

# A PRESENCE-ENABLED MOBILE SERVICE SYSTEM FOR INTEGRATING MOBILE DEVICES WITH ENTERPRISE COLLABORATIVE ENVIRONMENT

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**Abstract:** Mobile worker's presence and availability at mobile devices can be very crucial in enterprise collaborative environment due to the not-always-on nature of the mobile devices. We identify the key challenges in tracking the presence status of mobile device and user and in the integration of mobile devices with enterprise collaborative environment. We present the design ideas of a Presence-Enabled Mobile Service (PEMS) system that uses a device-resident Mobile Presence Agent (MPA) to automatically determine and update the presence of a mobile device and its user and securely integrates the presence information with enterprise collaborative environment via Web Services and SMS for the synthesis of user's availability. A prototype system and its implementation are presented to verify the design concepts and the feasibility of the PEMS system.

## 1 INTRODUCTION

The emerging of presence-aware communications in enterprise applications has been causing a fundamental transformation of how people interact with individuals or groups and how enterprise operates as a whole. Presence-enabled communication now is a trend for enterprise to simplify workflow in communications-intensive businesses to yield process and productivity improvements. It allows people to quickly connect with their colleagues, whether on the road, in meetings, or working from remote locations, via the best choice of communication means. It also helps to simplify time-consuming tasks such as scheduling conference calls or collaboration sessions. With the wide availability of a new generation of Smartphones and PDAs that take advantage of 2.5G and 3G mobile network capabilities it becomes inevitable for enterprise to bring its mobile workforce into the presence-aware communication and collaboration environment.

Due to the limited energy supply available from its small batteries and the problem of unexpected

disconnections, a mobile terminal can suddenly lose its connection to servers. Therefore, mobile devices are not intended to be always-on clients or servers that either provide or consume services. Device and user presence information can be extremely important when integrating mobile devices with enterprise applications. At present time the presence information of mobile phones is controlled and managed by mobile network operators and is only available to the public through service subscription. Instant Messaging (IM) adds some rudimentary presence information to mobile devices to allow users to update their status upon login and logout. However, mobile phone or PDA with telephony capability is a device that combines the telephony and data capabilities. Knowing in advance about the other party's availability is particularly important when it comes to telephony. It is not efficient to call colleagues who are busy and end up with voicemail. Also, mobile device users can be on-the-move. Any kind of user intervention for presence updating can be cumbersome. Automated and richer presence information about device and user, which goes beyond IM presence, is necessary for enterprise to effectively synthesize user's availability. Another challenging issue particularly pertinent to mobile access to enterprise is how data and information exchanged between

mobile devices and enterprise can securely pass the corporate firewall. Considering all key factors, a simple low-overhead method, combined with security strategies and effective data exchange, is essential for enterprise to independently determine mobile user's presence and to fully integrate mobile devices with presence-aware enterprise collaborative environment.

This paper describes a Presence-Enabled Mobile Service (PEMS) system for integrating mobile devices with presence-aware enterprise collaborative environment. PEMS system extends the presence awareness functionality to mobile devices such as Smartphones and PDAs to facilitate more efficient enterprise communications and collaborations. In PEMS system, a Mobile Presence Agent (MPA) automatically detects mobile device's status and user's presence and propagates the presence information to a mobile service gateway, MiGate (Shan, 2004), via Web Services (W3C, 2003b) and SMS (ICE, 2003). MiGate then securely forwards the presence information to the enterprise communication manager, again via Web Services, for the synthesis of user's availability in realtime.

The remainder of this paper is organized as follows. Section 2 reviews the related work in presence-aware enterprise applications and mobile service integration. In Section 3 we discuss the design implications and describe our approach to integrating mobile devices with presence-aware enterprise collaborative environment. We present a prototype system and its implementation in Section 4. Section 5 concludes the paper with some conclusions and future work.

## 2 RELATED WORK

Several systems have attempted to address issues of integrating mobile devices with enterprise collaborative applications. A "live addressbook" is proposed (Milewski and Smith, 2000) to provide dynamic awareness information. It allows users to manually update their availability and best phone contact, from multiple devices including Palm handheld, as they move around. Awarenex (Tang et al, 2001) integrates other realtime awareness information into the IM service at work to help users to find good times to establish contacts. In the Contact List, user's locale is displayed on client device to indicate whether user is in office, at home, or another location. User's absence is also reflected by displaying any inactive duration of the user's keyboard or other input devices. Additional activity indicators such as appointments scheduled in the online calendar or telephone calls are monitored and

provided. A set of servers such as the Awarenex Server and Dialler Server are responsible for tracking such communication status and activities. In our approach, we use a single device-resident MPA to determine and report the device status, user presence, and communication activities through a general-purpose enterprise mobile service gateway. No additional servers or services from any third party, such as mobile network operators, are required in tracking communication activities. Presence tracking and updating are automated and transparent to users, which can be particularly beneficial for users who are on-the-move. Another key differentiator of our approach is that the presence information will only be propagated to enterprise communication manager or other clients in a restricted manner, freeing user from being overwhelmed with communication decisions and protecting user's privacy as well.

Security and interoperability are two other critical issues in extending the perimeter of enterprise out to mobile workers. WMTIP system (Chou, Shan and Li., 2001) enhances the security in notification delivery by introducing a Wireless Secure Broker (Li et al, 2003) between the mobile devices and the enterprise application server. It ensures that sensitive data only stays on WSS for a pre-specified period of time to prohibit unauthorized access. Another system, MiGate (Shan, 2004), provides a secure and interoperable solution for the access to enterprise data and services through Web Services and ensures all sensitive data is behind firewall. A few projects have focused on connecting mobile and pervasive devices with business-to-business applications through Web Services. A Web Services-based system (Steel, 2003) is proposed for ad-hoc mobile application integration over Bluetooth and Wi-Fi. Another project (Berger et al, 2003) focuses on hosting and consuming Web Services on mobile devices over Bluetooth and Wi-Fi, providing a powerful means for facilitating automatic interactions between resource-constrained mobile devices, time starved users, and pervasive environment. We focus on Web Services between mobile devices and enterprise over 2.5G and 3G mobile networks for data exchange to and from client devices outside the enterprise premises.

## 3 OUR APPROACH

In this section we discuss key design issues and overview the system architecture of PEMS system. We also describe the details of MPA and MiGate and explain the mechanisms for presence tracking and information integration. Figure 1 illustrates a

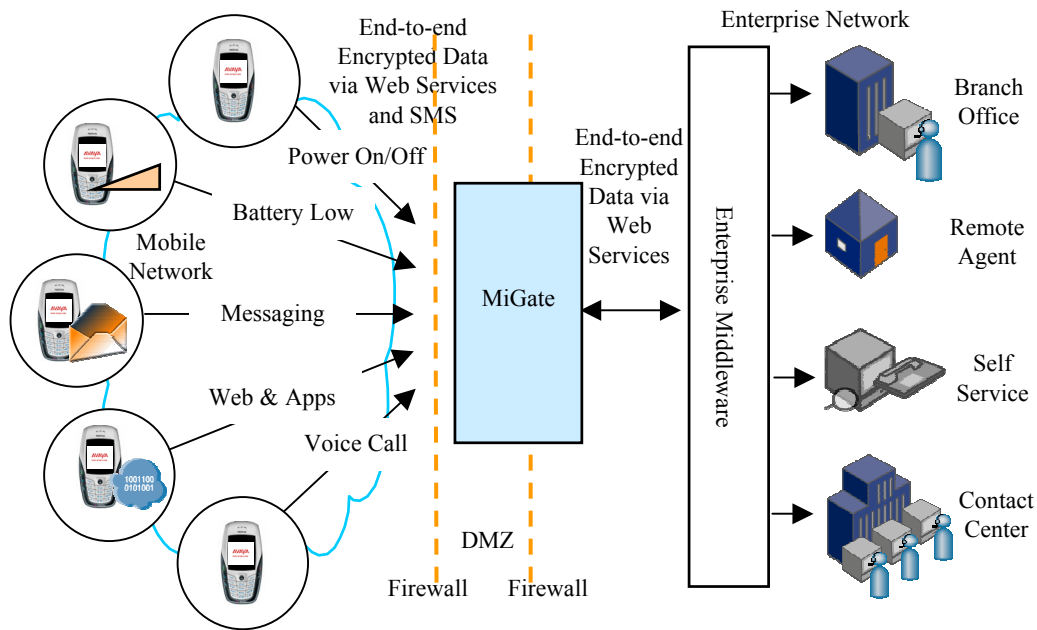


Figure 1: Presence-Enabled Mobile Service (PEMS) system in enterprise environment

high-level view of how PEMS system works in an enterprise environment.

### 3.1 Overview

There are several challenges in integrating mobile devices with presence-aware enterprise collaborative environment, especially those devices used outside the enterprise premises over 2.5G and 3G mobile networks. At current time the presence information about those devices is usually controlled and managed by mobile network operators and only available to enterprises through service subscription. Therefore, implementing a scheme that can independently determine and report mobile device presence is the very first step towards such integration.

IM allows users to update their current status on their mobile devices through login and logout. However, in many situations this information is far from adequate to determine a mobile user's availability. More device presence information, such as power on or off, and more user presence information, such as keypad activities, communication mode, and channel usage, etc., are necessary in order to determine if a mobile worker is truly available and what the best communication means is for initiating a contact or negotiating a collaboration session with minimal interruptions. Additional presence indications may be needed

when user is absent or user is preoccupied by some other activities, for example, in the middle of a voice call or a data synchronization process, and less receptive to additional incoming communications. Low battery can also be an important indicator in forecasting a possible disconnection or user's unavailability at the mobile device in the near future.

We propose a device-resident agent, MPA, to automatically track and report the device status and user presence information. It is invoked at device boot-up time and stays in memory at all times to monitor the device electronic status, such as power on and off, user activities, such as keypad activities, inactivity, use of applications or peripherals, and communication events, such as voice calls or messaging. Another important consideration in designing MPA is that MPA alone should be able to track communication activities without any additional servers or third-party services including mobile network operator's services.

The ultimate goal of presence-aware application is to free users from decision-making for communication means and to improve productivity. If presence becomes another task that people have to actively manage as part of their work, people will not use it as much as they could. Our strategy is to automate both presence tracking and updating and free user from constantly responding to updating prompts. Measures have been taken to balance the tradeoffs of informativeness vs. privacy and overhead vs. control. The presence information

provided by PEMS system will only be propagated to enterprise communication manager and other clients in a restricted manner. In addition, a Presence Manager (PM) is provided to allow users to vary the level they would like to publish presence activities, or to stop monitoring to make them unavailable during the off-duty time and private time.

The other important component of PEMS system is MiGate which plays a critical role in securely connecting mobile devices with enterprise services and in propagating presence information to enterprise communication manager. It provides fine-grained two-way access controls and allows requests and responses to securely pass the firewall while keeping all sensitive data behind the corporate firewall.

PEMS system adopts Web Services as its primary interface to loosely connect mobile devices with MiGate and enterprise services to achieve high level of extensibility and interoperability. Due to the lacking of devices on the market at current time that support simultaneous voice and data, MPA offers alternative interface for propagating presence information from mobile devices to MiGate via SMS. In 2.5G mobile networks, Web Services is used whenever the GPRS connection is available. SMS over GSM is used otherwise. There is no need to establish a constant connection between MPA and MiGate. This further isolates enterprise and mobile devices to enhance the security. Moreover, data is encrypted by MPA for end-to-end security. Additional security can be achieved at the SOAP (W3C, 2003a) level using authentication, digital signature, and encryption. In the situation of unexpected disconnection, the presence status will be reported to MiGate as soon as the connection resumes.

### 3.2 Mobile Presence Agent

MPA is a software agent with a small footprint residing on Smartphones or mobile devices that are equipped with an embedded operating system and networking capabilities. It silently monitors and tracks the device status, network connectivity, line status, channel usage, keypad activities, and use of applications and peripherals and reports such presence information to enterprise through MiGate. The information is owned by enterprise, in other words, it is not controlled or managed by any mobile service providers and not shared with any third parties. Figure 2 shows the block diagram of MPA.

MPA is designed to facilitate the need for adding new sources of presence information as they become available. Each Event Tracker (ET) tracks an

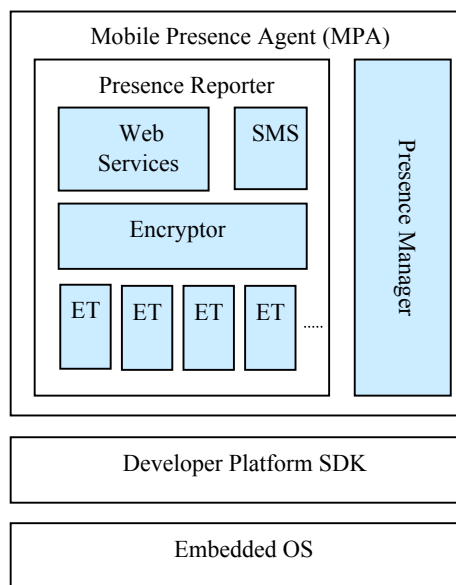


Figure 2: Major components of Mobile Presence Agent (MPA)

individual event and invokes the encryptor to get the information encrypted before a particular presence indicator to be propagated to the enterprise communication manager. Given the dynamics and flexibility of the Web Services interface, Presence Reporter (PR) can potentially handle any new event or activity by adding a new ET. SMS is chosen as an alternative to Web Services whenever the data connection is not available, for example, when a voice session is in progress.

A PM is offered as a tool for users to vary their preferences about to what level of details they are willing to publish their presence and activity information. Users may turn off the tracking functionality completely during their off-duty or private time to make them unavailable. The presence information will be managed and utilized by the communication manager for the synthesis of user's availability in realtime. One of the significances implied here is that communication can be entirely transparent to user in terms of how to contact a person in the most efficient manner, further reducing the communication overhead and resulting in drastically increased productivity.

### 3.3 Mobile Service Gateway

MiGate is a service gateway for enterprises to extend wireline services to mobile devices securely and easily. Figure 3 shows the major components of MiGate and its interfaces to enterprise services and mobile networks.

The Mobile Proxy Server (MPS) is situated in the DMZ as mobile firewall to authenticate users and to securely redirect requests and responses. Varieties of mobile gateway adaptors are used to connect MiGate with mobile operator's networks to deliver notifications and other types of traffics over different bearers and networks.

The main functionalities of the Mobile Image and Presentation Server (MIPS) include service brokerage, content transformation, and creation and storage of Mobile Service Image (MSI). Mobile Service Broker (MSB) interfaces with enterprise services. It manages service access control, MSI creation, backend synchronization, and service coordination, where MSI comprises all mobile service images that users currently subscribed. The event-triggered and routine backend synchronization between enterprise applications and MIPS updates MSI accordingly to maintain the data consistency. More importantly, MIPS enables realtime data replication that makes the system highly scalable and eases the setup of redundant servers to avoid the single-point-of-failure. Mobile Content Converter (MCC) transforms the service content into a format most suitable for the target device in realtime. Adaptation to new devices is achieved by adding device adaptors.

MiGate addresses the security and firewall issues through MPS and the separation of mobile proxy and the presentation server, which leaves no sensitive data outside firewall. The loose coupling of enterprise applications and MiGate provides an additional level of security. Furthermore, MiGate

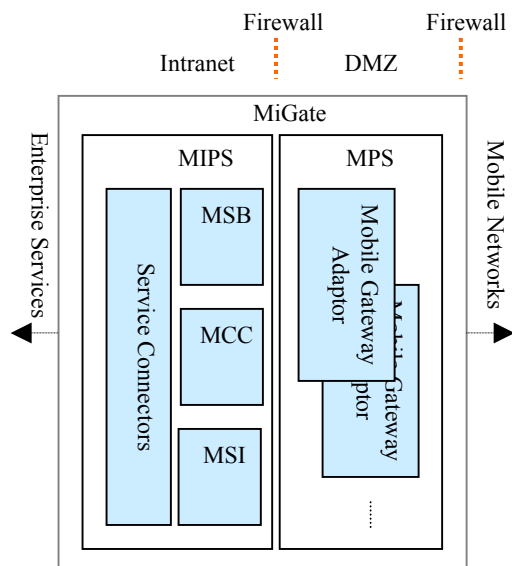


Figure 3: MiGate components and interfaces to enterprise services and mobile networks

imposes user registration prior to data exchange between a client device and enterprise applications. Its fine-grained two-way access control further blocks unauthorized access from either mobile devices or enterprise applications.

We expanded MSB to handle encrypted presence-update notifications from client devices via Web Services and SMS for PEMS system.

## 4 PROTOTYPE

We developed a proof-of-concept prototype system with all essential function blocks implemented to verify our design concepts and the feasibility of PEMS system. Currently we are integrating it with enterprise middleware for the creation of presence-rich collaborative applications.

Many different mobile devices with embedded operating system and wireless networking capabilities can be used as the residence device for MPA. We use a Nokia 3620 phone which is equipped with Symbian OS and a developer platform SDK.

A MPA, Ghost Reporter, is created in C++ using Nokia Series 60 SDK. Ghost Reporter invokes at device boot-up time and is executing in the background at all times. Two ETs have been created to track the power on/off status, and user inactivity and resume of activity, respectively. The open source gSoap library (Van Engelen and Gallivan, 2002) is used for the development of the Web Services connector. The presence information is propagated to MiGate via a Web Services call.

In the MiGate prototype implementation, we adopt Microsoft Mobile Information Server (MIS), which is deployed in the corporate DMZ, as MPS. It authenticates users and securely connects with AT&T Wireless GSM/GPRS network through SSL. Essential components of MIPS have been implemented to feature service brokerage, basic content transformation, and service image creation and storage. A new device adaptor for Nokia 3620 has been created. The MiGate side Web Services are implemented using MS SOAP Toolkit to connect enterprise services. We created a new Service Representative (SP) in MSB to handle the presence-update notifications from client devices via Web Services.

In this prototype system, device presence is detected by the Ghost Reporter when the mobile device is powered up. If there is no user activity on the keypad after a preset period of time, user's inactivity is detected and reported. Resumed activity following an inactivity period is also detected and reported. Those presence indicators are

securely propagated to enterprise middleware, through MiGate, for the synthesis of user's availability. At current time all information propagation from mobile device to MiGate is through Web Services.

We have integrated our prototype system with some enterprise middleware. We plan to create interesting collaborative applications to evaluate how enterprise and employees can benefit from the services offered by PEMS system in terms of communication efficiency and people's productivity.

## 5 CONCLUSIONS AND FUTURE WORK

In this paper we identified compelling reasons and key challenges for extending presence awareness beyond desktop to enterprise mobile users. We presented a presence-enabled mobile service system, PEMS system, for integrating mobile devices with enterprise collaborative environment. We discussed design implications particularly pertinent to mobile devices which are used outside the enterprise premises over 2.5G and 3G mobile networks. We believe that PEMS system offers several advantages. Its automated presence tracking and updating frees user from being burdened by manual updating of presence status and makes the communication choices transparent to user in terms of how to make the best contact and how to initiate the best collaboration session. The controlled distribution and management of presence information and the flexibility of allowing user to vary the level of publishing the presence balance the tradeoffs of informativeness vs. privacy and overhead vs. control. The presence enabling is through MPA alone for status detection and requires no additional servers or services from third parties including mobile network operators. Highly secured information integration is through MiGate as well as additional end-to-end data encryption. PEMS system leverages the existing wireline business services and offers enterprise privately owned presence information about mobile devices and users, which can be shared among enterprise collaborative applications. We examined our design ideas through the implementation of a prototype system. Currently we are integrating the system with some enterprise middleware for the creation of collaborative applications.

The future work will be focusing on the heterogeneity in mobile computing to provide device-independent solutions for client agent. Effort will also be focusing on the creation of applications that utilize the presence information that PEMS

system offers to evaluate the PEMS system operating in an enterprise collaborative environment.

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