Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

PRACTICAL IMPROVEMENTS IN HANDLING 112 EMERGENCY CALLS: CALLER LOCATION INFORMATION

Lisbon, April 2010

0 EXECUTIVE SUMMARY

Each year in the European Union several millions of citizens dial the emergency call number to access emergency services. Due to increasing penetration of mobile telephony in the society, the share of emergency calls emanating from mobile networks is rapidly outgrowing emergency calls for fixed networks; this causes that an emergency situation mobile callers are increasingly not able to indicate the precise location for an optimum response. Similarly, VoIP services are substituting voice calls over traditional networks, customers increasingly use VoIP for emergency calls and expecting the same reliability and completeness of the emergency calls service.

Location information is normally represented by data indicating the geographic position of the terminal equipment of a user. These data vary in range, indicating in a general way where the user is or very precise, pinpointing the user's whereabouts to within a few meters. Some location data are effectively a subset of signalling data as they are necessary for setting up a telephone connection.

In the framework of Enhanced emergency call services, the availability of location information must serve three main goals:

- Route the calls to the right emergency call centre;
- Locate the caller and/or the incident site.
- Dispatch the most appropriate emergency response team(s);

The Report identify the most relevant regulatory principles applicable to caller location requirements in the context of emergency calls and analyses the location information standards produced by ETSI as a Standard Development Organization for fixed, mobile and IP communications networks.

In the end, the Report also includes the best European practices on the basis of the latest implementation report concerning treatment by each Member State of the caller location information for 112 activities.

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1 INTRODUCTION

The ability to initiate an emergency communication to request help when needed is a right of all citizens, and this ability should be independent of the network and access technologies deployed or the physical abilities of the citizen.

The rights of individual users to privacy should be adhered to according the European regulation and it is therefore essential that all information derived from emergency calls should only be used for management of the related emergency. If applied to non-emergency calls, the use of caller location information for commercial purposes will be subject to European and national regulation.

In many circumstances, citizens reporting an incident requiring urgent assistance are unable to provide the emergency service with accurate information about the location of emergency. This may be due either to the nature of emergency, the callers' lack of local knowledge, their disabilities or lack of linguistic ability, etc. Young children or cognitively impaired people may not have the language skills to explain their location, speech and/or hearing impaired users may not be able to use text terminals, elderly or confused people may not be able to use any form of terminal, etc. The successful outcome of emergency call could make the difference between life and death. It is therefore essential for the emergency responders to be provided with accurate location information via an automated process based on communication network being used by the caller.

Implementation of caller location system is also likely to result in a welcome positive impact on the reduction of malicious calls made by criminal or anti-social persons when they realise that the automatic provision of their location information to the emergency services could contribute significantly to their prosecution.
For these significantly large categories of users the successful outcome of an emergency call could make the difference between life and death. It is therefore essential for the emergency responders to be provided with accurate location information via an automated process based on the communication network being used by the caller.

The European emergency number 112 was introduced in 1991 to introduce a single European emergency call number in parallel with any other existing national emergency call numbers. . Since 1998, EU rules require Member States to ensure that all fixed and mobile phone users can call 112 free of charge. Since 2003, telecoms operators must provide caller location information to emergency services, where technically possible.

2 SCOPE

The main goal of the document is to explain the several roles that location information plays in handling emergency calls in a satisfactory manner, to describe the technical methods used for the location of the user equipment in Land Mobile Communications Networks in Fixed Networks and managed IP Networks and for determining the information that needs to be provided to the respective national authorities managing 112 emergency response systems.

The Report also outlines the legal requirements in place in relation with location information and the current status of implementing the caller location information in the European Union Member States.

The present document also includes an analysis of location information standards produced by ETSI (European Telecommunications Standardization Institute). The object of this analysis was to determine what standards existed and had been adopted for determination of caller location, in order to assist in the response to emergency calls.

3 REFERENCES

For the purpose of the present document the following references apply:

ETSI TS 125 305 v8.0.0 (2008-10)	Universal Mobile Telecommunications System (UMTS); User Equipment (UE) positioning in Universal Terrestrial Radio Access Network (UTRAN); Stage 2 (3GPP TS 25.305 version 8.0.0 Release 8)
ETSI TS 123 271 v8.0.0 rel.8 (2009-01)	Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Functional stage 2 description of Location Services (LCS) (3GPP TS 23.271 version 8.0.0 release 8)
ETSI TS 143 059 v8.1.0 rel.8 (2009-01)	Digital cellular telecommunications system (Phase 2+); Functional stage 2 description of Location Services (LCS) in GERAN (3GPP TS 43.059 version 8.1.0 release 8)
ETSI TS 102 660 v1.1.1 (2008-07)	Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Signalling Requirements and Signalling Architecture for supporting the various location information protocols for Emergency Service on a NGN
ETSI TR 102 476 v1.1.1 (2008-07)	Emergency Communications (EMTEL); Emergency calls and VoIP: possible short and long term solutions and standardization activities
ETSI TS 102 650 v1.1.1 (2008-07)	Telecommunications and Internet converged Services and Protocols for advanced Networking (TISPAN); Analysis of Location Information Standards produced by various SDOs
ETSI TS 123 167 v8.3.0 (2009-03)	Universal Mobile Telecommunications Systems (UMTS); IP Multimedia Subsystem (IMS) emergency sessions (3GPP TS 23.167)
COCOM09-11 Report	Implementation of the European emergency number 112 – Results of the second data gathering round (January 2009)
COCOM09-11 Annex	Annex to document COCOM09-11 Report on the implementation of 112
ERG 07-56 rev2	ERG Common Position on VoIP
ERG 09-19	ERG Action Plan to achieve VoIP conformity with ERG Common Position

Other relevant references related to caller location information:

ETSI TR 102 299 v1.1.1 (2008-04)	EMTEL –Emergency Communications Collection of European Regulation Principles
ITU-T Y.2205 (09/2008)	Next Generation Networks – Emergency telecommunications- Technical considerations
ITU-T Y.1271 (10/2004)	Framework(s) on network requirements and capabilities to support emergency telecommunications over evolving circuit –switched and packet switched networks
ETSI TR 102 180 v1.1.1 (2007-02)	Basis requirements for communication of individuals with authorities/organizations in case of distress (Emergency call handling)
ETSI TS 102 164 v1.3.1 (2006-09)	TISPAN; Emergency Location Protocols
ETSI TS 123 171 v3.11.0 (2004-03)	UMTS; Location Services; Functional description; Stage 2 (UMTS) (3GPP TS 23 171 version 3.11.0 Release 1999)
ETSI SR 002 777	EMTEL; Test /verification procedure for emergency calls

4 DEFINITIONS

Enhanced 112 (E112)	emergency communications service using the single European emergency call number 112, which is enhanced with location information of the calling user
Emergency call	call from an individual who wants to reach the PSAP
Emergency call facilities	emergency telephone stations/boxes, fire alarms, etc
Emergency Control Centre	facilities used by emergency organizations to handle rescue actions in answer to an emergency call (Note: a PSAP forwards emergency calls to the Emergency Control Centres)
Emergency number	special short code or number which is used to place an emergency call; There exist two different types of Emergency numbers in Europe: ▪ European emergency number, 112: the emergency number for pan-European access to Emergency services used in EU member states and other European countries; ▪ National Emergency numbers: each country may also have a specific set of emergency numbers
Emergency response organization	e.g. the police, fire services and emergency medical services
Emergency service	service, recognized as such by the Member State, which provides immediate and rapid assistance in situations where there is a direct risk to life, individual or public health or safety, to private or public property, or the environment
Location information	data enabling to know the geographic position of a terminal used by the calling party
Originating network	the portion of the communication network that provides the connection of a user's equipment to the public communication services from which the emergency call is originated
Public Safety Answering Point (PSAP)	physical location where emergency calls are received under the responsibility of a public authority

User access	point of access to a telecommunications network where an emergency call can be requested (this includes public telephones and emergency call facilities
IP network	packet transport network deploying the Internet Protocol
Voice over Internet Protocol (VoIP)	the generic name, which defines the transportation of voice traffic by means of transmission in packets using Internet Protocol (IP)
IP–based telephony (Voice over Broadband - VoB)	specific VoIP service, where the voice traffic is carried by data packets fully or partially on a managed IP network, in which case the management of network means management of quality, reliability and security of calls; the Voice over Broadband provider controls the access network of his subscribers; NGN and LTE are examples of VoB scenarios
Internet Telephony (Voice over Internet – VoI)	a specific VoIP service using transmission in packets on the Internet public network which is by definition open and non-controllable
Nomadicity	feature of a service that makes that the service is not linked to a particular physical location and that the service can be provided from potentially any fixed network endpoint in the world for incoming and outgoing communication

5 GENERAL ASPECTS

5.1 European Union rules concerning caller location information for calls to 112

Universal Service Directive (2002/22/EC)

The directive provides the requirements concerning caller location information of 112 calls:

”Member States must also ensure that emergency services are able to establish the location of the person calling 112. The ability to locate the caller in case of an emergency may be of great significance in a situation where the person is unable to state his or her location, which can happen particularly when calling from mobile phones or travelling abroad.”

Commission Recommendation on the processing of caller location information in electronic communication networks for the purpose of location-enhanced emergency call services (2003/558/EC)

The document establishes a set of principles and conditions for provision of caller location information to 112 emergency services. The main provisions are the following:

- Forwarding (pushing) to Public Safety Answering Points (PSAPs), by the public telephone network operators of the best information available as to the location of the caller, to the extent technically feasible;
- Provision of the location information in a non-discriminatory way, by the public telephone network operators, e.g. not to discriminate between the quality of information provided concerning their own subscribers and other users;
- Provision by the public telephone network operators, for each emergency call for which the subscriber or user number of the capability of renewing the location information through a call back functionality (pulling) for the purpose of handling the emergency.

In addition to the above-mentioned conditions, national administrations were required to encourage the use of a common open interface standard and in particular for a common data transfer protocol adopted by ETSI aimed at facilitating data transfer between operators and Public Safety Answering Points.

Communication Committee (COCOM) Working Documents

COCOM09-11 Communications Committee - Working Document “Implementation of the European emergency number 112 – Results of the second data-gathering round (January 2009) “and the ANNEX to COCOM09-11 are the latest documents submitted to the Commission as the results of the survey for updating the Commission 112 website (http://ec.europa.eu/112).

The Report analyses the information submitted by Member States in the response to COCOM Questionnaire on the implementation of the European emergency number 112. The purpose of this second exercise was to gather as complete data as possible on the functioning of 112 in the EU Member States.

COCOM09-11 Report summarizes the information from the Member States replies, outlining the main implementation trends and highlighting best practice. The findings of this Report serve as a basis for the Commission website on 112, launched in June 2008, aiming to inform citizens about the functioning of 112 across the Member States.

For the purpose of this Report the chapter Caller Location and the sub-chapters Mobile Calls, Fixed Calls where cited.

Since 2006, the Commission has launched infringement proceedings for lack of caller location against 13 Member States. As of October 2009 two cases are still open.

5.2 The role of Location Information in case of calls to 112 Emergency Services

5.2.1 Use of the Location Information

The location information in case of calls to 112 Emergency Services plays several important roles in handling emergency situations.

Usually, a national emergency system comprises several public safety answering points (PSAPs), nodes that concentrate call handling resources and, in case of integrated PSAPs, even specialized emergency dispatch centres (police, fire brigade, ambulance, law enforcement…). Each PSAP has allocated a certain area of responsibility. Routeing the call to the appropriate PSAP, the one that is responsible for the area from which the call has been placed, is dependent on the location information sent by the network in which the call is initiated. This requires a good accuracy to ensure that the emergency call is not routed to the wrong PSAP, which would cause an extra delay.

Better accuracy of the location information is needed to establish the right dispatch centre (e.g. police or fire brigade station), usually the one closest to the incident, that will respond to the emergency. Inadequate location information sent by the network could result in delays in responding to an emergency which may have serious consequences.

Even better accuracy is needed, in the case of high density areas, in order to determine the location of the incident and consequently the best route to reach the emergency. In case of high density areas, e.g. mismatching one road with another could result in dispatching the emergency units to a wrong place, resulting again in delays in responding to the emergency.

Last but not least, a very good accuracy of caller location information is needed in order to determine if multiple mobile calls refer or not to the same incident.

Where for the most emergency calls on the fixed network location accuracy is not an issue, in networks using mobile or nomadic terminals accurate location information is vital and may be difficult to obtain.

There are 2 types of location information:

- Network dependent location (type A) information which is determined and used inside a network during the call setup procedure; it is the network detectable call origin;
- Map dependent location information (type B) which is used after the call has been established for locating a caller on a map; it is usually derived using the network location information and/or user location information stored in databases.

5.2.2 Call routing

In order to route emergency calls to the designated PSAP in most countries emergency calls are handled at centralized facilities which may cover areas ranging from single villages to whole countries. It is important that callers are connected to the facility designated to handle calls from their area. For call routing the following accuracies on the location information are usually sufficient:

	Rural	**Suburban**	**Urban**	**Dense Urban**	**Indoor**
Mobile and Nomadic calls	<35 Km	<10 Km	<1 Km	< 1 Km	< 1 km

The values in the table, derived from ETSI TS 102 650 v1.1.1 shall be considered as baseline requirements.

For example FCC 99-245 adopts the following standard:

- For network – based solutions: 100 meters for 67 percent of calls, 300 meters for 95 percent of calls;
- For handset – based solutions: 50 meters for 67 percent of calls, 150 meters for 95 percent of calls

Usually the Emergency Control Centres (ECC) are responsible for certain areas in the region or country. Those areas are typically defined by municipal borders or federal borders. The accuracy of location information (type A) is good enough when the detectable origin of an emergency call can be linked to the responsibility area of the ECC with a high probability (close to 100%)

It is usual that arrangements are in place for the rapid transfer of calls arriving at an inappropriate answering point, for example, due to the caller being close to a boundary. Special considerations may need to be given when emergency calls originate close to an international boundary. In some cases, mobile terminals may be roamed to base stations in another country thus adding to the potential for location ambiguity.

5.2.3 Dispatching

The accuracy requirements for dispatching the appropriate emergency unit, which is usually the closest to the place of the incident, are similar to those for call routing but with the added consideration of geographical obstacles, such as mountain ranges, rivers, lake shores, etc. or on which side of a highway the incident has occurred.
The location information could also be used to recognize that several emergency calls are for the same incident (emergency call clusters). In this case the accuracy requirements of the location information are as follows:

	Rural	**Suburban**	**Urban**	**Dense Urban**	**Indoor**
Emergency call cluster detection	< 500 m	< 500 m	< 150 m	< 150 m	< 150 m

Reference: ETSI TS 102 650 v1.1.1 (2008-07)

It is usual for emergency response teams to co-operate with neighbouring authorities in the event of their being incorrectly despatched, for example, due to the caller being close to a boundary. As above, special considerations may need to be given when emergency calls originate close to an international boundary.

In some countries there are so many locally distributed PSAPs that calling the local responsible PSAP includes already the main dispatching function. In those countries the accuracy values of this table apply to the emergency call routing requirements as well.

5.2.4 Locating

For achieving the goal of locating the incident and consequently the best route to reach it finding the caller or the incident can initially be based on any location estimate available from the communications network and needs to be refined by information provided directly by the caller or by other means provided by the terminal or the network. There are three possible cases:

1) no location estimate is provided by the network but the caller provides location information which appears to be sufficiently accurate to despatch emergency response personnel, though this information must be considered as unverified;
2) a location estimate is available from the network and the caller is able to provide additional information. If the caller's information corroborates the network estimate within the accuracy requirements for call clusters, the location may be considered as verified;
3) if a location estimate is available from the network but the caller is unable to provide further location information, the need for accuracy of the network provided information becomes more stringent.

Regarding the information of locating the terminal via service provider or network facilities the following accuracies should be supported:

	Rural	**Highway**	**Suburban**	**Urban**	**Indoor**
Caller provides location information	50m to 100m	20m to 100m	30m to 100m	10m to 50m	10m to 50m
Caller provides no information	10m to 100m	10m to 100m	10m to 100m	10m to 50m	10m to 50m

Reference: ETSI TS 102 650 v.1.1.1

The values in the table shall be recommended as base line requirements. More accurate values may be appropriate, if they can be achieved with state of the art telecommunication systems.

The location information from the network should be available within a few seconds after call initiation, thus to enable its timely corroboration by the caller.

5.2.5 Location Information

Location information can be presented in one of two formats: Geodetic or civic.

Geodetic location information refers to a standardized coordinate system whereas civic location information reflects the postal address system, possibly augmented for emergency application with additional information e.g. floor level.

Geodetic location information is by nature unambiguous; it is based on a specified grid of latitudes, longitudes and elevations.

Civic location information is presented in a variety of structures in different areas, depending on local practice and might not be amenable to be cast into a common data structure. In addition, the information can be inaccurate, imprecise, etc. Hence, before civic location information is presented to the PSAP, it needs to be validated by the Street Address Guide or some similar facility available to the PSAP. Since this validation could take some time, in order not to delay the call answering by the PSAP it should take place while the call is answered.

6 METHODS FOR LOCATION OF CALLERS TO 112 EMERGENCY SERVICES IN MOBILE NETWORKS

6.1 Current solutions

Identifying the mobile location information for a particular emergency call is a process composed by two main parts:

a) location of the user equipment inside the respective mobile network and
b) mapping the obtained network specific location into a geographic or administrative location system (i.e. using a specific GIS application).

The location of the user equipment is done by measuring radio signals in order to determine the geographic position and velocity of the terminal. The location information should be reported in standard formats, such as those for cell based or geographical co-ordinates, together with the estimated errors of the location and velocity of the user equipment and, if available, the location method used to obtain the location estimate.

The uncertainty of the position measurement is network implementation dependent at the choice of the network operator. The uncertainty may vary between networks as well as from one area within a network to another. The uncertainty may be hundreds of meters in some areas and only a few meters in others. In the event that the position measurements are also a user equipment assisted process, the uncertainty may also depend on the capabilities of this equipment.

The uncertainty of the location information is also dependent on the method used, the position of the user equipment within the coverage area and the activity of the equipment. Several design options of the system (e. g. size of cell, adaptive antenna techniques, path loss estimation, timing accuracy) allow to choose a suitable and cost effective location method.

According with the relevant standards taken into consideration, ETSI TS 125 305 v8.0.0, ETSI TS 123 271 v8.0.0 and ETSI TS 143 059 v8.1.0, the location methods used for locating a caller are almost identical, regardless the technical type of the network (i.e. GSM or UMTS). 3GPP is currently extending the location methods with a new Path-Loss technology family:

RF Pattern matching. A Work Item (WI) for the inclusion of RF Pattern Matching in UMTS has been approved and ' Stage 2' technology definition Change requests to the 3GPP specifications have been presented for approval at the January 2010 Working Group Meeting .

Thus, the main methods for the location of the user equipment in both GSM and UMTS mobile networks are the following:

a) cell coverage based method (Cell-ID);
b) Observed Time Difference (OTD) based method, with the Enhanced-OTD (E-OTD) variety for GSM and Observed Time Difference of Arrival (OTDOA) for UMTS;
c) Network –assisted GPS (Global Positioning System)/ Global Navigation Satellite System (GNSS)–method (A-GNSS);
d) Uplink- Time Difference of Arrival (U-TDOA) method.
e) RF Pattern Matching method.

Due to the normal evolution towards 3G mobile networks, this document focuses on the mobile network user equipment location methods that can be used in the Universal Terrestrial Radio Access network (UTRAN) of the UMTS mobile networks for 112 emergency service purposes. Detailed information on the location methods are outlined in ETSI TS 125 305 v8.0.0.

6.1.1 Cell ID Based Method

In the cell ID based (i.e. cell coverage) method, the position of a user equipment is estimated with the knowledge of its serving node B. The information about the serving node B and cell may be obtained e. g. by paging, locating area update, cell update, routing area update.

The cell coverage based positioning information can be indicated as the Cell Identity of the used cell, the Service Area Identity or as the geographical co-ordinates of a position related to the serving cell. The location information shall include a QoS estimate (e.g. regarding achieved accuracy) and, if available, the positioning method (or the list of the methods) used to obtain the position estimate.

In order to determine a cell coverage estimate and to map it to the geographical coordinates or Service Area parameter Identity, the network may use parameters such as the best reference signal, Round Trip Time (RTT) in Frequency Division Duplex (FDD) or Rx Timing Deviation and knowledge of the user equipment timing advance in the Time Division Duplex (TDD), as well as antenna beam direction parameters. Alternatively, the service area coverage of a cell may be determined by using a reference signal power budget. Based on the reference signal power budget power budget it is possible to obtain , for example , the node B transmitted power, isotropic path loss, coverage threshold at coverage area border for a given location probability and a cell radius for an indoor and outdoor coverage.

The network can use a reference signal link budget based cell radius estimate, in conjunction with the cell identifier, to make coverage estimation for the cell(s) related to the user equipment. Additionally, the network may compare the received power levels with the power budget, whereby more accurate information of the position of the user equipment may be provided. Also, the interaction between neighbouring cell coverage areas may be used to determine a more exact location of the user equipment.

6.1.2 OTD Based Method

a) OTDOA method for UMTS networks

The OTDOA method involves measurements made by user equipment and Location Measurement Unit (LMU) of the UTRAN frame timing (e.g. Single Frequency Network (SFN) observed time reference). These measures are then transmitted to a Radio Network Controller (RNC) or to a Mobile Location Centre (MLC), depending on the network configuration which calculates the position of user equipment.

The OTDOA method may be operated in two modes: user equipment – assisted OTDOA and user equipment – based OTDOA. The two modes differ in where the actual position is carried out:

a. In the user equipment – assisted mode, the user equipment measures the difference in time of arrival of several cells and signals the measurement results to the network, where the SRNC or the SAS carries out the position calculation.
b. In the user equipment – based mode, the user equipment makes the measurements and also carries out the position calculation and thus requires additional information (such as the position of the measured NodeBs) that is required for position calculation.

b) E-OTD method for GSM networks

The E-OTD method is based on measurements in the mobile station of the Enhanced Observed Time Difference of arrival of bursts of nearby pairs of Base Transciever Stations (BTSs). For E-OTD measurement synchronization, normal and dummy bursts are used. When the transmission frames of BTSs are not synchronized, the network needs to measure the Real or Absolute Time Differences (RTDs or ATDs) between them. To obtain accurate trilateration, E-OTD measurements and, for non-synchronized BTSs, RTD or ATD measurements are needed for at least three distinct pairs of geographically dispersed BTSs. Based on the measured E-OTD values the location of the mobile station can be calculated either in the network or in the mobile station itself, if all the needed information is available in the mobile station.

6.1.3 Network –assisted GPS/GNSS Method (A-GNSS)

These methods make use of user equipments which are equipped with radio receivers capable of receiving GNSS-Global Navigation Satellite System signals. Different GNSS (e.g. GPS, Galileo) can be used separately or in combination to perform the location of the user equipment. When GPS is designated to inter-work with the UTRAN, the network assists the user equipment GPS receiver to improve the performance in several respects. The performance improvements will:

- reduce the user equipment GPS start-up and acquisition times; the search window can be limited and the measurements speed up significantly;
- increase the user equipment GPS sensitivity; positioning assistance message are obtained via UTRAN so the user equipment GPS can operate also in low signal-noise ratio (SNR) situations when it is unable to demodulate user equipment GPS signals;
- allow the user equipment to consummate less handset power than with stand-alone GPS; this is due to rapid start-up times as the GPS can be in idle mode when it is not needed.

The Network-assisted GPS methods rely on signalling between user equipment GPS receivers (possibly with reduced complexity) and a continuously operating GPS reference receiver network, which has clear sky visibility of the same GPS constellation as the assisted user equipments. GPS reference receivers may be connected to the UTRAN to enable derivation of user equipment assistance signals.

6.1.4 Uplink-Time Difference of Arrival (U-TDOA) method

The U-TDOA positioning method is based on network measurements of the Time of Arrival (TOA) of a known signal sent from the user equipment and received at four or more Location Measurement Units (LMU). The method requires LMUs in the geographic vicinity of the user equipment to be positioned to accurately measure the Time of Arrival of the bursts. Since the geographical coordinates of the measurement units are known, the user equipment position can be calculated via hyperbolic trilateration, one hyperbola being determined by the results of combined signals received by two LMUs.

The U-TDOA method does not require knowledge of the time the user equipment transmits nor does it require any new functionality in the user equipment. In the U-TDOA method, the reference measurement is the one that represents the U-TDOA capable Location measurement Unit site that collects the signal with the highest quality. That site is usually the site closest to the user equipment and normally generates the highest signal level as well as the highest Signal to Noise Ratio. In addition it presumably exhibits the lowest multi-path error.

The more hyperbolas that are calculated, that is, the more cooperating U-TDOA capable Location Measurement Units used in calculation, the more accurate is the estimate of the user equipment position. When many sites enter into the calculation, the effects of a large time delay measurement error at a single site are minimized.

6.1.5 RF Pattern Matching method

The Pattern Matching technologies represent a family of Path Loss technologies that rely on matching the Radio Frequency (RF) environment (as experienced by UE) to the known characteristics of the larger RF System in which the UE is operating. Information from the UE, including measurements of neighbour cell signal strengths, time delay and other network parameters from the basis of the RF environment to be compared to the established System RF Database. As a consequence, this technology can mitigate the negative impacts of anomalies within the RF environment that challenge the accuracy of trilateration technologies (e.g. multipath and reflection).

The RF Pattern Matching positioning method is currently defined in ETSI TS 25.215 and necessary for the basic mobility functionality and hence this method will work with existing mobiles without any modification.
The RF Pattern Matching technology is based on the observation that the radio environment varies from location to location due to features such as terrain, buildings, foliage and cellular signal coverage. If enough elements of the radio environment can be measured with sufficient accuracy, each set of measured values provides a radio signature that uniquely identifies a particular location. In typical cellular networks, handsets measure the signal strengths (or signal -to-interference ratio) of

serving and neighbour sector broadcast control channels for normal handover operations. These measurements from the basis of the radio signatures used to locate the handsets.

RF Pattern Matching can provide high accuracy in urban and indoor situations because of its ability to take advantage of shadowing conditions that can degrade other methods that relay on line-of –sight circumstances. Urban areas typically contain extremely high densities because of the large concentrations of wireless user; therefore, many neighbouring cell site measurements are reported in the RF Pattern data base, enabling especially accurate location estimation. Through use of radio propagation modelling and geographical information system data and measurements, the predicted RF Pattern Database contains information about local shadow fading conditions. This is particularly critical in urban areas, where non-line-of-sight conditions are predominant due to extensive building obstructions and clutter. Therefore this method is well suited for urban and indoor location estimation.

6.2 Standardization activities

ETSI-TISPAN (Technical Committee Telecommunications and Internet converged Services and Protocols for Advanced Networking): two relevant Technical Specifications produced by ETSI TISPAN have been considered:

ETSI TS 102 650 - Analysis of Location Information Standards produced by various SDOs.

ETSI TS 102 660 - Signalling Requirements and Signalling Architecture for supporting the various location information protocols for Emergency Service on a NGN.

These documents examine the work of various Standards Development Organizations in developing and implementing protocols for the transmission of location information over telecommunications networks for use in establishing the location of users of the emergency responders to have timely and accurate information that enables them to correctly identify the location of the incident.

The TS 102 650 document reports on an analysis of location information standards produced in Europe, USA, Asia by various standards developments organizations. The object of the analysis was to determine what standards existed and had been adopted for determination of caller location, in order to assist in the response to emergency calls.

The TS 102 660 document reports on the signalling requirements and signalling architecture for supporting the various location information protocols for emergency services on a NGN. The object of this work was to determine what standards existed and had been adopted for signalling details of an emergency caller's location, in order to assist in the response to emergency calls.

The document makes recommendations on the standards to be used for the acquisition and conveyance of location information associated with emergency calls. These are derived from the analysis of the outputs of various ETSI work groups and other standards bodies documented in TS 102 650. The recommendations are produced for TISPAN WG3 so that interworking and integration between various networks can be accomplished for the support of Emergency Communications on a NGN.

It is therefore concluded that the base Signalling Requirements and Signalling Architecture for Supporting Location Information Protocols for Emergency Services on a NGN could be modelled on existing TISPAN NGN and 3GPP work, with the possibility of its further development in the future.

3rd Generation Partnership Project: The 3GPP relevant standards (**ETSI TS 123 167** - UMTS; IP Multimedia Subsystem (IMS) emergency sessions) will allow, in principle, the establishment of the location information relating to any call, not only emergency calls. Some networks may require the introduction of new protocols but this is seen as an inevitable consequence of the introduction of new functionality in the network. Establishing of the caller's location will be a network responsibility. Legacy terminals must be able to continue to be used, although possibly with reduced functionality when compared with new terminals.

From a network operator's perspective, the ability to establish the location of any caller has the potential to support the introduction of a variety of a new location –based services, thus the possibility exists of operators being able to recoup some of the investment necessary to support the emergency service.

The TISPAN and the 3GPP standards currently appear to be the most mature standards available to enable an emergency caller's location information to be obtained and transmitted over NGN and traditional access technologies. It is recognized that to completely achieve the full required functionality, it may be necessary for further development of the existing standards.

7 METHODS FOR LOCATION OF CALLERS TO 112 EMERGENCY SERVICES IN FIXED NETWORKS

7.1 Current solutions

In the case of a fixed telephony network (a telephone network having fixed customer network termination points) obtaining the location of a caller is usually a much simple operation.

The network operator usually has the civic location information of the customer premises where it has installed a certain network termination point (NTP). This data is normally stored into a database and regularly updated.

When providing the fixed service operators assign NTPs distinct E.164 subscriber numbers. These numbers identify the NTP and are passed to the network for every call placed from the specific NTP as part of the call establishment procedure. The assigned subscriber numbers are also included in the operator's customer civic location information database.

Having the E.164 number of the calling NTP a query over the customer civic location information database can return in (almost) real-time the civic location information of the calling NTP. This operation can be done either by the operator or by the emergency call handling system manager, provided that it has access to the database. This is the CLI-Caller Line Identification either pushed with each emergency call in some member states, either pulled when needed by the PSAP.

The location information can reach the PSAP either in a "pull" fashion (i.e. at PSAP's request the network operator/ emergency call handling system manager runs the database query and sends the obtained information), or in a "push" fashion (i.e. the database query is run simultaneously with call processing and forwarded to the PSAP for every emergency call).

7.2 Current issues regarding location information in fixed networks

MSAGs - Master Street Address Guides should be established for fixed lines to compare telephone locations from the operators databases to the MSAGs. These MSAGs must be both civic (physical streets and boundaries) and geodetic with X and Y coordinates of all Emergency Serving Zone (ESZ) boundaries included. This will accommodate routing of calls to the proper PSAP.

The databases often do not include private numbers, and in fact, most systems have "directory" published numbers and locations in them. Also PBX stations allocated numbers are not always included in databases (depends on the established national requirements).

Most of the databases are not updated with additions, changes and deletes but once a month, therefore untold numbers of telephone locations are not correct, or are not in the database at all. An Enhanced ALI (Automatic Location Information) database, to qualify as Enhanced, must be updated in real time as changes occur, or at least, every 24 hours.

In case of systems not having "push" location information receiving procedure, the location of the fixed caller has to be "pulled" from the database, wasting precious time, and introducing the possibility of an erroneous telephone number keyed by operator, which will result in a wrong address being displayed.

Last but not least, technical specifications should be developed, according to the specific status of the emergency handling system in each country for handling and transmitting information from network operators to 112 systems.

8 DEVELOPMENTS RELATED TO VOIP PROVIDERS AND EMERGENCY CALLS

8.1 Current status

Transition from POTS/PSTN/ISDN (including mobile) networks to IP based networks seems to happen at a slower pace than previously expected, mostly due to slow network switchover of big voice market players (eg. mobile operators, fixed incumbent) in terms of number of users and established interconnection agreements. This influence also the behaviour of smaller players, usually already operating IP networks, who need to maintain their non-IP interconnection agreements.

It should also be noted that the migration procedure for operators running circuit switched networks requires a gradual elimination of all switching equipment and at the same time replacement with new packet switched equipment, equivalent of implementing a new switching network.

Also, evolutions related to the take-off of broadband internet access demand, an IP service from its very beginning, require better service and higher bitrates, thus imposing also the upgrading of the access network infrastructure. This usually requires replacing portions of copper cable and/or microwave systems from the access network with optic fibre (for both fixed and mobile networks).

However, due to lower prices and easily available service, the number of consumers using VoIP services for voice calls is increasing, making the question of location information of VoIP services users increasingly relevant.

Efforts have been made by regulators and standardization bodies in the direction of transmission of location information from VoIP services in case of emergency calls, keeping in mind the further development of VoIP services and eventually the complete switchover to IP based networks.

8.2 Technical aspects related to VoIP providers to deliver emergency communications services

ETSI TR 102 476 v1.1.1 (2008-07) Emergency Communications (EMTEL); Emergency calls and VoIP; possible short and long term solutions and standardization activities; the document gives an overview of standardisation activities and summarises different methods for VoIP providers to deliver emergency communications services.

<u>The most relevant technical aspects in relation with provisioning of caller location information for emergency calls supplied by VoIP network providers refer to:</u>

a) <u>Network evolution</u>

- The circuit switch network era will end;
- The routing from IP networks to PSTN for reaching PSAPs-Public Safety Answering Points is not necessary when PSAPs are connected directly to IP networks;
- A pure IP-interface for PSAPs should be defined; standardisation of a pure IP based interface to the PSAP is recommended.
- More information can be transferred through IP into the PSAPs compared to today’s circuit switched signalling interfaces (trunk or access signalling);
- Common requirements are beneficial for meeting requirements on Emergency Services, cost for systems and exchange of experiences;

b) <u>Broadband subscribers</u>

- VoIP is going from being a complement to PSTN into becoming a replacement;
- The subscriber expects Emergency Calls to work “as usual”;
- It is desirable to have a harmonized approach in Europe since the VoIP is borderless;
- There are a lot of standardization activities going on in different groups (IETF, 3GPP, ETSI);

c) <u>General requirements on Access to Emergency Services</u>

- The efficient operation of Emergency Services requires fulfilment of the following basic functions:
    1) Routing to the appropriate PSAP (as defined by the relevant authority);
    2) Identification of the caller (network identity through e.g. NTP and/or SIM);
    3) Location of the caller;

d) <u>Service types</u>

- All Emergency Communication have to originate over a Service type. Below is given a list of possible Service Types:

Voice Services:

1) POTS (Plain Old Telephone Service);
2) Mobile telephony (circuit switched);
3) Satellite telephony;
4) VoB:
    - Fixed (The subscriber cannot move the service to another Network Access Point);
    - Nomadic (The subscriber can move the service to another Network Access point);
    - Mobile Communication Services on Packet Access;

5) VoI
   - Fixed Internet Access;
   - Nomadic Internet Access;
   - Mobile Internet Access;

Other services:

1) Video calls (e.g. from 3G telephone);
2) Data calls (e.g. alarm from a device);
3) E-mail;
4) SMS (Short Message Service);
5) MMS (Multimedia Messaging Service);
6) Real-time Instant-messaging and Chat;

e) The PSAP - Public Safety Answering Point interface

The interface between the Communication Network (telecom or Internet) and the PSAP can be of two main types.

1) Circuit switched (PSTN-based)

The content of the communication – voice and the signalling information for call handling and transport of emergency related information – will be done using the same interface.

2) IP-based

Only the content of the communication – voice – will be delivered from access network.

a) IP-based telephony/VoB. The signalling information for call handling and the emergency related information will be delivered from VoIP session provider. Typically the caller location is basically available from the managed access network of the caller.
b) Internet telephony/VoI. The signalling information for call handling and the emergency related information may - if possible - be delivered from the VoIP session provider or directly from user equipment. As no managed access network is involved in this case currently no caller location will be available (refer to IETF ECRIT later in the text).

Independent of what interfaces are implemented, the f**unctional requirements** are the same. Therefore, information conveyed over any interface should facilitate **identification** and **location** of the caller. Furthermore the VoIP provider should be able to route the Emergency Call to the designated PSAP.

f) Emergency Calls and VoI

VoI services can be classified with regard to their features in terms of sending and receiving calls from PSTN/ISDN.
Descriptions of various VoI scenarios depending on how the telephone service is offered technically:

Type 1: non PATS peer-to-peer services to make and receive voice calls over the Internet only, usually within the same application community. The terminal equipments do not have PSTN telephone numbers (according to the ITU Recommendation E.164, the service providers do not provide the normal 112 or E112 services). The PSAP can receive emergency calls from these terminals only if it has Internet type VoIP interface and the users have retrieved the PSAP's IP ID number(s);

Type 2: VoI services to make voice calls over the Internet to the PSTN - the standard public network, but not to receive calls from the PSTN. Tough the terminal equipments need not have ITU Recommendation E.164 type telephone numbers, the service providers can provide the normal "112" or "E112" services. At present roughly half of European countries do not require the service providers of type 2 services to ensure the "112" or "E112" services;

Type 3: VoI services to receive voice calls over the Internet from the PSTN, but not to make calls to the PSTN. To be reached from PSTN the customers have to be allocated an ordinary geographic number or a number from a VoIP specific E.164 number range. Though the terminal equipments have ITU Rec. E.164 type telephone numbers, these services do not support the "112" or "E112" services as they do not support outgoing calls;

Type 4: VoI In and Out services to receive voice calls over the Internet from the PSTN and to make voice calls over the Internet to the PSTN. Customers can be allocated an ordinary geographic number or a VoIP specific number. The terminal equipments have ITU Rec. E.164 type telephone numbers, and the VoI service can be made able to support the "112" and "E112" services. Today in the telecommunication regulating practice of the European countries there is slight difference whether all service providers are obliged to provide these services or only those , who declared their services as PATS - Publicly Available Telephone Services.

From the point of view of the users the following scenarios have been identified:

1) <u>IP-based telephony/VoB from fixed terminal</u>

- An IP telephony service offered and controlled by the operator who owns the infrastructure for the physical access and at the same time acts as Internet Service Provider. (ex. Cable TV networks offering telephony);
- The use of a subscription cannot be moved to another Network Terminal Point by the subscriber;
- A telephone number from ITU Rec. E.164 is assigned.

2) <u>Internet telephony/VoI from fixed terminal</u>

- A telephony service offered over an Internet access, with or without a number from the E.164 numbering plan;
- The subscription may not be associated with a specific fixed network terminal point;
- The subscription can be moved to another network termination point by the subscriber;
- A telephone number from E.164 is not assigned to terminal and hence the E112 service is not guaranteed.

(Example: Any Internet connection)

3) <u>IP-based telephony/VoB from nomadic terminal</u>

- An IP-telephony service offered by a service provider over any operator's network;
- The subscription can be moved to another Network Termination Point by the subscriber;
- A telephone number from E.164 or the SIP URI from the operator's addressing plan is assigned;

(Example: Any broadband network that has not barred access to VoIP-servers (SIP-servers)).

4) <u>Internet telephony/VoI from nomadic terminal</u>

- A telephony service offered over an Internet access, with or without a number from the E.164 numbering plan;
- The subscriber can activate the subscription from any Network Terminal Point;

5) <u>IP- based telephony/VoB from mobile terminal</u>

- An IP-telephony service offered to mobile terminals;
- The VoIP –subscription is related to the mobile subscription;
- A telephone number from E.164 or the SIP URI from the operator's addressing plan, is assigned.

(Example: Any PLMN-operator)

6) <u>Internet telephony/VoI from mobile terminal</u>

- A telephony service offered over an Internet access without a possibility to use telephone numbers;
- The Internet telephony service is not related to the mobile subscription;
- A telephone number from E.164 is not assigned.

(Example: Any PLMN-operator that has not barred access to VoIP-servers (SIP-servers))

Emergency Calls

The short term solution focus on PSTN-interconnection between and the long term solution focus on IP-interconnection between any IP-network and the PSAP.

<u>IP-based telephony/VoB from fixed terminal</u>

Normally this type of VoIP-service is treated in the same way as POTS. See figure 1.

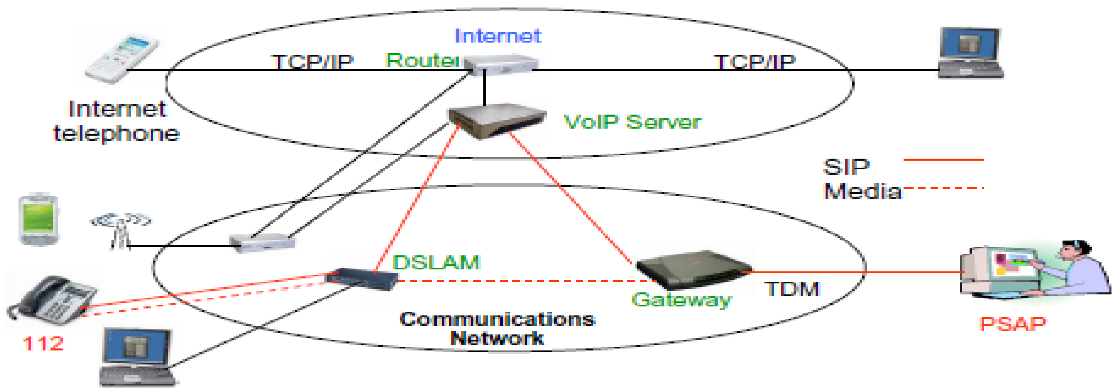

Figure 1: Emergency call from IP-based fixed telephony

Routing: Routing to the correct PSAP is achieved through knowledge of Network Access Point.

Identification: The identification of the subscriber is done in the same way as the ordinary POTS-subscribers where the telephone number is used as identifier.

Location: The location of a Network Termination Point is known.

IP-based telephony/VoB from nomadic terminal
Work on standardized procedures for Emergency Calls from Nomadic IP-based terminals is not finalized at the time of publishing the document. See figure 2

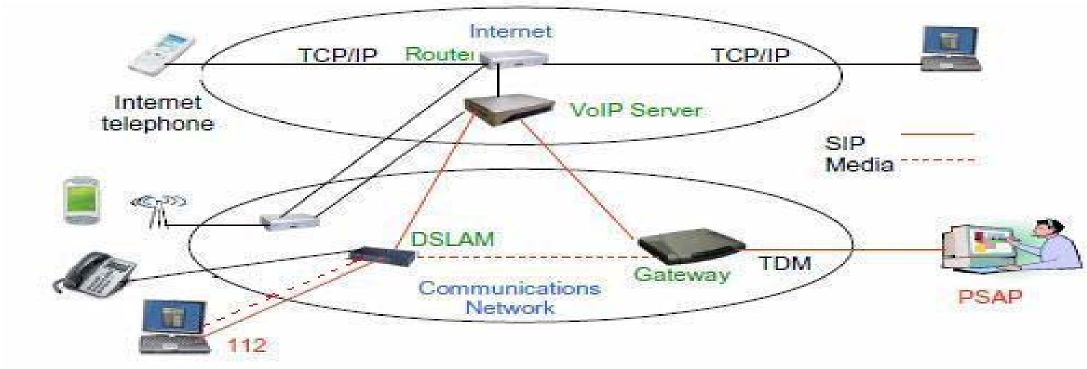

Figure 2: Emergency call from IP-based nomadic telephony

Routing: Routing to the correct PSAP can be achieved using different solutions:
- Subscriber updates routing information on log-in to the service;
- Network updates routing information on log in to the service;
- IP-calls are marked and specific PSAP is assigned;
- The VoIP server requests the address of the PSAP using DNS and uses that for routing;
- Geographical area of IP-address is known (Long-term);

Identification: The identification of the subscriber is done in a similar way as for ordinary POTS-subscriber where the telephone number (E.164 and/or URI) is used as identifier.

Location: Since location of the subscriber based on the received telephone number is depending on how up to date the latest location information is, procedures for the verification and updates have to be established.
- Subscriber updates location information on log-in to the service:
  - Validated by the network and contractual relationship;
  - Not validated, user provided to the network;
- VoIP service provider updates location information when subscriber registers for emergency service;
- Location information is provided by the VoIP service provider to the PSAP on a database data look-up interface;
- Coordinate information is provided by the terminal through the signalling (Long term):
  - Validated by the VoIP service provider and contractual relationship;
  - Not validated, transparent to the network;
- Coordinate information is provided by the VoIP service provider through the signalling (Long term);
- Geographical area of IP-address is known (Long-term).

IP-based telephony/VoB from mobile terminal

The treatment of IP-based telephony from mobile terminals is illustrated in figure 3.

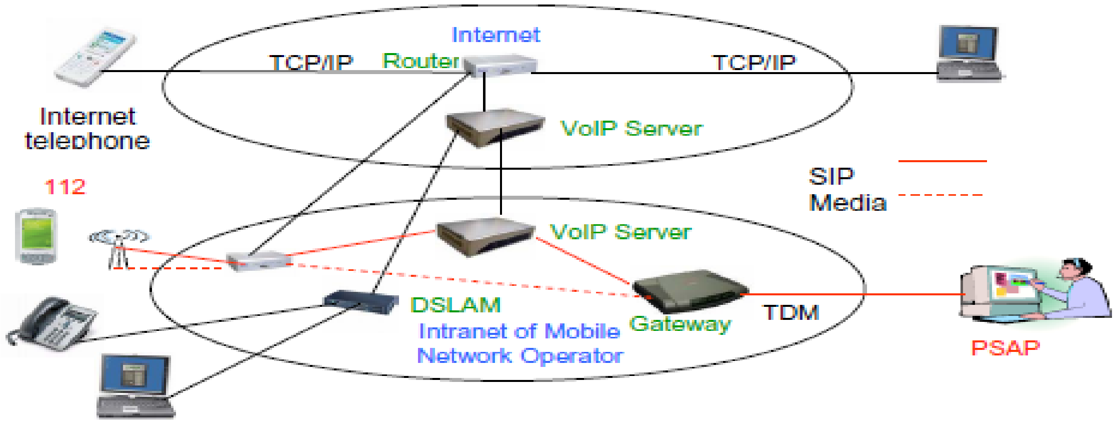

Figure 3: Emergency call from IP-based mobile terminal

Routing: Routing to the correct PSAP can be achieved using different solutions:

- Location of Base Station is known by the VoIP Server and used for routing.
- Location information is known by the VoIP Server (database data look-up) and used for routing.
- Network updates routing information on attach to the network and when roaming.
- IP-emergency-calls are marked and a specific PSAP is assigned.
- The VoIP Server (E-CSCF for mobile networks) will request the location of the terminal using Location Based Services or other mechanisms and requests the correct PSAP address (from internal or external resources).
- Terminal requests its location; when an emergency call is set up it sends this location information to the VoIP server who will request the correct PSAP address (from internal or external resources)

Identification: The identification of subscriber is done in a similar way as for ordinary POTS-subscribers where the telephone number (ITU Rec. E.164 or URI) is used as identifier.

Location: Location of the subscriber can basically be done in two ways that also can complements to each other.

The mobile network (VoIP server, E-CSCF) can provide location based on base station or using location based services.
The terminal sends the location information when it places an emergency call.
The received telephone number can be used. Depending on how updated the latest location information related to the telephone number is, procedures for verification and updates should be established.
Examples related to telephone number:

- Network (VoIP server, E-CSCF) updates location information on registration to the emergency service.
- Coordinate information is provided by the terminal through the signalling (Long term).
- Coordinate information is provided by the network (VoIP server, E-CSCF) through the signalling (Long term).

Examples related to mobile network:

- Location of Base Station is known and used for determination of Location.

Note: In the case of "IP–based /VoB telephony from nomadic terminal" or " IP-based telephony / VoB from mobile terminal" when subscriber is in roaming (abroad from its service provider home network) and if there are no IP PSAP interconnection it is not possible today to route the emergency call over the international borders.

8.3 Related regulatory obligations imposed on VoIP providers

The design and development of simple, uniform technical solutions for obtaining VoIP services user location information, applicable in every provisioning scenario, seems not to be finalized at this moment.

However, due to the increased usage of VoIP services, with users accustomed to use the same line for ordinary calls and for emergency ones, some regulatory steps have been taken.

The ERG document ERG (07)56 rev2 "ERG Common Position on VoIP" analyses in detail the case of VoIP services in the context of accessing Emergency Services.

The main issue related to VoIP caller location information identified by the document is nomadism. Since address information is key element for rescue, the ERG recommends that all providers guarantee the availability of information that alert the PSAP when subscribers' address is not trustable, as it is in the case of mobile and nomadic service.

In most European countries the location information of calls directed to 112 and originated from non mobile end users is found by the emergency response centre by looking up the telephone number in a database or requiring such information from the operator that provides the service to the customer (pull approach). The database contains, at least, the telephone number and address of all subscribers. Such a database is, in some cases, fed with information by all service providers, who every week/month update the data and provide the emergency response centre with it. This database is, in some countries, the same as the one used for directory enquiry services.

To cover the case of nomadic use, as a first step, providers could inform the emergency centres when a terminal can be used nomadically (reliability of the address data). A second step that is often discussed is where the provider enables the user to update his current location (via the web), which could be interrogated by the emergency centre if necessary. This approach could also be used when a geographic number might be used nomadically. The database would contain the caller location information and a warning that address data might not be reliable in the case of a call to 112. This approach assumes that the CLI is transmitted with a call.

Another approach under consideration for implementation in some countries is to impose to VoIP providers the capability to recognise if the user is not located at the address corresponding to the NTP as a condition to obtain the right of use of geographic numbers to established calls (where 112 calls are necessary included).

After analyzing the issue of VoIP access to Emergency Services from several different angles (legal basis, proper routing to of calls, CLI provision, caller location information provision, QoS of access to emergency services, availability and reliability of the access to emergency services) the document also establishes several important features regarding the ability of VoIP services to access Emergency Services, including sending of user location information. These features are to be implemented in national regulations by all ERG members. The defined features refer to type 2 and type 4 VoIP provision scenarios as described in subchapter 8.2:

1. All telephony service providers should be obliged to provide access to emergency services;
2. Routing should be provided to the locally responsible PSAP to the extent allowed by the technology;
3. Information about the caller's location should be provided to the extent allowed by the technology;
4. Telephony service providers should be obliged to provide the emergency response centre with information on whether the call originates from a fixed or a potentially nomadic user;
5. Telephony service providers should be obliged to clearly inform subscribers about any limitations in the services as compared to the traditional telephony service; the information should be provided in comparable way in different MS, e.g. in the terms and conditions of contract, by means of a sticker on device or clearly visible information in bills;
6. Emergency calls should be setup with the priority, quality and availability to the extent allowed by the technology.

The ERG document ERG (09) 19 "VoIP – Action Plan to Achieve Conformity with ERG Common Position" details also the status of implementing the 6 points mentioned above (ANNEX B "State of National Conformity for Each Point of the Common Position", first point "Access to emergency services", sub points 1.1 to 1.6).

The level of conformity is very good, higher for type 4 VoI provision scenario than for type 2. The difference between the two types is mainly caused by the limits imposed on the national legislation (primary legislation), type 4 being actually a PATS service.

9 CURRENT STATUS OF IMPLEMENTING CALLER LOCATION INFORMATION FOR 112 EMERGENCY SERVICES IN EU MEMBER STATES

For the purpose of this analysis we used the latest data published on the Commission 112 web site (http:// ec.europa.eu/112) which represent the COCOM09-11 data gathering working document "*Implementation of the European emergency number 112- Results of the second data – gathering round (January 2009)*".

9.1 Caller Location – Mobile Calls

Relevant information provided by the 25 Member States in their replies to the questionnaire concern:

- Method and time needed to provide caller location upon request
- Type and accuracy of mobile caller location
- Possibility to additionally obtain the registered address of mobile subscription
- Mobile caller location in case of roaming (international and national)

Country	**Method of providing mobile caller location and time needed to provide it on request**	**Type of caller location information**	**Availability of caller. Location in case of users of International roaming**	**Possibility to additionally obtain the registered address of the subscription**
Austria	Pull – verbal/written request to respective network operator	Cell ID/ Sector ID	Yes	Yes, except users of pre-paid cards
Belgium	Pull	Cell ID/Sector ID	Yes	Yes
Bulgaria	Push	Cell ID	Yes	No
Cyprus	Push	Cell ID/ Sector ID	Yes	Yes
Czech Republic	Push	Depending on the network operator, the caller location provided is area with radius from 1 Km/70% to 5 km/70% or the Best Server Base Transceiver Station	Yes	Yes
Denmark	Push	Cell ID	Yes	Yes
Estonia	Pull; estimated average time: 23 sec.	Coordinates	Yes	No
Finland	Pull- by electronic request to a centralised mobile positioning database; estimated average time: 6 sec. or 3 to 30 seconds depending on operator and traffic	Cell ID/ Sector ID and also more accurate information based on the best available calculation method depending on the operator	Yes- by separate manual request to the operator	Yes
France	Pull; estimated time needed: about 10 min. during working hours and less than 30 min. outside working hours.	Postal code of the local community of the relevant cell base Transceiver Station (BTS). This provides for accuracy of a few km.	Yes	No

Germany	Pull; measured average 5 min. (in 2 Federal States)	Cell ID/Sector ID	Yes	Yes
Greece	Pull; estimated time from 7 to 60 min.	Cell ID	Yes	Yes
Hungary	Push	Cell ID/Sector ID	Yes	Yes
Ireland	Pull	Cell ID	No	Yes
Italy	Push, in the province of Salerno, only	Cell ID	Yes	Yes
Latvia	Pull, (for two operators is Push*); average measured time for 7361 requests:10.3 sec. ; caller location provided within 1 min. for 98.17% requests	Cell ID/ Sector ID	Yes	No
Lithuania	Pull (only in Vilnius PSAP), provided within 1.5 to 10 sec. and within one minute in all cases	Cell ID	Yes	Possible in one of the three mobile networks
Luxembourg	Push	Cell ID	Yes	
Hungary	Push	Cell ID / Sector ID	Yes	Yes
Malta				
Netherlands	Pull (from KPN mobile network) provided in less than 1 sec.	Cell ID	It is planned to make it possible	Yes (except for pre-paid card users who are not required to register)
Poland	Pull; Estimated average time: 13 sec.	Cell ID/ Sector ID Timing advance technology with accuracy of 100 m to 1 km	Yes	Yes
Portugal	Push	Cell ID Accuracy from 100m in urban areas to 30 Km in rural areas*	Yes	No*
Romania	Push	Cell ID/ Sector ID	Yes	Yes
Slovenia	Push in the case of *Mobitel* operator; Pull in the case of other operators; Measured time: 1.5 hours for 80% of caller location requests;	Sector ID	Yes	No
Slovakia	Push in the case of one operator (Telefonica O2). Pull in the case of other two operators. Caller location provided within 1 min. in case	Cell ID/ Sector ID	Yes	Will be required as from 1 Sept. 2009

* data collected from ECC PT2 members
* idem
* idem

	of 94.5% of requests; average time from 2-3 sec. to 20 sec. max.			
Spain	15 emergency centres Push 2 emergency centres Pull Estimated average time: 30 sec.	Cell ID /Sector ID Accuracy from a few meters in urban areas to a few Km in rural areas	Yes, except in 5 emergency centres	Yes, in general with some exceptions
Sweden	Pull from a database; estimated time: max. 3-5 sec.	Cell ID, with or without timing advance	No, discussions started on implementing this facility	Yes
Switzerland	Pull-emergency service requests location from a database	Time and ellipse plus optional information	Yes	Yes, from publicly available directory services
United Kingdom	Pull by retrieving caller location from a database to which it is forwarded automatically for every call; estimated time: max. 2 sec.	Cell ID, with or without timing advance	No	Yes, but not for all pre-paid customers of all service providers

Table: Caller Location –Mobile Calls

<u>Mobile caller location</u>

<u>Method and time needed to provide caller location upon request</u>

Out of the 25 Member States that provided the relevant information, **seven** Member States (**Bulgaria, the Czech Republic, Denmark**, **Cyprus**, **Luxembourg, Portugal** and **Romania**) reported to be using the ‘Push’ method for providing mobile caller location. In addition, in Slovenia and Slovakia the ‘Push’ method is used by one mobile operator in each country, in Italy this method is used in one province and in Spain it is used in 15 PSAPs. Among the Member States, which use the ‘Pull’ system, **five** Member States - **Latvia, Poland, Finland, Sweden** and **the United Kingdom** - reported near instant average times to provide caller location (i.e. within 15 sec.), which in practical terms render the performance of their caller location systems similar to that of ‘push’ systems. Also the Netherlands reported that caller location is provided instantly in case of one mobile network and Lithuania indicated the average time between 1.5 and 10 sec. for providing caller location in one, central PSAP.

Three countries additionally provided data according to the second requested measurement method - percentage of caller location requests, for which caller location is provided within one minute. This was reported to be 100% in **Lithuania** (i.e. in the PSAP of the capital city), 98.17% in **Latvia** and 94.5% in **Slovakia**. Data based on measurements were provided by **Germany, Latvia** and **Slovenia** while all the other respondents used estimates.

A slightly longer time to provide caller location information (up to about 1 min. on average and/or maximum) was reported by **Slovakia** (from 2-3 sec. to 20 sec. max.) and **Estonia** (23 sec.) and **Spain** (30 sec.). On the other hand, the longest delays were reported by **Germany** (5 min. on average), **France** (10 min during working hours and up to 30 min. outside working hours), **Austria** (up to 30 min. in case of verbal/written manual requests), **Greece** (7 to 60 min) and **Slovenia** (1.5 hours for 80% of caller location requests).

For comparison, in the first data gathering exercise nine countries reported using the ‘Push’ system or ‘Pull’ system with near instant (up to 15 sec.) provision of caller information - **Bulgaria**, the **Czech Republic**, **Denmark**, **Spain, Latvia, Luxembourg**, **Slovakia, Sweden** and the **United Kingdom**.

<u>Type and accuracy of mobile caller location</u>

In their replies to the first questionnaire, most Member States indicated mobile network Cell ID or Sector ID as the available mobile caller location information. Accordingly, this type of caller location currently appears to be the ‘technically feasible’ minimum caller location information in the meaning of Article 26(3) of the Universal Service Directive, which all mobile operators within the EU should be able to provide. In order to be understandable and usable by the emergency services it must obviously be possible to link the Cell ID/Sector ID to a particular geographical area on a map, and appropriate technical arrangements should exist in the Member States for this purpose.

The accuracy of mobile caller location in the case of Cell ID/Sector ID depends on the mobile cell or sector coverage that varies between urban and rural areas. The second questionnaire therefore invited the Member States to indicate the availability of any 'enhanced' mobile location technologies that allow for better results than Cell ID/Sector ID.

Out of the 25 respondent countries, **22** Member States reported Cell ID/Sector ID as the available mobile caller location information. Among these countries, **Poland, Finland, Sweden and the United Kingdom** indicated the existence of additional facilities to increase accuracy of mobile caller location, based on measurements and calculations ('timing advance information') and the **Netherlands** reported on the availability of a special 112 service for disabled users, which transmits GPS coordinates. As for the remaining countries, the **Czech Republic** uses specific area and Best Server Base Transceiver Station ID, **Estonia** reported 'coordinates' as the available caller location information while in **France** the mobile caller location is the relevant postal code.

Mobile caller location in case of roaming (international and national)

Finally, the Member States were invited to indicate whether caller location information is provided for calls made by the users of international mobile roaming services and domestic mobile subscribers in the situation of national roaming, if such facility is possible.

As regards the first category of mobile users, out of the 25 Member States that provided the relevant information, only **Ireland**, the **Netherlands**, **Sweden** and the **United Kingdom** replied negatively; the Netherlands and Sweden indicated that they are considering the introduction of such possibility. In addition, in **Spain** this facility is not available in some PSAPs.

As regards mobile users in the situation of national roaming, out of the 19 Member States that replied to the relevant question, **five** countries (**Belgium, Latvia,** the **Netherlands, Finland** and **Sweden**) reported that caller location is not provided for such users; the Netherlands and Sweden indicated that they are considering the introduction of such possibility. In addition, in **Spain** this facility is not available in some PSAPs.

9.2 Caller Location – Fixed Calls

Relevant information provided by 25 Member States concerns:

- Method of providing fixed caller location information and time needed to provide it on request (pull)
- Source of fixed caller location information
- Availability of caller location in case of:
  Subscribers not listed in directory services
  Subscribers of VoIP PATS services

Country	**Method of providing fixed caller location information and time needed to provide it on request (Pull)**	**Source of fixed caller location information**	**Availability of caller location in case of:** **Subscribers not listed in directory services**	**Availability of caller location in case of:** **Subscribers of VoIP PATS services**
Austria	Pull by electronic request to the telephone directory or verbal/written request to the respective network operator regarding unlisted numbers. Estimated time needed: less than 2 sec. for electronic requests and up to 30 min. for verbal/written requests	Centralised database including all subscribers of fixed PATS operators, except unlisted numbers. Frequency of updating: daily	Yes- by verbal/written request to the respective operator	No
Belgium	Pull	The database of the fixed incumbent, which includes also subscribers of some alternatives operators. Frequency of updating: daily	Yes	Yes
Bulgaria	Push	Centralised and comprehensive location information database. Frequency of updating: twice a month	Yes	Yes for fixed VoIP subscribers
Czech Republic	Pull; average time needed to provide caller location 0.5 sec, measured in January-October 2008	Centralised and comprehensive database administered by Telefonica O2-Czech Republic	Yes	Yes for fixed VoIP
Cyprus	Pull; estimated time: within 1 minute		Yes	Yes, the registered subscription address is provided by nomadic VoIP service providers if they cannot provide the actual location
Denmark	Push	Centralised comprehensive database. Frequency of updating: daily	No	Yes, if technically feasible
Estonia	Pull; estimated average time 23 sec.	Caller location obtained directly from the relevant operator		
Finland	Pull by electronic request to a database; estimated time 2 sec. and up to 10 sec in times of the heavy traffic	Centralised comprehensive location data base. Frequency of updating: daily	No	Yes
France	Pull; estimated time : a few seconds	Centralised database including more than 80% of numbers.	No, but work has started to produce a	

		Frequency of updating: every few days	comprehensive directory	
Germany	Pull; estimated average time 90 sec.	Centralised comprehensive database giving access to databases of individual providers Frequency of updating: daily or weekly depending on provider	Yes	Yes, the registered address can be provided which may not be the real one in the case of nomadic VoIP
Greece	Pull; estimated time from 3 to 7 minutes	Caller location obtained directly from the relevant operator	Yes	
Hungary	Push	Caller location obtained directly from the relevant operator	Yes	
Ireland	Pull; average time 30 sec; location provided for 100% calls within 1 min.	Centralised comprehensive database Frequency of updating: daily	Yes	
Italy	Push, in the province of Salerno only	Caller location obtained directly from the relevant operator	Yes	Yes
Latvia	Pull, location information is provided immediately	Centralised comprehensive database. Frequency of updating: daily	Yes	
Lithuania	Pull	Caller location obtained directly from the relevant operator	Yes	Yes in case of one provider
Luxembourg	Pull, provided in less than 1 sec.	Caller location obtained directly from the relevant operator	Yes	
Malta				
Netherlands	Push	Centralised comprehensive database. Frequency of updating: daily	Yes	Yes
Poland	Pull; estimated average time: 16 sec.	Currently caller location obtained directly from the relevant operator; a centralised database is in preparation	Yes	Yes
Portugal	Push	Centralised comprehensive database. Frequency of updating: until the next working day if changes to subscriber data are made	Yes	Yes
Romania	Push	Centralised comprehensive	Yes	Yes

		database. Frequency of updating: monthly		
Slovenia	Push in the case of two operators; Pull in the case of all other operators; Measured time: 1.5 hours for 80% of caller location requests	Caller location obtained directly from relevant operator	Yes	Yes
Slovakia	Push	Database of the incumbent operator and a centralised database of alternative fixed operators updated once every 3 months	Yes	Yes
Spain	13 emergency centres Push/ 6 emergency centres Pull Estimated average time: 25 sec.	Some emergency centres use CMT database, others the incumbents database. Frequency of updating: overall update every six months partial updates every two weeks.	Yes (in some emergency centres only)	Yes (in some emergency centres only)
Sweden	Pull by automatically retrieving caller location from a database; estimated time : max 1-2 sec.	Centralised comprehensive database. Frequency of updating: daily	Yes	Yes for VoIP services provided at fixed location; subscription address for nomadic VoIP
Switzerland	Pull- emergency requests location from a central database	Central database; the information must be available within seconds	Yes, but with limitations; indication in case of direct dial-in	The user's home address is provided together with an indication of nomadic usage
United Kingdom	Pull by retrieving caller location from a database to which it is forwarded automatically for every call; estimated time: max. 2 sec.	Centralised comprehensive database. Frequency of updating: daily	Yes	Yes for VoIP services provided at fixed location

Table: Caller Location –Fixed calls

Fixed caller location

Out of 25 member states that provided the relevant information, six countries (Bulgaria, Denmark, the Netherlands, Portugal, Romania and Slovakia) reported to be using the "Push" method for providing fixed caller location. In addition, in Slovenia the "Push" method is used by two operators, in Italy it is used in one province and in Spain by 13 PSAPs. Among the Member States, which use the "Pull" method, seven countries- the Czech Republic, France, Latvia, Luxembourg, Finland, Sweden and the United Kingdom – reported near instant times to provide caller location (up to 15 sec.) which in practical terms render the performance of their caller location systems similar to that of "Push" systems. Also Austria reported similar rapidity in case of electronically handled caller location information requests.

Only Ireland additionally provided data according to the second requested measurement method- percentage of caller location requests for which caller location is provided within one minute, which was 100%. Data based on measurements were provided by Czech Republic and Slovenia while all the other respondent member states used estimates.

A slightly longer time to provide caller location information (up to about 1 min. on average and/or maximum) was reported by Estonia, Spain, Cyprus and Poland. The longest delays were reported by Germany (90 sec. on average), Greece (3 to 7 min.), Austria (up to 30 min. in case of manual requests) and Slovenia (1.5 hours for 80% of caller location requests).

For comparison, in the first data gathering exercise there were also 13 countries using the “Push” system or “Pull” system with near instant (up to 15 sec.) provision of caller information.

VoIP caller location

Member States were invited to indicate whether caller location information is provided for subscribers of VoIP operators providing Publicly Available Telephone Services (PATS) in their countries. Among the 21 Member States that replied to this question, most confirmed that caller location is possible in case of such subscribers. The exceptions were Spain, where it depends on the PSAP, Austria, which replied negatively (no caller location typically possible in case of VoI, but only for VoB), and Lithuania, which indicated that caller location is provided only as regards the subscribers of one PATS VoIP provider.

Furthermore a number of countries, which in principle responded affirmatively, indicated that caller location is subject to technical feasibility, namely the actual address may not be available in case of using nomadic VoIP systems, for which only the registered subscription address may be available(Bulgaria, the Czech Republic, Denmark, Germany, Cyprus, Sweden and UK).

From a technical point of view the ability to provide caller location is heavily dependent on the implemented VoIP scenario, i.e. VoB or VoI (scenario 4). In case of VoI it is highly unlikely that a caller location can be provided, positive answers in the column may be mainly related to the fact that VoI scenarios are not seen as PATS in several countries. To clarify this it could be helpful to rephrase the questions such that it is understandable wether they refer to VoI or to VoB scenarios.

10 CONCLUSIONS

There is a great amount of specificity regarding the implementation of 112 emergency systems among the different countries. Main reasons can be found in specific evolutions, in time, of legacy emergency systems and the parallel running of all emergency numbers.

The evolution of the legacy emergency systems is also closely linked with the development, in time, of the telephony services, the various competition circumstances (e.g. private ambulance or security services) or the degree of administrative autonomy of different regions (high autonomy degree – bottom-up approach for implementing emergency systems, from regional to national level).

Visible efforts were made lately in order to respond to increased requirements regarding calls to emergency systems in general and processing location information requirements in particular. The new series of standards regarding emergency systems, the regulatory measures taken at European level, the improvements showed by the European 112 implementation questionnaire are proofs in this direction.

It is therefore foreseeable that the efforts made regarding emergency systems to be continued in the following time with focus moving from theoretical activities to practical implementation. Work, including work in ECC PT2, should be on caller location in the case of VoI, which currently is an unsolved matter. In this regard the ECRIT work of the IETF should be thoroughly considered (http://www.ietf.org/dyn /charter/ecrit-charter.html).

Future developments

The introducing of eCall, an in-vehicle system that automatically dials 112 when a car has a serious accident sending its location to the nearest emergency service, is also likely to have an impact on the way people perceive and use the emergency call services.

eCall builds on E112 – location enhanced version of 112. Emergency centres and emergency service chains must be capable of dealing with calls coming from an in-vehicle eCall device. They must also be able to process the minimum set of data, including locating data, which is automatically transmitted in the eCall, even when voice communication is not possible.

The European Commission’s strategy aims for introducing an affordable in-car emergency call system in all new vehicles across Europe by 2014, starting 2010[1].

[1] For more details of EC’s strategy please see
http://ec.europa.eu/information_society/activities/esafety/ecall/index_en.htm
The EU's Memorandum of Understanding and list of signatories are available at:
http://ec.europa.eu/information_society/activities/esafety/doc/esafety_library/mou/invehicle_ecall_mou.pdf
http://ec.europa.eu/information_society/activities/esafety/doc/esafety_library/mou/list_of_signatures.pdf

11 FURTHER ACTIVITIES REQUIRED

Due to the advancing into the technical transition from circuit switched networks to packet switched networks and the spreading of the nomadic service provision it is expected that the current fixed location solutions will be gradually replaced by VoIP specific ones. This will involve changes into the way providers operate their networks and also at the emergency systems operators. The turning point will however be closely related with the phasing out of traditional switching networks.

Suitable and precise information on caller location is of critical importance to emergency services in order to accurately identify where the assistance is required and determine what responsive measures are needed.

Thus, to ensure and update the reliability of emergency services, there is a need for defining common rules and procedures for conveying emergency calls. Such rules and procedures may address in particular:

- A common format and standard transportation means for location information;
- Harmonised requirements within the EU concerning accuracy and reliability of location information;
- The prioritisation for emergency calls versus non-emergency calls as well as non-telephone traffic carried on a subscriber access line;
- Quality of service requirements for emergency calls;
- Acceptable latency or delay in conveying messages between call connecting parties.