The present invention provides for a method of facilitating Radio Link Failure recovery for a mobile radio communications device within a mobile radio communications network and in which a connection reestablishment request is sent from the mobile radio communications device to the mobile radio network node device, and wherein device context information is included within the connection reestablishment request signal, and to a related mobile radio communications device and network node device.

Fig. 2

RRC_CONNECTED

10

40

42

12

46

50

48

52
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG). Published: — with international search report
DESCRIPTION

RADIO LINK FAILURE RECOVERY

TECHNICAL FIELD

The present invention relates to Radio Link Failure (RLF) recovery and in particular to a method of facilitating RLF recovery for a mobile radio communications device within a mobile radio communications network, and to such a device and related mobile radio communications network node device.

BACKGROUND ART

It is currently known that, when handling RLF within a mobile radio communications device User Equipment (UE) while in connected mode, that the UE will attempt to re-establish its Radio Resource Control (RRC) connection generally during the second phase of the RLF.

In the scenario in which the cell being accessed during the recovery procedure belongs to a network node device, such as an eNB, that does not have the UE context, the UE is requested to transfer to an idle state.

The subsequent attempt to recover the RRC connection is then performed by means of a Non Access Stratum (NAS) Service Request procedure.

DISCLOSURE OF THE INVENTION

It is of course possible that such a second random access procedure may also fail for reasons of signalling congestion that might have arisen
since an earlier random access attempt within the cell. A more typical scenario however arises in a situation where the UE attempts to connect to a cell having for example an eNB that does not have the UE context.

It should be appreciated that this can prove quite a common scenario since UE context transfer between eNB is generally considered to be optional and also comprises a complex procedure in a E-UTRAN/Core Network. Also, due to poor eNB implementation, such a feature may not in any case be supported. Also, it is often apparent that the UE may have changed its location in a relatively short space of time, for example when the user is travelling by fast-moving form of transportation. In such situations, the target eNB it unlikely to have received the UE context in time to be usefully employed.

Thus, with currently known RLF recovery procedures disadvantages can arise either generally through the unavailability of the UE context or through forcing the UE move into an idle state and its associated effect on service continuity and signalling overhead.

The present invention seeks to provide for a RLF recovery procedure, and related communications and network devices, having advantages over known such procedures and devices.

According to a first aspect of the present invention there is provided a method of facilitating Radio Link Failure recovery for a mobile radio communications device within a mobile radio communications network and in which connection reestablishment signalling is sent from the mobile radio communications device to a mobile radio network node device, and wherein identity information is delivered to the node device from the radio communications device in a connection reestablishment request signal.
The inclusion of the identity information with the connection reestablishment request can advantageously allow the network node device to access the device context as required and this serves to enhance the speed with which RLF recovery can be achieved. As a particularly advantage, the invention does not require transfer of the mobile radio communications device into an idle mode.

As will be appreciated from the following discussion, the invention can provide for improved service continuity subsequent to the RLF and in particular since any ongoing services are not released because the mobile radio communications device does not move into an idle mode.

It should be appreciated that the method finds particular use when facilitating RLF recovery for a mobile radio communications device in connected mode.

Indeed, the network node can comprise an eNB and the connection reestablishment signalling can comprise an RRC reestablishment request.

As an alternative, the said connection reestablishment signalling can comprise an RRC connection setup complete message. In particular, upon receipt of an RRC connection reestablishment request, the network node device can be arranged to send an RRC connection reestablishment reject signal. From this the mobile radio communications device can infer that it should wait for SRB1 configuration conveyed in to the RRC connection setup so that it can send the required identity information, for example the NAS message, within the RRC connection setup complete message. Subsequently, the network node device will then receive the mobile radio communications device context information from the core network.
Preferably, the connection reestablishment signalling contains at least one of the identity of a mobile radio communications device by a Mobile Management Entity (MME) and a selection of the MME at the network node device while RLF is ongoing.

In particular, the identity of the mobile radio communications device by the MME can comprise a short NAS Message Authentication Code - I message.

Also, the said identity can comprise UE temporary identity (S-TMSI) or the registered Core Network identity. The PLMN and/or the registered Core Network identity can be provided within the RRC connection Reestablishment Request.

Further, the selection by the network node of the MME while RLF is ongoing can be achieved by way of the PLMN identity and/or the registered Core Network identity.

Yet further, a short NAS MAC - I message can be included in initial mobile radio communications device messaging over the S1 interface and so as to allow for the MME to send the device context to the network node device.

Another alternative that is envisaged by the present invention is not to include any NAS message within the initial UE message, and thereby avoiding any implication of NAS in the radio link failure recovery procedure when the core network identity has not changed.

According to another aspect of the present invention there is provided a mobile radio communications device for operation within a mobile radio communications network and arranged for RLF recovery by way of connection reestablishment signalling to be sent to a network node, the
mobile radio communications device being arranged to include identity information within the connection reestablishment signalling so as to initiate retrieval of device context information from the core network.

It should be appreciated that the method finds particular use when facilitating RLF recovery for a mobile radio communications device in connected mode.

As noted, the connection reestablishment signalling can comprise a RRC reestablishment request.

The mobile radio communications device can be arranged such that the connection reestablishment signalling can contain at least one of the identity of a mobile radio communications device by a Mobile Management Entity (MME) and a selection of the MME at the network node device while RLF is ongoing.

As above, the identity of the mobile radio communications device by the MME can comprise a short NAS Message Authentication Code - 1 message.

The mobile radio communications device can further be arranged such that a further, short, NAS MAC - I message can be included in initial mobile radio communications device messaging over the S1 interface and so as to allow for the MME to send the device context to the network node device.

According to yet a further aspect of the present invention there is provided a mobile radio communications network node device for communication with a mobile radio communications device and associated network and arranged to receive information in combination with connection reestablishment signalling for facilitating RLF recovery, the node device
further being arranged to retrieve mobile radio communications device context data from the core network and to forward the same to the said associated network for subsequent retrieval and use in the RLF recovery.

Preferably, the said network node device comprises an eNB.

Yet further, the network node device is arranged to forward mobile radio communications device context data to a MME within the network.

From the above, and as will be illustrated further below, the invention can provide for an advantageous decrease in signalling load whilst also offering improved levels of service and, in particular, service continuity.

The invention is described further hereinafter, by way of example only, with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 comprises a signalling diagram between a network UE, eNB and MME according to the current art.

Fig. 2 comprises a similar signalling arising in relation to a RLF recovery procedure according to an embodiment of the present invention.

Fig. 3 comprises another signalling diagram relating to an RLF recovery procedure according to another embodiment of the present invention.

Fig. 4 comprises a further signalling diagram relating to yet further embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

As will be appreciated, the present invention relates to the proposal that the mobile radio communications device UE can provide its relevant
information, i.e. the UE context, to the network, for example to a node device such as an eNB, and along with the RRC connection reestablishment request. The UE context can include at least one of the PLMN identity, the UE temporary identity, such as the Temporary Mobile Subscriber Identity or indeed NAS NAC. This advantageously allows the eNB to then fetch the UE context as required and communicate this with the core network so as to facilitate RLF recovery and thereby achieve faster RRC connection resumption than can currently be achieved, and without requiring the UE to transfer to an idle mode.

As will be appreciated from the following, the present invention possesses the novelty of for example, including a short NAS MAC-I message within the RRC connection reestablishment request in order for the NME to identify the UE. Also, PLMN identity can be included within the RRC connection reestablishment request to allow the eNB to select the relevant MME while the RLF procedure is ongoing and, further, a short NAS MAC-I message can be employed in the initial UE message over the S1 interface so as to allow the MME to send the UE context to the eNB as required.

Such aspects of the present invention are illustrated and discussed further in relation to the accompanying drawings.

Turning first to Fig. 1, there is provided a signalling diagram according to a known RF recovery procedure and in scenario in which the eNB does not have the UE context.

The network signalling illustrated arises between a UE 10 such as a cell phone handset, a network node device comprising an eNB 12 and also a Mobile Management Entity (MME) 14 within the network.
With the UE 10 within its RRC connected state, and subsequent to RLF, a random access preamble 16 and is sent from the UE 10 to the eNB 12 and which initiates a response 18 from the eNB 12 to the UE 10.

In order to initiate the recovery procedure, a RRC connection reestablishment request 20 is then sent from the UE 10 to the eNB 12 and such a reestablishment request signal 20 can include the original UE identity and also integrity-check information.

However, in view of the RLF, the RRC connection reestablishment request signal 20 is rejected and this is confirmed in a rejection signal 22 which forces the UE 10 into its RRC_idle mode as indicated.

A random access preamble 24, and related response 26 is then delivered to, and received from, the eNB 12 and before transmission of a RRC connection request 28 while in the idle mode and which includes the original, UE identity and also the PLMN identity.

A RRC connection reconfiguration signal 30 can then be returned from the eNB 12 to the UE 10 and which can comprise Signalling Radio Bearer configuration information.

With the UE 10 then returned to its RRC_connected state as indicated, an uplink transfer signal 32 can be delivered to the eNB 12 and includes a NAS service request and, in response, the eNB 12 can deliver its initial UE message 34 to the MME 14 which, in turn, replies with the S1 initial context setup signal 36 received at eNB 12 and which then initiates a RRC connection reconfiguration signal 38 allowing for radio bearer configuration to be delivered to the UE 10 so as to complete the RLF recovery procedure.
Turning now however to Fig. 2, the advantageous operation of the present invention having regard to service continuity and decreased signalling overhead can be readily appreciated.

Again, in the illustrated embodiment of the present invention, signalling arising between a UE 10 eNB 12 and MME 14 is illustrated. Also, the illustration relates to a scenario in which the eNB 12 does not have RRC context for the UE 10.

Again, with the UE 10 in the RRC_connected mode as illustrated an initial random access preamble 40 is sent to the eNB 12 and initiates a random access response 42 returned to the UE 10.

Subsequent to the receipt of that response 42, the UE 10 then provides its RRC connection reestablishment request 44 to the eNB 12 which, in accordance with the invention, includes its UE context which, in addition to the original UE identity and integrity check information includes, in the illustrated embodiment, NAS MAC - 1 data and also the PLMN identity.

The provision of the UE context within the connection reestablishment request 44 can itself initiate the initial UE message 46 from the eNB 12 to the MME 14 and, as noted, without requiring the UE 12 to enter into its RRC_idle mode.

The initial UE message 40 can contain a short, NAS message for the MME 14 and allowing it to identify the UE 10. Generally, the initial UE message 46 can include a short NAS MAC - 1 message.

Subsequent to its transmission of its initial UE message 46, the eNB 12 is arranged to return a RRC connection reestablishment signal 48 to the UE 10 and which comprises signalling radio bearer configuration data.
Armed with the short NAS message serving to identify the UE 10, the MME 14 is able to signal to the eNB 12 at the appropriate initial context setup, i.e. the UE context, data 50 such that the eNB 12 can then deliver its RRC connection reconfiguration signal 52 containing the radio bearer configuration data to the UE 10 so as to achieve the required RLF recovery. As will therefore be appreciated the RRC Connection Reestablishment Request shall contain NAS MAC-I (short NAS message for the MME to identify the UE) and the PLMN identity so that the eNB can select the MME.

It should be noted that if there is a limited size for the RRC Connection Reestablishment Request, the NAS MAC-I and/or PLMN identity can be subsequently sent to the eNB in an UL Direct Transfer message. On NAS MAC-I message reception, MME shall infer a Radio Link Failure has occurred on the E-EUTRA interface and perform an S1 context setup to send the UE context to the eNB. On RRC Connection Reestablishment confirm reception, the UE shall supersede the current RRC context.

Turning now to Fig. 3 there is illustrated a signalling diagram according to a further embodiment of the present invention.

Again, signalling arising between a UE 10, eNB 12 and MME 14 is illustrated and with the UE 10 in an RRC connected state.

As will be appreciated from the discussion below, this illustrated embodiment is based upon an alternative manner of sending the NAS NAC-I information to the MME 14, and this time by way of connection re-establishment signalling comprising a RRC connection setup complete message.
Advantageously, such a message inherently allows for the delivery of a NAS message and so this as aspect of the invention can be implemented with only minimal amendments to the current RRC connection re-establishment procedure. As will further be appreciated, upon reception of the RRC connection re-establishment request, the eNB 12 serves to send a RRC connection re-establishment reject message - perhaps identifying "unknown UE context" as its cause of rejection. The UE 10 can then confirm that it has sufficient time to wait for the SRB1 configuration to be conveyed into RRC connection setup so that it can send the NAS message in the RRC connection setup completer message. Subsequently, the eNB 12 will then retrieve and receive the UE context from the MME 14 for use in the same manner as discussed in relation to the previous embodiment.

Turning therefore to Fig. 3 in greater details, there is illustrated the random access signalling comprising the preamble 54 and response 56 and the subsequent RRC connection re-establishment request 58.

The RRC connection re-establishment reject signal 16 noted above is then delivered from the eNB 12 to the UE 12 such that the UE then infers that the eNB 12 does not have the UE context. The UE 10 however does not interrupt its reestablishment outcome timer but rather waits for the SRB1 configuration to send the NAS message.

The RRC connection setup complete message 64 is then delivered from the UE 10 to the eNB 12 containing the identity information in the form of, for example, PLMN identity, or NAS MAC-1.

This then initiates the UE message 66 within the eNB 12 and which contains a NAS message from the MME 14 to identify the UE.
An initial context setup message 68 can then be delivered from the MME 14 to eNB 12 which leads to a RRC connection reconfiguration message 70 and delivered to the UE 10.

As will be appreciated, the above represents a further embodiment of the present invention permitting a faster RRC connection resumption without requiring the UE 10 to move into an "idle" state.

Turning now to Fig. 4, there is again illustrated signalling arising between a UE 10, an eNB 12 and MME 14.

A random access preamble signal 72 is again delivered from the UE 10 to the eNB 12 and which serves to initiate a random access response 74. The RRC connection reestablishment request 76 is then delivered from the UE 10 to the eNB 12 and the eNB 12 employs the PLMN identity and registered MME to select the core network entity. However, if the MME cannot be selected since, for example, the MME 14 is unknown to the eNB 12, the eNB 12 is arranged to reject the RRC connection reestablishment request from the UE 10.

Upon receipt of an initial UE message 78 from the eNB 12, the MME 14 is arranged to release the S1 connection with the previous eNB (if in existence) and to then setup a S1 connection with the new eNB. Subsequent to this, a RRC connection reestablishment signal 80 is delivered from the eNB 12 to the UE 10 and initial context setup signalling 82 is delivered from the MME 14 to the eNB 12.

As will therefore be appreciated, the signalling diagram Fig. 4 illustrates a further procedure for avoiding the implication of the NAS protocol, this time through the inclusion of the PLMN identity and the registered core network identity within the RRC connection reestablishment
request message. The target eNB can then select the previous core network entity to which the UE is connected prior to the radio link failure. Accordingly, the eNB transfer of the UE identity to the MME serves to allow the eNB to retrieve the UE context. Should, however, a scenario arise in which the eNB is unable to select the indicated MME, the eNB can move the UE to its idle state as required.

The invention therefore proves advantageous insofar as, upon radio failure, and improve speed of RRC connection assumption for service continuity can be achieved whilst also incurring reduced signalling loads over the E-TRAN interface and reduce signalling overhead over the S1 interface.

This application is based upon and claims the benefit of priority from three British Patent Applications No. GB0724316.5 filed in United Kingdom Patent Office on December 13, 2007 and No. GB0805227.6 filed in United Kingdom Patent Office on March 20, 2008 and No. GB0820037.0 filed in United Kingdom Patent Office on November 03, 2008, the contents of which are hereby incorporated by references.

While exemplary embodiments of the present invention have been described using specific terms, such description is for illustrative purposes only, and it is to be understood that changes and variations may be made without departing from the spirit or scope of the following claims.
CLAIMS

1. A method of facilitating Radio Link Failure recovery for a mobile radio communications device within a mobile radio communications network and in which connection reestablishment signalling is sent from the mobile radio communications device to a mobile radio network node device, and identity information is delivered to the node device from the mobile radio communication device in the connection reestablishment signalling as to initiate retrieval of device context information from the core network.

2. A method as claimed in Claim 1 and for facilitating RLF recovery for a mobile radio communications device in connected mode.

3. A method as claimed in Claim 1 or 2 and wherein the network node comprises an eNB.

4. A method as claimed in Claim 1, 2 or 3 and wherein the connection reestablishment signalling comprises an RRC reestablishment request.

5. A method as claimed in Claim 1, 2 or 3, wherein the said connection reestablishment signalling comprises an RRC connection setup complete message.

6. A method as claimed in Claim 5 and including the step of sending an RRC connection reestablishment reject signal from the network node device in response to receipt of an RRC connection reestablishment request.
7. A method as claimed in any one or more of the preceding claims wherein the connection reestablishment signalling contains at least one of the identity of a mobile radio communications device by a Mobile Management Entity (MME), the registered Core Network identity, and a selection of the MME at the network node device while RLF is ongoing.

8. A method as claimed in any one or more of Claims 1 to 7 and employing an NAS message.

9. A method as claimed in Claim 8 wherein the identity of the mobile radio communications device by the MME comprises a short NAS Message Authentication Code - 1message.

10. A method as claimed in Claim 7, 8 or 9, wherein the selection of the MME while RLF is ongoing is achieved by way of the PLMN identity and/or the registered Core Network identity.

11. A method as claimed in Claim 9 and 10 wherein one of the NAS MAC - 1 and the PLMN identity is sent subsequent to the other.

12. A method as claimed in any one or more of Claims 1 to 11 wherein a further short NAS MAC - 1 message is included in initial mobile radio communications device messaging over a S1 interface and so as to allow for the MME to send the device context to the network node device.
13. A mobile radio communications device for operation within a mobile radio communications network and arranged for RLF recovery by way of a connection reestablishment signalling to be sent to a network node, the mobile radio communications device being arranged to include identity information within the connection reestablishment signalling so as to initiate retrieval of the device context information for the core network.

14. A device as claimed in Claim 13 and arranged for RLF recovery while in connected mode.

15. A device as claimed in Claim 13 or 14 wherein the connection reestablishment request comprises a RRC reestablishment request.

16. A mobile radio communication device as claimed in Claim 13 and 14, and arranged such that the said connection reestablishment signalling comprises an RRC connection setup complete message.

17. A mobile radio communications device as claimed in Claim 16 and arranged to send an RRC connection reestablishment request signal for initiating an RRC connection reestablishment reject signal at the network node device.

18. A device as claimed in Claim 13, 14 or 15 and arranged such that the connection reestablishment signalling contains at least one of the identity of a mobile radio communications device by a Mobile Management Entity.
(MME), the registered Core Network identity, and a selection of the MME at the network node device while RLF is ongoing.

19. A device as claimed in Claim 18, and arranged such that the identity of the mobile radio communications device by the MME comprises a short NAS Message Authentication Code - I message.

20. A device as claimed in Claim 18 or 19 and arranged such that the selection of the MME at the network node is achieved by way of PLMN identity, and/or the registered Core Network identity.

21. A device as claimed in any one of Claims 18, 19 or 20 and arranged such that a further short NAS MAC - I message is included in initial mobile radio communications device messaging over a S1 interface and so as to allow for the MME to send the device context to the network node device.

22. A mobile radio communications network node device for communication with a mobile radio communications device and associated network and arranged to receive identity information in combination with connection reestablishment signalling for facilitating RLF recovery, the node device further being arranged to retrieve mobile radio communications device context data from the core network and to forward the same to the associated network for subsequent retrieval and use in the RLF recovery.

23. A network node device as claimed in Claim 22 and comprising an eNB.
24. A network node device as claimed in Claim 23 and arranged to forward mobile radio communications device context data to a MME within the network.

25. A mobile radio communications network node device as claimed in Claim 22, 23 or 24, and arranged to send an RRC connection reestablishment reject signal in response to an RRC connection reestablishment request signal from the mobile radio communications device.
Fig. 1
Fig. 3
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H04W76/02 (2009.01) i, H04W88/12 (2009.01)i

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)

Int.Cl. H04W76/02, H04W88/12

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)

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>A</td>
<td>Nokia Siemens Networks et al, Radio Link Failure Recovery, 3GPP TSG-RAN WG2 Meeting #58, R2-072382, 2007.06, p.2</td>
<td>1-25</td>
</tr>
<tr>
<td>A</td>
<td>Huawei, Multiple preparations of eNBs, 3GPP TSG RAN WG3 Meeting #57bis, R3-071943, 2007.10, pp. 4-6</td>
<td>1-25</td>
</tr>
<tr>
<td>T</td>
<td>NEC, Radio Link Failure recovery on non prepared eNB, 3GPP TSG-RAN WG2 #61, R2-081170, 2008.02, whole document</td>
<td>1-25</td>
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</tbody>
</table>

Γ" Further documents are listed in the continuation of Box C.  Γ” 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)

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"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

"G" document member of the same patent family

Date of the actual completion of the international search

05.01.2009

Date of mailing of the international search report

13.01.2009

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