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(54) **Title**: EXTENDED ACCESS BARRING AND NETWORK SHARING

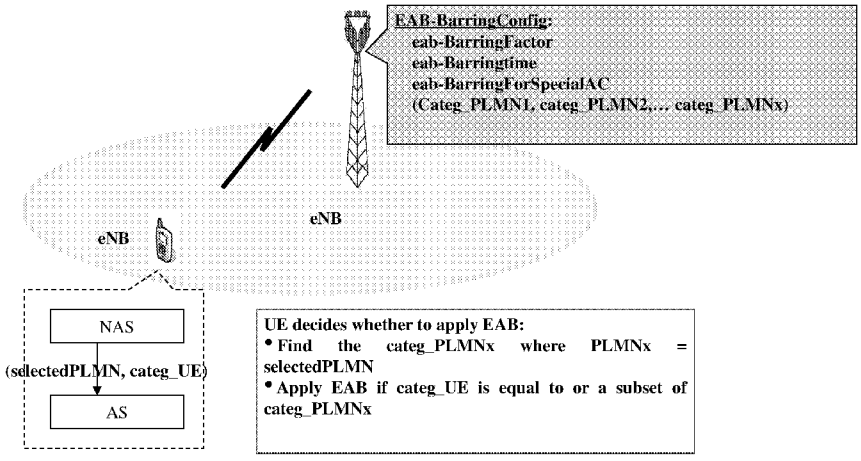


Fig. 3

(57) **Abstract**: It is provided an apparatus, comprising base station means adapted to provide a base station functionality for a first user equipment attached to a first network and a second user equipment attached to a second network different from the first network; access barring broadcasting means adapted to broadcast, via the base station means, a first EAB parameter comprising a first category indication for extended access barring related to the first network and a second category indication for extended access barring related to the second network.

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Extended access barring and network sharing

Field of the invention

The present invention relates to an apparatus, a method, a system, and a computer program product related to extended access barring. More particularly, the present invention relates to an apparatus, a method, a system, and a computer program product for extended access barring in a network sharing case.

Background of the invention

Abbreviations

3GPP	3rd generation partnership project
AC	Access Class
ACB	Access Class Barring
AS	Access Stratum
E-UTRAN	Evolved UTRAN
eNodeB, eNB	Evolved NodeB
EAB	Extended Access Barring
EDGE	Enhanced Data Rates for GSM Evolution
GERAN	GSM Edge RAN
GSM	Global system for mobile communication
IE	Information element
MME	Mobility Management Entity
MMEGI	MME group identity
MMEC	MME code
MTC	Machine Type Communication
NAS	Non Access Stratum
PLMN	Public Land Mobile Network
RAN	Radio Access Network
RRC	radio resource control
SIB	System Information Block
UE	User equipment (same as terminal)
UL	UpLink
UTRAN	Universal Terrestrial Radio Access Network

The present application is related to extended access barring (EAB). 3GPP is discussing EAB as a mean to bar the UEs in overload situations. The requirements are captured in 3GPP TS 22.011 V11.0.0. (chapter 4.3.4).

EAB should be applied depending on the category where UE belongs to and this category is up to the PLMN registration situation as following;

a) UEs that are configured for EAB;
b) UEs that are configured for EAB and are neither in their HPLMN nor in a PLMN that is equivalent to it;
c) UEs that are configured for EAB and are neither in the PLMN listed as most preferred PLMN of the country where the UE is roaming in the operator-defined PLMN selector list on the SIM/USIM, nor in their HPLMN nor in a PLMN that is equivalent to their HPLMN.

Above categories are designed as many MTC devices are roamers.

For instance, in some MTC application, MTC devices are using roamer SIM/USIM with preferred PLMN. That means Operator-A in country-1 gives Operator-A's SIM card of country-2 to its MTC devices in country-1. So all the MTC devices are actually roamers in country-1 but PLMN of Operator-A in country-1 will be the most preferred PLMN. Thus above category is important to bar separately between all the roamers (b) and roamers which are not in the most preferred PLMN(c). In the above example, if Operator-B's network node, which is serving the same area as Operator-A's network node, is breaking down, all Operator-B's MTC devices will try to roam to Operator-A's system and this will cause overload to Operator-A as well. However if there is no separation of category c) from b), network bars all roamer with b), Operator-A's own MTC devices cannot be served either. Thus in this case, category c) barring can be used only to bar the Operator-B's MTC devices.

However, in case that network sharing is used in the network, it is not clear how EAB should be applied and how EAB related parameters should be broadcast. If the E-UTRAN is shared by multiple operators, the system information broadcasted in each shared cell contains the PLMN-id of each operator (according to current specifications up to 6 PLMN-ids), i.e. PLMN-IdentityList as in Figure8. The UE shall read up the PLMN-ids to select one of the PLMN-ids during PLMN selection procedure and to indicate this PLMN-id to the E-UTRAN via RRC Connection Setup Complete message. The E-UTRAN then selects an appropriate MME for the PLMN indicated by the UE.

Fig. 8 explains parameters related to network sharing in pseudo-code language.

In case the network broadcasts multiple PLMN_IDs, UE AS layer will forward them to NAS layer and NAS layer will select one. And NAS layer will indicate this selected PLMN to AS layer and AS layer will include it in the corresponding RRCConnection Setup Complete message as shown in Fig 9.

Basically, the content of the RRCConnectionSetupComplete message is set as follows:

1> set the content of *RRCConnectionSetupComplete* message as follows:

2> set the *selectedPLMN-Identity* to the PLMN selected by upper layers (see TS 23.122, TS 24.301) from the PLMN(s) included in the *plmn-IdentityList* in *SystemInformationBlockType1*;

2> if upper layers provide the 'Registered MME', include and set the *registeredMME* as follows:

3> if the PLMN identity of the 'Registered MME' is different from the PLMN selected by the upper layers:

4> include the *plmnIdentity* in the *registeredMME* and set it to the value of the PLMN identity in the 'Registered MME' received from upper layers;

3> set the *mmegi* and the *mmec* to the value received from upper layers;

Combining network sharing and overload situation generates more cases to consider.

For instance, Operator-A and Operator-B are sharing the RAN node in country 1 as shown in Fig. 1. And Operator-C is serving the same area as Operators A and B but has his own RAN system. And Operator-A and Operator-B have own MTC customers but have different business models. Operator-A's MTC devices have Operator-A's Country-2 SIM/USIM (i.e, they are roamers in country 1), while Operator-B's MTC devices have Operator-B's Country-1 SIM/USIM (i.e., they are in their home network). And in case MME3 is broken, MTC devices of Operator-3 will try to roam to Operator-A/B's network which may cause overload. Thus EAB has to be set in eNB-a to prevent serving Operator-3's MTC devices while eNB-a still serves MTC devices of Operator-A/B as normal.

PLMN selection of Operator-C's MTC devices may vary depending on the settings of devices and the policy of Operator-C. They may select either PLMN1 or PLMN2. From Operator-A's point of view, Operator-C's MTC devices belong to category c) while from Operator-B's point of view Operator-C's MTC devices belong to category b). Thus with the current solution, if category b) is set for EAB in eNB-a, MTC devices of Operator-A will be also barred. If category c) is set for EAB in eNB-a and PLMN2 is configured as preferred PLMN in Operator-C's MTC devices, Operator-C's MTC devices will be served if they select PLMN2.

Even though EAB is invented to prevent RAN overload, the same mechanism may be used for Core network overload mitigation. In this example, MTC business model is the same as the above. (i.e., Operator-A's MTC has roamers' SIM/USIM while Operator-B's MTC has home SIM/USIM)

As in Fig. 2, in case MME2 is heavily loaded, eNB will want to bar the MTC devices of Operator-B while Operator-A's MTC devices can be served normally. However if the category for the EAB is common for all PLMN in network sharing, eNB will not be able to bar only Operator-B's MTC devices as it has to bar Operator-B's MTC devices in category a) while serves normally Operator-A's MTC devices in category b). Such a scenario is described in CR 178 to 3GPP TS 22.011.

For Access Class Barring in LTE system, SIB broadcasts barring related parameters are as according to Fig. 10.

According to 3GPP TS 22.011 V11.0.0, section 4.3.1, for access class barring the UE determines the barring status with the information provided from the serving network, and performs the access attempt accordingly. The UE draws a uniform random number between 0 and 1 when initiating connection establishment and compares with the current barring rate to determine whether it is barred or not. When the uniform random number is less than the current barring rate and the type of access attempt is indicated allowed, then the access attempt is allowed; otherwise, the access attempt is not allowed. If the access attempt is not allowed, further access attempts of the same type are then barred for a time period that is calculated based on the 'mean duration of access control' provided by the network and the random number drawn by the UE.

Thus one could consider extending ACB parameters for EAB, as proposed in R2-113339 and R2-113217. Also for GERAN, some detailed solutions for EAB had been discussed in G2-110010, G2-110018, G2-110026.

However currently all access barring parameters in LTE are common to all PLMNs which share the RAN node. And none of the proposals clarifies how EAB should work in case of network sharing.

In UMTS, the concept of per-PLMN access class barring is present. The network may include a "Domain Specific Access Restriction For Shared Network" IE which includes one or several Domain Specific Access Restriction Parameters per PLMN in case of network sharing in SIB3. However, the "domain specific access Restriction" indicates whether the cell is barred or not for Access Class 0 up to Access class 15. That means the parameter indicates whether the cell is barred for UEs having a certain access class and having selected a certain PLMN. Thus, this concept would mix up the ideas of access class barring and EAB. Thus, the operator may not apply simultaneously access class barring to certain access classes and EAB to UEs of a certain roaming status reducing flexibility for the operator.

Summary of the invention

It is an object of the present invention to improve the prior art.

According to a first aspect of the invention, there is provided an apparatus, comprising base station means adapted to provide a base station functionality for a first user equipment attached to a first network and a second user equipment attached to a second network different from the first network; access barring broadcasting means adapted to broadcast, via the base station means, a first EAB parameter comprising a first category indication for extended access barring related to the first network and a second category indication for extended access barring related to the second network.

In the apparatus, the access barring broadcasting means may be adapted to broadcast a second EAB parameter comprising a common extended access barring parameter, wherein the common extended access parameter may be related to both the first network and the second network and may comprise at least one of a barring factor, a barring time, and a barring for special access classes information element.

In the apparatus, the base station means may be adapted to broadcast an information message comprising an indication of the first network and an indication of the second network, the indications being arranged in a network sequence; the access barring broadcasting means may be adapted to broadcast the first EAB parameter, in which the first category indication and the second category indication are arranged in a category sequence; and the category sequence may correspond to the network sequence.

In the apparatus, a value range of at least one of the first category indication and the second category indication may comprise a first category and a second category different from the first category, and, if a value of the at least one of the first category indication and the second category indication comprises the second category, the at least one of the first category indication and the second category indication may contain the second category and the first category.

The apparatus may comprise first inhibiting means adapted to inhibit the access barring broadcasting means to broadcast the first category indication if a value of the first category indication is a predefined category, wherein the access barring broadcasting means may be adapted to broadcast an extended access barring parameter comprising at least one of a barring factor, a barring time, and a barring for special access classes information element, wherein the extended access barring parameter may be related to the first network.

In the apparatus, the base station means may be adapted to attach to a first core network entity and a second core network entity of the first network, wherein the first core network entity may be different from the second core

network entity, the apparatus may further comprise receiving means adapted to receive at least one of a third category indication from the first core network entity and a fourth category indication from the second core network entity; checking means adapted to check if at least one of the third category indication and the fourth category indication is not received; second inhibiting means adapted to inhibit the access barring broadcasting means to broadcast the first category indication if the checking means has checked that at least one of the third and fourth category indications is not received.

The apparatus may further comprise minimum finding means adapted to find, if the checking means has checked that both the third and fourth category indications are received, a minimum category out of values of the third and fourth category indications, and wherein the access barring broadcasting means may be adapted to broadcast the first category indication with a value of the minimum category.

The apparatus may further comprise load balancing means adapted to balance a load based on the received at least one of the third and fourth category indications.

According to a second aspect of the invention, there is provided an apparatus, comprising base station processor adapted to provide a base station functionality for a first user equipment attached to a first network and a second user equipment attached to a second network different from the first network; access barring broadcasting processor adapted to broadcast, via the base station processor, a first EAB parameter comprising a first category indication for extended access barring related to the first network and a second category indication for extended access barring related to the second network.

In the apparatus, the access barring broadcasting processor may be adapted to broadcast a second EAB parameter comprising a common extended access barring parameter, wherein the common extended access parameter may be related to both the first network and the second network and may comprise at least one of a barring factor, a barring time, and a barring for special access classes information element.

In the apparatus, the base station processor may be adapted to broadcast an information message comprising an indication of the first network and an indication of the second network, the indications being arranged in a network sequence; the access barring broadcasting processor may be adapted to broadcast the first EAB parameter, in which the first category indication and the second category indication are arranged in a category sequence; and the category sequence may correspond to the network sequence.

In the apparatus, a value range of at least one of the first category indication and the second category indication may comprise a first category and a second category different from the first category, and, if a value of the at least one of the first category indication and the second category indication comprises the second category, the at least one of the first category indication and the second category indication may contain the second category and the first category.

The apparatus may comprise first inhibiting processor adapted to inhibit the access barring broadcasting processor to broadcast the first category indication if a value of the first category indication is a predefined category, wherein the access barring broadcasting processor may be adapted to broadcast an extended access barring parameter comprising at least one of a barring factor, a barring time, and a barring for special access classes information element, wherein the extended access barring parameter may be related to the first network.

In the apparatus, the base station processor may be adapted to attach to a first core network entity and a second core network entity of the first network, wherein the first core network entity may be different from the second core network entity, the apparatus may further comprise receiving processor adapted to receive at least one of a third category indication from the first core network entity and a fourth category indication from the second core network entity; checking processor adapted to check if at least one of the third category indication and the fourth category indication is not received; second inhibiting processor adapted to inhibit the access barring broadcasting proces-

sor to broadcast the first category indication if the checking processor has checked that at least one of the third and fourth category indications is not received.

The apparatus may further comprise minimum finding processor adapted to find, if the checking processor has checked that both the third and fourth category indications are received, a minimum category out of values of the third and fourth category indications, and wherein the access barring broadcasting processor may be adapted to broadcast the first category indication with a value of the minimum category.

The apparatus may further comprise load balancing processor adapted to balance a load based on the received at least one of the third and fourth category indications.

According to a third aspect of the invention, there is provided a base station comprising an apparatus according to any of the first and second aspects.

According to a fourth aspect of the invention, there is provided an apparatus, comprising user equipment means adapted to access a base station device, to attach to a first network via the base station device, and to receive, from the base station device, a first EAB parameter comprising a first category indication related to the first network and a second category indication related to a second network different from the first network; evaluating means adapted to evaluate a category from the first EAB parameter based on the first category indication; checking means adapted to check, if the apparatus belongs to the category, and, if affirmative, to obtain a positive result; applying means adapted to apply extended access barring to the access of the user equipment means to the base station device if the result of the checking means is positive.

In the apparatus, the user equipment means may be further adapted to receive a second EAB parameter from the base station device, the apparatus may further comprise parameter obtaining means adapted to obtain a common extended access barring parameter from the second EAB parameter,

wherein the common extended access barring parameter may be related to both of the first network and the second network and may comprise at least one of a barring factor, a barring time, and a barring for special access classes information element.

In the apparatus, the user equipment means may be further adapted to receive an indication of the first network and an indication of the second network in an information message received from the base station device, the apparatus may further comprise sequence obtaining means adapted to obtain a network sequence from an arrangement of the indication of the first network and the indication of the second network in the information message; wherein the first category indication and the second category indication in the first EAB parameter are arranged in a category sequence, and the evaluating means may be adapted to identify the category indication related to the first network assuming that the network sequence corresponds to the category sequence.

In the apparatus, a value range of the first category indication may comprise a first category and a second category different from the first category, wherein the checking means may be additionally adapted to obtain the positive result if the apparatus belongs to the first category and the evaluated category comprises the second category.

In the apparatus, the user equipment means may be further adapted to receive an extended access barring parameter comprising at least one of a barring factor, a barring time, and a barring for special access classes information element, wherein the extended access barring parameter may be related to the first network, the checking means may be adapted to check, if the first category indication is not received, if the apparatus belongs to a predefined category, and, if affirmative, to obtain the positive result.

According to a fifth aspect of the invention, there is provided an apparatus, comprising user equipment processor adapted to access a base station device, to attach to a first network via the base station device, and to receive, from the base station device, a first EAB parameter comprising a first category indication related to the first network and a second category indication related to

a second network different from the first network; evaluating processor adapted to evaluate a category from the first EAB parameter based on the first category indication; checking processor adapted to check, if the apparatus belongs to the category, and, if affirmative, to obtain a positive result; applying processor adapted to apply extended access barring to the access of the user equipment processor to the base station device if the result of the checking processor is positive.

In the apparatus, the user equipment processor may be further adapted to receive a second EAB parameter from the base station device, the apparatus may further comprise parameter obtaining processor adapted to obtain a common extended access barring parameter from the second EAB parameter, wherein the common extended access barring parameter may be related to both of the first network and the second network and may comprise at least one of a barring factor, a barring time, and a barring for special access classes information element.

In the apparatus, the user equipment processor may be further adapted to receive an indication of the first network and an indication of the second network in an information message received from the base station device, the apparatus may further comprise sequence obtaining processor adapted to obtain a network sequence from an arrangement of the indication of the first network and the indication of the second network in the information message; wherein the first category indication and the second category indication in the first EAB parameter are arranged in a category sequence, and the evaluating processor may be adapted to identify the category indication related to the first network assuming that the network sequence corresponds to the category sequence.

In the apparatus, a value range of the first category indication may comprise a first category and a second category different from the first category, wherein the checking processor may be additionally adapted to obtain the positive result if the apparatus belongs to the first category and the evaluated category comprises the second category.

In the apparatus, the user equipment processor may be further adapted to receive an extended access barring parameter comprising at least one of a barring factor, a barring time, and a barring for special access classes information element, wherein the extended access barring parameter may be related to the first network, the checking processor may be adapted to check, if the first category indication is not received, if the apparatus belongs to a predefined category, and, if affirmative, to obtain the positive result.

According to a sixth aspect of the invention, there is provided a user equipment comprising an apparatus according to any of the fourth and fifth aspects.

According to a seventh aspect of the invention, there is provided an apparatus, comprising mobility management means adapted to provide a mobility management to a user equipment attached to the mobility management entity means via a base station device, and indicating means adapted to indicate a category for extended access barring to the base station device.

According to an eighth aspect of the invention, there is provided an apparatus, comprising mobility management processor adapted to provide a mobility management to a user equipment attached to the mobility management entity processor via a base station device, and indicating processor adapted to indicate a category for extended access barring to the base station device.

According to a ninth aspect of the invention, there is provided a system, comprising a base station apparatus according to any of the first and second aspects; a user equipment apparatus according to any of the fourth and fifth aspects; wherein the user equipment apparatus comprises the first user equipment of the base station apparatus and is attached to the first network of the base station apparatus; and the first EAB parameter received by the user equipment apparatus comprises the first EAB parameter broadcasted by the base station apparatus.

According to a tenth aspect of the invention, there is provided a method, comprising providing a base station functionality for a first user equipment attached to a first network and a second user equipment attached to a second

network different from the first network; broadcasting, using the base station functionality, a first EAB parameter comprising a first category indication for extended access barring related to the first network and a second category indication for extended access barring related to the second network.

The method may be a method of a base station.

The method may further comprise broadcasting a second EAB parameter comprising a common extended access barring parameter, wherein the common extended access parameter may be related to both the first network and the second network and may comprise at least one of a barring factor, a barring time, and a barring for special access classes information element.

The method may further comprise broadcasting an information parameter comprising an indication of the first network and an indication of the second network, the indications being arranged in a network sequence; wherein the first category indication and the second category indication are arranged in a category sequence in the first EAB parameter; and the category sequence may correspond to the network sequence.

In the method, a value range of at least one of the first category indication and the second category indication may comprise a first category and a second category different from the first category, and, if a value of the at least one of the first category indication and the second category indication comprises the second category, the at least one of the first category indication and the second category indication may contain the second category and the first category.

The method may comprise inhibiting broadcasting the first category indication if a value of the first category indication is a predefined category, and broadcasting an extended access barring parameter comprising at least one of a barring factor, a barring time, and a barring for special access classes information element, wherein the extended access barring parameter may be related to the first network.

In the method, the apparatus performing the method may be attached to a first core network entity and a second core network entity of the first network, wherein the first core network entity may be different from the second core network entity, the method may further comprise receiving at least one of a third category indication from the first core network entity and a fourth category indication from the second core network entity; checking if one of the third category indication and the fourth category indication is not received; inhibiting broadcasting the first category indication if it is checked that one of the third and fourth category indications is not received.

The method may further comprise finding, if it is checked that both the third and fourth category indications are received, a minimum category out of values of the third and fourth category indications, and broadcasting the first category indication with a value of the minimum category.

The method may further comprise balancing a load based on the received at least one of the third and fourth category indications.

According to an eleventh aspect of the invention, there is provided a method, comprising accessing a base station device, attaching to the first network via the base station device; receiving, from the base station device, a first EAB parameter comprising a first category indication related to the first network and a second category indication related to a second network different from the first network, evaluating a category from the first EAB parameter based on the first category indication; checking, if the apparatus performing the method belongs to the category and, if affirmative, obtaining a positive result; and applying extended access barring to the access to the base station device if the result of the checking is positive.

The method may be a method of a user equipment.

The method may further comprise receiving a second EAB parameter from the base station device, and obtaining a common extended access barring parameter from the second EAB parameter, wherein the common extended access barring parameter may be related to both of the first network and the second

network and may comprise at least one of a barring factor, a barring time, and a barring for special access classes information element.

The method may further comprise receiving an indication of the first network and an indication of the second network in an information parameter received from the base station device, obtaining a network sequence from an arrangement of the indication of the first network and the indication of the second network in the information parameter; wherein the first category indication and the second category indication in the first EAB parameter are arranged in a category sequence, and the evaluating may be adapted to identify the category indication related to the first network assuming that the category sequence corresponds to the network sequence.

In the method, a value range of the first category indication may comprise a first category and a second category different from the first category, the method further may comprise obtaining the positive result if the apparatus performing the method belongs to the first category and the evaluated category comprises the second category.

The method may further comprise receiving an extended access barring parameter comprising at least one of a barring factor, a barring time, and a barring for special access classes information element, wherein the extended access barring parameter may be related to the first network, and checking, if the first category indication is not received, if the apparatus belongs to a predefined category, and, if affirmative, obtaining the positive result.

According to a twelfth aspect of the invention, there is provided a method, comprising providing a mobility management to a user equipment attached to an apparatus performing the providing via a base station device, and indicating a category for extended access barring to the base station device.

According to a thirteenth aspect of the invention, there is provided a computer program product including a program comprising software code portions being arranged, when run on a processor of an apparatus, to perform the method according to any one of the tenth to twelfth aspects.

The computer program product may comprise a computer-readable medium on which the software code portions are stored, and/or the program may be directly loadable into a memory of the processor.

According to embodiments of the invention, at least the following advantages are achieved:

Overload in the RAN may be efficiently mitigated according to the defined categories also in case of network sharing. Flexibility of the operator is enhanced. Access classes are not involved and, thus, may be treated independently from EAB. Nevertheless, signaling load may be reduced by using common EAB parameters for different core networks and/or by applying more elaborated less consuming signaling schemes. On the other hand, by some signaling schemes, the processing power on the base stations or user equipment needed for EAB signaling may be reduced.

It is to be understood that any of the above modifications can be applied singly or in combination to the respective aspects to which they refer, unless they are explicitly stated as excluding alternatives.

Brief description of the drawings

Further details, features, objects, and advantages are apparent from the following detailed description of the preferred embodiments of the present invention which is to be taken in conjunction with the appended drawings, wherein

Fig. 1 shows an exemplary shared network configuration;

Fig. 2 shows another exemplary shared network configuration;

Fig. 3 shows a network configuration according to an embodiment of the invention;

Fig. 4 shows an apparatus according to an embodiment of the invention;

Fig. 5 shows a method according to an embodiment of the invention;

Fig. 6 shows an apparatus according to an embodiment of the invention;

Fig. 7 shows a method according to an embodiment of the invention;

Fig. 8 shows an exemplary SIB1 in case of network sharing (pseudo-code);

Fig. 9 shows an exemplary RRCConnectionSetupComplete message in case of network sharing (pseudo-code);

Fig. 10 shows an exemplary SIB2 in case of access class barring (pseudo-code);

Fig. 11 shows EAB-BarringConfig according to an embodiment of the invention (pseudo-code);

Fig. 12 shows an apparatus according to an embodiment of the invention; and

Fig. 13 shows a method according to an embodiment of the invention.

Detailed description of certain embodiments

Herein below, certain embodiments of the present invention are described in detail with reference to the accompanying drawings, wherein the features of the embodiments can be freely combined with each other unless otherwise described. However, it is to be expressly understood that the description of certain embodiments is given for by way of example only, and that it is by no way intended to be understood as limiting the invention to the disclosed details.

Moreover, it is to be understood that the apparatus is configured to perform the corresponding method, although in some cases only the apparatus or only the method are described.

This invention report proposes a way of efficient RRC signaling to realize EAB in case of network sharing.

To realize the EAB, the network may broadcast something similar to ac-BarringFactor, ac-BarringTime and ac-BarringForSpecialAC for EAB and an indication of category indicating whether the barring is applied to UEs belonging to category a) or b) or c). For example, ac-BarringFactor may be an ON/OFF type of indication or, in some embodiments, it may be not needed to further save signalling. Also ac-BarringForSpecialAC may not be needed if EAB is never configured for UEs having access class 11 – 15.

To simplify the configuration but to support network sharing with EAB, according to some embodiments of the invention, the EAB configuration (i.e, eab-Barring Factor (or ON/OFF indication) and eab-barring timer and potentially eab-BarringForSepcialAC) may be signalled common for all PLMNs if SIB1 broadcasts multiple PLMNs but the categories to apply EAB may be signalled per PLMN. However, in some embodiments, the category indications may not be signalled in the same message as the PLMN list indicating the PLMNs sharing the base station. For example, the PLMN list may be signalled in SIB1 and the category indications may be signalled in SIB2 or a new SIB. In case the UE NAS chooses a PLMN and indicates it to AS with which category UE belonging to (either in a separate indicator or as a part of call type), that PLMN will be the subject of EAB according to the category signalled in the system information with the rest of the EAB configuration.

In case, eab-BarringFactor is signalled instead of ON/OFF indication and AC 11-15 may have EAB as well, one example signalling according to an embodiment of the invention could be as shown in Fig. 11. In this embodiment, first entry of UE-EAB-Category corresponds to the first entry of PLMN-Identity listed in the SIB1, second entry of UE-EAB-Category corresponds to the second entry of PLMN-Identity listed in the SIB1, and so on.

Thus, for instance, if SIB1 includes three PLMN-Identities (e.g. PLMN1, PLMN2 and PLMN3), UE NAS layer may select e.g. PLMN2 to register and indicates that the UE belonging to category b, network broadcasts EAB-BarringConfig with eab-PLMN-Info as {categ-a, categ-b, categ-b}, UE applies EAB according to the rest of EAB-BarringConfiguration. As UE category b) belongs to a) and c) belongs to b) and a), in the above example, if NAS selects PLMN2 to register and indicates that UE belonging to category c), UE still should apply the EAB according to the rest of the EAB-BarringConfiguration parameter. However, depending on the definition of category bit in the signalling, the details may vary. All in all, the UE behaviour is shown in Fig. 3. Based on the indication from NAS to AS, and the EAB-BarringConfig advertised from SIB, UE could decide whether to apply EAB.

Instead of a 1:1 correspondence of the sequences of the PLMN identities in the SIB and the sequence of categories, in some embodiments there may be other correspondences such that e.g. the sequence of categories is reversed or cyclically shifted compared to the sequence of PLMN identities.

The name of the respective information elements, the implementations, and value ranges may be different from those shown herein. In general, they preferably may be specified by 3GPP.

If ON/OFF type of signalling is used instead of eab-BarringFactor, in some embodiments of the invention eab-BarringFactor may be replaced with

```
eab-Barring          BOOLEAN,
```

or

```
eab-Barring          ENUMERATED {barred} OPTIONAL,
```

Alternatively, in some embodiments of the invention, eab-BarringFactor may be removed and the network may indicate that EAB is activated by including EAB-BarringConfig with other configuration messages. Thus EAB-BarringConfig becomes OPTIONAL in this case.

Also for EAB-PLMN-Info, in some embodiments of the invention, eab-PLMN-List may have the list of SEQUENCE and ue-EAB-Category has only two values as below, wherein ue-EAB-Category is optional.

```
eab-PLMN-List ::=          SEQUENCE (SIZE (1..6)) OF EAB-PLMN-Info

EAB-PLMN-Info ::= SEQUENCE {
  ue-EAB-Category     ENUMERATED { categ-b, categ-c }     OPTIONAL
}
```

As by default, according to this embodiment, if EAB-BarringConfig is signalled, all the UEs belonging to categ-a should apply EAB. Thus, with this signalling, network does not need to signal the category explicitly if PLMN wants to bar categ-a UEs. Thus with above example, eab-PLMN-Info will broadcast {NULL, categ-b, categ-b} if network wants to bar category-a) UEs in PLMN1 and category-b) UEs in PLMN2 and PLMN3. However in this signalling, the number of PLMNs broadcast in the SIB1 and the number of entries in eab-PLMN-Info should be the same if the association between category in PLMN is based on their respective sequences. In some other embodiments, EAB-PLMN-Info may includes the number (1..6) to indicate which PLMN in the SIB1 is linked to UE-EAB-Category information.

If there are more than three categories, and/or if the default is one of the other categories, the same principle may apply wherein the value range of two

categories {categ-b, categ-c} as according to the above embodiment may comprise all the categories except for one which is the default category.

Since the UE NAS indicates to AS is category a), b) or c), a problem may arise how the UE maps its category with the category information included in EAB from the network. For example, if the EAB corresponding to the PLMN selected by the UE indicates "categ-b", and UE NAS indicates to AS shows "categ-c", should the UE apply the EAB or not?

Since category c) is a subset of category b), and category b) is a subset of category a), in some embodiments the UE may apply the EAB as long as its category is equal to or a subset of the category indicated in the EAB information, as shown in Fig. 3.

According to these embodiments, some mapping rules may be defined at UE.

According to other embodiments, in order to simplify UE's behaviour, one more variation of category signalling may be given as follows, so that UE could just read the category information in EAB and check whether its category is included.

```
EAB-PLMN-Info ::=SEQUENCE {
        ue-EAB-Category  ENUMERATED {categ-abc, categ-bc-Only, categ-c-Only, spare}
}
```

In embodiments employing this signalling, UE may apply the category information in the EAB configuration directly and does not need to deduce whether

it is a subset of the category in the signalling. Thus, if "categ-abc" is indicated for a certain PLMN, EAB-BarringConfig is applicable to UEs of category a) and b) and c) in that PLMN. If "categ-bc-Only" is indicated for a certain PLMN, EAB-BarringConfig is applicable only for UEs of category b) and c) but not for category a) UEs for that PLMN. And if "categ-c-Only" is indicated for a certain PLMN, EAB-BarringConfig is applicable to UEs of category c) only but not to UEs of category a) and b) for that PLMN.

Also if more flexibility is required and operators want to apply the EAB only to certain PLMNs but not all the PLMNs sharing the RAN node, in some embodiments more value can be added by the category value like "no barring". By adding this no-barring, network can set EAB only for a few PLMNs in case of network sharing.

UE-EAB-Category ENUMERATED {categ-a, categ-b, categ-c, no-barring}

The EAB parameters can be configured by O&M or based on the overload indication from core network. If more accurate indication is necessary to set the EAB in eNB, MME may need to signal which category it would like to bar for EAB and based on this information eNB set the EAB per category.

For example, if several MMEs belong to one PLMN, and eNB receives different categories from some of the MMEs belonging to the one PLMN,
eNB may decide depending on the MME capabilities in the MME pool of the PLMN. If other - non congested - MME can serve the device, eNB may not set the barring category as requested by the some MMEs but eNB may apply load balancing procedure and does not forward the connection request to the MME that indicated an EAB category.

In some embodiments, the eNB may find out the minimum category of the received categories. The minimum category is a category where barring is applied to the smallest number of user equipments. For example, if one MME indicates category a and another indicates category b, category b is the minimum category because each UE belonging to category b belongs to category a, too, but not vice versa. In other words, the minimum category defines the smallest sub-set. Then, the eNB may send an EAB indication with category b (the minimum category), and apply load balancing such that the connection requests are preferably forwarded to the MME indicating the minimum category. (i.e, MME indicating category b in the example).

If, in the MME pool, only one MME can serve the EAB configured devices and that MME sends an EAB indication to eNB, then eNB may set the EAB configuration accordingly.

If an MME belongs to different PLMNs, eNB may just set the parameter per PLMN accordingly in the EAB configuration and broadcasts it.

Fig. 4 shows an apparatus according to an embodiment of the invention. The apparatus may be a base station such as an eNodeB. Fig. 5 shows a method according to an embodiment of the invention. The apparatus according to Fig. 4 may perform the method of Fig. 5 but is not limited to this method. The method of Fig. 5 may be performed by the apparatus of Fig. 5 but is not limited to being performed by this apparatus.

The apparatus comprises base station means 10, and access barring broadcasting means 20.

The base station means 10 provides base station functionality for user equipments attached to different networks (S10). The access barring broadcasting means 20 broadcasts, via the base station functionality, an EAB parameter wherein the categories are related to the different networks (S20).

Fig. 6 shows an apparatus according to an embodiment of the invention. The apparatus may be a terminal such as a user equipment. Fig. 7 shows a method according to an embodiment of the invention. The apparatus according to Fig. 6 may perform the method of Fig. 7 but is not limited to this method. The method of Fig. 7 may be performed by the apparatus of Fig. 6 but is not limited to being performed by this apparatus.

The apparatus comprises user equipment means 60, evaluating means 70, checking means 80, and applying means 90.

The user equipment means 60 may access a base station, attach to a network via the base station, and receive messages from the base station. One of these messages may contain an EAB parameter comprising several category indications related to several networks (S60). The evaluating means 70 evaluates the category from the category indication related to the network to which the apparatus is attached (S70). The checking means 80 checks whether the apparatus belongs to the evaluated category (S80). If the check result is affirmative, the applying means 90 applies EAB to the user equipment means (S90).

Fig. 12 shows an apparatus according to an embodiment of the invention. The apparatus may be a mobility management entity such as an MME. Fig. 13 shows a method according to an embodiment of the invention. The apparatus according to Fig. 12 may perform the method of Fig. 13 but is not limited to this method. The method of Fig. 13 may be performed by the apparatus of Fig. 12 but is not limited to being performed by this apparatus.

The apparatus comprises mobility management means 110, and indicating means 120.

The mobility management means 110 provides a mobility management functionality for user equipment attached to a core network to which the mobility management means belongs (S110). The mobility management means may belong to more than one core network. The user equipment are attached to

their respective core network via a base station. The indicating means 120 indicates to the base station an EAB category related to the core network (S120).

Embodiments of the invention are described based on an LTE system but embodiments of the invention may be applied to UMTS or any other radio access network (e.g. GERAN, EDGE) where EAB and network sharing may be employed.

According to current LTE standards, up to 6 PLMNs may share an access network. However, the number of six is not a limitation for the present invention. In embodiments of the invention, any number of core networks may share a certain radio access network.

In some embodiments of the invention, the networks sharing the radio access network, in particular the base station, are PLMNs. In some embodiments, private networks or a mixture of public and private networks may share the base station.

In some embodiments, the networks sharing the base station may also share their core networks, that is one core network of several networks (e.g. PLMNs) is attached to the base station. In some embodiments, at least some of the networks may have their own core network, and several core networks are attached to the base station.

In some embodiments of the invention, the categories and the other EAB parameters are broadcasted in different messages, while they may be broadcasted in the same message in other embodiments.

In some embodiments of the invention, a machine type communication (MTC) device is employed. In other embodiments, any terminal of the respective access technology such as a mobile phone, a laptop, a smart phone, and a user equipment may be employed.

If not otherwise stated or otherwise made clear from the context, the statement that two entities are different means that they are differently addressed in the mobile network. It does not necessarily mean that they are based on different hardware. That is, each of the entities described in the present description may be based on a different hardware, or some or all of the entities may be based on the same hardware.

According to the above description, it should thus be apparent that exemplary embodiments of the present invention provide, for example a base station, or a component thereof, an apparatus embodying the same, a method for controlling and/or operating the same, and computer program(s) controlling and/or operating the same as well as mediums carrying such computer program(s) and forming computer program product(s). Further exemplary embodiments of the present invention provide, for example a user equipment, or a component thereof, an apparatus embodying the same, a method for controlling and/or operating the same, and computer program(s) controlling and/or operating the same as well as mediums carrying such computer program(s) and forming computer program product(s) controlling and/or operating the same as well as mediums carrying such computer program(s) and forming computer program product(s).

Implementations of any of the above described blocks, apparatuses, systems, techniques or methods include, as non limiting examples, implementations as hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

It is to be understood that what is described above is what is presently considered the preferred embodiments of the present invention. However, it should be noted that the description of the preferred embodiments is given by way of example only and that various modifications may be made without departing from the scope of the invention as defined by the appended claims.

Claims

1. Apparatus, comprising

base station means adapted to provide a base station functionality for a first user equipment attached to a first network and a second user equipment attached to a second network different from the first network;

access barring broadcasting means adapted to broadcast, via the base station means, a first EAB parameter comprising a first category indication for extended access barring related to the first network and a second category indication for extended access barring related to the second network.

2. Apparatus according to claim 1, wherein

the access barring broadcasting means is adapted to broadcast a second EAB parameter comprising a common extended access barring parameter, wherein the common extended access parameter is related to both the first network and the second network and comprises at least one of a barring factor, a barring time, and a barring for special access classes information element.

3. Apparatus according to any of claims 1 to 2, wherein

the base station means is adapted to broadcast an information message comprising an indication of the first network and an indication of the second network, the indications being arranged in a network sequence;

the access barring broadcasting means is adapted to broadcast the first EAB parameter, in which the first category indication and the second category indication are arranged in a category sequence; and

the category sequence corresponds to the network sequence.

4. Apparatus according to any of claims 1 to 3, wherein

a value range of at least one of the first category indication and the second category indication comprises a first category and a second category different from the first category, and,

if a value of the at least one of the first category indication and the second category indication comprises the second category, the at least one of

the first category indication and the second category indication contains the second category and the first category.

5. Apparatus according to any of claims 1 to 4, comprising

first inhibiting means adapted to inhibit the access barring broadcasting means to broadcast the first category indication if a value of the first category indication is a predefined category, wherein

the access barring broadcasting means is adapted to broadcast an extended access barring parameter comprising at least one of a barring factor, a barring time, and a barring for special access classes information element, wherein the extended access barring parameter is related to the first network.

6. Apparatus according to any of claims 1 to 5, wherein

the base station means is adapted to attach to a first core network entity and a second core network entity of the first network, wherein the first core network entity is different from the second core network entity, the apparatus further comprising

receiving means adapted to receive at least one of a third category indication from the first core network entity and a fourth category indication from the second core network entity;

checking means adapted to check if at least one of the third category indication and the fourth category indication is not received;

second inhibiting means adapted to inhibit the access barring broadcasting means to broadcast the first category indication if the checking means has checked that at least one of the third and fourth category indications is not received.

7. Apparatus according to claim 6, further comprising

minimum finding means adapted to find, if the checking means has checked that both the third and fourth category indications are received, a minimum category out of values of the third and fourth category indications, and wherein

the access barring broadcasting means is adapted to broadcast the first category indication with a value of the minimum category.

8. Apparatus according to any of claims 6 and 7, further comprising

load balancing means adapted to balance a load based on the received at least one of the third and fourth category indications.

9. Base station comprising an apparatus according to any of claims 1 to 8.

10. Apparatus, comprising

user equipment means adapted to access a base station device, to attach to a first network via the base station device, and to receive, from the base station device, a first EAB parameter comprising a first category indication related to the first network and a second category indication related to a second network different from the first network;

evaluating means adapted to evaluate a category from the first EAB parameter based on the first category indication;

checking means adapted to check, if the apparatus belongs to the category, and, if affirmative, to obtain a positive result;

applying means adapted to apply extended access barring to the access of the user equipment means to the base station device if the result of the checking means is positive.

11. Apparatus according to claim 10, wherein

the user equipment means is further adapted to receive a second EAB parameter from the base station device, the apparatus further comprising

parameter obtaining means adapted to obtain a common extended access barring parameter from the second EAB parameter, wherein the common extended access barring parameter is related to both of the first network and the second network and comprises at least one of a barring factor, a barring time, and a barring for special access classes information element.

12. Apparatus according to any of claims 10 to 11, wherein

the user equipment means is further adapted to receive an indication of the first network and an indication of the second network in an information message received from the base station device, the apparatus further comprising

sequence obtaining means adapted to obtain a network sequence from an arrangement of the indication of the first network and the indication of the second network in the information message; wherein

the first category indication and the second category indication in the first EAB parameter are arranged in a category sequence, and

the evaluating means is adapted to identify the category indication related to the first network assuming that the network sequence corresponds to the category sequence.

13. Apparatus according to any of claims 10 to 12, wherein

a value range of the first category indication comprises a first category and a second category different from the first category, wherein

the checking means is additionally adapted to obtain the positive result if the apparatus belongs to the first category and the evaluated category comprises the second category.

14. Apparatus according to any of claims 10 to 13, wherein

the user equipment means is further adapted to receive an extended access barring parameter comprising at least one of a barring factor, a barring time, and a barring for special access classes information element, wherein the extended access barring parameter is related to the first network,

the checking means is adapted to check, if the first category indication is not received, if the apparatus belongs to a predefined category, and, if affirmative, to obtain the positive result.

15. User equipment comprising an apparatus according to any of claims 10 to 14.

16. Apparatus, comprising

mobility management means adapted to provide a mobility management to a user equipment attached to the mobility management entity means via a base station device, and

indicating means adapted to indicate a category for extended access barring to the base station device.

17. System, comprising

a base station apparatus according to any of claims 1 to 8;

a user equipment apparatus according to any of claims 10 to 14; wherein

the user equipment apparatus comprises the first user equipment of the base station apparatus and is attached to the first network of the base station apparatus; and

the first EAB parameter received by the user equipment apparatus comprises the first EAB parameter broadcasted by the base station apparatus.

18. Method, comprising

providing a base station functionality for a first user equipment attached to a first network and a second user equipment attached to a second network different from the first network;

broadcasting, using the base station functionality, a first EAB parameter comprising a first category indication for extended access barring related to the first network and a second category indication for extended access barring related to the second network.

19. Method according to claim 18, further comprising

broadcasting a second EAB parameter comprising a common extended access barring parameter, wherein the common extended access parameter is related to both the first network and the second network and comprises at least one of a barring factor, a barring time, and a barring for special access classes information element.

20. Method according to any of claims 18 to 19, further comprising

broadcasting an information parameter comprising an indication of the first network and an indication of the second network, the indications being arranged in a network sequence; wherein

the first category indication and the second category indication are arranged in a category sequence in the first EAB parameter; and

the category sequence corresponds to the network sequence.

21. Method according to any of claims 18 to 20, wherein

a value range of at least one of the first category indication and the second category indication comprises a first category and a second category different from the first category, and,

if a value of the at least one of the first category indication and the second category indication comprises the second category, the at least one of the first category indication and the second category indication contains the second category and the first category.

22. Method according to any of claims 18 to 21, comprising

inhibiting broadcasting the first category indication if a value of the first category indication is a predefined category, and

broadcasting an extended access barring parameter comprising at least one of a barring factor, a barring time, and a barring for special access classes information element, wherein the extended access barring parameter is related to the first network.

23. Method according to any of claims 18 to 22, wherein

the apparatus performing the method is attached to a first core network entity and a second core network entity of the first network, wherein the first core network entity is different from the second core network entity, the method further comprising

receiving at least one of a third category indication from the first core network entity and a fourth category indication from the second core network entity;

checking if one of the third category indication and the fourth category indication is not received;

inhibiting broadcasting the first category indication if it is checked that one of the third and fourth category indications is not received.

24. Method according to claim 23, further comprising

finding, if it is checked that both the third and fourth category indications are received, a minimum category out of values of the third and fourth category indications, and

broadcasting the first category indication with a value of the minimum category.

25. Method according to any of claims 23 and 24, further comprising

balancing a load based on the received at least one of the third and fourth category indications.

26. Method, comprising

accessing a base station device,

attaching to the first network via the base station device;

receiving, from the base station device, a first EAB parameter comprising a first category indication related to the first network and a second category indication related to a second network different from the first network,

evaluating a category from the first EAB parameter based on the first category indication;

checking, if the apparatus performing the method belongs to the category and, if affirmative, obtaining a positive result; and

applying extended access barring to the access to the base station device if the result of the checking is positive.

27. Method according to claim 26, further comprising

receiving a second EAB parameter from the base station device, and

obtaining a common extended access barring parameter from the second EAB parameter, wherein the common extended access barring parameter is related to both of the first network and the second network and comprises at least one of a barring factor, a barring time, and a barring for special access classes information element.

28. Method according to any of claims 26 to 27, further comprising

receiving an indication of the first network and an indication of the second network in an information parameter received from the base station device,

obtaining a network sequence from an arrangement of the indication of the first network and the indication of the second network in the information parameter; wherein

the first category indication and the second category indication in the first EAB parameter are arranged in a category sequence, and

the evaluating is adapted to identify the category indication related to the first network assuming that the category sequence corresponds to the network sequence.

29. Method according to any of claims 26 to 28, wherein

a value range of the first category indication comprises a first category and a second category different from the first category, the method further comprising

obtaining the positive result if the apparatus performing the method belongs to the first category and the evaluated category comprises the second category.

30. Method according to any of claims 26 to 29, further comprising

receiving an extended access barring parameter comprising at least one of a barring factor, a barring time, and a barring for special access classes information element, wherein the extended access barring parameter is related to the first network, and

checking, if the first category indication is not received, if the apparatus belongs to a predefined category, and, if affirmative, obtaining the positive result.

31. Method, comprising

providing a mobility management to a user equipment attached to an apparatus performing the providing via a base station device, and

indicating a category for extended access barring to the base station device.

32. A computer program product including a program comprising software code portions being arranged, when run on a processor of an apparatus, to perform the method according to any one of claims 18 to 31.

33. The computer program product according to claim 32, wherein the computer program product comprises a computer-readable medium on which the software code portions are stored, and/or wherein the program is directly loadable into a memory of the processor.

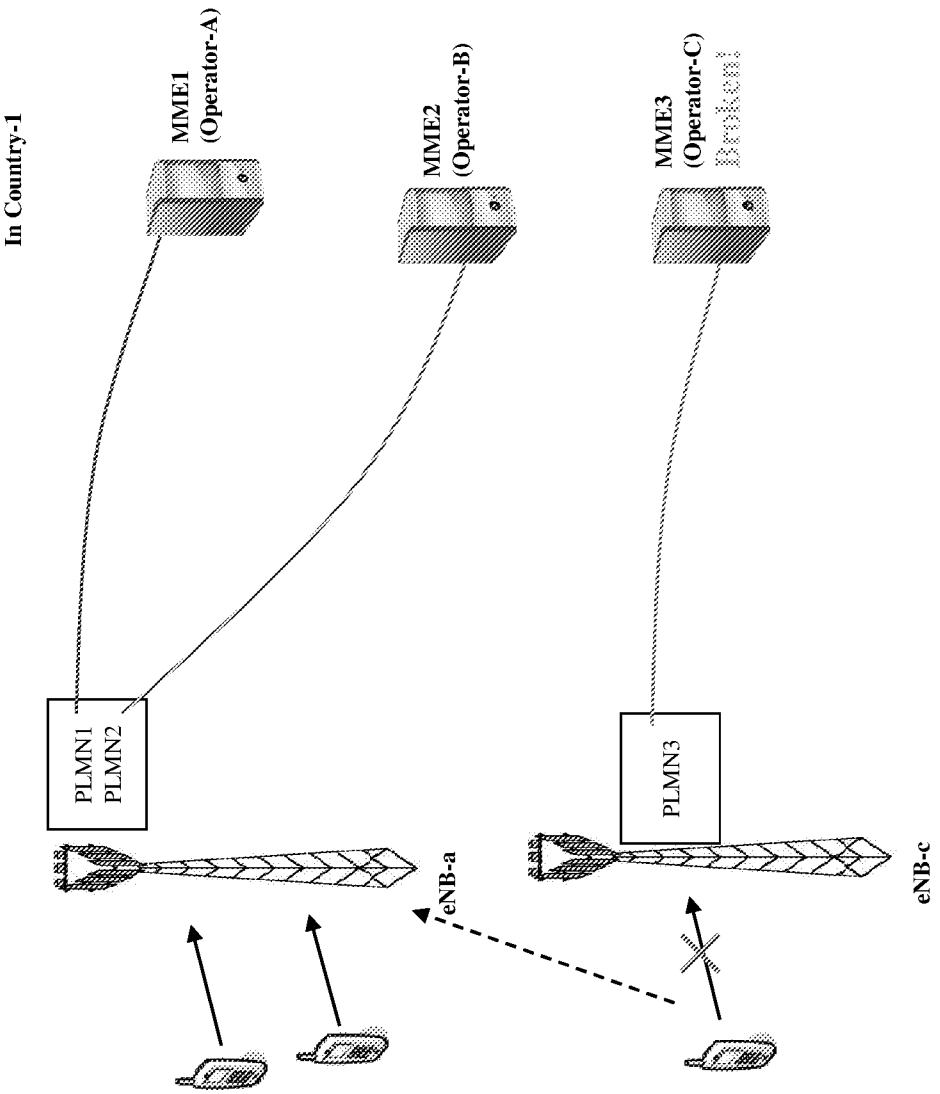

In Country-1
MME1
(Operator-A)
MME2
(Operator-B)
MME3
(Operator-C)
Broken!
PLMN1
PLMN2
PLMN3
eNB-a
eNB-c

Fig. 1

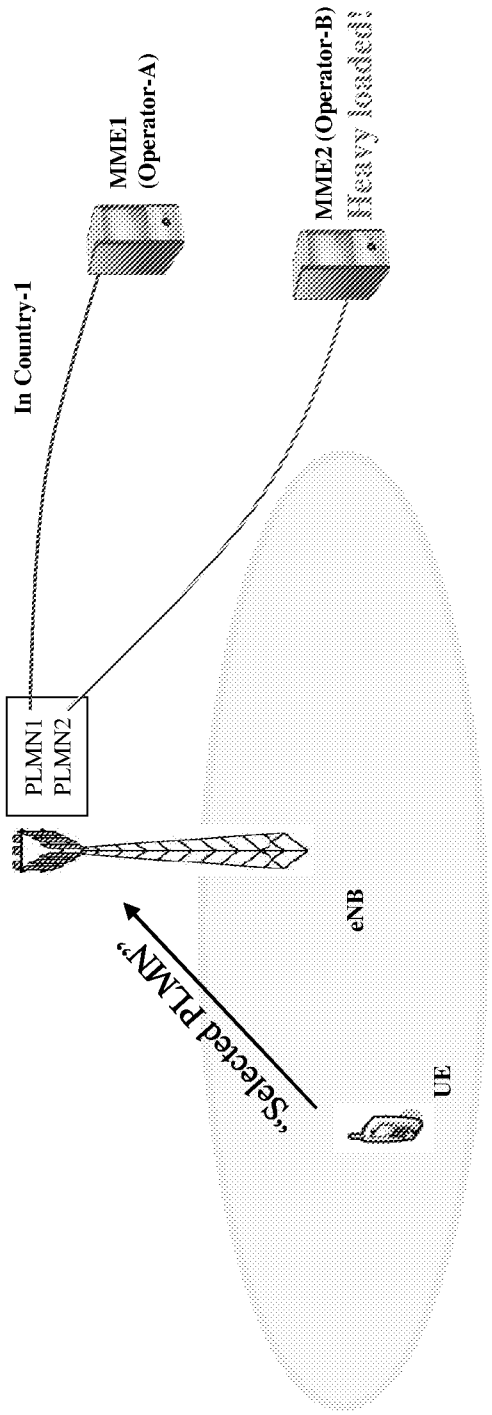

In Country-1
MME1
(Operator-A)
MME2 (Operator-B)
Heavy loaded!
PLMN1
PLMN2
eNB
„Selected PLMN"
UE

Fig. 2

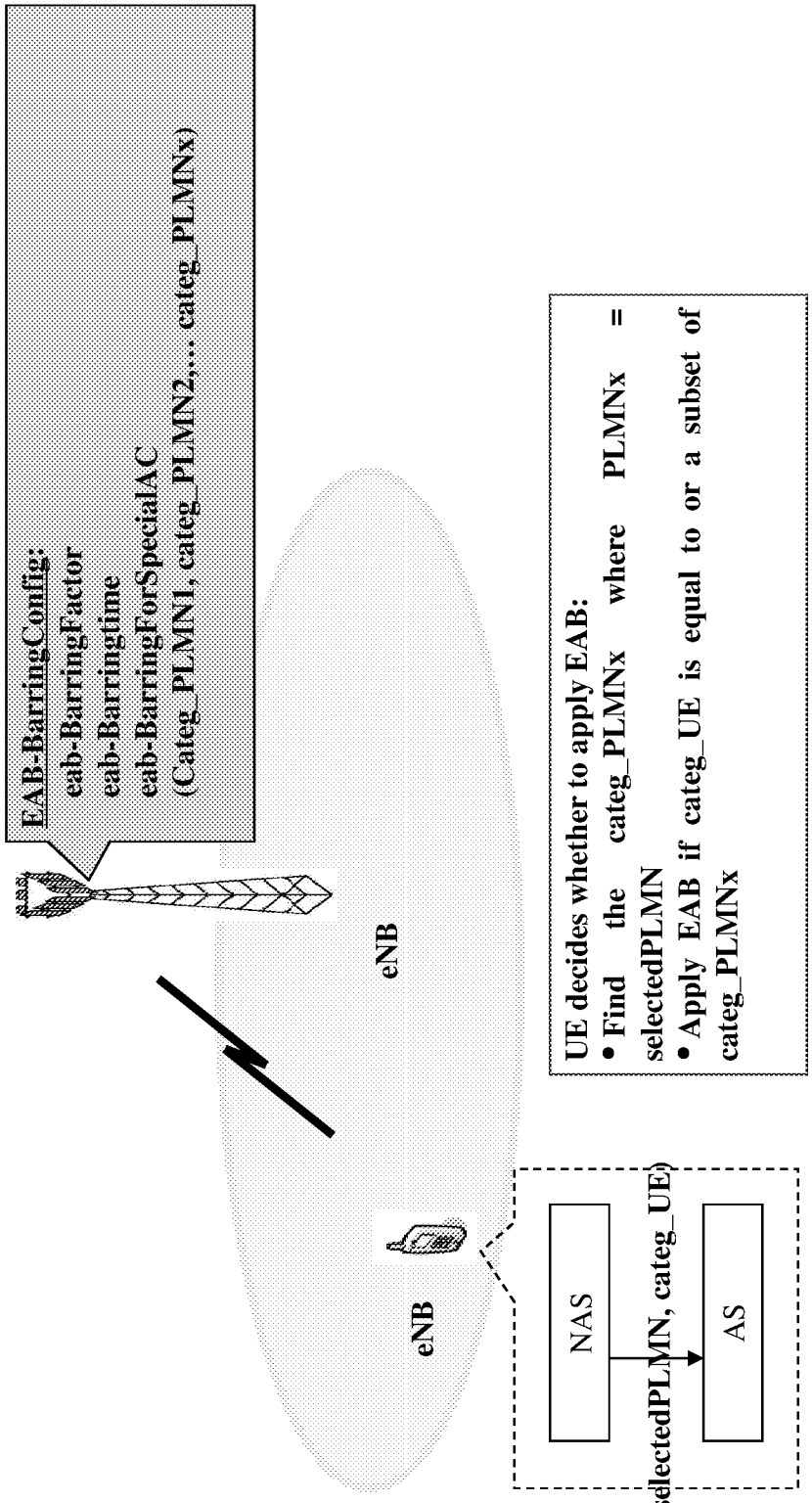

EAB-BarringConfig:
eab-BarringFactor
eab-Barringtime
eab-BarringForSpecialAC
(Categ_PLMN1, categ_PLMN2,... categ_PLMNx)
eNB
eNB
UE decides whether to apply EAB:
• Find the categ_PLMNx where PLMNx = selectedPLMN
• Apply EAB if categ_UE is equal to or a subset of categ_PLMNx
NAS
AS
(selectedPLMN, categ_UE)

Fig. 3

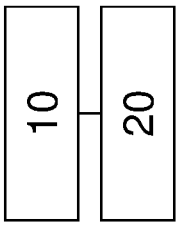


Fig. 4

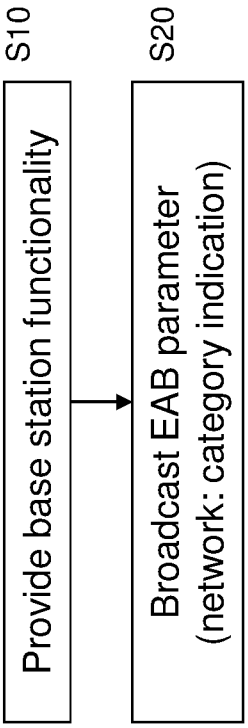


Fig. 5

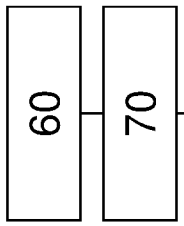


Fig. 6

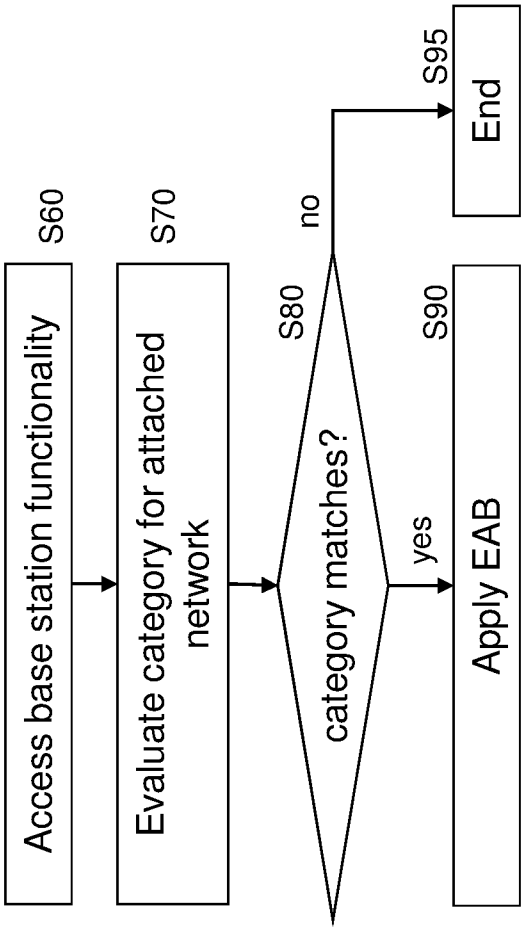


Fig. 7

```
SystemInformationBlockType1 ::=   SEQUENCE {
  cellAccessRelatedInfo             SEQUENCE {
    plmn-IdentityList                 PLMN-IdentityList,
    trackingAreaCode                  TrackingAreaCode,
    cellIdentity                    CellIdentity,
    cellBarred                      ENUMERATED {barred, notBarred},
    intraFreqReselection              ENUMERATED {allowed, notAllowed},
    csg-Indication                    BOOLEAN,
    csg-Identity                      CSG-Identity        OPTIONAL   -- Need OR
  },
  cellSelectionInfo                 SEQUENCE {

PLMN-IdentityList ::=             SEQUENCE (SIZE (1..6)) OF PLMN-IdentityInfo
PLMN-IdentityInfo ::=             SEQUENCE {
  plmn-Identity                   PLMN-Identity,
  cellReservedForOperatorUse            ENUMERATED {reserved, notReserved}
}

PLMN-Identity ::=                 SEQUENCE {
  mcc                               MCC                 OPTIONAL,          -- Cond MCC
  mnc                               MNC
}
MCC ::=                           SEQUENCE (SIZE (3)) OF
                                    MCC-MNC-Digit
MNC ::=                           SEQUENCE (SIZE (2..3)) OF
                                    MCC-MNC-Digit
MCC-MNC-Digit ::=                 INTEGER (0..9)
```

Fig. 8

```
RRCConnectionSetupComplete-r8-IEs ::= SEQUENCE {
   selectedPLMN-Identity          INTEGER (1..6),
   registeredMME                RegisteredMME                OPTIONAL,
   dedicatedInfoNAS               DedicatedInfoNAS,
   nonCriticalExtension           RRCConnectionSetupComplete-v8a0-IEs   OPTIONAL
}
```

Fig. 9

```
SystemInformationBlockType2 ::=     SEQUENCE {
   ac-BarringInfo                   SEQUENCE {
      ac-BarringForEmergency           BOOLEAN,
      ac-BarringForMO-Signalling          AC-BarringConfig             OPTIONAL,     -- Need OP
      ac-BarringForMO-Data             AC-BarringConfig            OPTIONAL  -- Need OP
   }                                                              OPTIONAL, -- Need OP

AC-BarringConfig ::=             SEQUENCE {
   ac-BarringFactor                 ENUMERATED {
                                    p00, p05, p10, p15, p20, p25, p30, p40,
                                    p50, p60, p70, p75, p80, p85, p90, p95},
   ac-BarringTime                   ENUMERATED {s4, s8, s16, s32, s64, s128, s256, s512},
   ac-BarringForSpecialAC           BIT STRING (SIZE(5))
}
```

Fig. 10

```
EAB-BarringConfig ::=
   eab-BarringFactor
                        SEQUENCE {
                        ENUMERATED {
                        p00, p05, p10, p15, p20, p25, p30, p40,
                        p50, p60, p70, p75, p80, p85, p90, p95},
      eab-BarringTime     ENUMERATED {s4, s8, s16, s32, s64, s128, s256, s512},
      eab-BarringForSpecialAC
                          BIT STRING (SIZE(5))
      eab-PLMN-List ::=
                        SEQUENCE (SIZE (1..6)) OF UE-EAB-Category
}
   UE-EAB-Category
                            ENUMERATED {categ-a, categ-b, categ-c, spare}
```

Fig. 11

Fig. 12

Fig. 13

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/063644

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W48/02
ADD.

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 practicable, search terms used)

EPO-Internal, COMPENDEX, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	ZTE ET AL: "Clarification on how EAB is applied in Shared Network", 3GPP DRAFT; S1-111376, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. SA WG1, no. Xian; 20110509, 16 May 2011 (2011-05-16), XP050515452, the whole document ----- -/--	1,2,10, 11

[X] Further documents are listed in the continuation of Box C.

[X] 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 application or patent 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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 April 2012	11/07/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Rosenauer, Hubert

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	LG ELECTRONICS INC: "Further Discussion on EAB", 3GPP DRAFT; R2-113339 EAB-R1, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG2, no. Barcelona, Spain; 20110509, 3 May 2011 (2011-05-03), XP050495447, cited in the application the whole document	1,2,10, 11
A	TELEFON AB LM ERICSSON ET AL: "Realizing Extended Access Barring", 3GPP DRAFT; GP-110973, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. TSG GERAN, no. Dallas; 20110516, 20 May 2011 (2011-05-20), XP050487387, page 3, paragraph 2.1.2 page 4, paragraph 3.2.1 page 6, paragraph 3.2.2.1 page 7, paragraph 3.3.1.1.1 - page 8, paragraph 3.3.1.4 page 12, paragraph 9.1.43m page 19, paragraph 10.5.2.37m - page 20, paragraph 10.5.2.37m	1,10
A	INTEL CORPORATION: "EAB for RAN overload protection", 3GPP DRAFT; R2-113217 MTC EACB, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG2, no. Barcelona, Spain; 20110509, 3 May 2011 (2011-05-03), XP050495384, the whole document	1,10
A	EP 1 912 461 A2 (NTT DOCOMO INC [JP]) 16 April 2008 (2008-04-16) paragraphs [0009], [0011], [0035], [0042] figures 2, 3, 4	1,10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2011/063644

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-15, 17-30(completely); 32, 33(partially)

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-15, 17-30(completely); 32, 33(partially)

   relates to apparatus, system and methods for broadcasting/ receiving EAB parameters for different networks sharing a common RAN to solve the problem of how to adapt EAB to a particular network

   ---

2. claims: 16, 31(completely); 32, 33(partially)

   relates to Mobility Management Entity, MME and corresponding method for transmitting access barring information to a base station in order to solve the problem of how to inform a base station about EAB parameters

   ---

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2011/063644

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1912461 A2	16-04-2008	AT 556552 T	15-05-2012
		CN 101163111 A	16-04-2008
		CN 101820647 A	01-09-2010
		EP 1912461 A2	16-04-2008
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		JP 4272225 B2	03-06-2009
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		KR 20080032619 A	15-04-2008
		KR 20090101874 A	29-09-2009
		US 2008130493 A1	05-06-2008
		US 2010130204 A1	27-05-2010