Presence Aware Location-Based Service For Managing Mobile Communications

Vishal Kumar Singh, Henning Schulzrinne
Department of Computer Science, Columbia University
New York, NY, USA
{vs2140, hgs}@cs.columbia.edu

Piotr Boni, Boris Elman, David Kenneson
Verizon Communications
Boston, MA, USA
{piotr.boni, boris.elman, david.kenneson}@verizon.com

***Abstract*—Presence technology based on Session Initiation Protocol can be used as an enabling platform for delivering communication and providing event-based services. We present a mobile workforce management solution which integrates fleet management with presence-based communication to show how presence technology can be used to realize location-based communication services. In particular, our solution integrates a user's presence information with their vehicle's status and location information to enable safe communications with a mobile user. Our solution can provide services for both consumer (residential) and an enterprise scenario, for example, E911, rental car management, delivery companies (e.g., Fedex), for purposes like scheduling and automatic dispatching of mobile crews. We discuss our solution in the context of Verizon's mobile workforce (mobile employee) management scenario. The solution incorporates integration of the mobile employee's location obtained from a GPS device in a vehicle; the mobile employee's presence information obtained from his/her cell-phone and laptop as well as the status and diagnostic information of the vehicle. A prototype system and its realization is presented to show the main concepts, feasibility and usefulness of such a solution.**

Keywords: watcher, presentity, event-package, GPS, SIP, fleet management

I. INTRODUCTION

Instant messaging and presence form an integral part of Internet communications, both in corporate and consumer world. A user's presence information [2] includes his/her availability and willingness for communication. The presence framework enables an informed communication decision, where dial tone is no longer the sole way to determine if one can communicate. Presence brings important information to the watchers (buddies) [2] like the user's mood (angry, happy, sad), his current activity (driving, sleeping, in a meeting, eating), his location (country, state, city), current device or application on which he can be communicated (cell-phone, landline phone, IM client). This set of information facilitates better communication between the entities. For example, a person decides not to call his buddy because his status shows 'driving'. Also, he chooses to get notified once the buddy stops or reaches a landmark so that he can make a call.

Service Overview: In this paper, we present a system where presence information of a user is combined with the location information (derived from a vehicle's location information) to achieve an integrated communication environment. This facilitates unification of vehicle location tracking with the core communication services and also allows building advanced domain-specific services, e.g., vehicle status monitoring, automatic communication set up based on triggers, for example, communicating with the user who is driving only when his vehicle's status changes to "Stop" or vehicle ignition status is "Off".

We have built a prototype system to improve communication capabilities for Verizon's mobile workforce consisting of the service installation and maintenance crews. This prototype also improves manageability of vehicles operated by the mobile workforce, by enabling location tracking and monitoring of the vehicle status information. These vehicles are equipped with an Integrated In-Vehicle Device (IIVD) which provides diagnostic and location information about the vehicle and also provides wireless communication channel for delivering the status and location information to the back end data collection and enterprise operations support system. Our system integrates the location and the diagnostic information obtained from IIVD with the mobile workforce availability information obtained from their cell-phone, PC-based IM client and enhances the communication capability to the mobile users by taking into account not only their communication devices, but also their current location and activity, like driving status. We call such a system and corresponding functionality **Presence-Aware Location-Based Service (PALS).** Specifically, the service improves the ability of the management to know the mobile workforce status as well as reduces the effort on the part of the supervisors and employees to remain in communication with each other. Supervisors have up-to-date information about where their mobile employees are, whether they are at a customer site, moving from one site to another, or if they are at a specific location which may or may not be related to a particular job they are currently working on. The PALS also provides tools for establishing diverse communication channels between all the entities within the defined communication environment, including the supervisor(s) and the mobile employee's (technicians).

Example Scenario: The following example illustrates the use of PALS. Jim is a technician and his vehicle is parked at 509W, 122^{nd} Street, New York, NY. His cell phone is switched on and his wireless coverage is good. His supervisor sees (in his/her client application) that Jim is available (online) and stationary (his vehicle is not moving). The supervisor can call Jim or send

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him an IM (text/voice). He can invoke these communications functions from a standard web browser on his PC. However, if Jim's vehicle is moving, the supervisor can plan to call him only when the vehicle stops. The supervisor can subscribe to vehicle "STOP" events and configure a "rendezvous" rule. When the vehicle stops, the system gets an event, the service selects the best communications channel (cell-phone, IM on laptop, voice-IM) and the parties get connected automatically. Additionally, depending on the job, location of mobile employee's vehicle and its status information, existing operations support infrastructure can use services like dispatching crew and vehicle based on factors like vehicle's current location, distance from the customer's site and their current activity completion levels, for example, to estimate how much more time their current activity may take.

Contributions: Some of the main contributions of PALS are:

- Aggregation of presence information from multiple sources. User's availability information is derived from mobile employee's cell-phone and his/her IM client or soft-phone. The aggregated information is stored and distributed.

- Enabling advanced service creation like dispatching or redirecting crews based on their location and availability.

- Vehicle as an entity in a presence system.

- Presence based fleet management application.

- Location tracking, status and health monitoring of vehicle and extending the Presence Information Document Format (PIDF) [7] schema to update the vehicle's location and health information to the presence server and identifying need for defining a new event-package [2] for managing vehicles.

- Deriving of user's location from vehicle's location.

We identified what new components need to be defined for a complete standards-based and interoperable presence-based solution. Specifically, how SIP identities in one domain need to be correlated with associated entities in different domains. For example, a vehicle as an entity can be used in vehicle monitoring domain, e.g., by companies like car rental companies. However, vehicles are operated by people moving with the vehicle, who will have their own SIP specific identities, and hence, a vehicle's location can be used to derive the location of the entity traveling in it.

From the consumer market perspective, the above described functionality allows for the extension of the OnStar type services and E911 services. For companies that own fleet, such a service will allow to better protect their assets (in particular, the vehicles) from misappropriation by unauthorized personnel. Since, it makes communication capabilities effortless, it is also a productivity enhancing mechanism for enterprises. Our system can clearly be used in other mobile workforce scenarios, such as contractors, package delivery, local freight delivery and public services such as garbage collection and electric utilities.

The remainder of the paper is organized as follows: Section II discusses presence technology and related work. Section III describes our architecture and its components. Section IV discusses some of the issues and challenges encountered in developing this solution. Section V presents future work. We conclude the paper in Section VI.

II. Related Work

We briefly explain how SIP based presence system works and then we discuss some earlier work to develop presence and location based services.

In a SIP-based presence system, watchers subscribe to presence information of presentities using SIP [1] SUBSCRIBE [2] messages and are notified about the changes in state of the presentities by SIP NOTIFY [2] messages. Diverse sources of presence information like wireline and wireless phones, applications like calendars and meeting maker applications and location sensors update presence information of a presentity to the presence server using the SIP PUBLISH [6] message. Presence Information Document Format (PIDF) [7] and its extension Rich Presence Information Document RPID [4] are XML-based format used for sending presence information. PIDF-LO [5] is an extension of PIDF for updating location information. Fig. 1 shows a basic block diagram of a presence system.

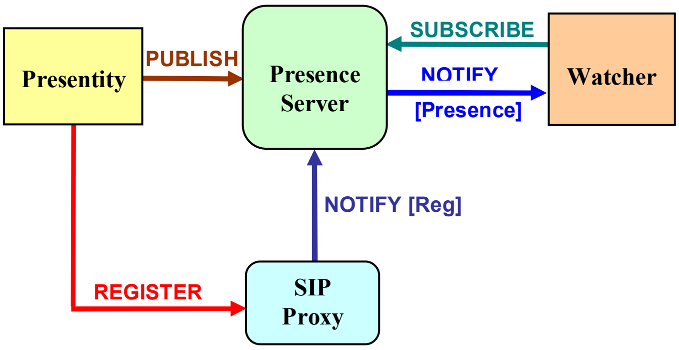

Figure 1 Presence Overview

Several systems have been built around location-based services [10], presence-based communications [9] and SIP event-based framework [12] in the past. Some of them [11] use SIP-based solution to combine location and presence based services. [11] uses a "location" event-package to get information about all the people in a room. It uses wifi-based cell-phone's location to determine a user's location, based on his SIP registration information. In our case, we use presence architecture for vehicle management and use this information for management of mobile workforce. We derive the location of user from the location of a vehicle, which is a different SIP entity in vehicle-management domain. This is used to provide more advanced services applicable to entities in both the domains. In doing so, we introduce the notion of entities in multiple domains, associated with each other, each using different event package [2]. Information about these entities across event packages can be used to derive presence information of a user. We build services in both the presence-domain of a user and the domain of other entity, e.g., vehicle tracking solution or vehicle monitoring. It also allows us to develop services which can be combined across these domains like automatic scheduling and rendezvous on specific events.

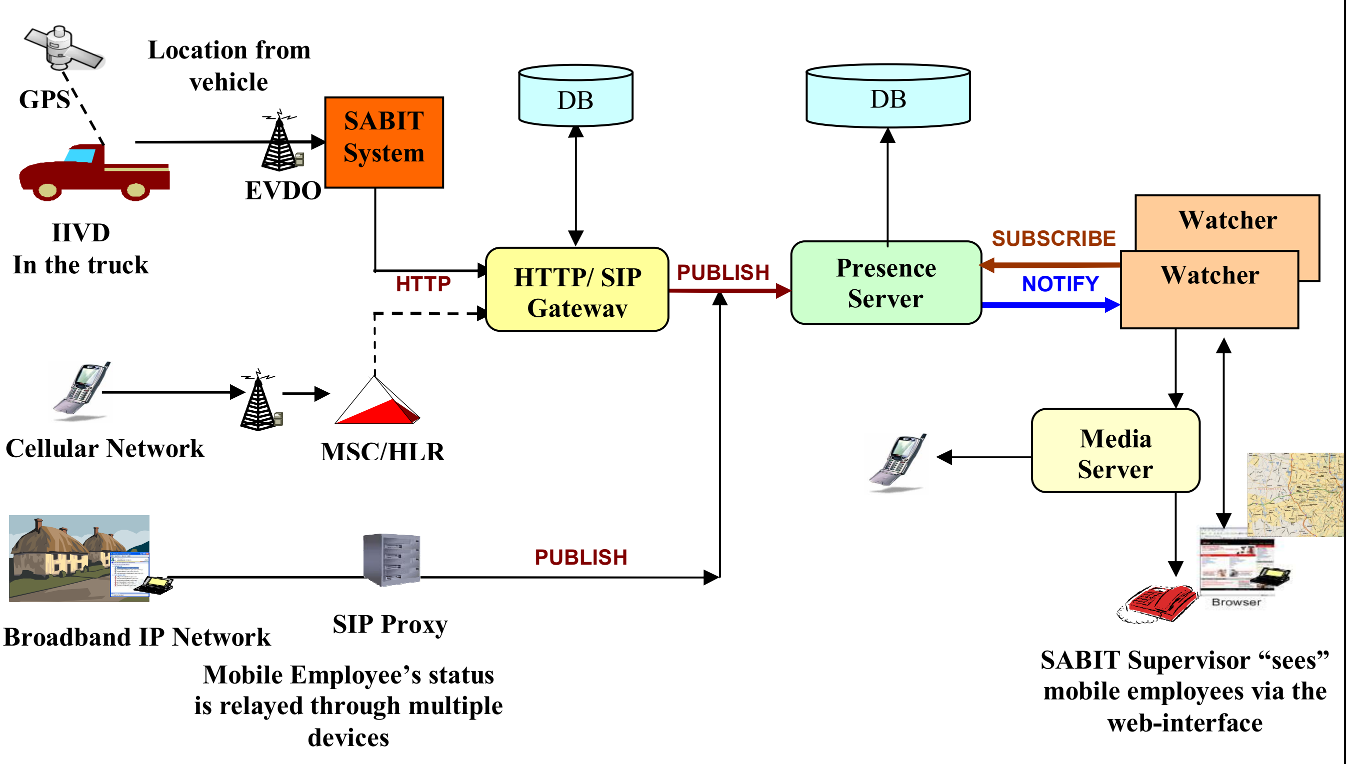

Fig 2 Presence Aware Location-based Services: Systems View

III. PALS ARCHITECTURE

In this section, we give a brief overview of how the entire system works and then we go on describing different components of the PALS architecture.

The status and location information of a vehicle is sent from the IIVD to the SABIT system, which is Verizon's location-based services and service delivery business intelligence solution. To add presence-based communication to the SABIT system, we modified the SABIT server to forward the events received from IIVD to a HTTP-SIP gateway, which processes these HTTP-based events and sends SIP PUBLISH message to the presence server. The mobile user's presence information from various sources is composed and stored on the presence server. The web-based supervisor's interface which originally obtained information from the SABIT system is modified to fetch information from supervisor's watcher application. Also, the supervisor's web interface is enhanced to provide him with new presence-based communication facilities. Figure 2 shows different components of the PALS architecture.

A. Components of the PALS architecture:

1) Integrated In-Vehicle Device (IIVD – Vehicle Events)

Different events originate from the IIVD which is fitted in the vehicle and are received by the SABIT server. The events are sent from the IIVD to the SABIT server using a proprietary protocol. Table 1 shows the event types and the protocols used by the SABIT and the presence servers to receive the events.

Table 1 IIVD Event Types

IIVD Event Type	*SABIT*	*Presence*
STOP	POST	PUBLISH
MOVING	POST	PUBLISH
IGNITION ON	POST	PUBLISH
IGNITION OFF	POST	PUBLISH
MODEM SERVICE LOST	POST	PUBLISH
MODEM SERVICE GAINED	POST	PUBLISH
GPS LOST	POST	PUBLISH
GPS GAINED	POST	PUBLISH

The IIVD has a Wifi interface, an Ethernet interface, an EVDO interface and a GPS receiver. The EVDO interface provides the wireless broadband connection.

2) SABIT System

The Service Assurance Business Intelligence Toolkit (SABIT) is a Verizon system delivering location based services enterprise wide and operational information from a variety of operations support systems for service delivery job lifecycle management. SABIT enables Verizon staff to access this information from a single web-based integrated environment. Typical information includes: management and operations hierarchies; dispatch information for installation and maintenance jobs and customer service addresses; customer premises locations, location-based services based upon geographic location of field service vehicles; etc. The purpose of this system is to allow Verizon management to improve both customer service as well as mobile employee productivity.

3) HTTP-SIP Gateway (LBS Presence User Agent)

We developed an HTTP-SIP gateway which acts as Location-based Service Presence User Agent (LBS-PUA). It modifies the presence information of the vehicle and the associated user by sending SIP PUBLISH requests to the presence server. It receives different events originating from IIVD in the form of HTTP POST requests from the SABIT server. These requests contain the vehicle's information and GPS-based location data. The vehicle information is used to obtain the SIP URI of the user which is mapped to the vehicle's ID. This mapping is created using a web based interface when a mobile employee is assigned to a vehicle. The mapping is stored in a database and is used to determine the SIP identity of the mobile employee to send a SIP PUBLISH request when a HTTP POST request is received. We used Tomcat's [14] Servlet engine to develop the HTTP-SIP gateway, specifically, to receive the HTTP requests and translate them to SIP PUBLISH messages. We use JAIN-NIST SIP [15] stack for developing the HTTP-SIP gateway. We plan to extend the HTTP-SIP gateway function to wireless networks and pass the events from the Mobile Switching Center (MSC) and Home Location Register (HLR) to the presence server.

4) Watcher or Supervisor Application

The supervisor's application consists of two parts: the web based interface and the watcher application. Both the web interface and the watcher application were enhanced to provide interfaces to enable use of advanced communication services. Originally, it provided the current and historical location information and the location of the vehicle on a map. Figure 3 shows a snapshot of web page which was developed to set up rendezvous communication based on presence.

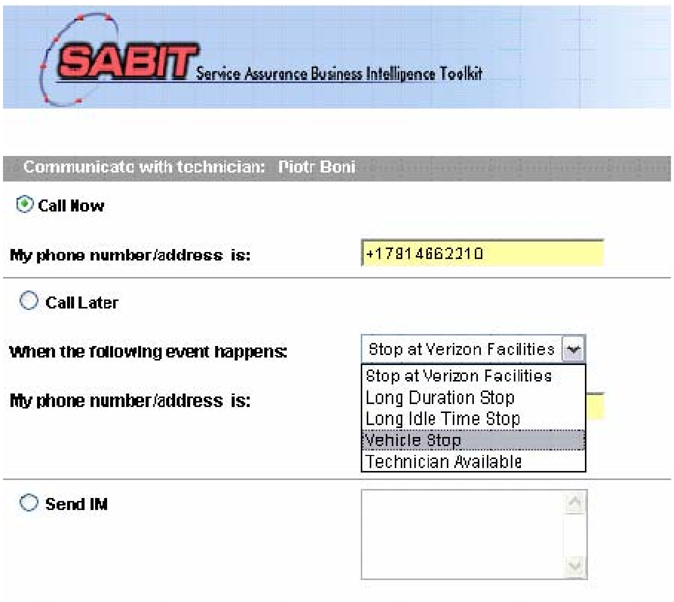

Figure 3 Supervisor application

The supervisor's web-interface fetches the presence information from watcher application, which stores information after getting notification from the presence server. The supervisor's web-interface allows making a call immediately to the mobile employee's contact address. In addition, it allows specifying business rules for establishing communication. The watcher application gets notification of all the events and compares the received event with the trigger condition. Depending upon if a match occurs, the watcher application takes an appropriate action i.e., makes a call or sends an IM after choosing the best contact address for the mobile employee.

5) Presence Server

The presence server creates a composed view of the user's presence information. It receives the vehicle's location information from the HTTP-SIP gateway as PUBLISH request and updates the location information of the user on the presence server.

The events described in Table 1 are used to construct the presence information of the vehicle containing the IIVD and infer the presence information of the mobile employee associated with the vehicle. Thus, depending on the watcher applications, the presence server's generic event distribution functionality can be leveraged in fleet management scenario or user's presence information management scenario. If the presence server is used for vehicle management, the application needs to subscribe to vehicle's information using vehicle's URI and a "vehicle" event package.

6) Media Server

The media server is used to create rendezvous service for the users. It is based on a 3rd party call control service [17]. It allows the watcher's application to establish calls between management (supervisor) and mobile employees when the rendezvous rule matches.

IV. ISSUES AND CHALLENGES

We describe the main issues encountered and their solutions developed or proposed in this section.

A. Interoperability

The current SABIT system does not use SIP event architecture. The IIVD box has a proprietary interface for sending the information. If instead, IIVD has a built-in presence client that sends PUBLISH messages, the architecture would be simpler.

The presence server used with the supervisor application was Microsoft LCS [16]. However, LCS does not interoperate with standard SIP-based presence servers. As a result, the HTTP-SIP gateway had to fork the request to two presence servers, the first one – PUBLISH request toward the standards-based SIP/SIMPLE server and the other to the LCS-based PUA, which translates it to a PUBLISH-like message for the LCS server. This forking of requests by HTTP-SIP gateway is not shown in figure 2.

The CDMA/GSM-based cellular system does not directly provide the registration and location information of the cell-phones. Hence, composing presence from user's cell-phone is not straight forward. Either a presence client on the cell phone or the cell-phone service provider must provide a trigger or send a PUBLISH message.

B. Data Model for Vehicle Tracking System

Presence information from a vehicle consists of two parts and can be modeled based on the entity to be managed. Vehicle as a presentity can have two components of presence information i.e., the location component and the vehicle's status information (the device specific component). The location component can be expressed using the Geo-location or civic location format specified in the PIDF-LO schema [5]. If the user is the managed entity, presence information from vehicle acts as one of the user's presence sources. In this case, the vehicle is the source of user's location.

C. PIDF Schema Extension

There is no defined schema for publishing vehicle's information. We used the following XML format for publishing vehicle's status information and its location.

```
<?xml version="1.0" encoding="UTF-8"?>
<presence xmlns="urn:ietf:params:xml:ns:pidf"
………………………
entity="pres:user@example.com">
<dm:device id="MH74L1">
        <car:vehicle>
            <car:status>closed</car:status>
            <car:movement>parked</car:movement>
            <car:ignition>off</car:ignition>
            <car:connectivity>off</car:connectivity>
            <car:connectionType>Wifi</car:connectionType>
              …………………
         </car:vehicle>
        <dm:deviceID>mac:IIVD1280</dm:deviceID>
            <gp:geopriv>
              <gp:location-info>
                   <gml:location>
                    ………..
                   </gml:location>
                  <cl:civicAddress>
                     <cl:country>US</cl:country>
                     <cl:A1>New York</cl:A1>
                     <cl:A6>Broadway</cl:A6>
                     ………..
                   </cl:civicAddress>
              </gp:location-info>
                   ……………………..
             <gp:method>gps</gp:method>
         </gp:geopriv>
   </dm:device>
 </presence>
```

There are two components in the above XML; one is location of device which is similar to location of any device which a person may have as per presence data model draft [8] and the second component contains vehicle's specific status information. This allows managing the vehicle itself or using vehicle as a source of user's presence.

D. Mapping the Identities

The vehicle's presentity needs to be mapped to the person's presentity to derive person's presence information. In our system, this was based on mapping between vehicle's ID and person's URI, stored in a database. However, such mapping can change dynamically and may involve multiple functional domains and entities. There are ways which can be used to automatically determine the occupants of a vehicle e.g., RFID [20], Bluetooth sensors in vehicle's. Such techniques can also be used to perform the mapping between different SIP entities.

V. FUTURE WORK

We plan to specify a new event package for vehicle tracking and monitoring system. Such an event package can be used to provide the information about the vehicle. Also, user's presence information can be derived from it. The presence server derives user's information using presence composition [21]. Presence composition requires mechanism to obtain Rich Presence Information Document (RPID) [4] elements from a vehicle-specific event package's schema, e.g., "vehicle" event package. The XML schema under the "vehicle" event package needs to be standardized based on specifications such as On Board Diagnostic (OBD-II) [13], so that general purpose vehicle tracking and monitoring systems can interoperate, across different service provider and developer communities.

We identified need for creating and updating associations between different SIP-entities across domains. Information about these entities can be used to derive useful presence information. In our case, the presence server needs to know which SIP URI to subscribe to, under which event package to derive presence information for the user.

On a system level, as mentioned, we plan to extend the HTTP-SIP gateway functionality to wireless networks and pass the events from the MSC/HLR to the presence server.

Security is another important consideration which becomes more difficult when multiple entities are involved. We need to add authentication and authorization of SABIT to the HTTP-SIP gateway and use TLS [19] for the communication between SABIT and HTTP-SIP gateway as well as between HTTP-SIP gateway and the presence server. Privacy concerns should be reviewed in the context of the existing presentity and watcher policies and filters

VI. CONCLUSION

In this paper, we demonstrated how presence can integrate communication and location based services. We presented a solution to extend Verizon's SABIT system by integrating location, vehicle's status, mobile employee's availability to facilitate and create new communications services. We showed how new innovative services can be built using a presence-based architecture.

Also, we identified issues in using a pure SIP-based presence infrastructure in different functional domains. In particular, we identified need for a new event package for managing vehicles in a fleet management application. Also, with entities across multiple domains, having one-to-many mappings, we identified requirements for a mechanism to associate these entities.

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