Title: SUBSCRIBERS ROAMING BETWEEN SECOND AND THIRD GENERATION MOBILE NETWORKS

Abstract: The present invention is aimed to provide a location updating procedure whereby the amount of useless signalling is minimized. Therefore, a new location updating procedure is provided, wherein restrictions of roaming for a subscriber due to access technology are detected at a home subscriber database holding subscription data for the subscriber, and wherein this home subscriber database directly rejects the location updating without sending the subscriber data towards a switching entity where the subscriber attempts to roam.
SUBSCRIBERS ROAMING BETWEEN SECOND AND THIRD GENERATION MOBILE NETWORKS

TECHNICAL FIELD

[0001] The present invention generally relates to roaming of mobile subscribers among a 2nd generation network and a 3rd generation network. In particular, the invention relates to the allowance or prevention of roaming for subscribers of the 2nd generation network in networks of the 3rd generation and for subscribers of the 3rd generation network in networks of the 2nd generation.

BACKGROUND

[0002] Mobile communications are offered to subscribers of each Public Land Mobile Network (hereinafter PLMN) and there is a number of different PLMN’s operating in each country, each PLMN owned and operated by a particular network operator.

[0003] Operators of combined PLMN networks that include a 2nd generation (hereinafter 2G) network and a 3rd generation (hereinafter 3G) network may be interested in controlling the access of subscribers through said 2G and 3G networks. This control is especially interesting for establishing different roaming agreements with other operators for home subscribers roaming in visited PLMN networks owned by said other operators.

[0004] For the purpose of the present invention, a first exemplary 2G network may be a Global System for Mobile communications (hereinafter GSM), a second exemplary 2G network may be a General Packet Radio Service (hereinafter GPRS), and a third exemplary 2G network may be an Enhanced
Data rates for GSM Evolution (hereinafter EDGE); whereas a first exemplary 3G network may be a Universal Mobile Telecommunications System (hereinafter UMTS), a second exemplary 3G network may be a Wideband Code Division Multiple Access (hereinafter WCDMA), and a third exemplary 3G network may be a Code Division Multiple Access 2000 (hereinafter CDMA-2000).

[0005] The control of the subscriber's access through 2G or 3G networks may be carried out by distinguishing PLMN's not only on an operator basis but also on a network generation basis, thus having a different PLMN's code for each PLMN of a different generation, even if owned by a same operator. However, the PLMN's operators wish to offer a unique brand image and are not in favour of making use of different PLMN's codes for the different network technologies they are using.

[0006] Apart from differentiating the access by making use of a different PLMN's code, the access technology used by each different access network may be a distinguishing feature to allow the control, in terms of allowance or restriction of roaming, for subscribers with a subscription in a PLMN.

[0007] Regarding access technologies in these 2G and 3G networks, there is at present a common access technology characteristic of 2G networks, the so-called GSM-EDGE Radio Access Network (hereinafter GERAN); and there is a common access technology characteristic of 3G networks as well, the so-called UMTS Terrestrial Radio Access Network (hereinafter UTRAN).

[0008] The International Publication WO 02/069660 teaches a method of carrying out a location updating procedure in a mobile communication system whereby, as a subscriber
attempts to roam in a visited PLMN, an Update Location message is received at a switching element of said visited PLMN. This switching element may be a Mobile Switching Centre (MSC) of a GSM network in a standalone configuration or collocated with a Visited Location Register (VLR), and hereinafter referred to as an MSC-VLR irrespective of being in a standalone or in a collocated configuration. The switching element may be also an entity of a GPRS network such as a Serving GPRS Support Node (hereinafter SGSN).

[0009] The switching element receiving the Update Location message sends a corresponding message towards a Home Location Register (hereinafter HLR) of the home PLMN where the subscriber holds a subscription, and obtains in response subscription data for the subscriber that includes possible roaming restrictions set for the subscriber. Upon reception of the subscription data, the switching elements returns a successful acknowledge to the HLR, and the latter updates the location of the subscriber in its internal memory and returns a successful result to the Update Location message. When a further call is made having this subscriber as the called subscriber, the HLR will be inquired about the current location of the called subscriber.

[0010] The switching element receiving the subscription data for the subscriber from the HLR, and having received the original Update Location message, is able to determine the type of access that the subscriber has made use of.

[0011] The switching element checks any roaming restriction, possibly included in the received subscription data, versus the type of access that the subscriber has made use of, and determines whether the roaming is allowed or not. If roaming is not allowed due to a roaming
restriction and in views of the access type, the location updating is rejected.

SUMMARY

[0012] It is an object of the present invention to find an alternative mechanism minimizing the amount of useless signalling exchanged between entities of the home and visited PLMN’s. To this end, the present invention is aimed to find an alternative mechanism whereby restrictions of roaming due to subscriber’s access, at least, are detected before sending subscription data for the subscriber from a home subscriber database, such as the HLR of a GSM home PLMN, towards a switching element of the visited PLMN where the subscriber is attempting to roam.

[0013] This is achieved by the teaching of the independent claims.

[0014] Thus, in accordance with a first aspect of the present invention, there is provided a home subscriber database generally holding subscription data for subscribers of a mobile network, wherein the subscription data include an access technology restriction selected from: no access restriction; GSM-EDGE Radio Access Network, GERAN, not allowed; UMTS Terrestrial Radio Access Network, UTRAN, not allowed.

[0015] This home subscriber database comprises: input protocol means for receiving an Update Location message from an entity of the mobile network where the subscriber is attempting to roam; processing means for verifying whether the selected access technology restriction prevents roaming in the entity where the subscriber is attempting to roam; and output protocol means for returning an appropriate error code responsive to the prevention of
roaming. For practical reasons, this home subscriber database may be implemented in such a way that the subscription data includes assigned roaming service areas, so that the access technology restriction applies per roaming service area.

[0016] In accordance with an advantageous first embodiment, the input protocol means of the home subscriber database is adapted for receiving, from the entity where the subscriber is attempting to roam, a first access technology indicator applicable for the entity. This first access technology indicator may be selected from the above access technology restrictions, or from a group of allowed access technologies that includes: GERAN-access and UTRAN-access.

[0017] In accordance with an advantageous second embodiment, the home subscriber database may further comprise input configuration means for being configured with a list of entities of the mobile network where the subscriber may roam and with a second access technology indicator applicable for each entity, the second access technology indicator selected from the above access technology restrictions, or from a group of allowed access technologies that also includes: GERAN-access and UTRAN-access.

[0018] Both first and second embodiments are compatible and may be simultaneously supported in the home subscriber database provided for in the present invention. To overcome any possible conflict derived from the simultaneous use of the first and second access technology indicators applicable for a same entity, the present invention also provides for a third embodiment, wherein the input configuration means is adapted to establish a priority,
namely to determine a prior access technology indicator, between more than one access technology indicators.

[0019] In this third embodiment, the processing means of the home subscriber database is adapted to verify whether the prior access technology indicator applicable for the entity where the subscriber is attempting to roam prevents the roaming.

[0020] In particular, the output protocol means of the home subscriber database is adaptable to send a cancel location message responsive to the verification that the entity where the subscriber is attempting to roam is prevented from roaming.

[0021] In accordance with a second aspect of the present invention, there is also provided for a method for verifying at the home subscriber database whether a subscriber has an access technology restriction among the subscription data. This access technology restriction is selected from a group of access technology restrictions that includes: no access restriction; GSM-EDGE Radio Access Network, GERAN, not allowed; UMTS Terrestrial Radio Access Network, UTRAN, not allowed.

[0022] This method comprises a step of receiving an Update Location message from an entity of the mobile network where the subscriber is attempting to roam; a step of verifying whether the selected access technology restriction prevents roaming in the entity where the subscriber is attempting to roam; and a step of returning an appropriate error code responsive to the prevention of roaming. In this method, the step of verifying the access technology restriction may include a step of fetching the access technology restriction applying to a roaming service area assigned in the subscription data for the subscriber.
[0023] Aligned with the above first embodiment for the home subscriber database, this method may further comprise a step of receiving, from the entity where the subscriber is attempting to roam, a primary access technology indicator for the entity. This primary access technology indicator may be selected from the above group of access technology restrictions, or from a group of allowed access technologies that includes: GERAN-access and UTRAN-access.

[0024] Aligned with the above second embodiment for the home subscriber database, this method may further comprise a step of configuring the home subscriber database with a list of entities of the mobile network where the subscriber may roam and with a secondary access technology indicator for each entity. This secondary access technology indicator may be selected from the above group of access technology restrictions, or from a group of allowed access technologies that includes: GERAN-access and UTRAN-access.

[0025] Given that both embodiments outlined above are compatible and can co-exist, and in order to solve possible conflicts when both first and second embodiments are simultaneously handled in the mobile network, this method may further comprise a step of establishing a priority, namely a step of determining a prior access technology indicator, between more than one access technology indicators. Accordingly with this embodiment, the step of verifying in this method whether the access technology restriction prevents roaming may also include a step of verifying whether the prior access technology indicator prevents the roaming.

[0026] Moreover, the method may further comprise a step of sending a cancel location message responsive to the prevention of roaming.
Furthermore, the invention can be realised by a computer program, which is loadable into an internal memory of a computer that includes input and output units as well as a processing unit. This computer program comprises executable software adapted to carry out the above method steps when running in the computer. In particular, the computer program may be recorded in a carrier readable in a computer, such as a CD-ROM.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] The features, objects and advantages of the invention will become apparent by reading this description in conjunction with the accompanying drawings, in which:

[0029] FIG. 1 is a basic diagram showing network nodes and interfaces in a scenario where a mobile subscriber may attempt to attach in two visited PLMN's different than the home PLMN.

[0030] FIG. 2 is a basic diagram showing network nodes and interfaces in a scenario where a mobile subscriber may attempt to attach in the home PLMN or in a visited PLMN different than the home PLMN.

[0031] FIG. 3 shows basic contents in exemplary network entities of Fig. 1 and 2 as well as possibly corresponding data to be transmitted through exemplary interfaces of Fig. 1 and 2.

[0032] FIG. 4 illustrates contents stored in a home subscriber database in accordance with an embodiment of the invention.

[0033] FIG. 5 illustrates a successful location updating where the home subscriber database has verified that, in
accordance with a first embodiment of the invention, there is no access restriction preventing roaming in a network entity.

[0034] FIG. 6 illustrates a successful location updating where the home subscriber database has verified that, in accordance with a second embodiment of the invention, there is no access restriction preventing roaming in a network entity.

[0035] FIG. 7 illustrates a successful location updating where the home subscriber database has verified that, in accordance with a third embodiment of the invention, there is no access restriction preventing roaming in a network entity.

[0036] FIG. 8 illustrates an unsuccessful location updating where the home subscriber database has verified that, in accordance with the first embodiment of the invention, there is an access restriction preventing roaming in a network entity.

[0037] FIG. 9 illustrates an unsuccessful location updating where the home subscriber database has verified that, in accordance with a second embodiment of the invention, there is an access restriction preventing roaming in a network entity.

[0038] FIG. 10 illustrates an unsuccessful location updating where the home subscriber database has verified that, in accordance with a third embodiment of the invention, there is an access restriction preventing roaming in a network entity.

[0039] FIG. 11 shows a basic block diagram of structural elements included in a home subscriber database according to the present invention.
DETAILED DESCRIPTION

[0040] The following describes some preferred embodiments of a new location updating procedure for a subscriber whereby the restrictions of roaming based on access technologies are verified before submitting subscription data towards a switching element where the subscriber is attempting to roam.

[0041] Currently, there is provided a home subscriber database E-10 for storing subscription data E-102 and location data for subscribers of a home PLMN network that includes 2G and 3G networks.

[0042] Among the subscription data for a subscriber, as shown in Fig. 4, the home subscriber database may include, on one hand, service roaming restrictions E-1023 (hereinafter SSR) to control whether the subscriber is allowed or not to enter in certain coverage areas; and, on the other hand, access technology restrictions E-1021 (hereinafter ATR) based on the technology available in the visited PLMN where the subscriber is attempting to roam and on the agreements reached for roaming between the home and the visited operators.

[0043] The home subscriber database E-10 thus comprises, among the subscription data E-102 for each subscriber, an ATR selected from a group of ATR values E-1021 that includes: no access restriction; GERAN not allowed; UTRAN not allowed. The home subscriber database may also comprise, among the subscription data E-102 for each subscriber, an SSR selected from a group of SSR values E-1023 that includes: no roaming restriction; roaming restricted in a GPRS network; roaming restricted in a non-GPRS network; and roaming restricted in both GPRS and non-GPRS networks.
[0044] Then, in accordance with the present invention, these service roaming and access technology restrictions are verified in the home subscriber database versus the roaming area and type of access where the subscriber is attempting to roam. To this end, alternative and combinable embodiments are proposed.

[0045] In a first embodiment of the invention illustrated in Fig. 5 and Fig. 8, a switching entity E-25 where the subscriber E-90 is attempting S-500 to roam in the visited PLMN sends S-510 an Update Location message towards the home subscriber database E-10. The switching entity, which in particular may be an MSC-VLR of a GSM network or a SGSN of a GPRS network, includes an Access Technology Indicator (hereinafter ATI). This ATI may be expressed in terms of a type of access not allowed for the subscriber or, in the other way around, in terms of the type of access allowed for the subscriber under the roaming agreement with the home PLMN operator.

[0046] In view of Fig. 1, Fig. 3 illustrates an exemplary MSC-VLR-1 E-21 where the only Radio Access Technology (hereinafter RAT) supported is “UTRAN-access”, and such MSC-VLR-1 E-21 sends via interface I-11 an Update Location Message towards the home subscriber database E-10 including an ATI with value “GERAN not allowed”. In the same Fig. 3 and in view of Fig. 2, there is an exemplary SGSN-0 E-20 where both “UTRAN-access” RAT and “GERAN-access” RAT are supported, and such SGSN-0 E-20 sends via interface I-10 an Update Location Message towards the home subscriber database E-10 including an ATI with value “No access restriction”. In these two examples, the ATI value submitted to the home subscriber database E-10 is expressed in the same terms as the ATR values E-1021 stored in subscription data per subscriber; however, both ATI and ATR
at the home subscriber database and switching entity might be expressed in the same terms as RAT to avoid mapping between positive and negative expressions and without departing from the inventive concept of the invention. Therefore, the home subscriber database E-10 is adapted so that input protocol means E-104, as shown in Fig. 11, for receiving the Update Location message, via interfaces I-10, I-11, I-12 and I-13, is also enabled for receiving an ATI applicable for the switching entity E-20, E-21, E-22 and E-23 where the subscriber is attempting to roam.

[0047] Back to the first embodiment illustrated in Fig. 5 and Fig. 8, this ATI received from the switching entity E-25 is verified in steps S-520 or S-524 at the home subscriber database E-10 versus the ATR value E-1021 set for the switching entity under subscriber’s subscription data E-102. To this end, the home subscriber database E-10 comprises processing means (E-103), as shown in Fig. 11, for verifying whether the selected access technology restriction prevents roaming in the entity where the subscriber is attempting to roam. If there is a match, and taking into account a possible equivalence of positive and negative terms like “UTRAN not allowed” and “GERAN-access”, the Update Location message is found acceptable as shown in Fig. 5, and an Insert Subscriber Message is sent in step S-530 towards the switching entity. The switching entity acknowledges back in step S-540 the reception of such message with subscriber data, and the home subscriber database thus acknowledges in step S-550 a successful location updating procedure. If there is no match as shown in Fig. 8, and taking into account the possible equivalence of positive and negative terms like “UTRAN not allowed” and “UTRAN-access”, the Update Location message is directly rejected in step S-551 from the home subscriber database E-10, without submitting subscriber data, towards the
switching entity E-25 where the subscriber is attempting to attach in the visited PLMN.

[0048] This new location updating procedure is advantageous in that useless signalling, such as the sending of successive Insert Subscriber Data messages, is not sent when there is an access restriction preventing the roaming, as sought by the present invention; however, it may be not enough where not all the switching entities E-20, E-21, E-22, E-23, and E-25 in all PLMN's N-01, N-02, N-03, and N-10 shown in Fig. 1 and Fig. 2 are upgraded with means for submitting to the home subscriber database E-10 the applicable ATI value.

[0049] To overcome this, and especially useful before upgrading any switching entity, the present invention provides for a second embodiment illustrated in Fig. 6 and Fig. 9, which is compatible with the above first embodiment, wherein the home subscriber database E-10 may comprise configurable ATI related data E-101 for each switching entity of those PLMN's with which the home PLMN has roaming agreements.

[0050] To this end, Fig. 4 illustrates ATI values E-1011 set for exemplary switching entities E-1012, wherein the ATI is expressed in terms of the supported RAT at each exemplary switching entity E-20, E-21, E-22, and E-23 shown in Fig. 3. However, as already commented for the first embodiment, the ATI values E-1011, which are preferably configurable in the home subscriber database E-10, may also be expressed in terms of the ATR values E-1021 stored among subscription data E-102 for the subscriber. Moreover, both ATI values E-1011 and ATR values E-1021 may be preferably configured per roaming service area (hereinafter RSA) to make a simpler and easier configuration with a smaller amount of data than if it were configured per switching
entity as currently drawn in the exemplary RSA table E-1012. For example, the configurable ATI values E-1011 may be configured per RSA E-1022 as done for ATR E-1021 instead of per RSA E-1012, without substantially departing from the inventive concept of the invention. The home subscriber database E-10, as provided for in accordance with the present invention, may comprise input configuration means E-106, as shown if Fig. 11, for being configured with a list of entities E-1012 of the mobile network or roaming service areas, as the case might be, where the subscriber may roam, and with an access technology indicator E-1011 applicable for each entity.

[0051] Under this second embodiment illustrated in Fig. 6 and Fig. 9, the switching entity E-25, where the subscriber E-90 is attempting S-500 to attach in the visited PLMN, sends a classical Update Location message S-511 towards the home subscriber database E-10 and without including any ATI value supported at said switching entity E-25. The home subscriber database E-10 then verifies at steps S-521 or S-525 whether a stored ATI value E-1011 for such switching entity, or for a corresponding RSA as explained above, matches or not the ATR value E-1021 set for the switching entity under subscriber's subscription data E-102. To this end, the home subscriber database E-10 comprises processing means (E-103), as shown in Fig. 11, for verifying whether the selected access technology restriction prevents roaming in the entity where the subscriber is attempting to roam. If there is a match as shown in Fig. 6, and also taking into account a possible equivalence of positive and negative terms like "GERAN not allowed" and "UTRAN-access", the Update Location message is found acceptable, an Insert Subscriber Message is sent towards the switching entity E-25 in step S-530, an acknowledgement is received back in step S-540, and the home subscriber database E-10 also
acknowledges in step S-550 a successful location updating procedure. If there is no match as shown in Fig. 9, and also taking into account the possible equivalence of positive and negative terms like "GERAN not allowed" and "GERAN-access", the Update Location message is rejected in step S-551 from the home subscriber database E-10, without submitting subscriber data, towards the switching entity E-25 where the subscriber is attempting to roam in the visited PLMN.

[0052] Whether making use of the first or second embodiment is merely depending on whether the whole switching entities or none at all is upgraded to carry out the novel location updating procedure proposed by the present invention, whereby the home subscriber database is the entity responsible for verifying whether there is any access technology restriction that prevents the subscriber roaming in a given roaming service area.

[0053] For practical reasons, and during an adaptation period whilst legacy switching entities E-20, E-21, E-22 and E-23 are upgraded to include means for submitting to the home subscriber database E-10 the applicable ATI value, both embodiments are perfectly and simultaneously compatible, and they both can be supported by a home subscriber database E-10 as provided for in the present invention.

[0054] Where both first and second embodiments are simultaneously supported, paying a special attention may be required to avoid configuring ATI related configuration data E-101 for any RSA or individual switching entity for which an ATI value reception may be expected during a location updating procedure.
[0055] Nevertheless, given that first and second embodiments are combinable and in order to solve possible conflicts when both first and second embodiments are simultaneously handled in a mobile network, the present invention provides for a third embodiment illustrated in Fig. 7 and 10 whereby a priority is configured on an RSA basis, or on an individual switching entity basis, for executing the first or the second embodiment where both may be possibly applied.

[0056] In accordance with this third embodiment illustrated in Fig. 7 and Fig. 10, the switching entity E-25, where the subscriber E-90 is attempting S-500 to attach in the visited PLMN, may send in step S-510 an Update Location message towards the home subscriber database E-10. Upon receipt of the ATI at the home subscriber database, it is determined in a step S-522 a prior ATI between the first ATI received in step S-510 from the switching entity E-25 and a second ATI E-1011 stored in the home subscriber database among configuration data for the subscriber.

[0057] Therefore, as illustrated in Fig. 4, the present invention provides for a home subscriber database E-10 that includes a priority field E-1013 along with those ATI values E-1011 stored per RSA basis, or per individual switching entity basis, among the configuration data E-101 for the subscriber. This priority field may have value “1” to indicate that the stored ATI value E-1011 is the prior ATI over the ATI value received in step S-510 via interface I-10, I-11, I-12 or I-13 as shown in Fig. 3; or may have value “0” to indicate that the ATI value received in step S-510 is the prior ATI over the stored ATI value E-1011. To this end, the input configuration means E-106, as shown in Fig. 11, in the home subscriber database are adapted to
configure a priority value E-1013 to determine a prior ATI between the received ATI and the stored ATI E-1011.

[0058] Back to this third embodiment illustrated in Fig. 7 and Fig. 10, the prior ATI determined in step S-522 is then verified in steps S-523 or S-526 at the home subscriber database E-10 versus the ATR value E-1021 set for the switching entity under subscriber's subscription data E-102. To this end, the home subscriber database E-10 comprises processing means (E-103), as shown in Fig. 11, for verifying whether the selected access technology restriction prevents roaming in the entity where the subscriber is attempting to roam. If there is a match as shown in Fig. 7, and taking into account a possible equivalence of positive and negative terms, the Update Location message is found acceptable, and an Insert Subscriber Message is sent in step S-530 towards the switching entity. The switching entity acknowledges back in step S-540 the reception of such message with subscriber data, and the home subscriber database thus acknowledges in step S-550 a successful location updating procedure. If there is no match as shown in Fig. 10, and taking into account the possible equivalence of positive and negative terms, the Update Location message is directly rejected in step S-551 from the home subscriber database E-10, without submitting subscriber data, towards the switching entity E-25 where the subscriber is attempting to attach in the visited PLMN.

[0059] All the three embodiments suggest the use of a new return code indicating the nature of failure, namely a prevention of roaming due to an access technology restriction for the subscriber. Therefore, in accordance with an aspect of the present invention, the home subscriber database E-10 includes output protocol means E-
105, as shown in Fig. 11, for returning an appropriate error code responsive to the prevention of roaming along with the rejection of the Update Location message carried out in step S-551.

[0060] The home subscriber database E-10 is not limited to a Home Location Register generally known for 2G networks but it may be also a Home Subscriber Database (generally abbreviated as HSS) having subscription data not only for subscribers of an IP Multimedia Subsystem (generally known as IMS) but also for subscribers of a 2G or 3G network.

[0061] The invention is described above in respect of several embodiments in an illustrative and non-restrictive manner. Obviously, variations, and combinations of these embodiments are possible in light of the above teachings, and any modification of the embodiments that fall within the scope of the claims is intended to be included therein.
CLAIMS

1. A home subscriber database (E-10) holding subscription data (E-102) for a subscriber of a mobile network, the subscription data including an access technology restriction (E-1021) selected from a group of access technology restrictions that includes: no access restriction; GSM-EDGE Radio Access Network, GERAN, not allowed; UMTS Terrestrial Radio Access Network, UTRAN, not allowed; the home subscriber database comprising:

- input protocol means (E-104) for receiving (I-10, I-11, I-12, I-13) an Update Location message from an entity of the mobile network (E-20, E-21, E-22, E-23) where the subscriber is attempting to roam; and

and characterized in that it also comprises:

- processing means (E-103) for verifying whether the selected access technology restriction prevents roaming in the entity where the subscriber is attempting to roam; and

- output protocol (E-105) means for returning an appropriate error code responsive to the prevention of roaming.

2. The home subscriber database of claim 1, wherein the subscription data includes at least one assigned roaming service area (E-1022), and wherein the access technology restriction is selected per roaming service area basis.

3. The home subscriber database of claim 1, wherein the input protocol means are adapted for receiving, from the entity where the subscriber is attempting to roam,
a first access technology indicator applicable for the entity, the first access technology indicator selected from the group of access technology restrictions.

4. The home subscriber database of claim 1, wherein the input protocol means are adapted for receiving, from the entity where the subscriber is attempting to roam, a first access technology indicator applicable for the entity, the first access technology indicator selected from a group of allowed access technologies that includes: GERAN-access and UTRAN-access.

5. The home subscriber database of claim 1, further comprising input configuration means (E-106) for being configured with a list of entities (E-1012) of the mobile network where the subscriber may roam and with a second access technology indicator (E-1011) applicable for each entity, the second access technology indicator selected from the group of access technology restrictions.

6. The home subscriber database of claim 1, further comprising input configuration means (E-106) for being configured with a list of entities (E-1012) of the mobile network where the subscriber may roam and with a second access technology indicator (E-1011) applicable for each entity, the second access technology indicator selected from a group of allowed access technologies that includes: GERAN-access and UTRAN-access.

7. The home subscriber database of any of claims 3-6, wherein the input configuration means are adapted to establish a priority (E-1013) between more than one access technology indicators.

8. The home subscriber database of claim 7, wherein the processing means are adapted to verify whether the
prior access technology indicator applicable for the entity where the subscriber is attempting to roam prevents the roaming.

9. The home subscriber database of claim 1, wherein the output protocol means are adapted to send a cancel location message responsive to the verification that the entity where the subscriber is attempting to roam is prevented from roaming.

10. A method for verifying at a home subscriber database (E-10) whether a subscriber has, among other subscription data (E-102), an access technology restriction (E-1021) selected from a group of access technology restrictions that includes: no access restriction; GSM-EDGE Radio Access Network, GERAN, not allowed; UMTS Terrestrial Radio Access Network, UTRAN, not allowed; the method comprising a step of:

- receiving (S-510, S-511) an Update Location message from an entity of the mobile network (E-25) where the subscriber is attempting to roam;

and characterized in that it also comprises:

- verifying (S-524, S-525, S-526) whether the selected access technology restriction prevents roaming in the entity where the subscriber is attempting to roam; and

- returning (S-551) an appropriate error code responsive to the prevention of roaming.

11. The method of claim 10, wherein the step of verifying the access technology restriction includes a step of fetching the access technology restriction (E-1021)
applying to a roaming service area (E-1022) in the subscription data for the subscriber.

12. The method of claim 10, further comprising a step of receiving (S-510), from the entity where the subscriber is attempting to roam, a primary access technology indicator for the entity, the primary access technology indicator selected from the group of access technology restrictions.

13. The method of claim 10, further comprising a step of receiving (S-510), from the entity where the subscriber is attempting to roam, a primary access technology indicator for the entity, the primary access technology indicator selected from a group of allowed access technologies that includes: GERAN-access and UTRAN-access.

14. The method of claim 10, further comprising a step of configuring (S-600) the home subscriber database (E-10) with a list of entities (E-1012) of the mobile network where the subscriber may roam and with a secondary access technology indicator (E-1011) for each entity, the secondary access technology indicator selected from the group of access technology restrictions.

15. The method of claim 10, further comprising a step of configuring (S-600) the home subscriber database (E-10) with a list of entities (E-1012) of the mobile network where the subscriber may roam and with a secondary access technology indicator (E-1011) for each entity, the secondary access technology indicator selected from a group of allowed access technologies that includes: GERAN-access and UTRAN-access.
16. The method of any of claims 12-15, further comprising a step of establishing (S-600) a priority between more than one access technology indicator.

17. The method of claim 16, wherein the step of verifying whether the selected access technology restriction prevents roaming in the entity where the subscriber is attempting to roam includes a step of verifying (S-526) whether the prior access technology indicator prevents the roaming in that entity.

18. The method of claim 10, further comprising a step of sending (S-551, S-561) a cancel location message responsive to the prevention of roaming.

19. A computer program, loadable into an internal memory of a computer that includes input and output units as well as a processing unit, the computer program comprising executable software adapted to carry out the method steps according to any of claims 10 to 18 when running in the computer.

20. The computer program of claim 19, wherein the executable software is recorded in a carrier readable in a computer.

21. A switching entity (E-20, E-21, E-22, E-23, E-25) serving a subscriber of a mobile network (N-10) whilst roaming, the switching entity comprising output protocol means for submitting an Update Location message towards a home subscriber database (E-10) holding subscription data (E-102) for the subscriber; and characterized in that the output protocol means are adapted for also submitting to the home subscriber database (E-10) a first access technology indicator applicable for the switching entity.
22. The switching entity of claim 21, wherein the first access technology indicator is selected from a group of access technology restrictions that includes: no access restriction; GSM-EDGE Radio Access Network, GERAN, not allowed; UMTS Terrestrial Radio Access Network, UTRAN, not allowed.

23. The switching entity of claim 21, wherein the first access technology indicator is selected from a group of allowed access technologies that includes: GERAN-access and UTRAN-access.
FIG.3-

MSC-VLR-1
- UTRAN-access

MSC-VLR-2
- UTRAN-access
- GERAN-access

SGSN-3
- GERAN-access

SGSN-0
- UTRAN-access
- GERAN-access
### HLR

<table>
<thead>
<tr>
<th>RSA</th>
<th>ATI</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSC-VLR-1</td>
<td>UTRAN-access</td>
<td>1</td>
</tr>
<tr>
<td>MSC-VLR-2</td>
<td>Both-UTRAN-GERAN-access</td>
<td>1</td>
</tr>
<tr>
<td>SGSN-3</td>
<td>GERAN-access</td>
<td>0</td>
</tr>
<tr>
<td>SGSN-0</td>
<td>Both-UTRAN-GERAN-access</td>
<td>0</td>
</tr>
</tbody>
</table>

### Subscription Data

<table>
<thead>
<tr>
<th>RSA</th>
<th>ATR</th>
<th>SRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPLMN</td>
<td>No access restriction</td>
<td>No roaming restriction</td>
</tr>
<tr>
<td>VPLMN-1</td>
<td>UTRAN not allowed</td>
<td>Roaming restricted in GPRS / non-GPRS</td>
</tr>
<tr>
<td>VPLMN-2</td>
<td>GERAN not allowed</td>
<td>Roaming restricted in GPRS</td>
</tr>
<tr>
<td>VPLMN-3</td>
<td>UTRAN not allowed</td>
<td>Roaming restricted in non-GPRS</td>
</tr>
</tbody>
</table>

**FIG.-4-**
FIG.-7-
FIG.-8-

- UE
  - E-90
  - Update Location
    - S-500

- MSC-VLR
  - E-25
  - Update Location (ATI)
    - S-510
    - S-524
      - Verify received ATI does not match stored ATR

- HLR
  - E-10

- Update Location Rejection
  - S-551
  - S-561
FIG.-9.-
FIG.-10-

UE

Update Location

S-500

MSC-VLR

Update Location (ATT)

S-510

HLR

DeterminePrior ATI between received ATI and stored ATI

S-522

Verify Prior ATI does not match stored ATR

S-526

Update Location Rejection

S-551

Update Location Rejection

S-561
A. CLASSIFICATION OF SUBJECT MATTER

INV. H04Q7/38

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)

H04Q

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

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td></td>
<td>2-9, 11-18, 20,22,23</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.

See patent family annex.

Date of the actual completion of the international search

20 March 2007

Date of mailing of the international search report

02/04/2007

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk
Tel. (+31-70) 940-2040, Tx. 31 651 epos nl, Fax: (+31-70) 340-3016

Authorized officer

Rosenauer, Hubert
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>WO 02/25981 A (NOKIA CORP [FI]; TUKIAINEN JYRKI [FI]) 28 March 2002 (2002-03-28) abstract page 1, line 7 - line 16 page 2, line 4 - line 12 page 7, line 28 - page 8, line 2 page 9, line 9 - page 10, line 16 page 11, line 16 - line 23 page 12, line 30 - page 13, line 5 figures 1,2A</td>
<td>1,10,19,2-9,11-18,20,22,23</td>
</tr>
<tr>
<td>A</td>
<td>WO 02/01905 A (NOKIA NETWORKS OY [FI]; PEGLION MARC [FI]) 3 January 2002 (2002-01-03) page 1, line 21 - page 2, line 8 page 5, line 10 - page 6, line 34 figure 1</td>
<td>1-23</td>
</tr>
<tr>
<td>A</td>
<td>WO 02/069660 A (ERICSSON TELEFON AB L M [SE]; KEUTMANN HEINZ-PETER [DE]; KOBRIGER PETE) 6 September 2002 (2002-09-06) cited in the application page 4, line 10 - line 22 page 6, line 4 - line 23 page 10, line 29 - page 13, line 5 page 14, line 19 - line 15, line 2 figures 2,3,7</td>
<td>1-23</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>WO 0225981 A 28-03-2002</td>
<td>AU 7289100 A</td>
<td>02-04-2002</td>
</tr>
<tr>
<td>WO 0201905 A 03-01-2002</td>
<td>AU 7259601 A</td>
<td>08-01-2002</td>
</tr>
<tr>
<td></td>
<td>CA 2413719 A1</td>
<td>03-01-2002</td>
</tr>
<tr>
<td></td>
<td>CN 1439232 A</td>
<td>27-08-2003</td>
</tr>
<tr>
<td></td>
<td>FI 20001531 A</td>
<td>29-12-2001</td>
</tr>
<tr>
<td></td>
<td>US 2003143996 A1</td>
<td>31-07-2003</td>
</tr>
<tr>
<td>WO 02069660 A 06-09-2002</td>
<td>CN 1493167 A</td>
<td>28-04-2004</td>
</tr>
<tr>
<td></td>
<td>US 2004072578 A1</td>
<td>15-04-2004</td>
</tr>
</tbody>
</table>