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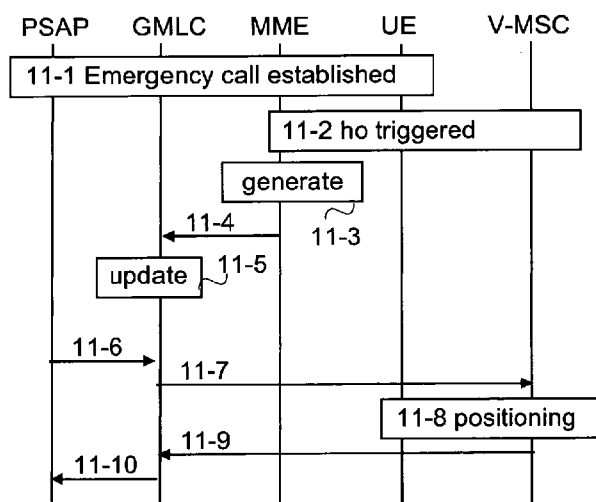


FIG.11

(57) Abstract: To facilitate emergency location continuity services, when detecting an emergency call handover to an access network using a control plane solution in location services is detected, location services related information associated with the emergency call is updated.

LOCATION SERVICE CONTINUITY IN HANDOVER TO AN ACCESS NETWORK
USING A CONTROL PLANE SOLUTION IN LOCATION SERVICES

FIELD OF THE INVENTION

The exemplary and non-limiting embodiments of this invention relate generally to location service continuity after a handover, and especially to location service continuity in an emergency call when the target domain of the handover uses control plane for location services.

BACKGROUND ART

The following description of background art may include insights, discoveries, understandings or disclosures, or associations together with disclosures not known to the relevant art prior to the present invention but provided by the invention. Some such contributions of the invention may be specifically pointed out below, whereas other such contributions of the invention will be apparent from their context.

The evolvement of mobile terminals to terminals supporting two or more different access technologies and the implementation of networks based on new communications technologies, such as an packet switched, Internet protocol (IP) based long term evolution (LTE), to convergence with other types of networks, especially with networks based on "older" technologies, such as a circuit switched global mobile system (GSM), have enabled handovers between different types of access networks.

The ability of users to move with their user equipments from one place to another and the evolvement of different positioning methods have led to location services (LCS). The location services is a service concept system that specifies how location information is obtained in the access network and delivered to a platform requesting the location information. The only location based service the location services define is the emergency location service. The location services allows access networks to use different position methods, even if the access networks are of same type. Basically the location services is either provided by control layer entities using embedded signalling protocols or by user plane entities using a data connection, i.e. a user plane data bearer, and the implementation is a network-specific feature. In other words, same type of networks may provide the location services differently.

When user equipment performs a handover between two different types of access networks during an ongoing voice call a concept called "voice call continuity" (VCC) ensures that in such a situation the voice call continues

without the user of the user equipment noticing the change of the access network. When the call is an emergency call and the emergency service uses the emergency location services to obtain the caller's position to assist the emergency service, also the location services continuity should be ensured during
5 and after a handover.

SUMMARY

The following presents a simplified summary of the invention in order to provide a basic understanding of some aspects of the invention. This summary is not an extensive overview of the invention. It is not intended to
10 identify key/critical elements of the invention or to delineate the scope of the invention. Its sole purpose is to present some concepts of the invention in a simplified form as a prelude to the more detailed description that is presented later.

An aspect of some embodiments is to facilitate emergency location
15 services continuity for a voice call handover to a target network using control plane to location services.

Various aspects of the invention comprise methods, an apparatus, and a computer program product, as defined in the independent claims. Further embodiments of the invention are disclosed in the dependent claims.

20 BRIEF DESCRIPTION OF THE DRAWINGS

In the following the invention will be described in greater detail by means of exemplary embodiments with reference to the attached drawings, in which

Figure 1 shows a simplified block diagram illustrating exemplary
25 system architecture;

Figure 2 is a flow chart illustrating an exemplary functionality of an apparatus according to an embodiment;

Figure 3 shows a messaging diagram illustrating an exemplary messaging event according to an embodiment;

30 Figures 4 to 7 are flow charts illustrating exemplary functionalities of apparatuses according to different embodiments;

Figures 8 to 11 show messaging diagrams illustrating exemplary messaging events according to different embodiments; and

Figure 12 shows a schematic diagram of an apparatus according to

exemplary embodiments.

DETAILED DESCRIPTION OF SOME EMBODIMENTS

Exemplary embodiments of the present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Although the specification may refer to "an", "one", or "some" embodiment(s) in several locations, this does not necessarily mean that each such reference is to the same embodiment(s), or that the feature only applies to a single embodiment. Single features of different embodiments may also be combined to provide other embodiments. Like reference numerals refer to like elements throughout.

The present invention is applicable to any server, network node, corresponding component, and/or to any communication system or any combination of different communication systems that support emergency location services and single radio voice call continuity. The communication system may be a wireless communication system or a communication system utilizing both fixed networks and wireless networks. The protocols used, the specifications of communication systems, servers and network nodes, especially in wireless communication, develop rapidly. Such development may require extra changes to an embodiment. Therefore, all words and expressions should be interpreted broadly and they are intended to illustrate, not to restrict, the embodiment.

In the following, different embodiments will be described using, as an example of a system architecture whereto the embodiments may be applied, an architecture based on the long term evolution LTE and system architecture evolution SAE. The system may be EPS (evolved packet system) that comprises E-UTRAN (evolved UMTS (universal mobile telecommunications system) terrestrial radio access network) on the access side and EPC (evolved packet core) on the core side.

A general architecture of such a communication system is illustrated in Figure 1. Figure 1 is a simplified system architecture only showing some elements and functional entities of a system 100, all being logical units whose implementation may differ from what is shown. The connections shown in Fig-

ure 1 are logical connections; the actual physical connections may be different. It is apparent to a person skilled in the art that the systems also comprise other functions and structures. It should be appreciated that the functions, structures, elements and the protocols used in or for handover and/or for voice call continuity and/or for positioning user equipment by the serving access network the user equipment, are irrelevant to the actual invention. Therefore, they need not to be discussed in more detail here.

In the exemplary embodiment illustrated in Figure 1, it is assumed that an originating network 110 is a packet switched network, employing an IP-based session control protocol, such as a SIP (Session Initiation Protocol) protocol, on the user plane and providing wireless access via an Internet Protocol connectivity access sub-network (IP CAN). Examples of such a network include EPS and IMS and examples of such an access sub-network include E-UTRAN, UTRAN and I-WLAN (interworked/interworking wireless local area network).

It is further assumed that in a target network 120 control plane entities provides the location service. However, the target network may be a packet switched network with a packet switched access sub-network, such as E-UTRAN, UTRAN, GPRS (general packet radio service) with HSPA (high speed packet access), I-WLAN, WiMax (worldwide interoperability for microwave access) and WiBro (wireless broadband) or a circuit switched network, such as CDMA (code division multiple access), GSM with GERAN (GSM edge radio access network), GSM with EDGE (enhanced data for GSM evolution), Wideband CDMA, or WLAN.

It should be appreciated that the above (access) network examples illustrate only some alternatives without restricting embodiments to such solutions and other wireless or fixed (access) networks may be used as well.

Herein term "originating" is used meaning the network wherefrom the handover is performed (i.e. the source network). The originating network may be the network via which the emergency call was established or it may be a network to which a handover has happened earlier. For example, an emergency call may have been established in a packet switched network having a non-3GPP (third generation partnership project) access network, such as WLAN, then handovered to E-UTRAN (originating network), wherefrom a handover to GERAN (target network) takes place.

Since positioning of user equipment is performed by the access network, access networks 110 and 120 both contain a location server. The location server 111, 121 is the entity that obtains location information on served user equipments, and which receives location requests from location services clients, such as PSAP described below. Further, in the illustrated embodiment, the location servers are configured to support emergency location services. In the illustrated example the location servers 111, 121 each contain an integrated location retrieval function LRF. However, LRF may be a separate entity (not shown in Figure 1) that interacts with a location server. The location retrieval function handles the retrieval of location information.

The location server 111 in the originating access network 110 may be a so called secure user plane location server which comprises a secure user plane platform, called below SLP and specified by Open Mobile Alliance. Since it is configured to support emergency location services, it may be also called E-SLP. SLP requires an IP capable network and uses user plane data bearer to determine the location of the user terminal. If the originating access network 110 uses the control plane solution for location services, the location server 11 may be a gateway mobile location centre GMLC.

The location server 121 in the target network 120 is in the illustrated example a network using the control plane solution for location services. Thus, depending on the target access network technology, the location server 121 may be GMLC.

The core network 130 in the exemplary embodiment is IP multimedia subsystem (IMS) core containing an emergency call service control function (E-CSCF) 133 controlling the emergency voice call and an emergency call continuity application server 134 at which the emergency call may be anchored and that provides the voice call continuity. In the illustrated example the call continuity application server is a single radio call continuity application server (SCC-AS) configured to ensure an emergency call continuity for so called "single radio user equipment" that support packet switched access and circuit switched access but are capable of transmitting or receiving on only one of the access networks at a time. Such a server may also be called E-SCC-AS. However, it should be appreciated that the call continuity application server 134 may be configured to provide, in addition to "single radio", or alternatively for the "single radio", call continuity to "dual radio" user equipment capable of transmitting or receiving on both types of access networks simultaneously.

The home network 140 of the user equipment 160 contains a home subscriber server (HSS) 145. The home subscriber server contains subscriber information, including routing information. The home subscriber server 165 is accessible from location servers 111 and 121.

- 5 Emergency services are provided in public safety answering point (PSAP) 156. In the illustrated exemplary embodiment, PSAP is a legacy PSAP locating in a public switched network 150 and accessible by the core network 130 via a public switched network gateway comprising a media gateway control function MGCF (not shown in Figure 1) that performs protocol conversions.
- 10 However, PSAP may be an IP PSAP supporting voice over IP traffic, preferably supporting SIP, and it thus may be connected directly to the core network 130.

User equipment 160 is any device capable to access the access networks, and thereby allowing a user to access network services.

- 15 It should be appreciated that an originating network may be a home network or a visited network, and the target network may be a visited network or a home network.

- Below different embodiments are disclosed assuming that the user equipment does not enter a shadow region, or the like, but the emergency call
- 20 is released either by the user or PSAP. Further, below terms positioning, determining location or location detecting are used to describe a functionality, which detects a geographical location and optionally, velocity of the user equipment, and any positioning method may be used. The positioning method used in a currently serving network (either in the originating network or in the
- 25 visited network), bears no significance to the embodiments, and therefore it is not described in detail below. Further, a man skilled in the art is familiar with different positioning methods.

- Figure 2 is a flow chart illustrating an exemplary functionality of an apparatus according to an embodiment, the apparatus being configured to perform a location server functionality with some enhanced functionality. In the
- 30 embodiment it is assumed that the apparatus is in the originating access network and responsible for determining locations of user equipment in the originating access network. However, the determination may be performed using either the control plane solution or the user plane solution. Thus, the apparatus
- 35 may be SLP if the originating network uses user plane for location services, or GMLC if the originating network uses control plane for location services, as

described above. A further assumption made with Figure 2 is that an emergency call has been set up between PSAP and the target user equipment.

The apparatus receives, in step 201, a positioning inquiry from PSAP. Then the apparatus determines, in step 202, whether or not the target user equipment is reachable. If the handover has happened, the target user equipment is detected, in step 203, as not-reachable. For example, the apparatus may try to obtain the location information using stored address information associated with the target user equipment but fails, or the apparatus may have received information, for example a notification, indicating that a handover has happened, and detects on the basis of such information that the target user equipment is not-reachable. It should be appreciated that also other procedures may be used to detect the reachability of the target user equipment.

Since the target user equipment is not-reachable, the apparatus requests, in step 204, routing info for location services from HSS, and receives and stores, in step 205, a visited address wherefrom to request the location information. The visited address is either an address of a visited (target) GLMC or an address of a visited (target) mobile switching centre MSC or MSC server or a serving support node (SGSN) or a mobility management entity (MME) depending on the access network technology and/or on the access network configuration. Then the apparatus inquires, in step 206, the location of the user terminal, by sending location inquiry message to the visited address. If the visited address is an address of a target GMLC, the apparatus inquires the location of the user terminal from the visited GMLC. If the visited address is an address of a visited MSC or MSC server or SGSN or MME, the apparatus inquires the location of the user terminal directly from the visited MSC/MSC server/SGSN/MME. Then the apparatus receives, in step 207, the location of the user equipment and sends, in step 208, the location to PSAP.

If the user equipment is reachable (step 202), the apparatus determines the location of the user equipment.

Thus, PSAP receives the location information after a handover as if the user equipment would still locate in the originating network, and the location service continuity is guaranteed, regardless of whether PSAP is a legacy PSAP or IP PSAP.

It should be appreciated that if the target access network uses the user plane solution and comprises SLP as a location server, the address received in step 205 may be an address of a visited SLP.

Figure 3 illustrates exemplary messaging event according to an exemplary embodiment, wherein the originating location server is SLP that may be implemented according to the embodiment disclosed with Figure 2, and the target network is a visited second generation circuit switched network with GERAN without limiting the embodiment to such network structures. A further assumption here is that an emergency call can be tied to a subscription and thereby to subscription information in HSS (in other words is not a SIM-less emergency call or a non-registered (U)SIM emergency call).

Referring to Figure 3, an emergency call has been established between the user equipment UE and the emergency centre PSAP and the initial location has been provided by an originating location server SLP in point 3-1. During the call the user equipment has performed a handover with voice call continuity to a visited circuit switched network, and is being served by a visited mobile switching centre V-MSC, which has performed a location update to HSS in point 3-2. Further details of points 3-1 and 3-2 are well known to one skilled in the art and are therefore not discussed in more detail here.

PSAP, not being aware of the handover, sends message 3-4, such as a "MLP SLIR (Standard Location Immediate Request)", to SLP to obtain location of UE. Due to the handover there is no active connection between the user equipment and SLP. SLP may try to open a connection, and after a while notice that the connection could not be opened, or use other procedures to determine that the target user equipment is not reachable by SLP (point 3-5). In other words, the SLP detects that a handover has happened. Therefore SLP sends message 3-6, such as "send routeing info for lcs" to HSS. HSS obtains from subscriber information the address of a serving switching entity and then sends it in message 3-7. In the illustrated example HSS sends in message 3-7, such as "send routeing info for lcs ack", the address of V-MSC. It should be appreciated that an address of a visited V-GMLC and/or a network address with which addresses of one or more network entities involved in the positioning may be obtained, for example, may be received instead of or in addition to the address of V-MSC.

After receiving the address of V-MSC, SLP sends message 3-8, such as "MAP provide subscriber location", directly to V-MSC, which performs

the positioning in point 3-9, and sends in message 3-10, such as "MAP provide subscriber location ack", location information on the target user equipment to SLP. Then SLP sends the location information to PSAP in message 3-11, such as "MLP SLIA (Standard Location Immediate Answer)".

5 In another embodiment, a network entity in IMS core involved in the handover procedure, such as the voice call continuity server, may send during or just after the handover to SLP a notification which indicates that the earlier connection to the user equipment may have been lost. SLP stores the notification and on the basis of the notification detects in point 3-5 that the user terminal is non-reachable.

As can be seen, the handover is transparent to PSAP which receives the required location information as if no handover had taken place. Another advantage of the embodiment is that since it is performed in response to PSAP requesting a "positioning update", no extra signalling is caused in situations in which PSAP does not need "positioning updates".

Figure 4 is a flow chart illustrating exemplary functionality of an apparatus according to an embodiment, the apparatus being configured to perform the functionality of SCC-AS with enhanced functionality. A further assumption made with Figure 4 is that an emergency call has been set up between PSAP and the target user equipment.

When the apparatus receives (step 401) a domain transfer request containing correlation information, the apparatus determines, in step 402, whether or not PSAP is a legacy PSAP. The apparatus may determine this by detecting whether PSAP is connected via IP (IP PSAP) or via MGCF (legacy PSAP). If the apparatus determines (step 402) that PSAP is a legacy PSAP, the apparatus generates, in step 403, a remote leg update message to be sent via E-SCSF to PSAP, and then sends, in step 403, the remote leg update message to PSAP. The remote leg update message contains connection information needed for user plane traffic. Further, the apparatus generates, in step 404, a location notification message containing the received correlation information, and sends, in step 405, the location notification message to the location server, such as SLP or GMLC, in the access network via which the emergency call was established. The location notification message may be sent via E-CSCF.

If the PSAP is IP PSAP (step 402), the apparatus generates, in step 406, the remote leg update message to be sent via E-SCSF to PSAP, adds, in

step 407, correlation information to the remote leg update message, and only after that sends, in step 408, the remote leg update message to PSAP. Then the apparatus indicates, in step 409, to the originating location server that it may release all information relating to the emergency call.

5 The correlation information identifies the location server or a switching entity, such as MSC, MSC server, SGSN, MME, in the target network. The correlation information may also identify a call session relating to the emergency call in the location server.

10 It should be appreciated that the apparatus may receive instead of the domain transfer request, an access transfer request or a voice call continuity transfer request, or a single radio voice call continuity request.

15 An advantage of the embodiment is that no changes are needed to legacy PSAP, but when PSAP is SIP or IP capable, PSAP may update its information and inquiry the location of the user equipment next time directly from the new access network.

 In another embodiment of the invention, the apparatus does not determine the type of PSAP but always forms a location notification to location server. Thus, steps 402, 406, 407, 408, and 409 are skipped.

20 Further, by sending the correlation information to the location server, the location server receives, as part of a handover procedure, information by means of which the location server is able to update information needed to obtain the location of the target user equipment. In other words, SLP or GMLC receives an address of the serving entity (visited GMLC or MSC or MSC server or SGSN, for example) which may position the user equipment, and the handover remains transparent to PSAP.

30 Figure 5 is a flow chart illustrating exemplary functionality of an apparatus according to an embodiment, the apparatus being configured to act as E-CSCF with enhanced functionality. A further assumption made with Figure 5 is that an emergency call has been set up between PSAP and the target user equipment, and that SCC-AS is configured to perform the remote leg update in the same way for legacy PSAP and IP PSAP, and send a location notification to the location server.

35 When the apparatus receives, in step 501, the location notification relating to an ongoing emergency call and targeted to a location server, the apparatus determines, in step 502, whether or not PSAP is a legacy PSAP. The apparatus may determine this by detecting whether PSAP is connected

via IP (IP PSAP) or via GMCF (legacy PSAP). If the apparatus determines (step 502) that PSAP is a legacy PSAP, the apparatus sends, in step 503, the location notification with the correlation information to the location server so that the location server may update its information.

5 However, if the PSAP is not a legacy PSAP (step 502), it is IP PSAP, and the apparatus changes, in step 504, the target address of the location notification to be the address of PSAP and then sends, in step 505, the update message to PSAP so that the PSAP can update the information wherefrom to inquiry the location of the user equipment. Then the apparatus indicates, in step 506, to the location server the location notification was targeted to, that it may release all information relating to the emergency call.

10 An advantage of the embodiment is that no changes are needed to legacy PSAP, but when PSAP is SIP or IP capable, PSAP may update its information and inquiry the location of the user equipment next time directly from the new access network. Another advantage is that the voice call continuity server need not to determine PSAP type.

15 Figure 6 is a flow chart illustrating exemplary functionality of an apparatus according to an embodiment, the apparatus being configured to participate to a handover in the originating access network with enhanced functionality. Thus, the apparatus may be MME with enhanced functionality. A further assumption made with Figure 6 is that an emergency call has been set up between PSAP and the target user equipment, and the target user equipment is served by MME before the handover.

20 The user equipment has triggered a handover, and the apparatus detects the handover in step 601. Therefore the apparatus checks, in step 602, whether the handover happens within its service area. If the handover happens within the service area of the apparatus, i.e. is an internal handover in view of the apparatus, the apparatus updates, in step 603, internal information so that it knows wherefrom the user equipment can be found.

25 However, if the handover is targeted to an area not belonging to the service area of the apparatus (step 602), the apparatus sends, in step 604, after the handover and relating procedures has been completed, a message to the location server, the message containing a new address, i.e. the address of MSC/MSC server/SGSN/MME, in the target network, wherefrom location information of the user equipment may be inquired. The apparatus obtains the

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address information during the handover and the relating procedures. Then the apparatus releases, in step 605, its resources allocated to the emergency call.

An advantage of the embodiment is that it is ensured that as long as the apparatus, such as MME, can provide location information on the user equipment, it may receive such request, but immediately, when it cannot any-
5 more provide the location information, the location server sending location requests is informed on the new address, the new address being determined during the handover. In other words, the advantage is that the location server gets aware of the MSC address during the handover (SRVCC) directly from
10 MME, there is no need to carry the location correlation in SIP/ISUP signalling via IMS to location server.

Figure 7 is a flow chart illustrating exemplary functionality of an apparatus according to an embodiment, the apparatus being configured to perform the functionality of a location server with enhanced functionality. Thus, the
15 apparatus may be SLP or GMLC with enhanced functionality. A further assumption made with Figure 7 is that an emergency call has been set up between PSAP and the target user equipment.

Referring to Figure 7, the apparatus receives, in step 701, location services related information associated with a specific emergency call thereby
20 detecting that a handover has taken place. Then the apparatus updates, in step 702, corresponding information, and when a further positioning inquiry is received from PSAP relating to the emergency call, the apparatus has required information with which to obtain the location information in the currently serving access network (the target network).

25 The advantage is that the apparatus can directly inquiry the location from an entity currently serving the target user equipment.

In an embodiment the location services related information is correlation information indicating an address of a location server, MSC, MSC server, SGSN, or MME, as described above. In another embodiment the location services related information is the address of the location server, MSC, MSC
30 server, SGSN or MME.

Depending on an implemented embodiment, the apparatus may receive the location services related information in a location notification originating from SCC-AS or as pushed by a serving location server. The push may
35 correspond to the one sent by GLMC (i.e. a serving location server) to PSAP

(or more precisely, to location services client in PSAP). In other words, the push may be "SRVCC PS to CS request".

Figure 8 illustrates exemplary messaging event according to an exemplary embodiment, wherein the originating location server is SLP, and the target network is a visited circuit switched network with GERAN without restricting the embodiment to such a network solution. For example, the target network may be a third generation UTRAN and the originating location server GMLC.

Referring to Figure 8, an emergency call has been established between the user equipment UE and the emergency centre PSAP and the initial location has been provided by an originating location server SLP in point 8-1. During the call the user equipment notices that a handover with voice call continuity procedure needs be performed, and the handover is triggered, in point 8-2 between the user equipment and a visited mobile switching centre V-MSC in the target network. Therefore V-MSC send message 8-3 to visited GMLC (V-GMLC) in the target network to inform V-GMLC about the user equipment and its identification information. Message 8-3 may be "MAP Subscriber location report". In response to receiving message 8-3 and thereby detecting the handover, V-GMLC allocates the correlation information in point 8-4 by itself. (In another embodiment the correlation information may be allocated with the help of the V-MSC.) In the illustrated example the correlation information indicates the V-GMLC as a serving entity to which direct positioning requests. Then V-GMLC acknowledges message 8-3 by message 8-5, message 8-5 containing the correlation information. Message 8-5 may be "MAP Subscriber location report ack". Then V-MSC generates a domain transfer request message 8-6 to which V-MSC adds the correlation information. The domain transfer request contains also an indication that this request relates to an emergency call in which a single radio user terminal is involved. The indication may be an address, such as emergency session transfer number – single radio (E-STN-SR), preconfigured to the user equipment, or the user of the user equipment, the address indicating preferably SCC-AS and indicating to SCC-AS that the request relates to a single radio voice call continuity. Then V-MSC sends message 8-6 to SCC-AS. Examples of domain transfer request messages include "CS-SET UP" or, if V-MSC supports SIP, "SIP INVITE". Further details of points 8-1, 8-2 and 8-3 and messages 8-4, 8-5 and 8-6 are well known to one skilled in the art and are therefore not discussed in more detail here. For ex-

ample, E-STN-SR is obtained from HSS by MME, when the handover is triggered.

When SCC-AS receives message 8-6, SCC-AS generates, in point 8-7, a remote leg update message to transfer user plane related information, and a location notification that contains the received correlation information. Then SCC-AS sends the location notification, i.e. message 8-8 directly or via E-CSCF in the originating network (not shown in Figure 8) to SLP. Message 8-8 may be "SIP re-INVITE" or "SIP UPDATE" or "SIP NOTIFY". SCC-AS sends also the remote leg update message 8-15 to PSAP via E-CSCF.

In this way SLP receives the address of the location server in the target network, and stores it in point 8-9 to be used, if current location of UE needs to be determined.

PSAP, needing updated information on the location of UE and not being aware of the handover, sends message 8-10, such as a "MLP SLIR", to SLP. However, SLP is aware of the handover and the new address. Therefore SLP sends message 8-11, such as "RLP SRLIR" directly to V-GMLC, which performs the positioning in point 8-12, and sends in message 8-13, such as "RLP SRLIA", location information on the target user equipment to SLP. Then SLP sends the location information to PSAP in message 8-14, such as "MLP SLIA".

In another example the correlation information is in SIP URI (uniform resource identifier) format. In that case SLP may use "SIP SUBSCRIBE" to obtain the location information from V-GMLC.

An advantage of the embodiment is that SLP can without HSS inquiry, i.e. without any delay, forward the positioning inquiry, and thereby ensure the emergency location service continuity. Another advantage is that SIM-less emergency calls and non-registered (U)SIM emergency calls are supported.

In another embodiment the correlation information indicates the switching entity. In that case instead of message 8-11, a corresponding message (in another protocol format) is sent directly to the switching entity. The switching entity then performs the positioning and sends a message corresponding to message 8-13.

Figure 9 illustrates exemplary messaging event according to an exemplary embodiment, wherein the originating location server is SLP, the originating network comprises E-CSCF that is configured to detect, whether a re-

remote leg update contains correlation information and is related to an emergency voice call continuity, the target network is a second generation circuit switched network with GERAN and the emergency service centre is IP PSAP without restricting the embodiment to such a network solution. For example,
5 the target network may be a third generation UTRAN and the originating location server GMLC.

Referring to Figure 9, points 9-1, 9-2, 9-3, and messages 9-4, 9-5, 9-6, correspond to points 8-1, 8-2, 8-3, and messages 8-4, 8-5, 8-6, in Figure 8, respectively and are therefore not repeated in vain here.

10 However, in the embodiment SCC-AS is configured to generate, in point 9-7, a remote leg update message 9-8 containing the correlation information regardless of whether PSAP is a legacy PSAP or IP PSAP. When message 9-8 is formed, SCC-AS sends message 9-8 to IP-PSAP via E-SCSF. In the illustrated embodiment, E-CSCF is configured to examine message 9-8
15 and to determine the PSAP type (legacy or IP). In other words E-CSCF performs, in point 9-9, the examination and detects that PSAP is IP PSAP. Therefore E-CSCF generates message 9-8' that contains the same correlation information that is in message 9-8. Then message (9-8' containing correlation information) is sent to IP PSAP. Further, E-CSCF sends message 9-10 to SLP,
20 message 9-10 indicating that SLP may release all information on the emergency call. Message 9-10 may be "SIP re-INVITE", "SIP UPDATE", "SIP SUBSCRIBE" or "SIP NOTIFY" and it may indicate that the control of location service has been transferred to another location server. When SLP receives message 9-10, it releases all information on the emergency call (not shown in Figure 9) and does not wait for further positioning inquiries.
25

In this way IP PSAP receives the address of the location server in the target network, and updates the location server address to be according to the received correlation information in point 9-11. In another embodiment the received address is an address of V-MSC, which is then used as the address
30 wherefrom location information is obtained.

When IP PSAP next time needs to obtain the location of UE, IP PSAP, sends message 9-12, such as "Request for location information", directly to location server in the target network, i.e. to V-GMLC. Then the positioning is performed in point 9-13, and V-GMLC sends in message 9-14, such
35 as "Request for location information ack", location information on the target user equipment directly to IP PSAP.

In the embodiment, if PSAP is a legacy PSAP, E-CSCF is configured to generate, in point 9-9, a location notification, to add to the location notification the correlation information received in message 9-8, and send the location notification to SLP, which then stores the correlation information for
5 later use. Further, in another embodiment E-CSCF may be configured to remove from message 9-8 the correlation information and only after that to send the modified message 9-8' to PSAP.

An advantage of the embodiment is that IP PSAP can send the positioning inquiry directly to a proper location server, thereby ensuring the emergency location service continuity and minimizing the messaging needed to obtain the location information. A further advantage is that memory and processing resources in the originating location server can be released. Still an advantage is that SIM-less emergency calls and non-registered (U)SIM emergency calls are supported.

15 Figure 10 illustrates exemplary messaging event according to an exemplary embodiment, wherein the originating location server is SLP, and the target network is a second generation circuit switched network with GERAN without restricting the embodiment to such a network solution. For example, the target network may be a third generation UTRAN and the originating location server GMLC.
20

Referring to Figure 10, an emergency call has been established between the user equipment UE and the emergency centre PSAP and the initial location has been provided by an originating location server SLP in point 10-1. During the call the user equipment notices that a handover with voice call continuity needs be performed, and the handover is triggered, in point 10-2 between the user equipment and a visited mobile switching centre V-MSC in the target network. Also a mobility management entity V-MME in the target network is involved in the messaging since V-MME is the network entity that starts the voice call continuity towards V-MSC.
25

30 As explained above, V-MSC allocates the correlation information in point 10-3 by itself. (In another embodiment the correlation information may be allocated with the help of the visited GMLC (V-GMLC) in the target network.

Parallel to that V-MME examines information relating to an active connection over LTE. Since an emergency access point name (em-APN) is
35 used, MME detects that the connection relates to an emergency call, and determines, based on secure user plane location/transport control protocol

(SUPL/TCP) used over the connection, for example, the address of SLP. V-MME may, for example, examine transmission control protocol/Internet protocol (TCP/IP) connection. When the address is determined, in point 10-4, V-MME pushes the address to V-MSC in message 10-5. Message 10-5 may be
5 "SRVCC PS to CS request".

In response to the pushed address, V-MSC further pushes the address in message 10-6 to V-GMLC. Message 10-6 may be "MAP Subscriber_location_report".

Then V-MSC sends message 10-7 to V-GMLC to inform V-GMLC
10 about the user equipment, its identification information and correlation information and V-GMLC acknowledges message 10-7 (not shown in Figure 10). Message 10-7 may also be "MAP Subscriber location report". In another embodiment messages 10-6 and 10-7 are combined to one message.

Then V-GMLC generates, in point 10-8, message 10-9 which contains the correlation information and pushes message 10-9 to SLP. Message
15 10-9 may be "location information". In another embodiment the address of V-GMLC/V-MSC/V-MME/V-SGSN may be pushed in message 10-9 instead of the correlation information.

In this way SLP receives the address of the location server, or a corresponding entity to which send positioning inquiries, in the target network, and
20 stores the address in point 10-10 to be used, if current location of UE needs to be determined.

The determination of the current location is triggered by message 10-11. However, messages 10-11, 10-12, 10-14, 10-15 and point 10-13 correspond to messages 8-10, 8-11, 8-13, 8-14 and point 8-12 in Figure 8, respectively and are therefore not repeated in vain here.
25

In another embodiment V-MME is not involved, but other methods are used to provide SLP address (location server address in the originating network) to V-GMLC.

30 An advantage of the embodiment is that SLP can without HSS inquiry, i.e. without any delay, forward the positioning inquiry, and thereby ensure the emergency location service continuity. Still an advantage is that SIM-less emergency calls and non-registered (U)SIM emergency calls are supported.

35 In a further embodiment, V-GMLC is configured to push message 10-9 to PSAP instead of pushing it to SLP (or GMLC or other corresponding

location server), and the location server is configured to store and use the correlation information.

Figure 11 illustrates exemplary messaging event according to an exemplary embodiment, wherein both the originating access network and the target access network uses the control plane solution for location services. In the embodiment, it is assumed that PSAP sends positioning inquiries to a location server determined when the emergency call was established. In other words, the emergency call is anchored to the initial location server which is in the illustrated example GMLC.

Referring to Figure 11, an emergency call has been established between the user equipment UE and the emergency centre PSAP and the initial location has been provided by an originating location server GMLC in point 11-1. During the call the user equipment UE notices that a handover with a single radio voice call continuity needs be performed, and the handover with a corresponding single radio voice call continue procedure are performed, in point 11-2, between the user equipment (via MME in the originating network) and a visited mobile switching centre V-MSC in the target network.

When MME in the originating network, i.e. in the old network, notices that the handover and the radio voice call continue procedure are completed, it generates, in point 11-3, message 11-4 to inform GMLC on the new address wherefrom inquiry the location of the UE. Message 11-4 may be "update serving entity" and it contains the address of V-MSC, and it may contain also information identifying the user equipment and/or an indication of the reason why serving entity information needs to be updated, the reason being the handover (more specifically, single radio voice call continuity handover). When GMLC receives message 11-4, it updates, in point 11-5, corresponding information.

When PSAP next time wants to inquire the position of UE, PSAP is not aware of the handover, and sends message 11-6 to GMLC. Message 11-6 may be "Location request". However, GMLC is aware of the handover and the new address. Therefore GMLC sends message 11-7, such as "MAP provide subscriber location message" directly to V-MSC, which performs the positioning in point 11-8, and sends in message 11-9, such as "MAP provide subscriber location message ack", location information on the target user equipment to GMLC. Then GMLC sends the location information to PSAP in message 11-10, such as "Location request ack".

An advantage of the embodiment is that GMLC can without HSS inquiry, i.e. without any delay, forward the positioning inquiry, and thereby ensure the emergency location service continuity. Another advantage is that SIM-less emergency calls and non-registered (U)SIM emergency calls are supported. A further advantage of the embodiment is that the handover is transparent to PSAP. Further, since the location server obtains the MSC address during the handover directly from MME, a signalling load is reduced since the location correlation is not transmitted to the location server in SIP/ISUP signalling via IMS.

The steps/points, messages and related functions described above in Figures 2 to 11 are in no absolute chronological order, and some of the steps/points may be performed and/or messages sent simultaneously or in an order differing from the given one. Other functions can also be executed between the steps/points or within the steps/points and other messages sent between the illustrated messages. Some of the steps/points or part of the steps/points can also be left out or replaced by a corresponding step/point or part of the step/point. Further, step/points and/or messages described with different embodiments may be combined to obtain further embodiments. The emergency location service continuity operations illustrate a procedure that may be implemented in one or more physical or logical entities. The messages are only exemplary and may even comprise several separate messages for transmitting the same information. In addition, the messages may also contain other information. Depending on the network technologies involved, other entities may take part to the messaging than those described above.

Figure 12 is a block diagram of an apparatus according to an embodiment of the invention. Although the apparatus has been depicted as one entity, different units, and processors and memory (not shown in Figure 10) may be implemented in one or more physical or logical entities. The apparatus 200 is configured to perform one or more of the functionalities of a network entity described above with an embodiment. For this purpose, the apparatus comprises an emergency location continuity unit (ELC) 21 for providing functionality to facilitate the emergency location continuity according to one of the above described embodiments. In other words, the emergency location continuity unit 21 is configured to detect an emergency call handover to an access network using a control plane solution in location services, and/or to update location services related information associated with the emergency call to im-

plement an enhanced functionality of an apparatus described above with an embodiment. It should be noted that detecting and updating may be performed in many ways, as described above. Further, the apparatus comprises a receiving unit 22 for receiving different inputs, information and messages, and a
5 sending unit 23 for sending different outputs, information and messages. The units may be software and/or software-hardware and/or firmware components (recorded indelibly on a medium such as read-only-memory or embodied in hard-wired computer circuitry).

The apparatus may generally include a processor (not shown in
10 Figure 10), controller, control unit, micro-controller, or the like connected to a memory and to various interfaces of the apparatus. Generally the processor is a central processing unit, but the processor may be an additional operation processor. The emergency location continuity unit 21 may be configured as a computer or or a processor, or a microprocessor, such as a single-chip com-
15 puter element, or as a chipset, including at least a memory for providing storage area used for arithmetic operation and an operation processor for executing the arithmetic operation. The emergency location unit may comprise one or more computer processors, application-specific integrated circuits (ASIC), digital signal processors (DSP), digital signal processing devices (DSPD), pro-
20 grammable logic devices (PLD), field-programmable gate arrays (FPGA), and/or other hardware components that have been programmed in such a way to carry out one or more functions of an embodiment. The apparatus may be provided with two or more interfaces, through which the apparatus communicates with the other network entities (or the user equipment). Preferably the
25 apparatus comprises a separate interface for each communication technology. An interface provides a transmitter and/or a receiver or a corresponding means for receiving and/or transmitting data, content, messages including the above described messages.

The apparatus may generally include volatile and/or non- volatile
30 memory (not shown in Figure 10) and typically stores content, data, or the like. For example, the memory may store computer program code such as software applications (for example for the emergency location continuity unit) or operating systems, information, data, content, or the like for the processor to perform steps associated with operation of the apparatus in accordance with embodi-
35 ments. The memory may be, for example, random access memory, a hard

drive, or other fixed data memory or storage device. Further, the memory, or part of it, may be removable memory detachably connected to the apparatus.

It should be appreciated that the apparatus may comprise other units used in or for emergency call and/or voice call continuity. However, they are irrelevant to the actual invention and, therefore, they need not to be discussed in more detail here.

The apparatus may be any node or a server which is involved in the emergency call handling somehow. Different embodiments of such an apparatus are disclosed above. Depending on an embodiment, one or more apparatuses may be configured to contain the above described features.

For example, the apparatus may be a location server, such as SLP or GMLC, and comprising an emergency location continuity unit 21 configured at least to request, in response to detecting a handover, from HSS routing information for location services, and receive in a response an address, or corresponding information, of a network entity currently serving the user equipment. Alternatively, when the apparatus is a location server, the emergency location continuity unit 21 may be configured to detect the handover by receiving a message indicating a new address, or other information indicating a new network entity, wherefrom to request location information and to update corresponding information with the received information, so that when a positioning inquiry is next time received for the call, it can send a location request to the new network entity serving the user equipment.

Further, the apparatus may be a voice call continuity server, such as a single radio voice call continuity server, that comprises an emergency location continuity unit 21 configured at least to detect a handover in response to receiving a transfer request for an emergency call, to generate a message (or a notification) containing correlation information, or corresponding information, and to send the message (or the notification) to emergency location services client (PSAP) and/or to a location server (GMLC, SLP, LRF) to update corresponding emergency call related information. When the apparatus is a voice call continuity server, the emergency location continuity unit 21 may be further configured to detect whether PSAP is a legacy PSAP or an IP PSAP, and in response to a legacy PSAP to generate the notification and send it to the location server, and in response to an IP PSAP, add to a remote leg update message the correlation information, or corresponding information, and to send the message to the IP PSAP. Further, the emergency location continuity unit 21 in

the voice call continuity server may be configured to indicate to a network entity in the source network to release resources received for the emergency call, or at least resources received for obtaining the location of the user equipment.

In addition, the apparatus may be a network node configured to
5 contain an emergency CSCF comprising an emergency location continuity unit 21 configured at least to detect from a message received from a voice call continuity server and targeted to another apparatus, whether the message relates to an emergency call and indicates a handover, and in response to detecting
10 such a message to update location services related information by sending a message with the information to a proper network entity. Depending on the implementation, the proper network entity may be PSAP or a location server. The emergency location continuity unit 21 in the emergency CSCF may be further configured, when the message received is targeted to a location server,
15 to detect whether PSAP is a legacy PSAP or an IP PSAP, and in response to a legacy PSAP to forward the message to the location server, and in response to an IP PSAP, change the target address and send the message to the IP PSAP. Further, the emergency location continuity unit 21 in the emergency CSCF may be configured to indicate to a network entity in the source network to release resources received for the emergency call, or at least resources re-
20 ceived for obtaining the location of the user equipment.

Still, the apparatus may be a network node configured to contain a mobility management entity comprising an emergency location continuity unit 21 configured at least to send, in response to a emergency call handover to another mobility management entity, to a location server a new address in the
25 target network, the address being an address of a network entity wherefrom location information may be obtained.

The techniques described herein may be implemented by various means so that an apparatus implementing one or more functions of a corresponding mobile entity described with an embodiment comprises not only prior
30 art means, but also means for implementing the one or more functions of a corresponding apparatus described with an embodiment and it may comprise separate means for each separate function, or means may be configured to perform two or more functions. For example, these techniques may be implemented in hardware (one or more apparatuses), firmware (one or more appa-
35 ratuses), software (one or more modules), or combinations thereof. For a firmware or software, implementation can be through modules (e.g., procedures,

functions, and so on) that perform the functions described herein. The software codes may be stored in any suitable, processor/computer-readable data storage medium(s) or memory unit(s) or article(s) of manufacture and executed by one or more processors/computers. The data storage medium or the memory
5 unit may be implemented within the processor/computer or external to the processor/computer, in which case it can be communicatively coupled to the processor/computer via various means as is known in the art.

It will be obvious to a person skilled in the art that, as technology
10 advances, the inventive concept can be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

1. A method comprising:
detecting an emergency call handover to an access network using a control plane solution in location services;
updating location services related information associated with the
5 emergency call.
2. A method as claimed in claim 1, wherein the updating is performed by sending a message containing an indication of a new serving entity to a location server or to a location services client.
3. A method as claimed in claim 1 or 2, wherein the detecting is performed by receiving a message indicating the handover.
4. A method as claimed in claim 3, wherein the message indicating the handover is a message containing an indication of a new serving entity or a message containing correlation information.
5. A method as claimed in claim 1, wherein the detecting is performed by noticing that user equipment involved in the emergency call cannot be reached.
6. A method as claimed in claim 1, 3 or 5, wherein the updating is performed by requesting an address of a new serving entity from a home subscriber server of user equipment involved in the emergency call.
7. A method as claimed in any of claims 1 to 6, wherein the method further comprises indicating to a previous serving entity via which the location information was obtained that it may release resources relating to the emergency call.
8. A method as claimed in any of claims 1 to 7, wherein the location services related information is address information of a new serving entity or correlation information indicating the new serving entity.
9. An apparatus comprising means for performing a method as claimed in any of claims 1 to 8.
10. An apparatus as claimed in claim 9, wherein the apparatus is a
30 network node configured to contain a mobility management entity, a network node configured to contain an emergency call service control function, a single radio voice call continuity server, a voice call continuity server, a gateway mobile location centre, or a secure user plane location server, or a location server comprising a location retrieval function.
11. A computer program product comprising computer program code, wherein execution of the program code in an apparatus causes the ap-
35

paratus to carry out a method according to any of claims 1 to 8.

1/6

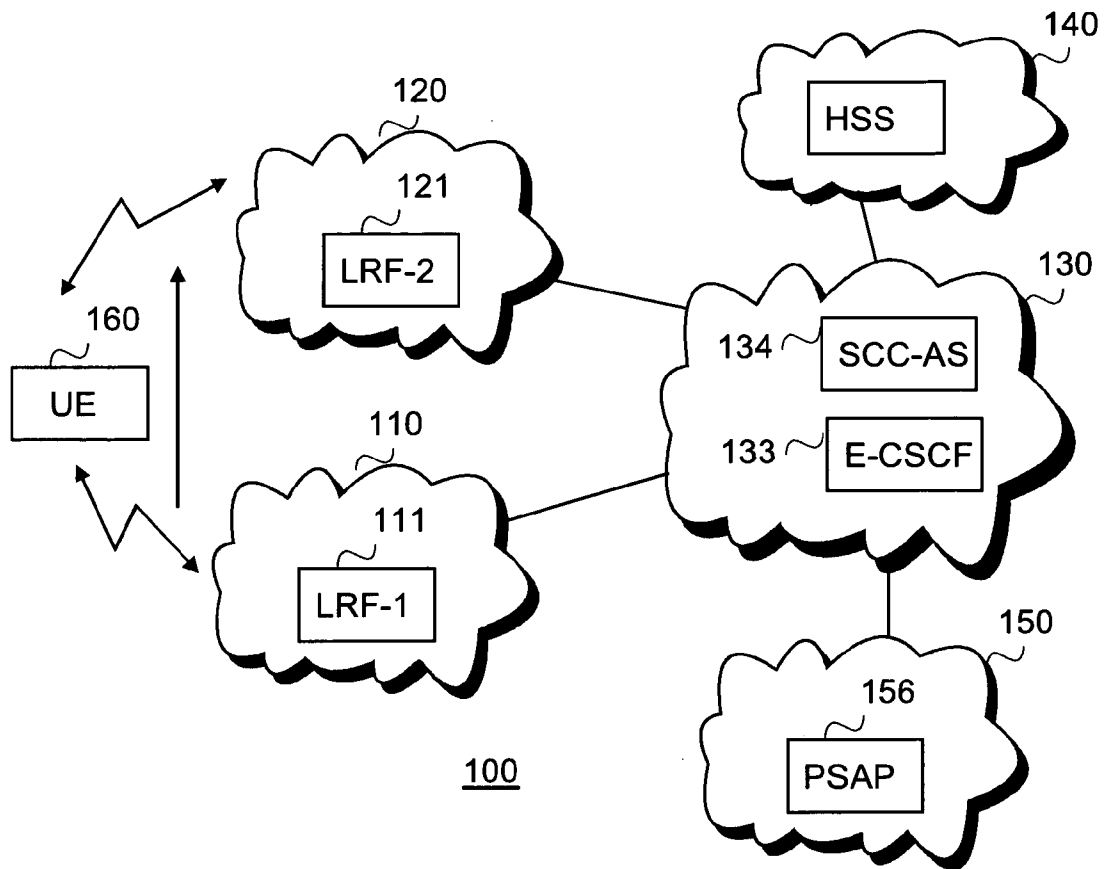


FIG. 1

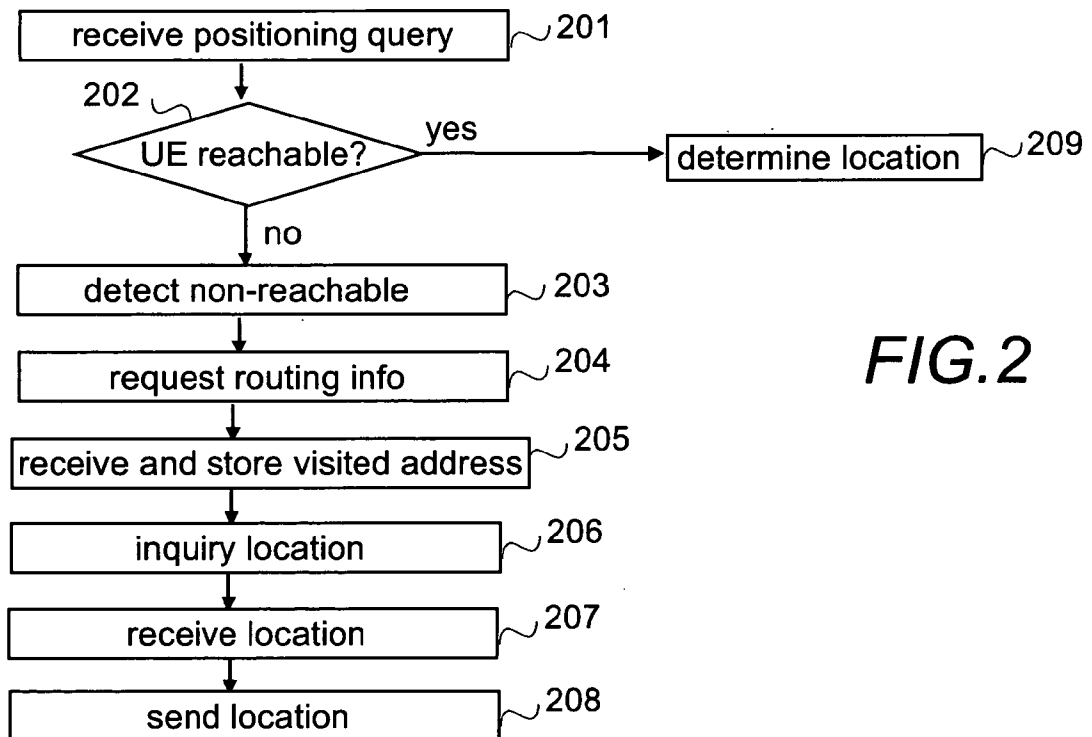


FIG. 2

2/6

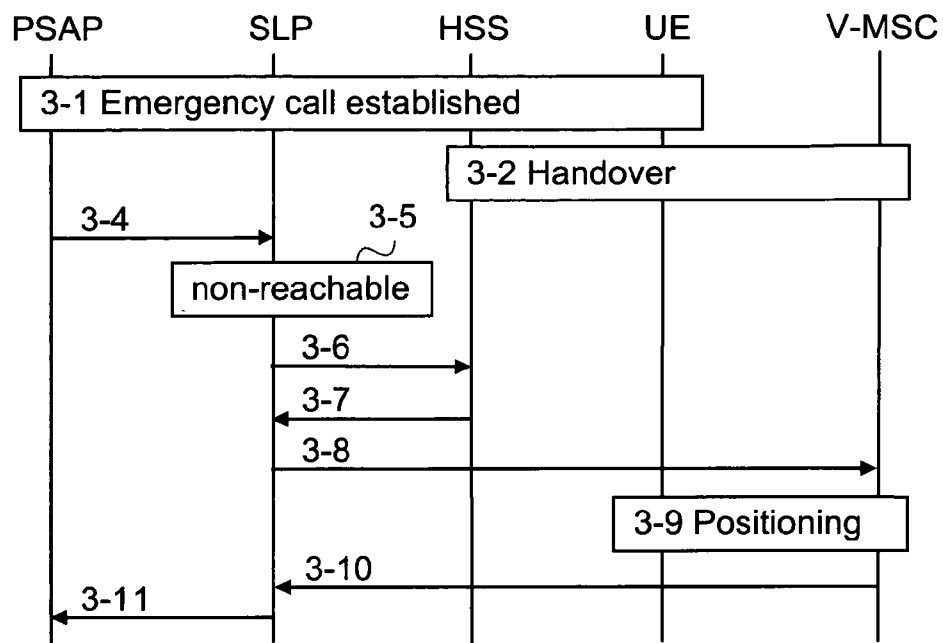


FIG.3

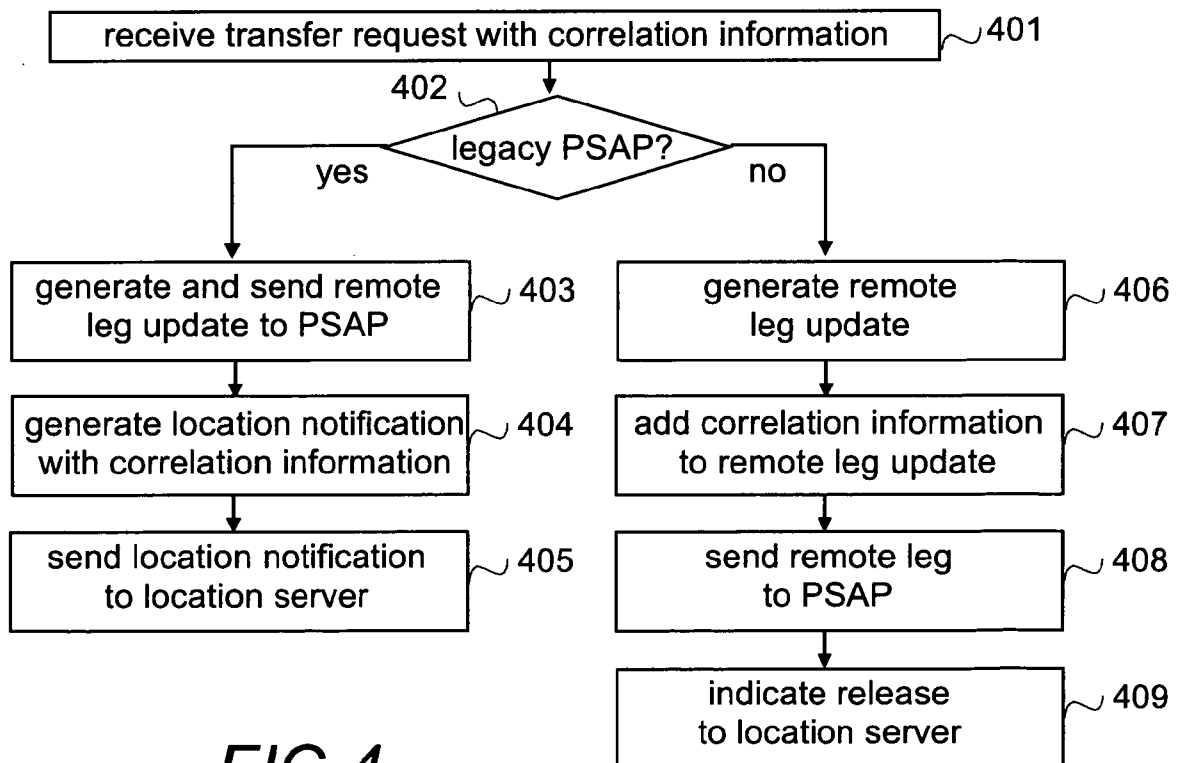
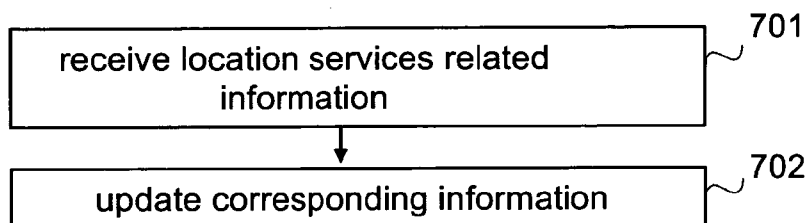
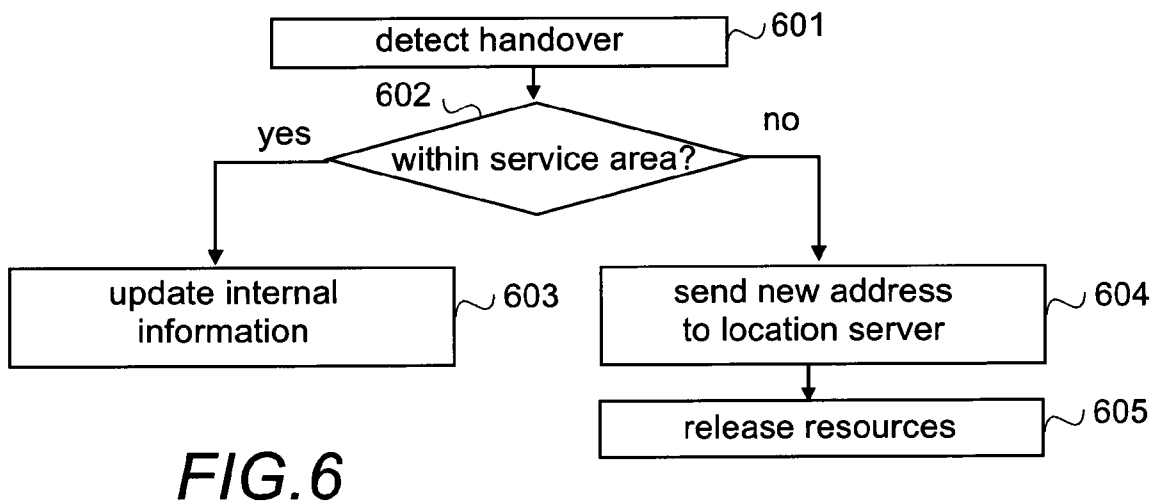
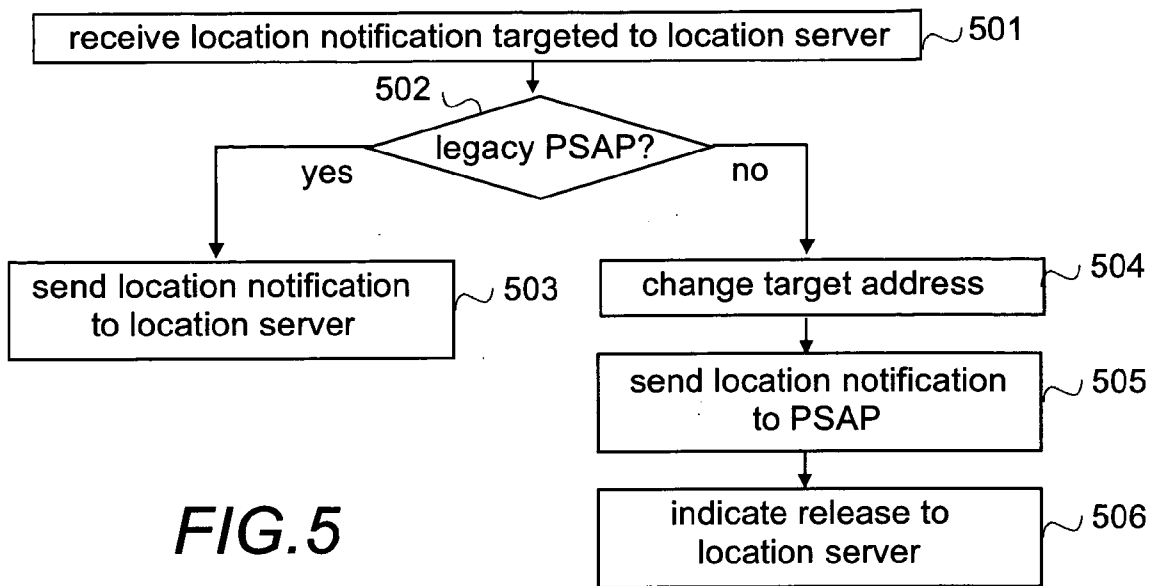


FIG.4

3/6



4/6

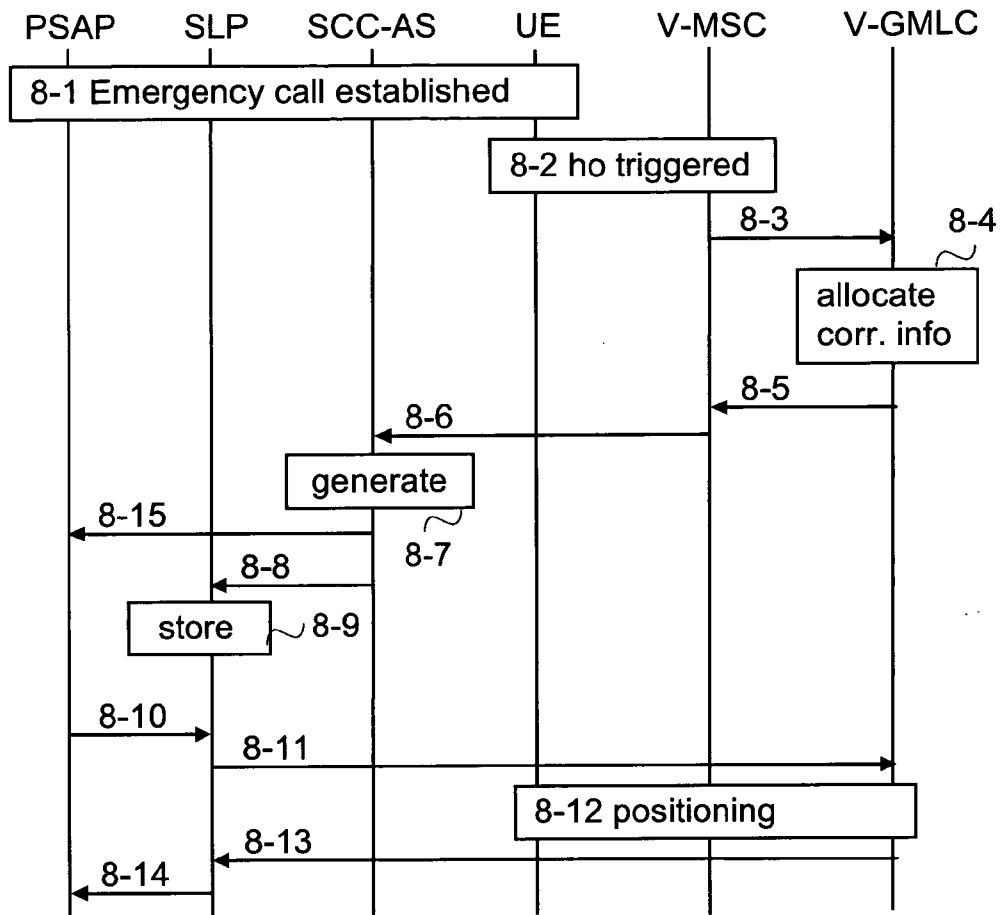


FIG. 8

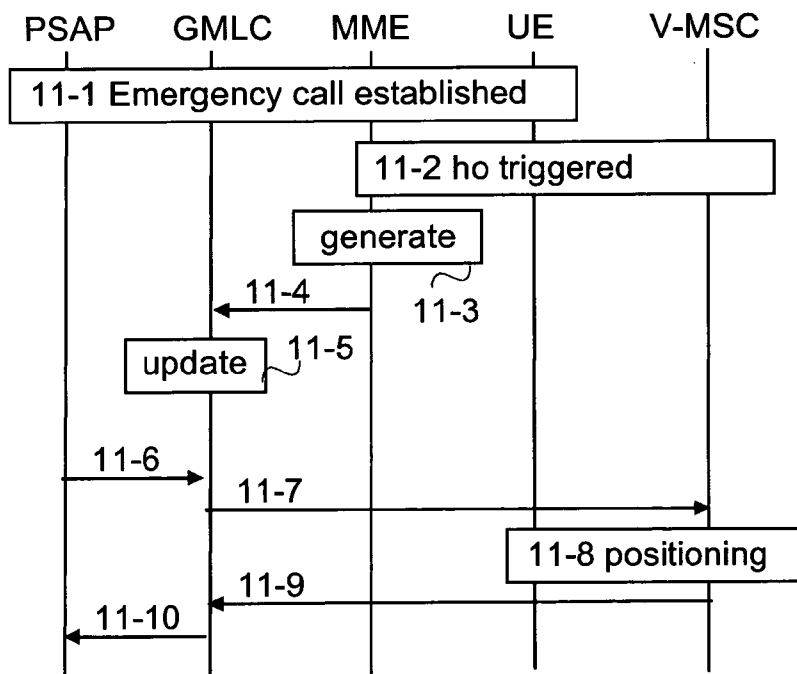


FIG. 11

5/6

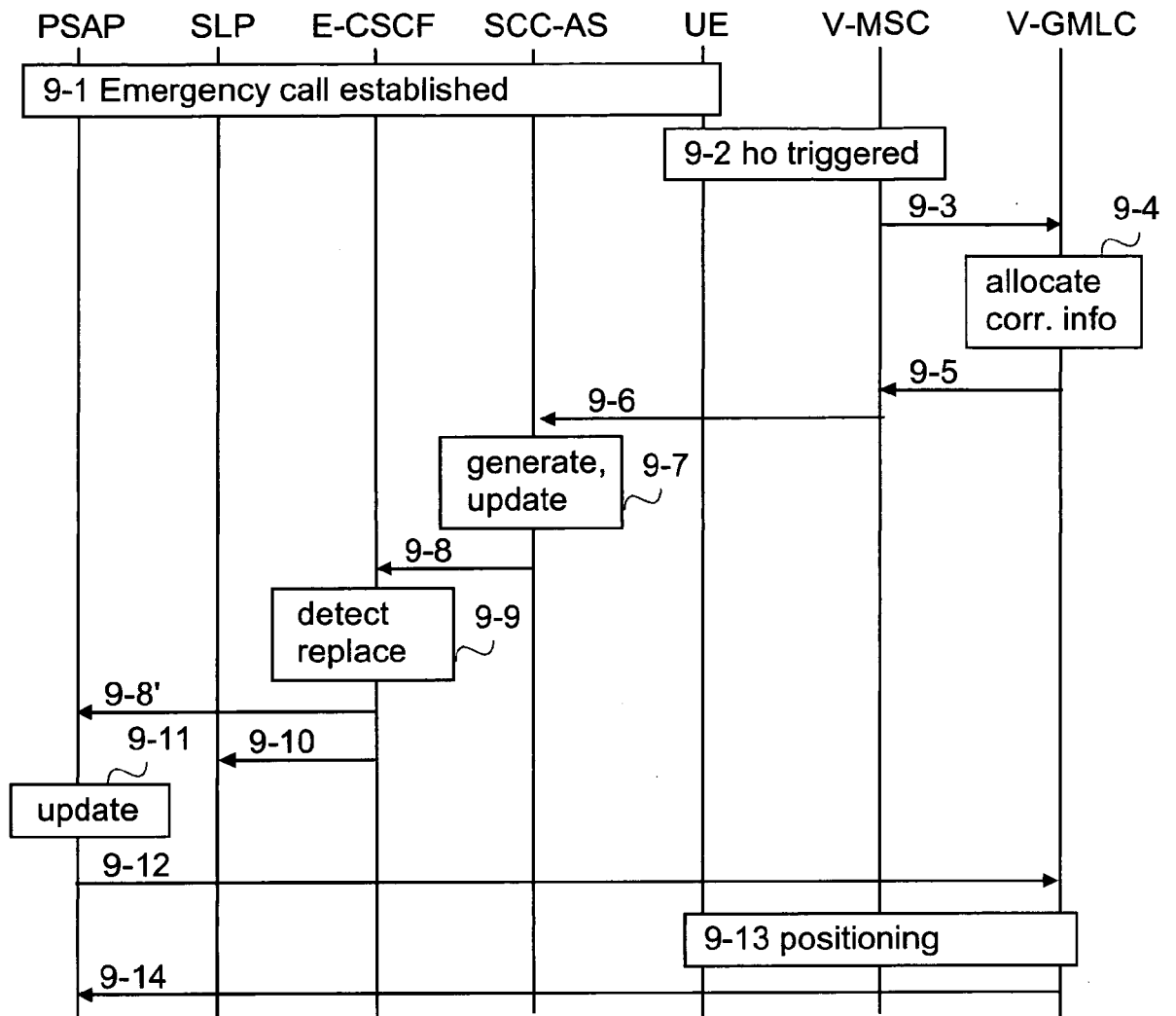
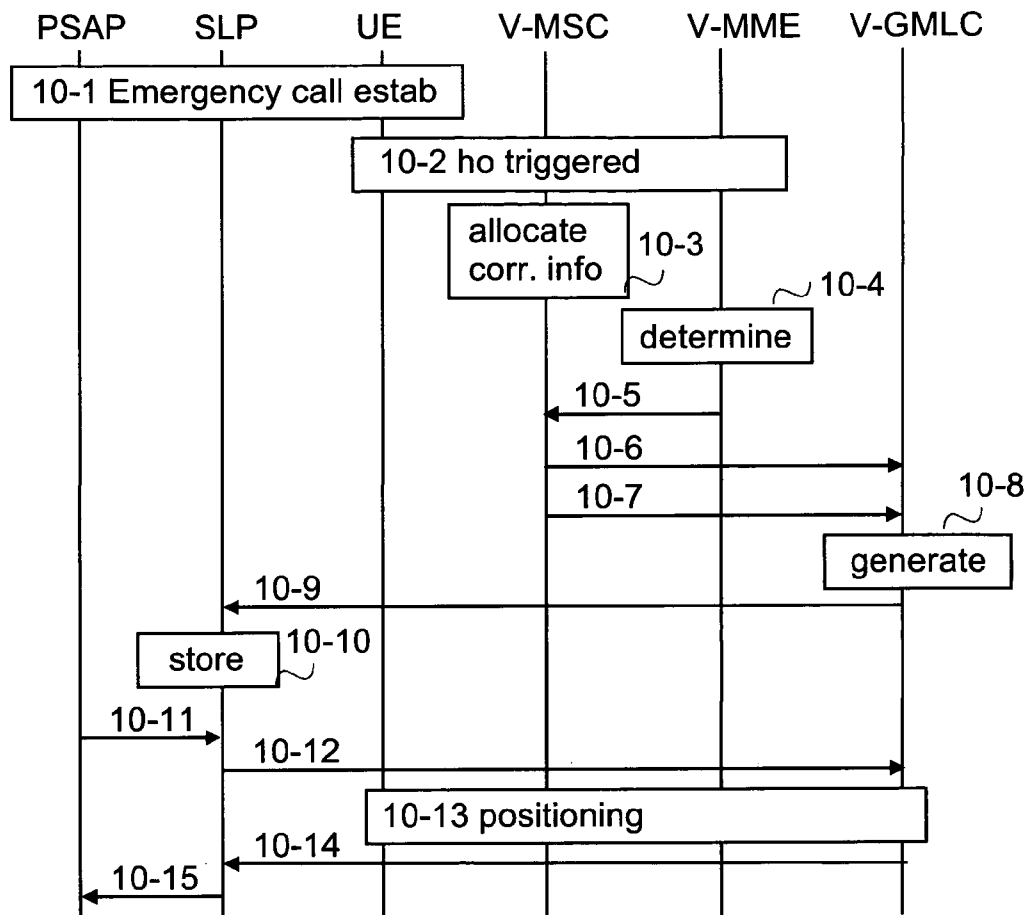
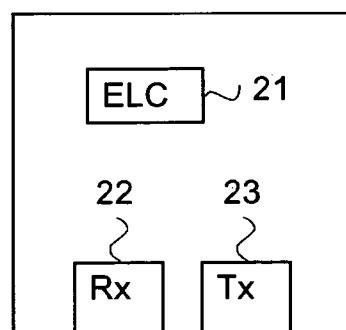


FIG.9

6/6

**FIG.10****FIG.12**

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/051504

A. CLASSIFICATION OF SUBJECT MATTER INV. H04W4/22		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) H04W		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, WPI Data, INSPEC, COMPENDEX		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	3GPP: "Technical specification group Services and System Aspects; Evaluation of LCS Control Plane Solutions for EPS (Release 9)" 3GPP TR 23.891 V.0.3.0, [Online] 29 January 2009 (2009-01-29), pages 1-62, XP002556518 Retrieved from the Internet: URL: http://www.3gpp.org/ftp/Specs/archive/23_series/23.891/ [retrieved on 2009-11-20] page 11, paragraph 6.1.2.1 - page 12, paragraph 6.1.2.2 page 18, paragraph 6.1.3.5 page 20, paragraph 6.1.3.5.3 - page 23, paragraph 6.1.3.5.5 page 24, paragraph 6.1.3.5.6.3 - page 26, paragraph 6.1.3.6 page 35, paragraph 6.2.3.5 - page 36, -/--	1-11
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents : *A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) *O* document referring to an oral disclosure, use, exhibition or other means *P* document published prior to the international filing date but later than the priority date claimed *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. *Z* document member of the same patent family		
Date of the actual completion of the international search	Date of mailing of the international search report	
23 November 2009	04/12/2009	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Rosenauer, Hubert	

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2009/051504

G(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	paragraph 6.2.3.5.5 page 38, paragraph 6.2.3.6 page 48, paragraph 6.3.3.6 - page 48, paragraph 6.3.3.7 figures 6.1-1, 6.1-2, 6.1-13, 6.1-15, 6.1-17, 6.1-18, 6.1-2-11 figures 6.2-12 -----	
X	ALCATEL-LUCENT ET AL: "TR 23.891 Inter-MME Location Continuity" 3GPP DRAFT; S2-090682 R2 (WAS 0071) E-UTRAN LOCATION CONTINUITY, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, no. Phoenix; 20090116, 16 January 2009 (2009-01-16), XP050333147 [retrieved on 2009-01-16] page 2, paragraph 6.1.3.5X - page 7, paragraph 6.3.5.Y.D -----	1,9,11
X	QUALCOMM EUROPE: "Extensions to Alternative #1 for LCS Control Plane Support for EPS" 3GPP DRAFT; S2-090684 (LCS CP ALTERNATIVE 1 FOR EPS EXTENSIONS), 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, no. Phoenix; 20090116, 16 January 2009 (2009-01-16), XP050333149 [retrieved on 2009-01-16] page 8, paragraph 6.1.3.5 - page 9, paragraph 6.1.3.5 page 12, paragraph 6.1.3.5.4 - page 13, paragraph 6.1.3.6 -----	1,9,11
T	NOKIA SIEMENS NETWORKS ET AL: "Location Continuity in SRVCC" 3GPP DRAFT; S2-091903, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, no. Hangzhou; 20090324, 24 March 2009 (2009-03-24), XP050345259 [retrieved on 2009-03-24] the whole document -----	1-11