Emergency call positioning

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Abstract

This is an article about an emergency call position in mobile and fixed networks. Main emphasis resides in the mobile networks, as its challenges are bigger than in the fixed networks. This article is focused to describe how an emergency centre can obtain user's location and what are the network solutions. This article does not describe the actual positioning mechanism.

The article begins with a review of regulatory requirements for an emergency call positioning in European Union and in the United States. It is followed by description of the circuit switched position solutions that can be used for locating mobile and fixed users. After that mechanism to provide positioning in case of packet switched emergency calls is given in the context of the IP Multimedia Subsystem (IMS). This part contains author's opinions how the solution could be provided. Finally impacts to different players in the value chain are analysed.

1. INTRODUCTION

You place an emergency call when you realize that there is a need for rapid or immediate assistance regardless of the subject. The subject might be person or animal and reason might be direct risk of life or damage to a property or environment. Emergency personals in emergency centres will respond to your call and they will dispatch proper help to the emergency scene. Sometimes you know your location and you are able to tell the exact location to an emergency dispatcher but sometimes you do not know or you are not able to speak. In these type of cases, it is a tremendous advantage that an emergency centre knows your location and is able send help to the right place as soon as possible. Sometimes few minutes might mean difference between death and live.

Location information in this article means data in a mobile network indicating the geographic positioning of a user's user equipment and in fixed network the data about the physical address of the termination point. Emergency call positioning means in this article a mechanism to deliver user's location information to an emergence centre.

2. REGULATORY STATUS

This chapter gives an overview of regulation in European Union and the United States

2.1 European Union

In July 2003 European Union released commission recommendation on the processing of caller location information in electronic communication networks for the purpose of location-enhanced emergency call services. It forms the regulatory framework for emergency call positioning. It states that member states should apply the following harmonized conditions and principles to the provision of caller location information to emergency services for all calls to the single European emergency call number 112 [EU]. The following recommendations are the key recommendations from this article's point of view.

'For every emergency call made to the European emergency call number 112, public telephone network operators should, initiated by the network, forward (push) to public safety answering points the best information available as to the location of the caller, to the extent technically feasible. For the intermediate period, it is acceptable that operators make available location information on request only (pull).

Fixed public telephone network operators should make available the installation address of the line from which the emergency call is made.

Public telephone network operators should provide location information in a non-discriminatory way, and in particular should not discriminate between the quality of information provided concerning their own subscribers and other users.

All location information provided should be accompanied by an identification of the network on which the call originates.

Public telephone network operators should keep sources of location information, including address information, accurate and up-to-date.

For each emergency call for which the subscriber or user number has been identified, public telephone network operators should provide the capability to public safety answering points and emergency services of renewing the location information through a call back functionality (pulling) for the purpose of handling the emergency.'

After the release of the commission recommendation member states will define country specific implementations. The commission has requested European Union member states to submit their status on the situation of emergency call implementation by end of 2004. After receiving the feedback the commission will analyze experiences and practicalities within each member state and is able to update the commission recommendation. For instance in Finland so called 'pull' model is required in the first phase [Ficora]. In contrary, in Sweden two models are allowed: 'ordinary Pull type of solution and 'Cell-Id based solution' [ITS]. Here it is not important to understand how different technical models work rather to realize that different variants exist and understand that it will impact the network infrastructure vendors as explained later on this article.

2.2 The United States

The authority in the United States, the US Federal Communications Commission (FCC), took action already in year 1994 and requested mobile radio service providers to provide caller's location information for emergence service providers [FCC1].

Year 1996 the FCC released E911 First Report and Order [FCC2] that contains two phase approach to an emergency call positioning. This report has been commented several times by industry players and it has been revised multiple times.

In the phase I carriers are mandated to transmit a caller's automatic number identification and the location of the cell site or base station receiving a 911 call to the designated 911 Public Safety Answering Point (PSAP) (i.e. emergence centre). In the Phase II, carriers are mandated to transmit more accurate automatic location information of a caller. The accuracy of the required location information depends on whether a handset-based location technology (such as Global Positioning Systems) or Network-based Location Technology is used.

- *"For network-based technologies: 100 meters for 67 percent of calls, 300 meters for 95 percent of calls;*
- *For handset-based technologies: 50 meters for 67 percent of calls, 150 meters for 95 percent of calls.*
- *For the remaining 5 percent of calls, location attempts must be made and a location estimate for each call must be provided to the appropriate PSAP* [FCC3]*"*

Timing for phase II has been set flexible as it is stated that operators using a network-based location technology shall provide Phase II 911 enhanced service to at least 50 percent of their coverage area or 50 percent of their population beginning October 1, 2001 or within 6 months of PSAP request, whichever is later; and to 100 percent of their coverage area or 100 percent of their population within 18 months of such a request or by October 1, 2002, whichever is later [FCC3]. Similar type of requirement exists for operators using handset-based location technologies. For example it is required:

- *without respect to any PSAP request for deployment of Phase II 911 enhanced service, the operator shall begin selling and activating location-capable handsets no later than March 1, 2001.*
- *once a request from* PSAP *is received, the licensee shall, in the area served by the PSAP: Within six months or by October 1, 2001, whichever is later: ensure that 100 percent of all new handsets activated are location-capable.*
- *Within two years or by December 31, 2004, whichever is later, undertake reasonable efforts to achieve 100 percent penetration of location-capable handsets among its subscribers* [FCC3].

Current situation in the US is that operators have chosen different location technologies to be used.

Moreover, different phases have been implemented using different schedules across the US.

3. SOLUTION DESCRIPTION

This chapter gives a short overview on technical solutions required for an emergency call positioning. The explanation is limited to minimum. Please refer to 3GPP TS 23.271 (120 p.) [23271] and J-STD-036 (318 p.) [JSTD036] for detailed descriptions. First circuit switched (CS) mechanism is explained and secondly packet switched (PS) mechanism is covered. The reader should acknowledge that the CS based position for emergency calls is well documented and standardized in appropriated standardization bodies. However, the PS based emergency calls are not standardized yet. The standardization is expected to take place in 3rd Generation Partnership Project (3GPP) Release 7 in the scope of IP Multimedia Subsystem (IMS). The description here is based on author's knowledge of 3GPP Release 6 standardization activities.

3.1 Positioning in the circuit switched mobile network.

The figure 1 shows key network functions for performing positioning for emergency calls. The Gateway Mobile Location Center (GMLC) is the focal function for location services. It acts as a contact point for location clients and takes care of authentication and finding of network entity that serves user equipment such as mobile station. In case of an emergency call two main positioning variants exist: pull model and push model.

3.1.1 Pull model

In the pull model an emergency centre acts as a location client and contacts GMLC for requesting a calling user's position using an identity identifying the caller that was received in the call setup request. When the GMLC receives the request it uses Home Location Register to find the mobile services switching centre (MSC) that serves the user. After finding the MSC the GMLC sends location request to the MSC including e.g. information how accurate information and how fast the information should be delivered. Then the MSC requests location information from Radio Access Network (RAN). Finally, the RAN resolves the user's location and returns the information back in the chain.

3.1.2 Push model

In contrary to the pull model in the push model the network takes active role. I.e. when an emergency call is detected in MSC it starts positioning procedures in parallel to a call setup. After receiving the location information from RAN the MSC sends the location information to GMLC. Finally, the GMLC may push information to an emergency centre or it may store the information and wait that an emergency centre requests the information. A different push model variant for US market exists in 3GPP standards [23271]. It is possible that the call setup is halted in the MSC until the user's location is obtained. In reality it means that the MSC receives an emergence call request from a user equipment and does not pass the call to an emergency centre prior having the user's location. This model adds delay to a call setup but in contrary it helps for selecting the correct emergency centre for a call. In the US, same cell area may be covered by two emergency centres and more accurate positioning is required for selecting the correct emergency centre e.g. at a state border.

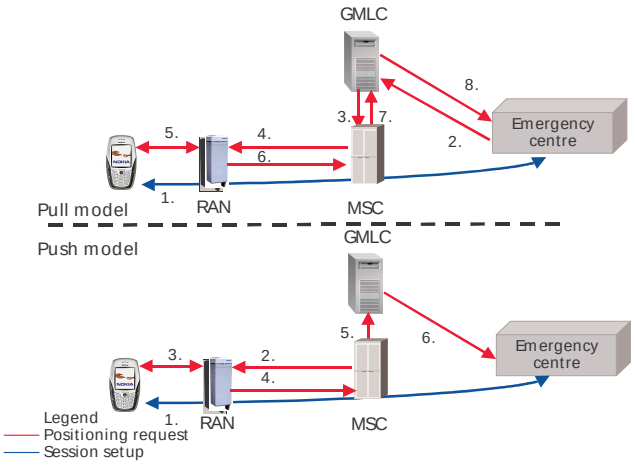

Figure 1. Architecture for pull and push models.

3.2 Positioning in the fixed network.

Positioning of emergency calls initiated from fixed (landline) is straightforward as the caller's position is fixed. For providing user's position in a fixed network, an operator needs to maintain a database in its network that contains information about the installation address (street address and X and Y

coordinates) of the line. When a user makes an emergency call then the operator either adds the user's position information to the call control signaling (push) or makes the database available for an emergency centre (pull). In the pull case the emergency center could use user's telephony number as a key to the database search.

3.3 Positioning in the packet switched mobile network.

In this section packet switched network refers to Universal Mobile Telecommunications System (UMTS).

Positioning is also possible in packet switched networks as GMLC is able to contact serving GPRS support node (SGSN) and SGSN is able to obtain the location information from RAN [23.271].

At the moment there is one global standardized architecture defined for all kind of SIP based multimedia applications such as VoIP. It is IP Multimedia Subsystem as defined in 3GPP. Currently, users are not able to place emergency calls via the IMS in contrary the user equipment must use CS network to place emergency call [23228]. Work is ongoing in 3GPP to add an emergency call feature to the IMS in Release7.

The following description presents author's view how an emergency session positioning could be provided in the IMS. Figure 2 presents a high level architecture for IMS emergency sessions.

General Packet Radio Service (GPRS) core in the figure 2 contains both SGSN and Gateway GPRS Support Node (GGSN) that are needed to offer PS services in the UMTS architecture. The Proxy-Call Session Control Function (P-CSCF) and Serving-Call Session Control Function are the minimal IMS functions that the author sees necessary for offering IMS emergency calls. The P-CSCF is the first contact point for users within the IMS. All signaling traffic from or to the user equipment go via the P-CSCF. The S-CSCF is responsible for controlling the calls and routing request further. For full details, please refer to 3GPP standards[23228] or IMS specific book [IMS].

As depicted in the figure 2 the S-CSCF routes the emergency call directly to an emergency centre if the emergency centre is able to handle PS traffic (e.g. Session Initiation Protocol (SIP) and Real-time Transport Protocol). In contrary if the emergency centre is not able to handle PS traffic then the S-CSCF routes the call via interworking functions that takes care of protocol conversion (e.g. SIP to ISUP). This provides necessary routing machinery between user equipment and emergency centre for IMS emergency calls. When this capability is built then it is time consider how an emergency call positioning could be provided.

3.3.1 Pull model

This model could be supported in very similar manner than in CS network when this is look at from emergency centre point of view. I.e. when the emergency centre receives an emergency call it will act as a location client and sends a location request to GLMC that will realize that the user is server by PS network and requests user's location from SGSN. The SGSN further request the user's location from the RAN after receiving it will return the info to emergency centre via the GMLC.

3.3.2 Push model

Supporting of this model would require additional changes to the UMTS architecture as the IMS is built on principle that user plane and control plane are separated. This is a big difference compared to CS networks where MSC handles both user and control plane traffic and is able to communicate with RAN. The impact of this design is that the IMS does not have knowledge about user's mobility and location. Making the push model to work two options exist: add a new reference point between S-CSCF and GMLC or push the location information from the GPRS layer. If the first option is chosen then S-CSCF needs to contact the GMLC via the new interface when an emergency request arrives to the S-CSCF and ask it to do positioning while S-CSCF sends the emergency call request to an emergency centre. In the second alternative, SGSN initiates the location procedure when realizing that the user is making an emergency call. E.g. when a Packet Data Protocol (PDP) context with an emergency indication is activated then the SGSN request location information from the RAN and after receiving it the SGSN delivers the user's location information to GMLC.

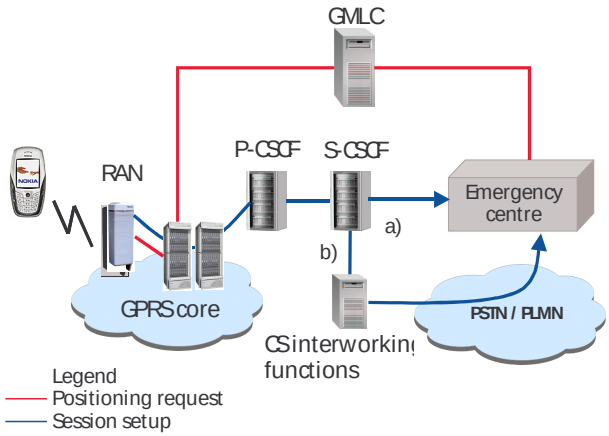

Figure 2. Architecture for emergency call positioning in the IMS.

4. IMPACT TO DIFFERENT PLAYERS

This chapter highlights how an emergency call positioning feature impacts to main stakeholders – end-users, operators, vendors and emergency centres.

Like any other technical feature end-users do not see how a new feature is provided. However, this type of technical feature makes entire society more secure as people can trust they will get rapid and efficient emergency help. It is quite evident that this type feature saves lives and improves speed of rehabilitation of injured people. In some market areas such as in the US this type feature increases the price of handsets due to need for having a Global Positioning Systems chipset in the handset. On the other hand, deployment of network based location technologies may mean that operators introduce other location based services such as 'locate a friend' or 'find the nearest pub'.

From operators point of view this feature increases the cost as operators are paying the cost of network infrastructure. Additional cost for those operators who have commercial location based services should not be too high. However, if an operator does not plan to introduce commercial location services the cost of upgrading its core network is clearly higher. In most of the countries emergency calls are free of charge so operators are not able to get invested money directly back.

Telecommunication vendors are needed to provide solutions for operators that fulfill operator's business case and complements with overall regular framework. As mentioned earlier in this article there are country specific variants of emergency call positioning this clearly increases the development cost and time of network products. Supporting emergency calls via the IMS makes possible to offer telephony services to customers that are using WLAN or other broadband devices. Moreover, in longer term it makes possible to offer network solutions for replacing circuit switched networks.

For emergency centres the cost consists of upgrading the call system to be able to receive and present the caller's location.

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