Service Composition in IMS: A Location Based Service Example

Agata Brajdic, Ozren Lapcevic, Maja Matijasevic
Faculty of Electrical Engineering and Computing
University of Zagreb
Zagreb, Croatia
{agata.brajdic|ozren.lapcevic|maja.matijasevic}@fer.hr

Miran Mosmondor
R&D Center
Ericsson Nikola Tesla
Zagreb, Croatia
miran.mosmondor@ericsson.com

***Abstract*— The IP Multimedia Subsystem (IMS) is a standardized architectural framework for the provision of multimedia services over a packet based next generation network (NGN). We present an overview of IMS, with emphasis on use of IMS application servers and enablers for service delivery, and show how an innovative prototype service can be designed and developed based on principles of service composition and reuse of common service enablers and content resources. The prototype service, dubbed LocalNote, may be described as a location triggered messaging service enhanced with presence. It allows the originating user to create a location-based "sticky note" in form of a SMS message, to be delivered to the recipient user(s) upon entering a designated geographical area. The service is based on a new application server in IMS and it also makes use of the presence, location, and location context enablers, as well as a map content server.**

Keywords—IP Multimedia subsystem, application server, service composition, location, presence

I. INTRODUCTION

The IP Multimedia Subsystem (IMS) [1] is a standardized architectural framework for the provision of multimedia services over a packet based next generation network (NGN). The objectives commonly associated with the adoption of an IMS-based infrastructure include end-to-end QoS, charging, and service integration. This paper deals with service integration, adopting the point of view that IMS should not only host services but also mediate and add value to 3rd party services [2]. To achieve that, a service delivery environment is needed which allows the reuse of common enablers and resources, leading to faster and possibly more cost-efficient introduction of new services. In this paper, we demonstrate the use of IMS application servers and enablers for service delivery, and show how an innovative location based prototype service, dubbed LocalNote, can be designed and developed based on these principles.

The paper is organized as follows. Section 2 briefly describes the IMS architecture, with emphasis on the service layer and service composition. Section 3 describes the design of LocalNote. Section 4 presents an example and the corresponding SIP signaling diagram. Section 5 concludes the paper.

II. IP MULTIMEDIA SUBSYSTEM

The IMS was initially developed by the Third Generation Partnership Project (3GPP) and 3GPP2, and later harmonized with the NGN architecture developed by ETSI/TISPAN. For transport and session signaling purposes, 3GPP adopted the use of the Internet Protocol (IP) and Session Initiation Protocol (SIP) [3], developed by the Internet Engineering Task Force (IETF). The IMS architecture [4] comprises the Service Layer, the Control Layer, and the Connectivity Layer, as shown in Figure 1.

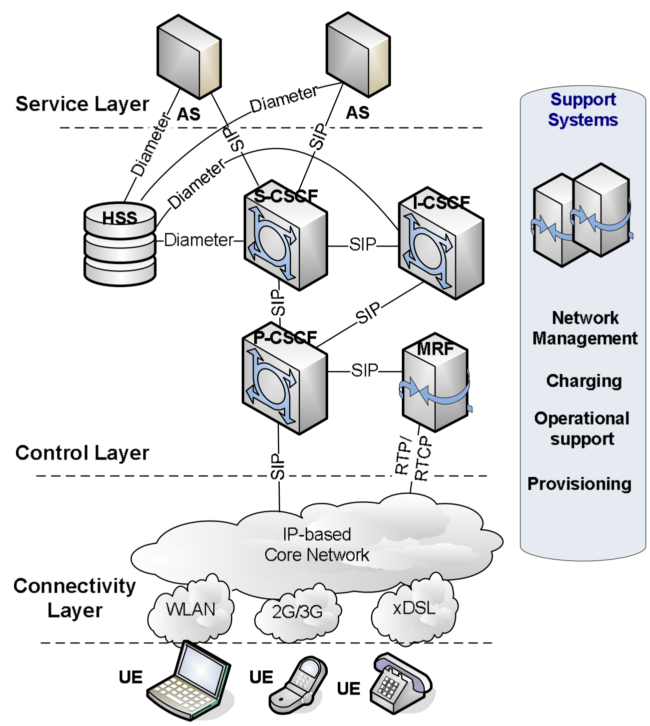

Figure 1. Simplified view of the IMS architecture

The **Service Layer** comprises application and content servers which host and execute services. The IMS allows for generic and common capabilities, implemented as services in SIP Application Servers (ASs), to be reused as building blocks across multiple applications and services. A capability which may be utilized to provide a service to the end user, by itself or in conjunction with others, is called the *service enabler*. Examples include presence, group list management, instant messaging, and PoC; and other novel enablers such as those for location [5][6] and QoS matching and optimization [7] have been proposed.

The **Control Layer** comprises databases and network control servers for managing call/session set-up, modification, and release. The Home Subscriber Server (HSS) is a database which serves as a central repository for user related information, including user identity, allocated S-CSCF name, roaming profile, authentication parameters, and service information. HSS communicates with other entities in the control and the application layers by using Diameter [8]. The key IMS entity in the Control Layer is the Call Session Control Function (CSCF). The CSCF is a SIP server responsible for session control and processing of signaling traffic. The CSCF plays three distinct "roles": the Proxy Call Session Control Function (P-CSCF), Serving Call Session Control Function (S-CSCF), and the Interrogating Call Session Control Function (I-CSCF). The function responsible for service control and composition is the S-CSCF. The S-CSCF is always located in the user's home network. It uses HSS for user profile retrieval, as well as for acquiring authorization and service triggering information.

The **Connectivity Layer** comprises routers and switches for the IP Core and access networks including 3GPP's GPRS or UMTS RAN, 3GPP2's CDMA2000 RAN, Wireless LANs, and various fixed DSL options). The User Equipment (UE), like PCs and mobile phones, connect to the network at this layer.

A. *IMS Application Servers*

IMS defines three types of ASs: SIP AS, OSA Service Capability Server (OSA SCS), and IP Multimedia Service Switching Function (IM-SSF), as shown in Figure 2.

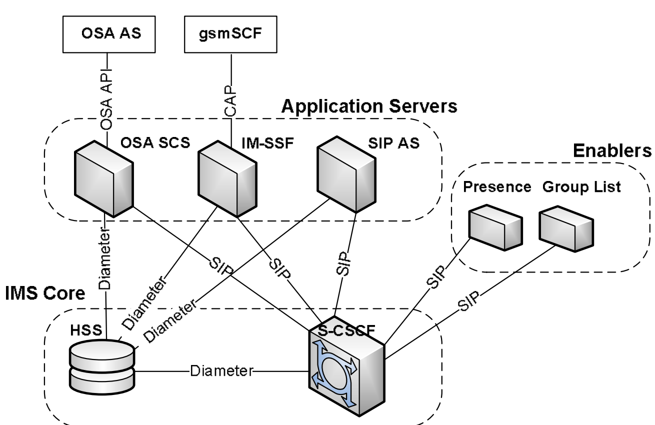

Figure 2. IMS service delivery components

The SIP AS is the "native IMS" AS, representing the preferred means for implementing new value added services designed specifically for IMS. The two main capabilities of the AS are: 1) the capability to process and impact an incoming SIP session received from the IMS Core, and 2) the capability to originate SIP requests and to send accounting information to charging functions. The IMS Service Control (ISC) reference point is used to send and receive SIP messages between the CSCF and the AS.

B. *IMS service composition*

Service composition in IMS is based on integration of multiple applications acting on a single communication session (call instance). The use of functional applications as building blocks allows service providers to mix and match different application offerings without the need to additionally customize their interworking principles.

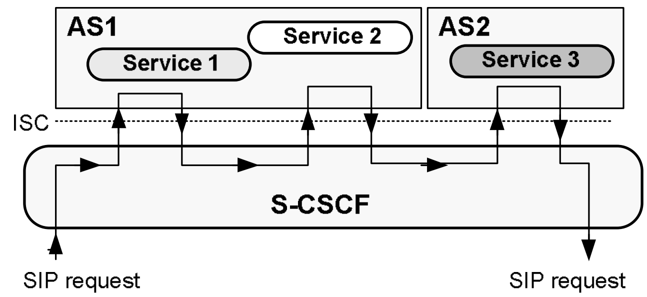

Figure 3. Sequential AS chaining by S-CSCF

The S-CSCF is used for session control and service orchestration, while the service logic is implemented within ASs. Upon registration, the service profile linked to the user is downloaded from HSS to S-CSCF. Service profile includes service-triggering information in form of prioritized Initial Filter Criteria (iFC). Each iFC contains information on particular service which needs to be invoked when the particular triggering conditions (Service Point Triggers) are met. When a user issues a SIP request, the S-CSCF will route the request to the appropriate AS based on triggering information in service profile and invoke (zero or more) services, in sequence based on their priority order. The SIP message received by the S-CSCF will be passed to the AS hosting the service, and the output will form an input to the next AS (Figure 3).

III. DESIGN OF THE LOCALNOTE SERVICE

The LocalNote service may be described as a location triggered messaging service enhanced with presence. It allows the originating user to create a location-based "sticky note" in form of a SMS message, to be delivered to the recipient user(s) upon entering a designated geographical area (and possibly based on their presence status). The sender can specify the area and the time interval within which the message is valid. After the message is sent, the sender is notified about the status of message delivery. The other feature included in this service, based on linking presence with location as described later in this section, is an enhanced "address book", enabling the user to obtain the location information for all users listed in her "buddy list" (assuming they agree with and/or permit this info to be shared), together with their presence status.

The service uses a newly designed AS in IMS, called LocalNote Content Server, and makes use of the presence and location enablers. The components needed to implement this service are shown in Figure 4:

- LocalNote Content Server
- Location Context Enabler
- Map Server
- Presence+Location Enabler
- Client Application

The service uses the IMS Charging Server for on-line charging, and the Location Enabler (LE), developed in our previous work [5]. The LE uses several different positioning systems to retrieve the end user's geographic location, which it then makes available to other IMS entities via the standard SIP (ISC) interface.

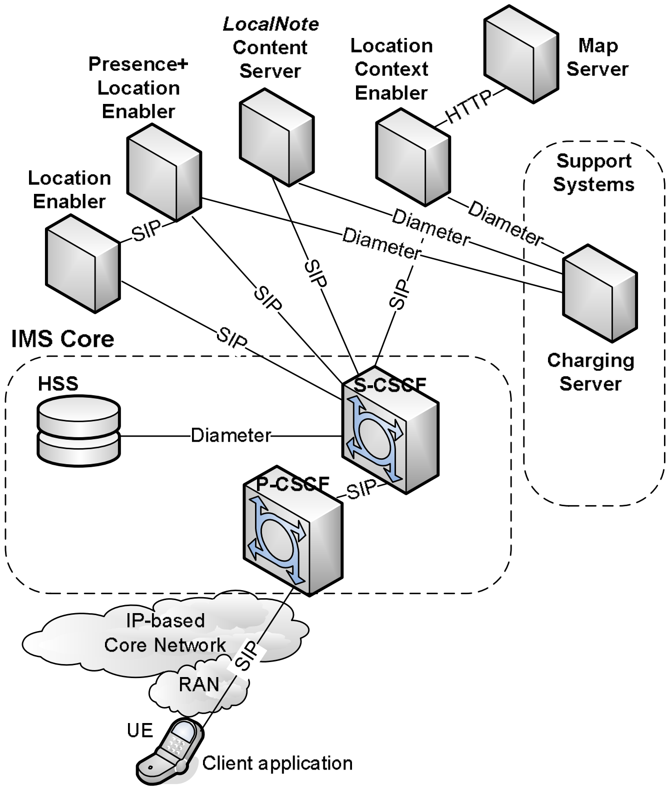

Figure 4. LocalNote components in IMS architecture

The **LocalNote Content Server** is the main AS for the LocalNote service. Its role is: 1) to receive and store LocalNote messages, 2) to contact the LE to obtain information about the recipient's location, and, 3) to forward LocalNote messages to the recipient. It also provides a delivery report to the sender, and verifies with the Charging Server that the sender has a sufficient credit (budget) to use the service.

The **Location Context Enabler** is an enabler which stores the user-defined list of locations, and makes them available to the user when composing the LocalNote message. The user may also add new entries to the list, as well as modify and remove the existing locations. When the service logic so requires, the SIP request may be "chained" with the Presence+Location service, which can retrieve a geographical map referring to the location from the HTTP server (shown in Figure 4 as the **Map Server**).

The **Presence+Location (PresLoc) Enabler** is based on the standard Presence enabler, enhanced with location information. In general, presence service allows a user to be informed about the reachability, availability and willingness of communication of another user on the network (e.g., available, unavailable, offline). When used as an enabler, presence can be invoked by an application that requires information on the status of a user. The PresLoc enabler uses a LE for retrieving the user location data and sends this information to a subscribed IMS entity together with the requested presence status. In the integrated LocalNote **Client Application**, the user gets a map showing the labels with her buddies' current position. The application provides a GUI to compose, send and receive LocalNote messages, and to manage a personal list of locations. A geographic map may be used to set the area centre by clicking on the desired location on the map instead of choosing the area center from the personal location list.

IV. Implementation and Results

The listed components have been implemented in Java programming language, using the Ericsson Service Development Studio (SDS), which provides an integrated environment for design, coding and testing of IMS applications.

A service profile containing a total of six iFCs was defined to enable SIP request routing in S-CSCF. The service profile resides in the HSS, from where it is retrieved by CSCF, as is the user profile. Each iFC contains one or more SPTs, which represent individual filters. By evaluating a Boolean expression as a collection of SPTs, the CSCF decides to which AS the received SIP message should be forwarded if the conditions described in SPTs are met. For example, the iFCs and SPTs defined for the LE and PresLoc are:

Location:	SPT1	Event header = geolocation (group 0)
	SPT2	SIP method = SUBSCRIBE (group 1)
Condition type= "All groups true and at least one trigger true for each group"		
PresLoc	SPT1	Event header = presloc (group 0)
	SPT2	SIP method = SUBSCRIBE (group 1)
	SPT2	SIP method = PUBLISH (group 1)
Condition type= "All groups true and at least one trigger true for each group"		

The implementation of LE is based on the SIP event notification framework [9]. The subscriber (a recipient of location information) sends a SIP SUBSCRIBE message to the LE, and receives a location response in a SIP NOTIFY message. In order to reduce the amount of signaling exchanged during the subscription period, the subscriber may include a location filter within the location request. A location filter is an XML documents which limits the location notification to events of relevance to the subscriber. For the purposes of the LocalNote service, the filer *enterOrExit* was used [5]. As implied by its name, the *enterOrExit* filter event is triggered when the user either enters or exits, i.e. traverses the boundary, of a specified area.

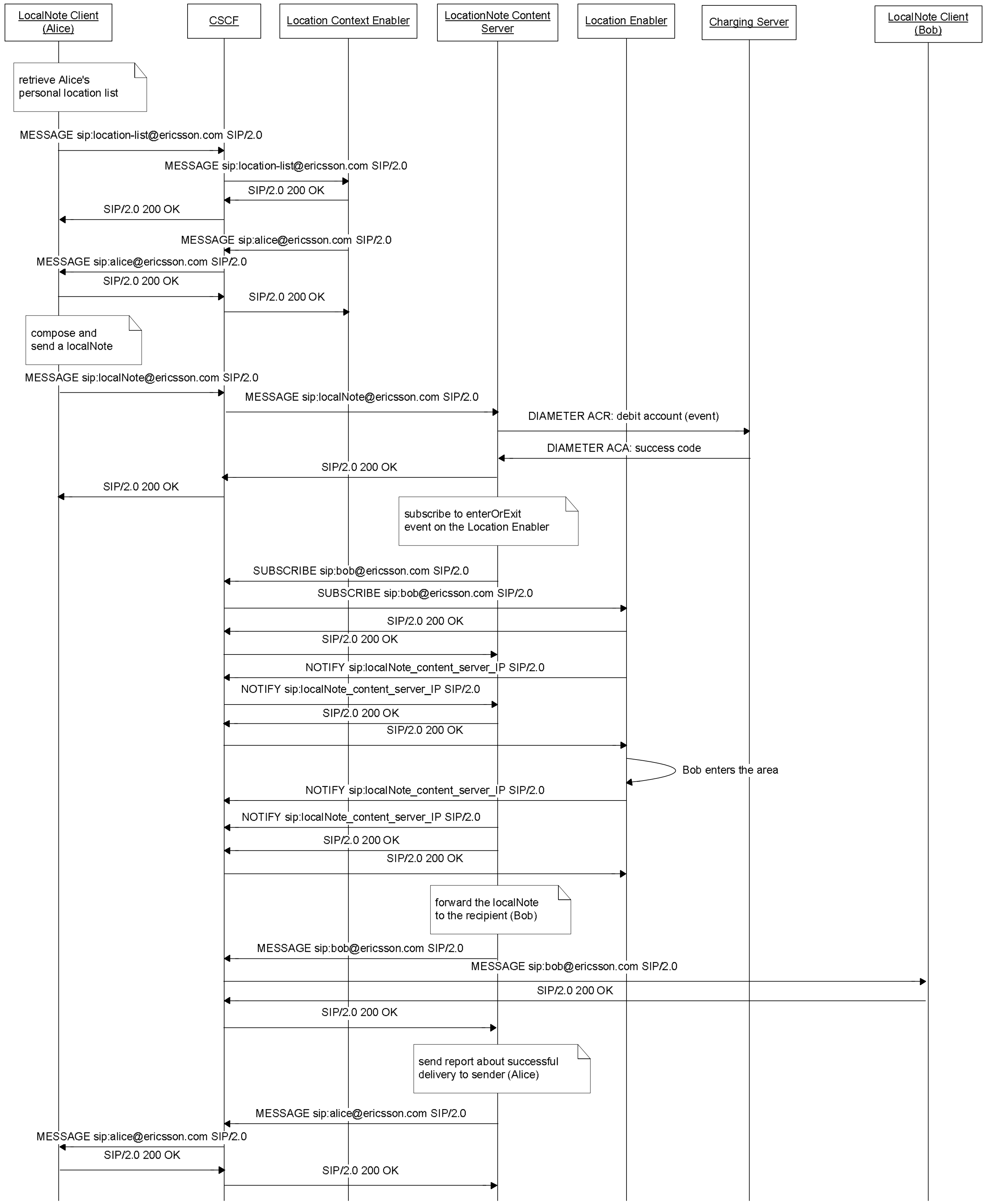

Figure 5. SIP signaling for the basic successful service scenario

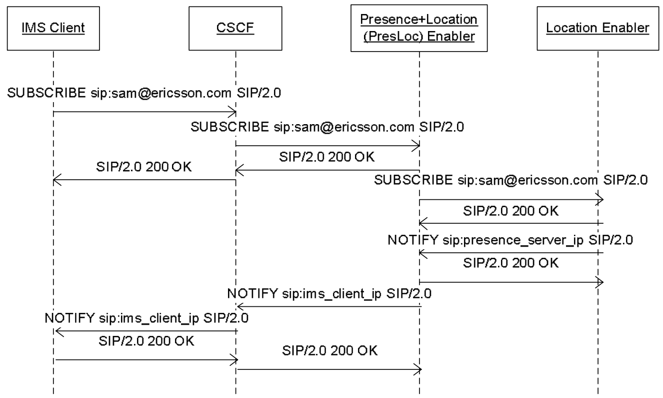

Figure 6. Use of Presence+Location enabler

In Figure 5, a typical use case for the LocalNote service is shown, presenting a signaling diagram for a successful service execution scenario. (To simplify the diagram, P- and S-CSCF are jointly shown as CSCF.) The case involves two users, Alice and Bob, with associated Public SIP URIs alice@ericsson.com and bob@ericsson.com, respectively. Alice attends an out-of-town conference and decides to send a LocalNote to (say, her work colleague) Bob, to ask him to do something in the office for her. She chooses not to utilize SMS for this purpose, since the task is not urgent and she wants to remind Bob of it only if/once he gets to (or close to) the office. She composes a LocalNote and chooses a desired location area ("work/office") from her personal location list. This location area is defined with position of the area center and the size of the area (e.g. "300 meters"). Next, she types in a message to Bob, specifies the validity period of the message, and states that she wants to receive a delivery report. The Client application is responsible for composing the correct SIP request based on input data from the user. The LocalNote service requests, as well as corresponding delivery reports are conveyed by using SIP MESSAGE requests. The LocalNote Content Server then processes the request, and stores the newly received request and the message in its local database. Next, it subscribes itself to the event regarding the location of designated user (in our case, Bob) through the LE. The LE will respond with Bob's initial location status (inside or outside the designated area) and it will send notification when Bob enters designated area (assuming that Bob is initially outside this area). Once Bob enters the area and the LocalNote Server is notified, the server will attempt to forward Alice's message to him. Upon successful message delivery, Alice receives a delivery report. If Bob does not enter the given area until the time when the LocalNote message expires, Alice will be informed that the message could not be delivered.

The enhanced "address book" feature in our prototype uses the PresLoc enabler to allow sharing current location and presence status with colleagues. Although we do not use this enabler in the previous LocalNote messaging scenario, it could be easily done so that the LocalNote context server subscribes to PresLoc (instead of directly to LE). That way, the PresLoc would subscribe to LE (using the *enterOrExit* filter) and, upon receiving a notification from LE, send a notification to watchers, as shown in Figure 6. Potential services where message delivery could be based on presence and location information include, e.g., advertising and fleet management.

The implementation of PresLoc is also based on [9]. Upon receiving a SIP SUBSCRIBE request for a particular user's presence and location information, the PresLoc enabler retrieves the requested location information from the LE, and places it together with the presence status information (using Presence Information Data Format – Location Object (PIDF-LO) [10]) into the body of the response SIP NOTIFY message. Later, after receiving any SIP PUBLISH messages with an updated presence status from the user, the PresLoc Enabler refreshes the user's presence status and sends a SIP NOTIFY message with the updated presence status to all the watchers subscribed to this particular users' presence with location information.

V. CONCLUSION

The work presented in this paper serves as a proof of concept and illustrates by example how the IMS principles of service integration can be applied in practice. Our future work will focus on performance and scalability.

ACKNOWLEDGMENT

The authors acknowledge the support of research projects 036-0362027-1639 and 071-362027-2329 funded by the Ministry of Science, Education and Sports of the Republic of Croatia, and "Session-level Signaling for Advanced Multimedia" of Ericsson Nikola Tesla, Croatia.

REFERENCES

[1] Camarillo, G., and M. Garcia-Martin, The 3G IP Multimedia Subsystem: Merging the Internet and the Cellular Worlds, John Wiley & Sons, 2004.

[2] Gourraud, C. "Using IMS as a Service Framework", IEEE Vehicular Technology Mag. 2(1), March 2007, pp. 4-11.

[3] Rosenberg J., H. Schulzrinne, G. Camarillo, A. Johnston. J. Peterson, R. Spark, M. Handley, and E. Scholer, "SIP: Session Initiation Protocol", IETF RFC 3261, June 2002.

[4] 3GPP TS 23.228: IP Multimedia Subsystem (IMS); Stage 2. Release 7, 2005-06.

[5] Mosmondor, M.; L. Skorin-Kapov, R. Filjar, and M. Matijasevic, M. "Conveying and Handling Location Information in the IP Multimedia Subsystem", Journal of Comm. Software and Systems 2(4), 2006, pp. 313-321.

[6] Reichl, P. P. Reichl, S. Bessler, J. Fabini, R. Pailer, A. Poropatich, N. Jordan, R. Huber, H. Weisgrab, C. Brandner, I. Gojmerac, "Practical Experiences with an IMS-Aware Location Service Enabler on Top of an Experimental Open Source IMS Core Implementation", Int. J. on Media Management, Vol. 2, No. 3, December 2006.

[7] Skorin-Kapov, L., M. Mosmondor, O. Dobrijevic, and M. Matijasevic, "Application-Level QoS Negotiation and Signaling for Advanced Multimedia Services in the IMS", IEEE Communications Mag. 45(7), July 2007, pp.108-116.

[8] Calhoun, P., J. Loughney, E. Guttman, G. Zorn, J. Arkko, "Diameter Base Protocol", RFC 3588, September 2003.

[9] Roach, A., "Session Initiation Protocol (SIP) – Specific Event Notification", IETF RFC 3265, 2002.

[10] J. Peterson, "A Presence-based GEOPRIV Location Object Format", IETF RFC 4119, 2005.