top of various lower level mobile transports such as SMS, IP over 2.5G/3G and Mobile IP. We select IMPS as our favoured implementation protocol because it supports multiple mobile transport protocols allowing us to deploy it on legacy devices that may not have packet data capabilities.

The 128 kilobyte Gemplus Xpresso card is selected as our card of choice for hosting the SIMPre application as it the most widely supported card in the Gemplus family [18]. The Xpresso card supports the Java Card platform and the Java API specified in the 03.19 standard [9]. This makes it possible to develop an application that can utilise the SIM Toolkit interface.

SIMPre is comprised of an applet and a library written in the Java language for the Java Card platform. The applet houses the UI and PSI components and utilises the SIM Toolkit interface [9] to provide these components access to mobile equipment functionality. The library containing the Logic component implements the application logic required by the IMPS presence protocol.

The following section details each of the SIM card components shown in Figure 2 with reference to their implementation in either the applet or the library.

B. Presence Server Interface Implementation

The PSI component, implemented in the applet, sends and receives messages to and from the server with the network channels that the mobile equipment supports. Therefore we utilise the SIM Toolkit interface provided by the 03.19 Java API [9] to access these network channels.

SIMPre currently supports messaging utilising SMS because packet data support on the Xpresso SIM card is unavailable. SMS messages are received from the server using the SIM Data Download facility [20] which allows the SMS message to pass straight through the mobile equipment to the SIM card. This allows SIMPre to communicate with the server without distracting the user from the normal usage of the mobile station.

Fig. 5. A menu that allows a presentity to change its presence status

Fig. 6. Phone book entries integrated with presence information

The PSI component communicates with the Logic component via an interface defined by the library. The implementation of the Logic component is detailed next.

C. Logic Component Implementation

The Logic component is implemented as a Java Card library providing the necessary logic to process messages specified by the OMA IMPS specification [14]. The messages may be encoded either as text, typically for use with SMS, [21] or as XML [22]. We favour text encoding as this allows us to send messages with any mobile transport mechanism, whereas it is not desirable to send XML encoded messages with SMS.

The goal of endpoint transparency is achieved through this library as it contains no functionality dependant on the hosting SIM card or mobile equipment. This keeps the application logic required to run the IMPS presence service separate from the terminal that delivers the service. Therefore the SIMPre library may run on any Java Card supporting SIM card without changes to the presence service application logic housed within it.

In order to minimise the memory footprint of a SIM application that utilises the SIMPre library, no new memory is declared or managed within the library. All memory management must be done by the applet that calls the library's functions. For example, if the library returns a result through a Java array structure, this structure must be created by the applet and a reference to the structure must be passed to the library. The reason for this optimisation is to limit the extra memory burden that the library may place on the limited memory resources of the SIM card. We find this helps mitigate the implementation tension between resource efficiency and cross-platform extensibility.

The final component implemented for SIMPre is the UI component.

D. User Interface Implementation

The UI component, implemented in the applet, is responsible for the managing the communication that a presentity or watcher has with the SIMPre application. Therefore this component also utilises the SIM Toolkit interface to access mobile equipment resources such as the display screen and keypad. Figure 5 shows an example of a menu that allows a presentity to update its presence status. This menu is created on the mobile equipment screen by commands sent to the mobile equipment from the UI component through the SIM Toolkit interface.

The UI component also utilises the 03.19 Java API [9] to provide an integrated user experience by combining presence information into the normal usage of a mobile station. For example, Figure 6 shows how the UI component integrates the presence information received from presentities with their respective entries in a watcher's SIM phone book. Therefore when a watcher wishes to communicate with one of their contacts, they may open their SIM phone book and immediately see the presence information associated with that contact before initiating the communication.

The next section provides a brief discussion of providing a presence service via a SIM application as we have demonstrated in this section.

V. Discussion

Our application SIMPre demonstrates that is possible for a presence service to be deployed on legacy handsets. This section discusses the main challenge and two advantages we identified in providing a NGS with a SIM card application.

A. SIM Card resource limitation

The main challenge we identified in providing a NGS on the SIM card is the limited memory resources of the card. This is evidenced by the 128 kilobytes of memory size of our implementation card. Therefore the number of services that may be hosted on the SIM card is limited.

While limited memory is an issue to be considered with the SIM cards commonly available at the time of writing, new cards with larger memory capacities are being developed. For example, Samsung [23] has developed a SIM card with a 1 Gigabyte memory capacity. Such next generation SIM cards will be more favourable for providing NGSs as they offer more memory on which to store SIM applications. We discuss next two main advantages that accrue from the use of the SIM card as a platform to deliver NGSs.

B. Advantages accrued

Two advantages we believe accrue from utilising the SIM card as a platform are the ease of deployment of an NGS across multiple platforms and the control over the NGS that mobile operators will gain .

Based on the NGMN Project recommendations [2] and the GSM/UMTS standards[3], [4] we assume that most legacy and future NGMN devices will utilise the SIM card. SIMPre demonstrates that service application logic may be written for the SIM card in a platform independent manner. Therefore, a NGS may be deployed universally across most legacy and NGMN mobile stations with no need to rewrite the service application logic.

The SIM phone book integration delivered by SIMPre demonstrates that a NGS provided by a SIM application may be integrated with the internal structures of the SIM card. Therefore we assert that the mobile operator data residing on the SIM card and used for authentication and billing may also be integrated with the NGS. This allows the mobile operator to exercise full control over the NGS. This ability to easily integrate with existing mobile operator mechanisms makes a SIM application an attractive proposition for mobile operators.

The two advantages mentioned in this section are inherent to the leveraging of the SIM card as an application platform. However the main challenge we identified, of limited memory resources, is being technologically addressed and will no longer be a challenge in the future. Therefore we believe that the SIM card is a viable option for the future provision of NGSs.

VI. Conclusion

In this paper we present our application SIMPre to demonstrate the SIM card as a platform for the delivery of NGSs on legacy devices. Our contributions are as follows:

Firstly we demonstrate that a NGS may be provided by a SIM card application and consequently deployed on legacy terminals that support the SIM card. We show this by providing a presence service on the SIM card through our application SIMPre.

In addition, our work demonstrates that a NGS may be implemented on the SIM card in a manner that achieves the NGS goal of endpoint transparency. This is achieved by encapsulating all the service application logic of the SIMPre application in a Java Card library that can be deployed across multiple cards supporting the Java Card platform.

Finally we show that it is possible for a NGS to be integrated with the SIM card's internal mechanisms, for example billing and authentication mechanisms. This is demonstrated by the SIMPre application's capability to manipulate the SIM card's file-system in integrating presence information with the existing SIM card's phone book files.

Despite the resource limitations of pervasive SIM cards, we believe that the SIM card provides a platform-independent mechanism for the delivery of mobile operator controlled NGSs on legacy devices.

Thamsanqa Moyo is a Computer Science Masters student at Rhodes University. His research interests include mobile computing, web services, mobile security and biometrics.

References

[1] A. Lui, R. Patabbhiraman, S. Subramanian, and P. Tadicherla, "eSAE: A Rapid Service Creation Environment for Next-Generation Services," *Bell Labs Technical Journal*, vol. 6, 2001.

[2] Next Generation Mobile Networks, "Next Generation Mobile Networks. Beyond GSPA and EVDO," white paper, Next Generation Mobile Networks, 2006.

[3] Third Generation Partnership Project, "Subscriber Identity Modules (SIM),Functional characteristics (Release 4)," technical specification, Third Generation Partnership Project, 2001.

[4] S. Kasera and M. Narang, *3G Mobile Networks: Architecture, Protocols and Proceedures*. McGraw-Hill, 2005.

[5] G. Sanders, L. Thorens, M. Reisky, O. Rulik, and S. Deylitz, *GPRS Networks*. John Wiley and Sons, 2003.

[6] Sun Microsystems, "Java Card Technology," 2007. [Online]. Available WWW:http://java.sun.com/products/javacard/ (Accessed 3 April 2007).

[7] Third Generation Partnership Project, "Specification of the SIM Application Toolkit for the Subscriber Identity Module - Mobile Equipment(SIM - ME) interface (Release 1999)," technical specification, Third Generation Partnership Project, 2004.

[8] Sun Microsystems, "Java Card 2.1.1 Virtual Machine Specification," technical specification, Sun Microsystems, 2000.

[9] European Telecommunications Standards Institute, " Digital cellular telecommunications system (Phase 2+);Subscriber Identity Module Application Programming Interface (SIM API);SIM API for Java Card.Stage 2(GSM 03.19 version 7.1.0 Release 1998)," technical specification, European Telecommunications Standards Institute, 2000.

[10] Third Generation Partnership Project, "Technical Specification Group Terminals;Specification of the Subscriber Identity Module -Mobile Equipment (SIM - ME) interface (Release 5)," technical specification, Third Generation Partnership Project, 2001.

[11] M. Day and J. Rosenberg and H. Sugano, " A Model for Presence and Instant Messaging," rfc, Internet Engineering Task Force, 2000. [Online]. Available WWW:http://www.ietf.org/rfc/rfc2778.txt?number=2778 (Accessed 3 April 2007).

[12] Jabber Inc, "The Power of Presence," white paper, Jabber Inc, 2006. [Online]. Available WWW:http://www.jabber.com/index.cgi?CONTENT_ID=921 (Accessed 4 April 2007).

[13] Open Mobile Alliance, "WV-049 Presence Attributes," technical specification, Open Mobile Alliance, 2005.

[14] Open Mobile Alliance, "Enabler Release Definition for IMPS Approved Version 1.2," technical specification, Open Mobile Alliance, 2005.

[15] Internet Engineering Task Force , "SIP for Instant Messaging and Presence Leveraging Extensions ," 2007. [Online]. Available WWW:http://www.ietf.org/html.charters/simple-charter.html (Accessed 3 April 2007).

[16] P Saint-Andre, "Extensible Messaging and Presence Protocol (XMPP): Instant Messaging and Presence," technical specification, Jabber Software Foundation, 2004. [Online]. Available WWW:http://www.ietf.org/rfc/rfc3921.txt (Accessed 3 April 2007).

[17] Third Generation Partnership Project, "Technical Specification Group Core Network and Terminals.Presence service using the IP Multimedia (IM) Core Network (CN) subsystem.Stage 3.(Release 7)," technical specification, Third Generation Partnership Project, 2006.

[18] Gemplus, "Gemplus Xpresso Range," 2006. [Online]. Available WWW:http://www.gemplus.com/products/gemxplore_xpresso_range/ (Accessed 3 April 2007).

[19] Open Mobile Alliance, "WV-040 System Architecture Model Approved Version 1.2," technical specification, Open Mobile Alliance, 2005.

[20] Third Generation Partnership Project, "Technical Specification Group Terminals;Technical realization of the Short Message Service (SMS)(Release 1998," technical specification, Third Generation Partnership Project, 2001.

[21] Open Mobile Alliance, "WV-046 Client-Server Protocol SMS Binding Approved Version 1.2," technical specification, Open Mobile Alliance, 2005.

[22] Open Mobile Alliance, "WV-042 Client-Server Protocol Session and Transactions Approved Version 1.2," technical specification, Open Mobile Alliance, 2005.

[23] Samsung, "Samsung 1GB Multimedia SIM Card Supports Mobile Multimedia Environment," 2006. [Online]. Available WWW:http://www.samsung.com/PressCenter/PressRelease/PressRelease.asp?seq=20061108_0000299147 (Accessed 3 April 2007).