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(54) Title: CONNECTION RELEASE FOR DUAL CONNECTION

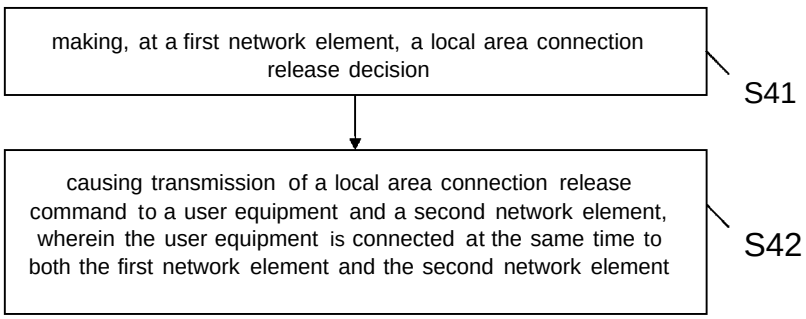


Fig. 4

(57) Abstract: The present disclosure relates to methods, apparatuses and a computer program product for connection release for dual connection. The present disclosure includes making, at a first network element, a local area connection release decision, and causing transmission of a local area connection release command to a user equipment and a second network element, wherein the user equipment is connected at the same time to both the first network element and the second network element.

CONNECTION RELEASE FOR DUAL CONNECTION

Technical field

The present disclosure relates to connection release for dual connection, and relates to methods, apparatuses and a computer program product for connection release for dual connection.

Background

Due to the recent booming of the wireless internet, it is easily expected that the requirement for wireless data service will keep on fast soaring in the near future. Among those advanced technologies proposed to meet the challenging request, reducing the cell size is one of the most prominent one. In the past 50 years, the wireless network capacity has been increased by more than 2700 times from smaller cells. Therefore, the local area (LA) network will inevitably become the next research hotspot in LTE evolution.

Dual connection is a new emerged concept for LA network. The basic idea is to let UE connect to macro eNB (MeNB) and Local Area eNB (LAeNB) simultaneously, so that macro eNB can control the mobility of the UE to avoid too many handover procedures/signalling when UE moving among different LA cells. On the other hand, macro eNB can offload most of data transmission to LA cell so that UE can enjoy the high data rate in LA cell and very low transmission power due to small distance. This concept is also called inter-eNB carrier aggregation (CA), user-control plane (U-C plane) split, multi-stream etc., and proposed by many companies during Rel-12 workshops (cf. documents [1], [2], and [3]). Dual connection concept is a promising concept in Rel-12, and is expected to have hot discussion in LA study of 3GPP Rel-12 phase.

As aforementioned, dual connection is a promising way forward for LA network. When UE connects to macro eNB and LA eNB simultaneously, macro eNB can

control the UE's mobility to avoid too many handover procedures and potential radio link failure from LA connection. At the same time, UE can enjoy the high data rate and low transmission power in LA cell. When the dual connection is setup for UE, it is necessary to also consider how to release the dual connection in the current stage and it is not clear how. For example, when a UE is connected to macro eNB and LA cell simultaneously, dual connection release may happen when e.g. dual connection is no longer suitable for high mobility UEs, or UE will move out of the coverage of LA cell etc.

The assumption for dual connection is that there is hard split for radio bearers of macro eNB and LA eNB, i.e. some radio bearer (RB) will be handled by macro eNB while some will be handled by LA eNB. The most important part of the LA connection release is how to handle the Radio Bearers (RBs) that are originally processed in LA cell. After LA connection release, LA RBs need to be reconfigured and continued via macro cell. Besides, it needs to determine which node controls the release procedure, so that signaling is sent or received from which node can be determined.

In current specification, there is Radio Resource Control (RRC) connection release procedure and RRC connection reestablishment procedure, wherein both procedure can do the connection release. However, such procedures have some limitations for the dual connection release specific problems e.g.

- They did not define the connection release command can be sent to UE from another network node;
- Did not handle the coordination between LAeNBs and MeNBs;
- Did not define the procedure how LAeNB and UE are handling the released RBs other than release them ;
- Did not define the procedure how LAeNB and UE finish the DL data arrived in LAeNB.

So if it is followed the similar procedure in current specification, when dual connection is released, UE's RBs in LA cell will be released and these RBs need to be reestablished by MeNB in macro cell. This needs a lot of signaling between

MeNB and UE, and during this procedure UE's service originally transmitted in LA cell will be interrupted or even dropped.

In current specification, there is a RRC connection release procedure, as defined in document [4]. The summarized procedure is as following and more details could be found in the document [4].

- The eNB sends the release command to UE
- UE releases the RRC connection to eNB
- Apply cell reselection
- Or leaving RRC connected mode

In current specification, another procedure that can release the connection is the RRC connection reestablishment procedure, as described in document [4]. The procedure can be summarized as shown in Fig. 1.

During the procedure, RBs will be suspended, Packet Data Convergence Protocol (PDCP) / Radio Link Control (RLC) is reestablish and resumed. However, such procedure still cannot handle the dual connection case, in which RBs need to be released in LA cell and resumed in macro cell. Besides, some procedure e.g. cell selection in reestablishment procedure is not necessary for dual connection release, and network nodes to control the procedure need to be determined, as well as the data transfer between LA eNB and MeNB and communication with Mobility Management Entity (MME) and Service Gateway (SGW).

In view of the above, the present disclosure has been made in order to solve the above problems.

References:

[1] 3GPP RWS-120003, Views on Rel-12, Ericsson & ST-Ericsson, June 1, 2012;

[2] 3GPP RWS-120006, Views on Rel-12 and onwards for LTE and UMTS, Huawei Technologies, HiSilicon, June 11, 2012;

[3] 3GPP RWS-120010, Requirements, Candidate Solutions & Technology Roadmap for LTE Rel-12 Onward, NTT DOCOMO, INC., June 11, 2012;

[4] 3GPP TS36.33 1, V11.3.0, Radio Resource Control (RRC) protocol specification, March 15, 2013.

Summary

According to example versions of the present disclosure, there are provided methods, apparatuses and a computer program product for connection release for dual connection.

Various example versions of the present disclosure are set out in the appended claims.

According to an example version of the present disclosure, there is provided a method comprising:

making, at a first network element, a local area connection release decision, and

causing transmission of a local area connection release command to a user equipment and a second network element, wherein the user equipment is connected at the same time to both the first network element and the second network element.

According to another example version of the present disclosure, there is provided a method comprising:

receiving, at a user equipment, which is connected to a macro base station and a local area base station at the same time and performs data transmission with the local area base station, a local area connection release command,

continuing data transmission with the local area base station until receiving an indication for end of the data transmission from the local area base station.

According to another example version of the present disclosure, there is provided a method comprising:

receiving, at a local area base station performing data transmission with a user equipment , a connection release command from a macro base station,

continuing data transmission with the user equipment after receiving the connection release command from the macro base station, and

causing transmission of an indication for end of data transmission to the user equipment.

According to another example version of the present disclosure, there is provided an apparatus for use in a first network element, the apparatus comprising:

at least one processor,

and at least one memory including computer program code,

the at least one memory and the computer program code arranged to, with the at least one processor, cause the apparatus at least to perform :

making a local area connection release decision, and

causing transmission of a local area connection release command to a user equipment and a second network element, wherein the user equipment is connected at the same time to both the first network element and the second network element.

According to another example version of the present disclosure, there is provided an apparatus for use in a user equipment, comprising:

at least one processor,

and at least one memory including computer program code,

the at least one memory and the computer program code arranged to, with the at least one processor, cause the apparatus at least to perform :

receiving, at the user equipment, which is connected to a macro base station and a local area base station at the same time and performs data transmission with the local area base station, a local area connection release command,

continuing data transmission with the local area base station until receiving an indication for end of the data transmission from the local area base station.

According to another example version of the present disclosure, there is provided an apparatus for use in a local area base station, comprising:

at least one processor,

and at least one memory including computer program code,

the at least one memory and the computer program code arranged to, with the at least one processor, cause the apparatus at least to perform :

receiving, at the local area base station performing data transmission with a user equipment , a connection release command from a macro base station,

continuing data transmission with the user equipment after receiving the connection release command from the macro base station, and

causing transmission of an indication for end of data transmission to the user equipment.

According to another example version of the present disclosure, there is provided an apparatus for use in a first network element, comprising:

means for making, at the first network element, a local area connection release decision, and

means for causing transmission of a local area connection release command to a user equipment and a second network element, wherein the user equipment is connected at the same time to both the first network element and the second network element.

According to another example version of the present disclosure, there is provided an apparatus for use in a user equipment, comprising:

means for receiving, at the user equipment, which is connected to a macro base station and a local area base station at the same time and performs data transmission with the local area base station, a local area connection release command,

means for continuing data transmission with the local area base station until receiving an indication for end of the data transmission from the local area base station.

According to another example version of the present disclosure, there is provided an apparatus for use in a local area base station, comprising:

means for receiving, at the local area base station performing data transmission with a user equipment, a connection release command from a macro base station,

means for continuing data transmission with the user equipment after receiving the connection release command from the macro base station, and

means for causing transmission of an indication for end of data transmission to the user equipment.

According to another example version of the present disclosure, there is provided a computer program product comprising computer-executable computer program code which, when the program is run on a computer (e.g. a computer of an apparatus according to any one of the aforementioned apparatus-related example versions of the present disclosure), is arranged to cause the computer to carry out the method according to any one of the aforementioned method-related example versions of the present disclosure.

Such computer program product may comprise or be embodied as a (tangible) computer-readable (storage) medium or the like on which the computer-executable computer program code is stored, and/or the program may be directly loadable into an internal memory of the computer or a processor thereof.

Advantageous further developments or modifications of the aforementioned example versions of the present disclosure are set out in the dependent claims.

Brief Description of the Drawings

For a more complete understanding of example versions of the present disclosure, reference is now made to the following description taken in connection with the accompanying drawings in which :

Fig. 1 is a signaling diagram illustrating a RRC connection reestablishment procedure;

Fig. 2 is an overview illustrating a scenario to which certain versions of the present disclosure are applicable;

Fig. 3 is a signaling diagram illustrating an example of a method according to certain versions of the present disclosure;

Fig. 4 is a flowchart illustrating an example of a method according to certain versions of the present disclosure;

Fig. 5 is a flowchart illustrating another example of a method according to certain versions of the present disclosure;

Fig. 6 is a flowchart illustrating still another example of a method according to certain versions of the present disclosure;

Fig. 7 is a block diagram illustrating an example of an apparatus according to certain versions of the present disclosure.

Description of example version

Example versions of the present disclosure will be described herein below. More specifically, example versions of the present disclosure are described hereinafter with reference to particular non-limiting examples and to what are presently considered to be conceivable versions of the present disclosure. A person skilled in the art will appreciate that the disclosure is by no means limited to these examples, and may be more broadly applied.

It is to be noted that the following description of the present disclosure and its versions mainly refers to specifications being used as non-limiting examples for certain example network configurations and deployments. Namely, the present disclosure and its versions are mainly described in relation to 3GPP specifications being used as non-limiting examples for certain example network configurations and deployments. In particular, a LTE/LTE-Advanced communication system and a (W)LAN system are used as a non-limiting example for the applicability of thus described example versions. As such, the description of example versions given herein specifically refers to terminology which is directly related thereto. Such terminology is only used in the context of the presented non-limiting examples,

and does naturally not limit the disclosure in any way. Rather, any other network configuration or system deployment, etc. may also be utilized as long as compliant with the features described herein. That is, the present disclosure is applicable to any other cellular wide-area communication systems and wireless local-area communication systems.

The present disclosure considers the connection release procedure and details for dual connection for UEs and eNBs capable of Rel-12 and/or future releases.

According to certain versions of the present disclosure, there is defined a new procedure to release LA connection for dual connection for future LTE network, and there are also defined UE behavior on handling radio bearers upon LA connection release, and related network (NW) side actions.

Fig. 2 shows a scenario to which certain versions of the present disclosure are applicable. As shown in Fig. 2, such a scenario includes at least one macro eNB and at least one LAeNB, here one MeNB 11 and two LAeNBs 12 and 13 are shown. It is noted that the number of MeNBs and LAeNBs shown in Fig. 2 are merely an example and that the number of MeNBs and LAeNBs is not particularly limited. The LAeNBs 12 and 13 and the MeNB 11 are connected via a backhaul connection, like e.g. an X2 or new backhaul interface. Further, there is shown a user equipment UE 14 which has a dual connection to the MeNB and the LAeNB 13 in this specific example. It is obvious that there may be more than one UE and that the UE may be connected to any one of the LAeNBs.

For explanation of the certain versions of the present disclosure, the following assumptions are made:

- the traffic split is above the PDCP layer, and each cell has its own security;
- LA cell has RRC layer and functionality;
- UE has dual connection with MeNB and LA cell, i.e. one connection with MeNB and one connection with LA cell;
- there is a backhaul connection between LAeNB and MeNB, for example via X2 or new backhaul interface.

According to certain versions of the present disclosure, the LA connection release procedure may be controlled by MeNB. In such a case,

- LA cells that have backhaul connection with MeNB will be controlled;
- Possible measurement procedure that support LA connection release is configured by MeNB, and measurement report from UE is sent to MeNB;
- LA connection release decision is made in MeNB;
- MeNB sends the LA connection release command to both UE and LAeNB.

Further, the LAeNB/SGW may send traffic status indication to MeNB to indicate e.g. that the traffic on LA RBs comes to end, to help MeNB decision on LA connection release. Such indication is sent via backhaul connection between LAeNB and MeNB, and such indication may be periodic or event triggered.

As an alternative, according to certain versions of the present disclosure, the LA connection release procedure may also be controlled by LAeNB, In this case

- Possible measurement procedure that supports LA connection release is configured by LAeNB, and measurement report from UE is sent to LAeNB;
- LA connection release decision is made in LAeNB;
- LAeNB sends the LA connection release command to both UE and MeNB.

Further, the LA connection release command could include the information e.g. EPS bearer ID, radio bearer ID, the indication of bearer release, the indication of bearer suspension, radio bearer/radio resource configuration etc. Such a release command may be a new message, an IE included in RRC connection re-establishment message or an IE included in handover message.

Moreover, when UE received LA connection release command (either from the LAeNB or the MeNB, as described above) , the UE behavior may be defined as follows:

- When UE received LA connection release command, both UE and LAeNB may not release the LA connection, but continue the data transmission on LA RBs until LAeNB send UE the indication for data ending;

- This procedure could be configured to be enabled or disabled.

- LA RB handling: After LA connection is released, RBs originally in LA cell may be automatically setup by both UE and eNB in macro cell, with using the same configuration as in LA cell. For another example alternative, MeNB may setup backup bearers for LA RBs in macro cell beforehand and pending these backup RBs before LA connection release; and after LA connection is released, the UE and MeNB may continue the transmission on backup bearers.

When UE has performed the LA connection release, UE will send the message to the MeNB irrespective of whether the LA connection release procedure is controlled by MeNB or LAeNB.

The message may be either the LA connection complete message to indicate the LA connection release procedure is complete, or the integrated indication to indicate that the UE is back to single connection mode from dual connection mode.

Further, such a message may contain the information of the reason of back to single connection mode, moved RB information e.g. which RB is moved from LA cell to Macro cell etc.

In the following, an example of an implementation of the above described certain versions will be described from a whole LA connection release procedure point of view with reference to Fig. 3.

In Fig. 3, a case is assumed where the MeNB controls the LA connection release procedure, as defined above. However, in a case where the LA connection release procedure would be controlled by the LAeNB, as described in the above alternative, corresponding signaling will be started / ended at the LAeNB. As shown in Fig. 3, the whole LA connection release procedure may be as follows:

It is noted that in Fig. 3, the solid lines indicate layer 3 signaling except for the step "UL allocation" within step S1, which is layer 1/layer 2 signaling. Further, the broken lines in Fig. 3 indicate transmission of user data.

As indicated by the broken lines between the UE and the LAeNB, Fig. 3 relates to a case where packet data for DRBs in LA cell are transmitted between the UE and the LAeNB.

In a step S1, possible measurement to support LA connection release is configured by MeNB, and the measurement report will be sent to MeNB.

In step S2, the LA eNB may send traffic status indication to MeNB to indicate e.g. that the traffic on LA RBs ends, to help the MeNB to make the decision on LA connection release.

Further, in a step S2, the MeNB makes the LA connection release decision for dual connection according to the input e.g. measurement results, traffic status etc.

Then, in a step S3, the MeNB will send LA connection release command to both the UE and the LAeNB. The LA connection release command could include the information e.g. EPS bearer ID, radio bearer ID, the indication of bearer release, the indication of bearer suspend, radio bearer/radio resource configuration etc.

Then, steps S5 and S6 relate to the data transfer procedure.

For example, the LAeNB may send SN status and transfer data to MeNB via e.g. X2 or new backhaul interface (choice 1 in Fig. 3). As an alternative, LAeNB may continue to send the data to UE until the data ends (choice 2 in Fig. 3).

That is, when UE receives the LA connection release command, it may do the following actions.

According to an example choice 2 in Fig. 3, the UE finishes the data transmission on corresponding RBs via LA cell or macro cell. Before the UE releases the LA connection, LAeNB and UE should finish the data that already arrives in LAeNB so that these data do not need to be forwarded to MeNB. For example, when the UE received the LA connection release command, both UE and LAeNB do not release the LA connection, but continue the data transmission on LA RBs until the LAeNB sends the indication for data ending to the UE.

Such a procedure could be configured to be enabled or disabled.

According to an example choice 1 in Fig. 3, the UE suspends/releases the corresponding RBs that are indicated in LA connection release command and updates security parameters for corresponding RBs that are indicated in LA connection release command, by using MeNB security parameters.

Then, the UE applies the radio bearer/radio resource configuration that is indicated in LA connection release command and resumes packet transmission/reception of corresponding RBs that are indicated in LA connection release command in macro cell.

This example procedure mainly relates to LA RB handling: Originally in single connection case, when connection is released, corresponding RB will be also released. But here for dual connection, when LA connection is released, LA RBs may be automatically setup by both UE and eNB in macro cell, with using the same configuration as in LA cell. The non-limiting advantage here is to avoid the signaling procedure and delays to setup these RBs in macro cell, at meanwhile keep the continuous transmission for corresponding service that on LA RBs and minimize the interruption time for corresponding service during LA connection release. For another example alternative, MeNB may setup backup bearers for LA RBs in macro cell beforehand and pending these backup RBs before AL connection release; after LA connection is released, the UE and MeNB may continue the transmission on backup bearers.

Then, the UE may send a LA connection release complete message to MeNB.

One message is needed for the release command to indicate to the MeNB when the UE is done for LA connection release, so that the corresponding LA RBs and services may be continued in the macro cell to avoid the long service interruptions or even service drop. Further, the content of the message is defined so as to be not restricted to only contain complete indication, but also the RB information that continues in macro cell, and also the message is a flag for the UE mode transition, i.e. from dual connection mode to single connection mode.

Then, in a step S7, the MeNB and LAeNB may communicate with MME and SGW about the connection release in LA cell.

Finally, as indicated by the broken lines between the UE and the MeNB, packet data for DRBs in LA cell are transmitted between the UE and the MeNB.

In view of the above, the present disclosure according to certain versions as described above achieves the following example advantages.

There is created the procedure for LA connection release considering the dual connection scenario in LA network.

The example procedure according to certain example versions of the present disclosure is simplified and minimizes the corresponding signaling exchange.

Further, according to certain example versions of the present disclosure, the release command may be flexibly determined and transmitted by MeNB. Since MeNB may have the information for all LA cells and MeNB may be the mobility anchor for UE, letting the MeNB control the LA connection release could minimize the service interruption for the UEs that are carried on LA cells.

Moreover, RB reestablishment procedure in macro cell may be simplified and optimized, so that service that is originally carried on LA cell will minimize the interruption and avoid service drop during the dual connection release procedure.

Fig. 4 shows a principle flowchart of an example for a method according to certain versions of the present disclosure. That is, as shown in Fig. 4, this method for use in a first network element comprises making, at a first network element, a local area connection release decision in a step S41, and causing transmission of a local area connection release command to a user equipment and a second network element, wherein the user equipment is connected at the same time to both the first network element and the second network element in a step S42.

According to certain versions of the present disclosure, the method further comprises configuring a measurement procedure that supports in making the local area connection release decision, and causing transmission of the configured measurement procedure to the user equipment.

According to certain versions of the present disclosure, the method further comprises receiving, at the first network element, a measurement report from the user equipment according to the configured measurement procedure, wherein the measurement report is taken into consideration when making the local area connection release decision.

According to certain versions of the present disclosure, the local area connection release command includes at least one of information on evolved packet system bearer identification, radio bearer identification, indication of bearer release, indication of bearer suspension, radio bearer configuration and radio resource configuration.

According to certain versions of the present disclosure, the local area connection release command is a separate message, an information element included in a radio resource control connection re-establishment message or an information element included in a handover message.

According to certain versions of the present disclosure, the first network element is a macro base station and the second network element is a local area base station and the user equipment communicates with the local are base station.

According to certain versions of the present disclosure, the method further comprises receiving, at the macro base station, traffic status indication from the local area base station.

According to certain versions of the present disclosure, the traffic status indication indicates that traffic on local area bearers comes to an end.

According to certain versions of the present disclosure, the traffic status indication is sent via a backhaul connection between the macro base station and the local area base station.

According to certain versions of the present disclosure, the traffic status indication is sent in a periodic manner or triggered by a predetermined event.

According to certain versions of the present disclosure, the method further comprises setting up, by the macro base station, a radio bearer, and after the connection between the user equipment and the local area base station is released, continuing data transmission with the user equipment on the bearer.

According to certain versions of the present disclosure, the method further comprises setting up, by the macro base station, a backup bearer, and after the connection between the user equipment and the local area base station is released, continuing data transmission with the user equipment on the backup bearer.

According to certain versions of the present disclosure, the first network element is a local area base station and the second network element is a macro base station and the user equipment communicates with the local are base station.

According to certain versions of the present disclosure, the method further comprises continuing the communication with user equipment, and causing transmission of an indication for end of data transmission to the user equipment.

Fig. 5 shows a principle flowchart of an example for a method according to certain versions of the present disclosure. That is, as shown in Fig. 5, this method for use in a user equipment comprises receiving, at a user equipment, which is connected to a macro base station and a local area base station at the same time and performs data transmission with the local area base station, a local area connection release command in a step S51, and continuing data transmission with the local area base station until receiving an indication for end of the data transmission from the local area base station in a step S52.

According to certain versions of the present disclosure, the method further comprises performing a local area connection release, causing transmission of a message indicating completion of the local area connection release to the macro base station, and continuing data transmission with the macro base station on a bearer setup by the macro base station.

According to certain versions of the present disclosure, the message further indicates that the user equipment has switched from a dual connection mode to a single connection mode.

According to certain versions of the present disclosure, the message further includes information indicating at least one of the reason for switching from the dual connection mode to the single connection mode and the radio bearers moved from local area cell to macro cell.

Fig. 6 shows a principle flowchart of another example for a method according to certain versions of the present disclosure. That is, as shown in Fig. 6, this method for use in a local area base station comprises receiving, at the local area base station performing data transmission with a user equipment, a connection release command from a macro base station in a step S61, continuing data transmission with the user equipment after receiving the connection release command from the macro base station in a step S62, and causing transmission of an indication for end of data transmission to the user equipment in a step S63.

According to certain versions of the present disclosure, the method further comprises causing transmission of traffic status indication to the macro base station.

According to certain versions of the present disclosure, the traffic status indication indicates that traffic on local area bearers comes to an end.

According to certain versions of the present disclosure, the traffic status indication is sent via a backhaul connection between the macro base station and the local area base station.

According to certain versions of the present disclosure, the traffic status indication is sent in a periodic manner or triggered by a predetermined event.

Fig. 7 is a block diagram illustrating an example of an apparatus according to certain versions of the present disclosure. The apparatus 70 comprises at least one processor 71 and at least one memory 72 including computer program code, which are connected by a bus 74 or the like. As indicated with a dashed line in Fig. 7, an interface 73 may optionally be connected to the bus 74 or the like, which may enable communication e.g. to/from another base station, user equipment, other network entity, or the like.

According to certain versions of the present disclosure, the apparatus may be part of a first network element or may be implemented in the first network element, and the at least one memory and the computer program code are arranged to, with the at least one processor, cause the apparatus at least to perform making a local area connection release decision, and causing transmission of a local area connection release command to a user equipment and a second network element, wherein the user equipment is connected at the same time to both the first network element and the second network element.

According to certain versions of the present disclosure, the apparatus may be part of a user equipment or may be implemented in the user equipment, and the at least one memory and the computer program code are arranged to, with the

at least one processor, cause the apparatus at least to perform receiving, at the user equipment, which is connected to a macro base station and a local area base station at the same time and performs data transmission with the local area base station, a local area connection release command, and continuing data transmission with the local area base station until receiving an indication for end of the data transmission from the local area base station.

One option for implementing this example for an apparatus according to certain versions of the present disclosure would be a component in a handset such as user equipment UE according to 3G or LTE/LTE-A. For example, the user equipment may be a mobile phone, a personal digital assistant (PDA), a laptop computer, a tablet computer, or the like.

According to certain versions of the present disclosure, the apparatus may be part of a local area base station or may be implemented in the local area base station, and the at least one memory and the computer program code are arranged to, with the at least one processor, cause the apparatus at least to perform receiving, at the local area base station performing data transmission with a user equipment, a connection release command from a macro base station, continuing data transmission with the user equipment after receiving the connection release command from the macro base station, and causing transmission of an indication for end of data transmission to the user equipment.

For further functions of the apparatus according to further example version of the present disclosure, reference is made to the above description of methods according to example versions of the present disclosure, as described in connection with Figs. 4 to 6.

In the foregoing example description of the apparatus implemented in e.g. the user equipment, network elements or base stations (or part of the user equipment, network elements or base stations), only the units that are relevant for understanding the principles of the disclosure have been described using functional blocks. The apparatuses may comprise further units that are necessary for its respective operation as user equipment, network element or base station,

respectively. However, a description of these units is omitted in this specification. The arrangement of the functional blocks of the apparatuses is not construed to limit the disclosure, and the functions may be performed by one block or further split into sub-blocks. Further, the apparatuses, i.e. the user equipment, network elements or base station, may be connected via a link 45. The link 45 may be a physical and/or logical coupling, which is implementation-independent (e.g. wired or wireless).

According to example versions of the present disclosure, a system may comprise any conceivable combination of the thus depicted devices/ apparatuses and other network elements, which are arranged to cooperate as described above.

In general, it is to be noted that respective functional blocks or elements according to above-described versions may be implemented by any known means, either in hardware and/or software, respectively, if it is only adapted to perform the described functions of the respective parts. The mentioned method steps may be realized in individual functional blocks or by individual devices, or one or more of the method steps may be realized in a single functional block or by a single device.

Generally, any procedural step or functionality is suitable to be implemented as software or by hardware without changing the idea of the present disclosure. Such software may be software code independent and may be specified using any known or future developed programming language, such as e.g. Java, C++, C, and Assembler, as long as the functionality defined by the method steps is preserved. Such hardware may be hardware type independent and may be implemented using any known or future developed hardware technology or any hybrids of these, such as MOS (Metal Oxide Semiconductor), CMOS (Complementary MOS), BiMOS (Bipolar MOS), BiCMOS (Bipolar CMOS), ECL (Emitter Coupled Logic), TTL (Transistor-Transistor Logic), etc., using for example ASIC (Application Specific IC (Integrated Circuit)) components, FPGA (Field-programmable Gate Arrays) components, CPLD (Complex Programmable Logic Device) components or DSP (Digital Signal Processor) components. A device/ apparatus may be represented by a semiconductor chip, a chipset,

system in package (SIP), or a (hardware) module comprising such chip or chipset; this, however, does not exclude the possibility that a functionality of a device/ apparatus or module, instead of being hardware implemented, be implemented as software in a (software) module such as a computer program or a computer program product comprising executable software code portions for execution/being run on a processor. A device may be regarded as a device/ apparatus or as an assembly of more than one device/ apparatus, whether functionally in cooperation with each other or functionally independently of each other but in a same device housing, for example.

Apparatuses and/or means or parts thereof may be implemented as individual devices, but this does not exclude that they may be implemented in a distributed fashion throughout the system, as long as the functionality of the device is preserved. Such and similar principles are to be considered as known to a skilled person.

Software in the sense of the present description comprises software code as such comprising code means or portions or a computer program or a computer program product for performing the respective functions, as well as software (or a computer program or a computer program product) embodied on a tangible medium such as a computer-readable (storage) medium having stored thereon a respective data structure or code means/portions or embodied in a signal or in a chip, potentially during processing thereof.

The present disclosure also covers any conceivable combination of method steps and operations described above, and any conceivable combination of nodes, apparatuses, modules or elements described above, as long as the above-described concepts of methodology and structural arrangement are applicable.

Even though the present disclosure and/or exemple versions are described above with reference to the examples according to the accompanying drawings, it is to be understood that they are not restricted thereto. Rather, it is apparent to those skilled in the art that the present disclosure may be modified in many ways without departing from the scope of the inventive idea as disclosed herein.

Abbreviations:

CA	Carrier Aggregation
DL	Downlink
eNB	Enhanced Node B
EPS	Evolved Packet System
LA	Local Area
LAeNB	Local Area eNB
LTE	Long Term Evolution
LTE-A	Long Term Evolution Advanced
MAC	Medium Access Control
MeNB	Macro eNB
MME	Mobility Managem ent Entity
PDCP	Packet Data Convergence Protocol
RB	Radio Bearer
RRC	Radio Resource Control
SGW	Service GateWay
SRB	Signaling Radio Bearer
UE	User Equipm ent
UL	Uplink

WHAT IS CLAIMED IS:

1. A method, comprising:

making, at a first network element, a local area connection release decision, and

causing transmission of a local area connection release command to a user equipment and a second network element, wherein the user equipment is connected at the same time to both the first network element and the second network element.

2. The method according to claim 1, further comprising:

configuring a measurement procedure that supports in making the local area connection release decision, and

causing transmission of the configured measurement procedure to the user equipment.

3. The method according to claim 2, further comprising:

receiving, at the first network element, a measurement report from the user equipment according to the configured measurement procedure, wherein the measurement report is taken into consideration when making the local area connection release decision.

4. The method according to any one of claims 1 to 3, wherein

the local area connection release command includes at least one of information on evolved packet system bearer identification, radio bearer identification, indication of bearer release, indication of bearer suspension, radio bearer configuration and radio resource configuration.

5. The method according to any one of claims 1 to 4, wherein

the local area connection release command is a separate message, an information element included in a radio resource control connection re-establishment message or an information element included in a handover message.

6. The method according to any one of claims 1 to 5, wherein

the first network element is a macro base station and the second network element is a local area base station and the user equipment communicates with the local are base station.

7. The method according to claim 6, further comprising

receiving, at the macro base station, traffic status indication from the local area base station.

8. The method according to claim 7, wherein

the traffic status indication indicates that traffic on local area bearers comes to an end.

9. The method according to claim 7 or 8, wherein

the traffic status indication is sent via a backhaul connection between the macro base station and the local area base station.

10. The method according to any one of claims 7 to 9, wherein

the traffic status indication is sent in a periodic manner or triggered by a predetermined event.

11. The method according to any one of claims 6 to 10, further comprising

setting up, by the macro base station, a radio bearer, and

after the connection between the user equipment and the local area base station is released,

continuing data transmission with the user equipment on the bearer.

12. The method according to any one of claims 6 to 10, further comprising

setting up, by the macro base station, a backup bearer, and

after the connection between the user equipment and the local area base station is released,

continuing data transmission with the user equipment on the backup bearer.

13. The method according to any one of claims 1 to 5, wherein

the first network element is a local area base station and the second network element is a macro base station and the user equipment communicates with the local are base station.

14. The method according to claim 13, further comprising:

continuing the communication with user equipment, and

causing transmission of an indication for end of data transmission to the user equipment.

15. A method, comprising:

receiving, at a user equipment, which is connected to a macro base station and a local area base station at the same time and performs data transmission with the local area base station, a local area connection release command,

continuing data transmission with the local area base station until receiving an indication for end of the data transmission from the local area base station.

16. The method according to claim 15, further comprising:

performing a local area connection release,

causing transmission of a message indicating completion of the local area connection release to the macro base station, and

continuing data transmission with the macro base station on a bearer setup by the macro base station.

17. The method according to claim 16, wherein

the message further indicates that the user equipment has switched from a dual connection mode to a single connection mode.

18. The method according to claim 16 or 17, wherein

the message further includes information indicating at least one of the reason for switching from the dual connection mode to the single connection mode and the radio bearers moved from local area cell to macro cell.

19. A method, comprising:

receiving, at a local area base station performing data transmission with a user equipment, a connection release command from a macro base station,

continuing data transmission with the user equipment after receiving the connection release command from the macro base station, and

causing transmission of an indication for end of data transmission to the user equipment.

20. The method according o claim 19, further comprising

causing transmission of traffic status indication to the macro base station.

21. The method according to claim 20, wherein

the traffic status indication indicates that traffic on local area bearers comes to an end.

22. The method according to claim 20 or 21, wherein

the traffic status indication is sent via a backhaul connection between the macro base station and the local area base station.

23. The method according to any one of claims 20 to 22, wherein

the traffic status indication is sent in a periodic manner or triggered by a predetermined event.

24. An apparatus for use in a first network element, the apparatus comprising:

at least one processor,

and at least one memory including computer program code,

the at least one memory and the computer program code arranged to, with the at least one processor, cause the apparatus at least to perform:

making a local area connection release decision, and

causing transmission of a local area connection release command to a user equipment and a second network element, wherein the user equipment is connected at the same time to both the first network element and the second network element.

25. The apparatus according to claim 24, wherein the at least one memory and the computer program code are further arranged to, with the at least one processor, cause the apparatus at least to perform :

configuring a measurement procedure that supports in making the local area connection release decision , and

causing transmission of the configured measurement procedure to the user equipment.

26. The apparatus according to claim 25, wherein the at least one memory and the computer program code are further arranged to, with the at least one processor, cause the apparatus at least to perform :

receiving, at the first network element, a measurement report from the user equipment according to the configured measurement procedure, wherein the measurement report is taken into consideration when making the local area connection release decision.

27. The apparatus according to any one of claims 24 to 26, wherein

the local area connection release command includes at least one of information on evolved packet system bearer identification, radio bearer identification, indication of bearer release, indication of bearer suspension, radio bearer configuration and radio resource configuration .

28. The apparatus according to any one of claims 24 to 27, wherein

the local area connection release command is a separate message, an information element included in a radio resource control connection re-establishment message or an information element included in a handover message.

29. The apparatus according to any one of claims 24 to 28, wherein

the first network element is a macro base station and the second network element is a local area base station and the user equipment communicates with the local are base station.

30. The apparatus according to claim 29, wherein the at least one memory and the computer program code are further arranged to, with the at least one processor, cause the apparatus at least to perform

receiving, at the macro base station, traffic status indication from the local area base station.

31. The apparatus according to claim 30, wherein

the traffic status indication indicates that traffic on local area bearers comes to an end.

32. The apparatus according to claim 30 or 31, wherein

the traffic status indication is sent via a backhaul connection between the macro base station and the local area base station.

33. The method according to any one of claims 30 to 32, wherein

the traffic status indication is sent in a periodic manner or triggered by a predetermined event.

34. The apparatus according to any one of claims 29 to 33, wherein the at least one memory and the computer program code are further arranged to, with the at least one processor, cause the apparatus at least to perform :

setting up, by the macro base station, a radio bearer, and

after the connection between the user equipment and the local area base station is released,

continuing data transmission with the user equipment on the bearer.

35. The apparatus according to any one of claims 29 to 33, wherein the at least one memory and the computer program code are further arranged to, with the at least one processor, cause the apparatus at least to perform :

setting up, by the macro base station, a backup bearer, and

after the connection between the user equipment and the local area base station is released,

continuing data transmission with the user equipment on the backup bearer.

36. The apparatus according to any one of claims 24 to 28, wherein

the first network element is a local area base station and the second network element is a macro base station and the user equipment communicates with the local are base station.

37. The apparatus according to claim 36, wherein the at least one memory and the computer program code are further arranged to, with the at least one processor, cause the apparatus at least to perform :

continuing the communication with user equipment, and

causing transmission of an indication for end of data transmission to the user equipment.

38. An apparatus for use in a user equipment, comprising:

at least one processor,

and at least one memory including computer program code,

the at least one memory and the computer program code arranged to, with the at least one processor, cause the apparatus at least to perform :

receiving, at the user equipment, which is connected to a macro base station and a local area base station at the same time and performs data transmission with the local area base station, a local area connection release command,

continuing data transmission with the local area base station until receiving an indication for end of the data transmission from the local area base station.

39. The apparatus according to claim 38, wherein the at least one memory and the computer program code are further arranged to, with the at least one processor, cause the apparatus at least to perform :

performing a local area connection release,

causing transmission of a message indicating completion of the local area connection release to the macro base station, and

continuing data transmission with the macro base station on a bearer setup by the macro base station.

40. The apparatus according to claim 39, wherein

the message further indicates that the user equipment has switched from a dual connection mode to a single connection mode.

41. The apparatus according to claim 39 or 40, wherein

the message further includes information indicating at least one of the reason for switching from the dual connection mode to the single connection mode and the radio bearers moved from local area cell to macro cell.

42. The apparatus according to any one of claims 38 to 41, wherein

the user equipment is a mobile phone.

43. An apparatus for use in a local area base station, comprising:

at least one processor,

and at least one memory including computer program code,

the at least one memory and the computer program code arranged to, with the at least one processor, cause the apparatus at least to perform :

receiving, at the local area base station performing data transmission with a user equipment , a connection release command from a macro base station,

continuing data transmission with the user equipment after receiving the connection release command from the macro base station, and

causing transmission of an indication for end of data transmission to the user equipment.

44. The apparatus according to claim 43, wherein the at least one memory and the computer program code are further arranged to, with the at least one processor, cause the apparatus at least to perform

causing transmission of traffic status indication to the macro base station.

45. The apparatus according to claim 44, wherein

the traffic status indication indicates that traffic on local area bearers comes to an end.

46. The apparatus according to claim 44 or 45, wherein

the traffic status indication is sent via a backhaul connection between the macro base station and the local area base station.

47. The apparatus according to any one of claims 44 to 46, wherein

the traffic status indication is sent in a periodic manner or triggered by a predetermined event.

48. An apparatus for use in a first network element, comprising:

means for making, at the first network element, a local area connection release decision, and

means for causing transmission of a local area connection release command to a user equipment and a second network element, wherein the user equipment is connected at the same time to both the first network element and the second network element.

49. An apparatus for use in a user equipment, comprising:

means for receiving, at the user equipment, which is connected to a macro base station and a local area base station at the same time and performs data transmission with the local area base station, a local area connection release command,

means for continuing data transmission with the local area base station until receiving an indication for end of the data transmission from the local area base station.

50. An apparatus for use in a local area base station, comprising:

means for receiving, at the local area base station performing data transmission with a user equipment, a connection release command from a macro base station,

means for continuing data transmission with the user equipment after receiving the connection release command from the macro base station, and

means for causing transmission of an indication for end of data transmission to the user equipment.

51. A computer program product comprising computer-executable computer program code which, when the program is run on a computer, is arranged to cause the computer to carry out the method according to any one of claims 1 to 23.

52. The computer program product according to claim 51, embodied as a computer-readable storage medium.

Fig. 1

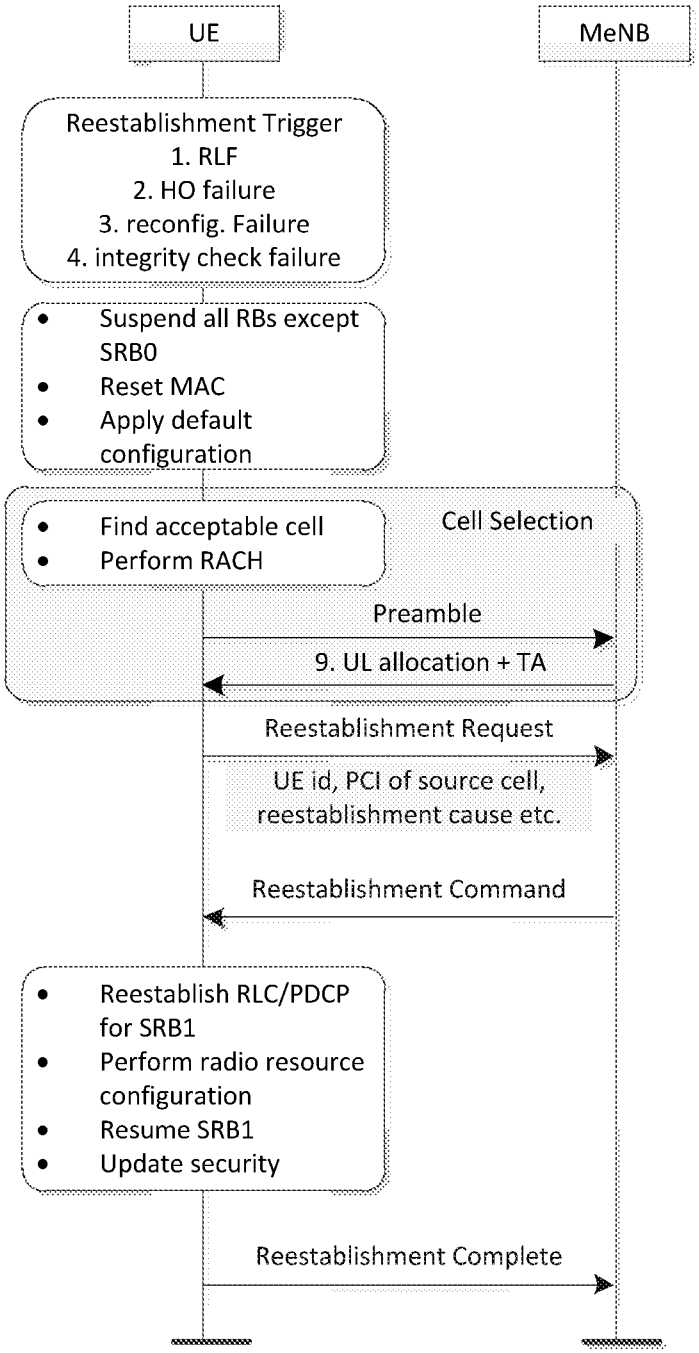

UE
MeNB
Reestablishment Trigger
1. RLF
2. HO failure
3. reconfig. Failure
4. integrity check failure
Suspend all RBs except SRB0
Reset MAC
Apply default configuration
Find acceptable cell
Perform RACH
Cell Selection
Preamble
9. UL allocation + TA
Reestablishment Request
UE id, PCI of source cell, reestablishment cause etc.
Reestablishment Command
Reestablish RLC/PDCP for SRB1
Perform radio resource configuration
Resume SRB1
Update security
Reestablishment Complete

Fig. 2

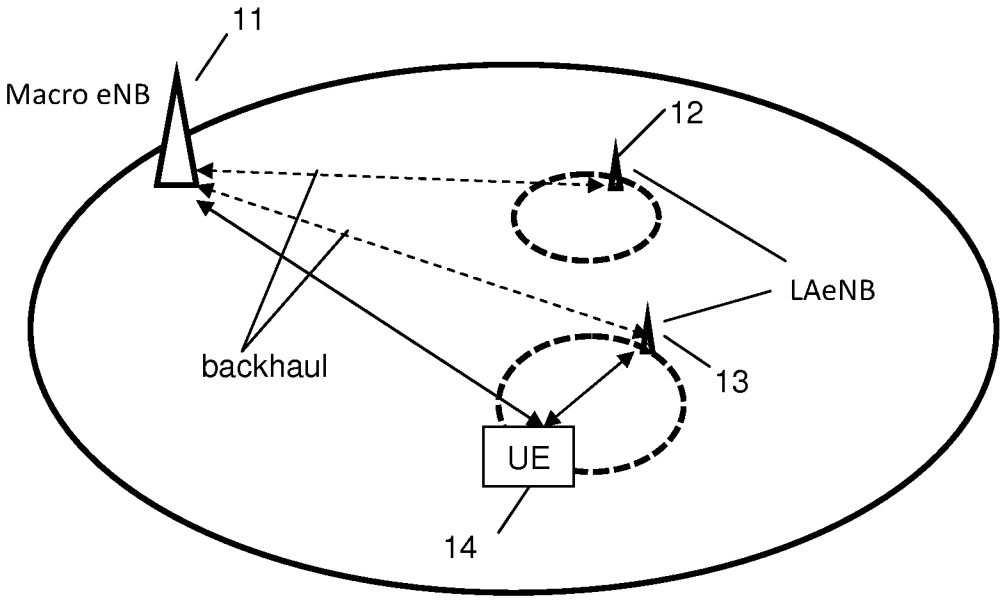


Fig. 3

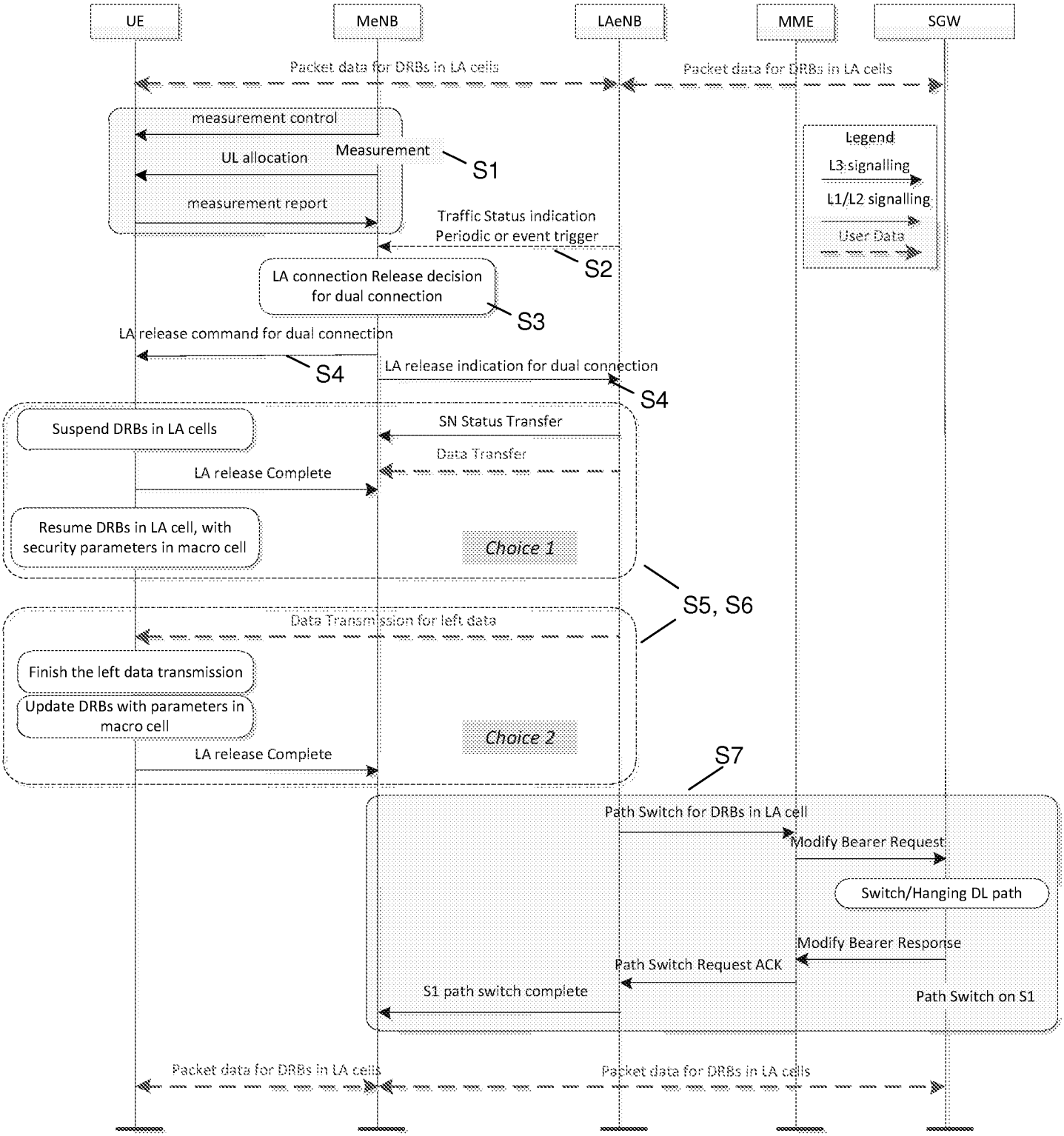

UE
MeNB
LAeNB
MME
SGW
Packet data for DRBs in LA cells
Packet data for DRBs in LA cells
measurement control
UL allocation
Measurement
S1
measurement report
Legend
L3 signalling
L1/L2 signalling
User Data
Traffic Status indication
Periodic or event trigger
S2
LA connection Release decision for dual connection
S3
LA release command for dual connection
S4
LA release indication for dual connection
S4
Suspend DRBs in LA cells
SN Status Transfer
Data Transfer
LA release Complete
Resume DRBs in LA cell, with security parameters in macro cell
Choice 1
S5, S6
Data Transmission for left data
Finish the left data transmission
Update DRBs with parameters in macro cell
Choice 2
LA release Complete
S7
Path Switch for DRBs in LA cell
Modify Bearer Request
Switch/Hanging DL path
Modify Bearer Response
Path Switch Request ACK
S1 path switch complete
Path Switch on S1
Packet data for DRBs in LA cells
Packet data for DRBs in LA cells

Fig. 4

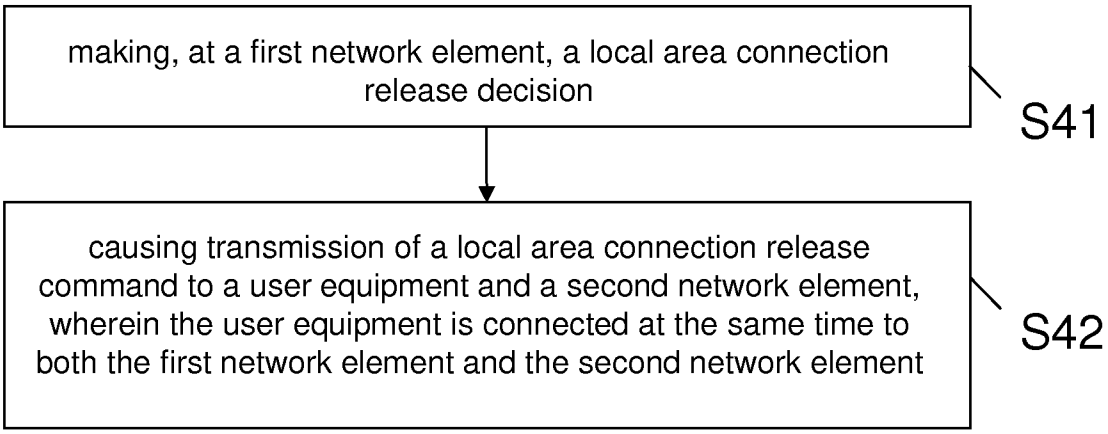

making, at a first network element, a local area connection release decision
S41
causing transmission of a local area connection release command to a user equipment and a second network element, wherein the user equipment is connected at the same time to both the first network element and the second network element
S42

Fig. 5

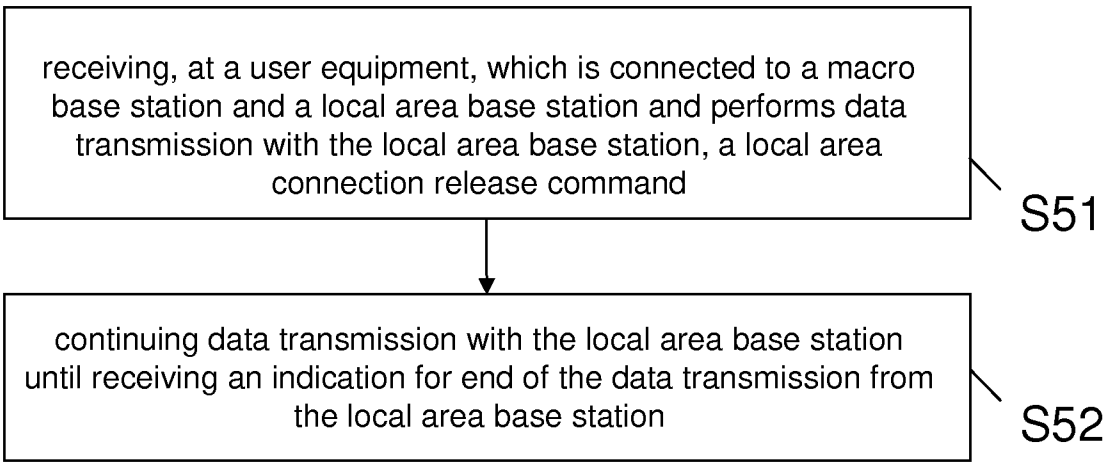

receiving, at a user equipment, which is connected to a macro base station and a local area base station and performs data transmission with the local area base station, a local area connection release command
S51
continuing data transmission with the local area base station until receiving an indication for end of the data transmission from the local area base station
S52

Fig. 6

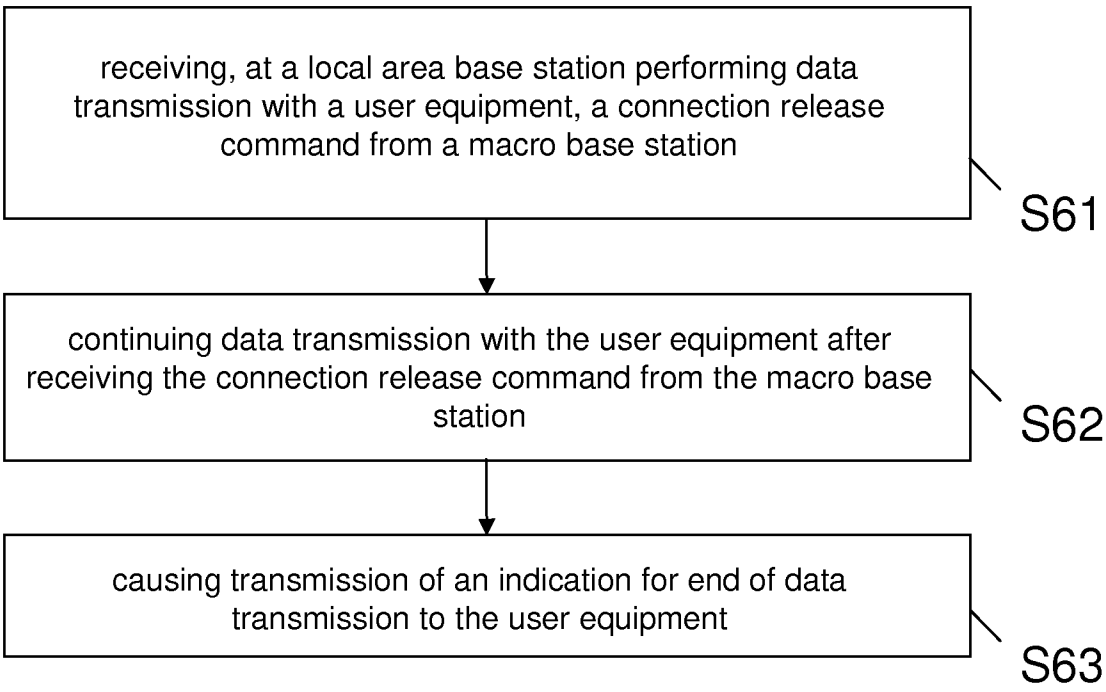
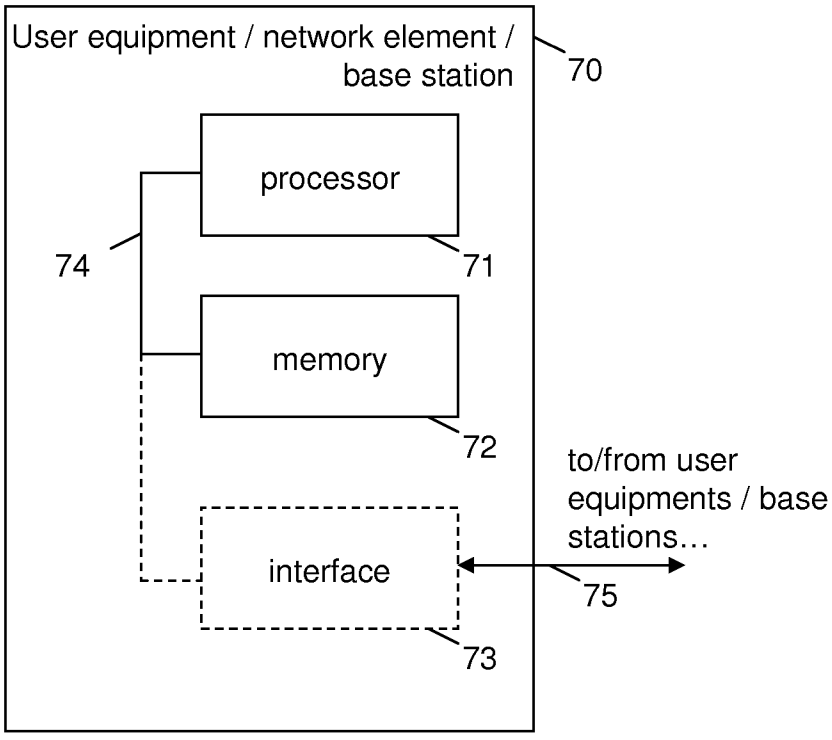

receiving, at a local area base station performing data transmission with a user equipment, a connection release command from a macro base station
S61
continuing data transmission with the user equipment after receiving the connection release command from the macro base station
S62
causing transmission of an indication for end of data transmission to the user equipment
S63

Fig. 7


User equipment / network element / base station
70
processor
74
71
memory
72
to/from user equipments / base stations…
interface
75
73

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/075419

A. CLASSIFICATION OF SUBJECT MATTER

H04W 76/06 (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)

IPC: H04W76/-, H04W36/-

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)

CNABS,CNTXT,VEN,USTXT,3GPP: macro, cell, base station, eNB, node, home, local area, dual connection, inter eNB carrier aggregation, release, deactivation, deregistration, remove, delete, disconnect, connect, simultaneity, command, request, carrier aggregation, cell aggregation, user, mobile terminal, client

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Mobility for Dual Connectivity, 3GPP T SG RAN WG2 Meeting #81bis R2-130990, 19 April 2013(19.04.2013). Retrieved from the Internet: <URL :http://Vww3Hppx>i¾^ TSG_RAN/WG2_RL2/TSGR2_81bis/Docs/R2-130990.zip>. the whole document	1-52
A	Small Cell Challenges and Benefits of Dual Connectivity, 3GPP TSG-RAN WG2 #81 T doc R2-130416, 01 February 2013(01 .02.2013) Retrieved from the Internet: <URL: http.//www.3gpp.org/fip/TSG RAN/WG2 RL2/TSGR2 Sl/Docs/R2-130416.zip >. the whole document	1-52
A	WO 2010030099 A2 (SAMSUNG ELECTRONICS CO LTD etc.) 18 March 2010(18.03.2010) the whole document	1-52

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier 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
14 January 2014 (14.01 .2014)	**30 Jan. 2014 (30.01.2014)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 facsimile No. 86-10-62019451	Authorized officer WU, Lijun Telephone No. (86-10)62411525

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/075419

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Discussion about Dual Connectivity, 3GPP TSG-RAN WG2 Meeting #81 R2-130400, 01 February 2013(01.02.2013) Retrieved from the Internet: <URL: httpy/mvw3eyp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_81/Docs/R2-130400.zip >. the whole document	1-52
A	CN 102118807 A(DATANG MOBILE COMMUNICATIONS EQUIP CO) 06 July 2011(06.07.2011) the whole document	1-52

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2013/075419

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
WO 2010030099 A2	18.03.2010	CN 101674622 A	17.03.2010
		WO 010030099 A3	24.06.2010
		EP 2324661 A2	25.05.2011
		US 2011164591 A1	07.07.2011
CN 102118807A	06.07.2011	CN 102118807 B	20.11.2013