Using Location Information for Sophisticated Emergency Call Management

Lambros Lambrinos and Constantinos Djouvas

Department of Communication and Internet Studies,
Cyprus University of Technology, Limassol, Cyprus
{lambros.lambrinos,costas.tziouvas}@cut.ac.cy

Abstract. It is widely accepted that the faster the response to an incident involving injuries, the higher the probability that lives are saved. Thus, any kind of system that improves the response of the emergency services is expected to be highly beneficial. Improved network connectivity facilities and powerful mobile devices allow the development of smart applications that exploit features such as geographical location identification and Voice over IP. In this paper, we see how we can utilize caller location information to apply policies that enhance emergency call management at both the call originating network and the emergency service call centre; the ultimate aim is to reduce emergency services response times.

Keywords: location based services, VoIP, emergency services, SIP.

1 Introduction

IP-based connectivity via mobile devices is becoming ubiquitous as technologies such as 3G and wi-fi are being widely deployed; the forthcoming 4G will allow for even higher connectivity speeds. Such connections can be utilized by suitable software to enable various applications that users of mobile devices can make the most of. Those applications, allow for much richer information to be exchanged when compared with the standard GSM networks; one such application that is proving quite popular among mobile users is Voice-over-IP (VoIP).

In many situations, people will use their mobile devices to place calls to the emergency services; this is particularly the case for outdoor incidents (e.g. car accidents). In this paper we see how we can utilize caller location information (GPS in particular) to enhance emergency call management at both the calling party gateway as well as at the emergency service call centre.

This paper is structured as follows: after a description of location based services from an emergency management perspective, we present the details of our proposed architecture and call management policies and finish the paper with some concluding thoughts and future work considerations.

2 Background

In this section we present some background information related to our work. First, we describe systems that can be used by mobile devices for location identification and

J. Lin and K.S. Nikita (Eds.): MobiHealth 2010, LNICST 55, pp. 227–232, 2011.

then present different Location Based Services (LBS) designed for providing different types of assistance during emergency situations. Systems that can be used for mobile device location identification can be divided into three categories: satellite-based, network-based and stand-alone [1].

The satellite-based systems utilize satellites that are in orbit around the earth and send information to terrestrial receivers. One such system is the Global Positioning System (GPS); the GPS receivers can estimate their current position with an accuracy between one and ten meters [2] using the information (the satellite's position and distance from the earth) received from the different satellites.

The network-based systems utilize the service carrier's wireless network infrastructure to identify their location. The simplest but least accurate approach is known as Cell of Origin (COO). Using COO, the location of a mobile device is approximated based on the cell it is currently in and its approximation error can be equal to the cell size; this may be up to 35 kilometers in rural areas. A different and more accurate method is called Angle of Arrival (AOA) and is based on triangulation. Mobile devices can calculate the line-of-sight path to a base station by measuring the strength, time of arrival, and the phase of a signal sent by that base station. Utilizing the signals of two base stations, the mobile phone calculates two paths; the intersection point of these two paths represents the location of the mobile phone. Other similar location identification methods are Time of Arrival (TOA) and Time Difference of Arrival (TDOA).

Stand-alone approaches can only be used for providing location information on designated and small size areas, e.g. buildings. Approaches in this category require special equipment appropriately configured; for example a Bluetooth device that provides location information to mobile devices that enter its coverage area. The accuracy of the resulting location can be controlled by the administrator since it can range from a single office (using Ethernet jacks [3]) up to whole buildings or blocks.

Utilizing location information, different Location Based Services (LBS) can be implemented. From the perspective of emergency management and according to [4], we can define two categories of location-based emergency services:

The first category, regards applications that provide location information. In this category we can assign applications that users use to establish emergency calls; the European Union and the United States have both defined standards (E112 [5] and E9-1-1 [6] respectively) that oblige telecommunication carriers to provide location information for emergency calls. Furthermore, emergency VoIP calls can also belong to this category. Identifying the shift towards IP telephony, an extension of E9-1-1 known as NG9-1-1 [7] is under development and the new standard will extend E9-1-1 with IP based compatibilities. For the dissemination of location information over IP calls, the SIP working group is in the process of defining an extension to the Session Initiation Protocol (SIP [8]), the Location Conveyance for Session Initiation Protocol [9], that can be used for "conveying" location data over a SIP message exchange.

The second category of location-based emergency applications includes applications that propagate emergency related information to users in specific areas; those can be used for informing users in particular areas about an unfolding emergency event. The dissemination of such information can be achieved using different methods with the simplest one being the use of the Short Message Service (SMS); a plain SMS message is sent to all users in a particular area, usually to all phones in the coverage area of one or more base stations [10]. A similar approach that achieves the same results is known as Short Message Service - Cell Broadcast. This method, has a distinct advantage against the plain SMS approach since it achieves the simultaneous delivery of messages to multiple users in a specified cell using broadcasting, preserving resources and bandwidth. In addition to the plain text messages that can be sent using the abovementioned approaches, services like Multimedia Message Service (MMS) [11] can be used for disseminating richer context.

Finally, techniques that allow users in specific areas to receive live streaming are available. For example, the Multimedia Broadcast and Multicast Service (MBMS) [12] facilitates broadcasting of different forms of content to different areas; this allows an unlimited number of users present in the same area to watch the same mobile TV program. Utilizing this technology, users in emergency areas can receive live streaming with the latest information updates on the emergency situation.

3 System Architecture and Call Management Policies

This work aims to create a system that reduces the time required for establishing and handling emergency calls. More precisely, leveraging from the assumption that calls include the caller's location, we concentrate on devising smart call management mechanisms at both the call initiation proxy as well as the call receiving proxy. These mechanisms will efficiently and effectively prioritize emergency calls, resulting in reduced possessing times for such calls.

We concentrate on IP-based telephony which uses the SIP protocol for call establishment. Calls from the User Agents on the mobile devices can include the caller's location in the form of coordinates acquired using GPS; this can be included in the SIP INVITE message. This information will enable the emergency service agents to quickly pinpoint the caller's location and thus emphasize on acquiring incident information.

3.1 System Architecture

The overall architecture proposed for our system is shown in Figure 1. As calls to the emergency services are highly important, it is imperative that they are prioritized over other calls in cases where demand for calls exceeds the capacity available (which is often the case in major incident areas). To facilitate this call handling scheme, we introduce two new entities: the Emergency Call Scheduler (ECS) and the Smart Emergency Call Queue Manager (SECQM).

The Emergency Call Scheduler (ECS) runs on the call initiation proxy and is responsible for handling call requests from mobile users within its coverage area which may include multiple wi-fi access points or mobile base stations. Thus, the prioritization of emergency call requests is the responsibility of the ECS which manages the outgoing call queue and can assign different priorities to pending call requests [13].

At the emergency call centre (PSAP) end, the Smart Emergency Call Queue Manager (SECQM) runs on the call receiving proxy and is responsible for managing the incoming call queue. The SECQM can utilize a number of call distribution and prioritization policies again based on the use of caller location information and call historical data.

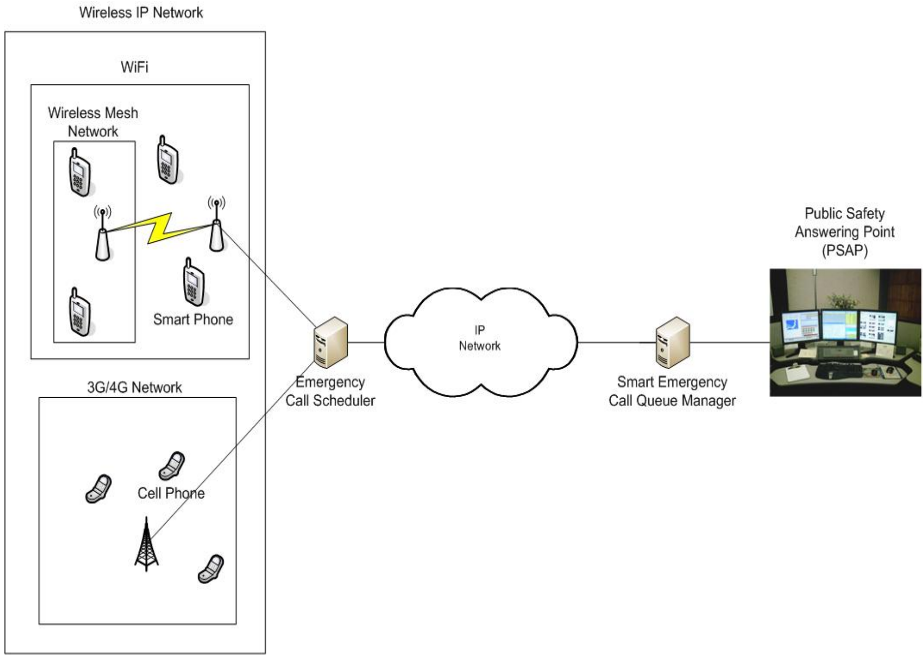

Fig. 1. System Architecture

3.2 Call Management Policies

As already mentioned, in the heart of the proposed system the ECS and SECQM will apply various call management policies to prioritize emergency-related calls; we discuss here some potential prioritization schemes. The elements used to determine a call's priority include: its destination, the caller's location and calling history.

From the point-of-view of the ECS, call requests may be destined for 9-1-1 type numbers or normal telephone numbers with the former having higher priority, as expected. Using calling history information, higher priority (among emergency calls) can perhaps be given to such calls originating from a new location; they are likely to report another incident. Moreover, calls to non-emergency numbers that originate from callers who have previously placed an emergency call may also be prioritized.

Based on the above, the order in a queue of pending calls could be as follows:

a) emergency calls from a new location,
b) emergency calls from a previously reported location,
c) normal calls from users who have previously placed emergency calls or from locations where emergency calls have previously originated and
d) all other calls.

The calls destined for 9-1-1 type services are received by the SECQM whose aim is to reduce call waiting and call handling times; the simple first-come-first-served policy for the calls may not always be appropriate and some call prioritization/allocation may be useful.

Calls with higher probability of reporting a new emergency incident (i.e., originating from regions where no active emergency incidents exist), could be considered as more important than calls originating from regions that the system already knows the existence of an emergency incident. In a more radical note, the queue manager may push calls from callers near a previously reported incident to the end of the queue. Such calls are likely to report the same incident or enquire about the status or location of emergency vehicles and may hence delay the handling of calls regarding new incidents.

The existence of call handling agents can make the operation of the SECQM much more complex. In another scenario, subsequent calls originating from a previously reported location can be directed towards the agent who handled the initial call; this agent (if available) will already be familiar with the incident which can potentially reduce the call completion time.

4 Conclusions and Future Work

It is widely accepted that the faster the response to an incident involving injuries, the higher the probability that lives are saved. Thus, any kind of system that improves the response of the emergency services is expected to be highly beneficial. In this paper we have presented our considerations for such a system that attempts to utilize advances in communication technologies and mobile devices to make emergency call handling mechanisms more sophisticated.

Our immediate plans are to modify an open-source SIP user agent in order to include GPS information in its INVITE messages. To implement the ECS we plan to extend the call scheduling capabilities of the enhanced SIP proxy proposed in [13] and add the ability of processing the additional information in the SIP messages. The acquired info will be passed to the SECQM for further processing.

By allowing the proposed system to manage the incoming call queue, we believe that we can achieve better resource allocation at the emergency call centre which can result in faster response from the emergency services. The implementation of the system will be evaluated under different scenarios to ascertain its effectiveness.

References

1. Zhao, Y.: Vehicle navigation and information systems. In: Webster, J.G. (ed.) Encyclopedia of Electrical and Electronics Engineering, vol. 23, pp. 106–118. Wiley, New York (1999)
2. Hightower, J., Borriello, G.: A Survey and Taxonomy of Location Systems for Ubiquitous Computing. IEEE Computer 34, 57–66 (2001)
3. Mintz-Habib, M., Rawat, A., Schulzrinne, H., Wu, X.: A VoIP Emergency Services Architecture and Prototype. In: 14th International Conference on Computer Communications and Networks, pp. 523–528. IEEE Press, New York (2005)
4. Aloudat, A., Michael, K., Abbas, R.: Location-Based Services for Emergency Management: A Multi-Stakeholder Perspective. In: The Eighth International Conference on Mobile Business (ICMB 2009), pp. 143–148. IEEE Press, New York (2009)

5. European Commission: Commission Recommendation of 25 July 2003 on the processing of caller location information in electronic communication networks for the purpose of location-enhanced emergency call services. Official Journal of the European Union L 189, 49–51 (2003)
6. National Emergency Number Association: NENA Technical Requirements Document On Model Legislation E9-1-1 for Multi-Line Telephone Systems. NENA 06-750, V.2 (2009)
7. The NG9-1-1 Project webpage, http://www.nena.org/ng911-project
8. Rosenberg, J., Schulzrinne, H., Camarillo, G., Johnston, A., Peterson, J., Sparks, R., Handley, M., Schooler, E.: SIP: Session Initiation Protocol, RFC 3261. IETF (2002)
9. Polk, J., Rosen, B.: Location Conveyance for the Session Initiation Protocol, Internet Draft. IETF (2009)
10. Aloudat, A., Michael, K., Yan, J.: Location-Based Services in Emergency Management-from Government to Citizens: Global Case Studies. In: Mendis, P., Lai, J., Dawson, E., Abbass, H. (eds.) Recent Advances in Security Technology, 1st edn., pp. 190–201. Australian Homeland Security Research Centre, Canberra (2007)
11. Mobile networks go broadcast with Ericsson, http://www.ericsson.com/thecompany/press/releases/2006/04/1043320
12. Multimedia Messaging Service V1.3, http://www.openmobilealliance.org/
13. Lambrinos, L., Djouvas, C.: Applying scheduling policies to improve QoE in wireless Voice-over-IP. In: 28th IEEE International Performance and Communications Conference (IPCCC). IEEE Press, New York (2009)