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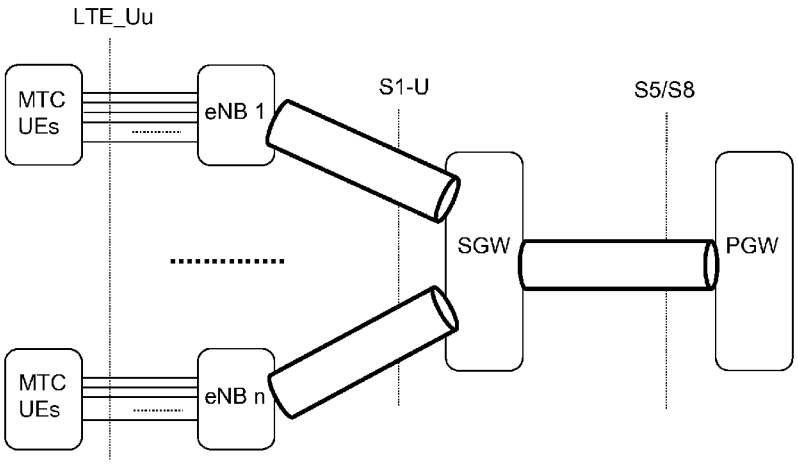
(54) Title: METHOD AND SYSTEM FOR PERFORMING BEARER CONFIGURATIONS IN A 3GGP ACCESS NETWORK



(57) Abstract: A method for performing bearer configurations in a 3GGP access network, comprising at least one base station being capable of serving a number of terminals, is characterized in the steps of grouping of terminals that reside at said base station according to configurable criteria, and creating only a single bearer - aggregation bearer - per group of terminals. Furthermore, a corresponding system is disclosed.

Fig. 5

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METHOD AND SYSTEM FOR PERFORMING BEARER CONFIGURATIONS IN A 3GGP ACCESS NETWORK

The present invention relates to a method and a system for performing bearer configurations in a 3GGP access network, comprising at least one base station being capable of serving a number of terminals.

In current mobile networks defined in 3GPP, the mobile terminal (User Equipment, UE) sets up EPS (Evolved Packet System) bearer(s) for data transmission. These bearers are concatenations of bearer parts on the radio link (Radio Bearer), on the S1 user plane interface (S1 bearer) and in the core network (S5/S8 bearer). Once the UE detaches from the network or the UE changes into ECM-IDLE mode (ECM: EPS Connection Management), the S1 bearers are released from the S1 interface between eNodeB (eNB) and Serving Gateway (SGW).

3GPP TS 23.401 states that the UE shall enter the ECM-IDLE state when its signaling connection to the MME (Mobility Management Entity) has been released or broken. This release or failure is explicitly indicated by the eNodeB to the UE or detected by the UE.

The S1 release procedure changes the state of the UE at both UE and MME from ECM-CONNECTED to ECM-IDLE. However, the UE may not receive the indication for the S1 release, e.g. due to radio link error or out of coverage. In this case, there can be temporal mismatch between the ECM-state of the UE in the UE and the ECM-state of the UE in the MME. After a signaling procedure, the MME may decide to release the signaling connection to the UE, after which the state of the UE at both the UE and the MME is changed to ECM-IDLE.

3GPP TS 23.401 states that when the state of the UE in both the UE and MME changed to ECM-IDLE then the MME deletes any information jointly related to UE and eNodeB (e.g., “eNodeB Address in Use for S1-MME” and “eNB UE S1AP ID”) from the UE’s MME context, but retains the rest of the UE’s MME context including the SGW’s S1-U configuration information (e.g., address and TEIDs (Tunnel Endpoint Identifiers)). All non-GBR (Guaranteed Bit Rate) EPS bearers

established for the UE are preserved in the MME and in the Serving GW, i.e. the MME and the SGW keep the non-GBR bearer information. If the cause of S1 release is User inactivity or Inter-RAT Redirection, then the MME shall preserve the GBR bearers, i.e. the MME keeps the GBR bearer information.

Figs. 1 and 2, corresponding to Figs. 4.6.4-3 and 4.6.4-4 of 3GPP TS 23.401, show the state ECM models in both UE and MME.

A frequent usage of small data by many UEs would therefore result in frequent establishments and releases of S1 bearers, which in turn would lead to a huge overhead of signaling for a relatively small amount of data to be sent. A possible type of UE, for which such behavior typically applies, would be a Machine Type Communication UE.

Fig. 3 shows how it would look like if several UEs, distributed over several eNBs, would establish bearers just to transmit a small amount of data. The number of bearers on the S5/S8 interface between SGW and PGW would be immense and all bearer state information would have to be kept active all the time. Note that for simplicity the arrangement includes only one SGW (Serving Gateway) and one PGW (PDN Gateway).

Fig. 4, corresponding to Fig. 5.3.5-1 of 3GPP TS 23.401, shows both the eNodeB-initiated and MME-initiated S1 release procedures. Since those skilled in the art are assumed to be sufficiently familiar with these release procedures, a detailed description is omitted here, and it is referred to section 5.3.5 of 3GPP TS 23.401 for details. In the context of the present invention it is just important to note that every time one of the UEs transits from ECM-CONNECTED to ECM-IDLE state all messages 1.-6. depicted in Fig. 4 have to be sent.

In view of the above it is an objective of the present invention to improve and further develop a method and a system of the initially described type for performing bearer configurations in a 3GGP access network in such a way that, by employing mechanisms that are readily to implement, the signaling overhead is reduced, in particular in case of small data transmissions.

In accordance with the invention, the aforementioned object is accomplished by a method comprising the features of claim 1. According to this claim such a method is characterized in the steps of grouping of terminals that reside at said base station according to configurable criteria, and creating only a single bearer – aggregation bearer – per group of terminals.

Furthermore, the above mentioned objective is accomplished by a system comprising the features of claim 17. According to this claim such a system is characterized in that at least one entity is provided that is configured to group terminals that reside at said base station according to configurable criteria, and to create only a single bearer – aggregation bearer – per group of terminals.

According to the present invention it has been recognized that in terms of signaling amount it is not beneficial to have a bearer setup that each single terminal, in particular when many terminals are camping on cells of the same base station and transmit only small amount of data. In this regard has been recognized that a significant reduction of signaling overhead can be achieved by generating groups of terminals and by using only one dedicated bearer for all terminals of a particular group. This dedicated bearer functions as aggregation bearer for the entire traffic of the terminals of the respective group. Consequently, in accordance with the present invention there is no additional signaling overhead for frequent small data transmission from a particular source base station/eNodeB, i.e. there is also less state handling in SGW and PGW and easier charging at the PGW for the whole group of terminals.

It is noted that while the present invention can generally be applied in various scenarios, it proves to be particularly useful for frequent or periodic transmissions and if there is a high number of terminals/UEs located at the same base station/eNodeB.

According to preferred embodiments terminals may be considered for being grouped that transmit frequently, e.g. periodically, independently of each other at uncorrelated or correlated points in time small amount of data. As a further criterion terminals may be considered for being grouped that are immobile or at

least have a low mobility characteristic without handing over to another base station. Furthermore, it may be provided that in particular MTC (Machine-Type-Communication) devices are considered for being group, which typically fulfill all of the above mentioned criteria.

According to further preferred embodiments the base station provides a binding of the radio bearers of the terminals of a group to form the aggregation bearer on the S1 reference point.

According to further preferred embodiments, when the MME receives subscriber information from a terminal during the attach procedure, it detects whether the terminal is a device of a specific group. The MME knows from which base station attach requests are coming from and knows also whether there are other devices from the same group camping in the same cell as well, due to previous attach requests and the assumed low mobility or even immobility of the terminals. The MME creates only one aggregation bearer for all terminals that reside at this particular base station on the S1 reference point. This could be further optimized by further aggregation of the (already aggregated) bearers on the S5/S8 interface.

According to further preferred embodiments even if none of the terminals of a group at the same base station is in ECM-CONNECTED mode, the aggregation bearer may not be released immediately. Instead, it may be provided that, e.g. based on operator policy, there might be a timeout and the aggregation bearer may be released based on inactivity for a certain time.

According to further preferred embodiments it may be provided that the creation of groups of terminals is performed by the MME on the basis of one or more features received in the subscription data of the terminals. Based on this information the MME may either create a new group to which the terminal that attaches to the respective base station will be associated with or make the terminal join an already existing group.

According to further preferred embodiments it may be provided that the creation of groups of terminals is performed on the basis of a Group IMSI (International

Mobile Subscriber Identity), wherein a terminal within the group may be identified via the Group IMSI together with a mobile terminal specific Sub-ID. Alternatively, a group of mobile terminals may be addressed by using a group ID, wherein a mobile terminal within the group is identified via the group ID together with its conventional IMSI.

According to further preferred embodiments the terminals may be configured to indicate whether they prefer to join an aggregation bearer or whether they prefer the creation of a bearer for their own, in particular by setting a corresponding flag in the Attach Request. In case an own bearer is explicitly requested by a terminal, special charging and handling may take place.

Since, as already explained above, applications of the present invention are particularly beneficial for MTC devices, it may be provided that the default QoS for the aggregation bearer is set to be Best Effort without Guaranteed Bitrate (GBR), or very low GBR since traffic of MTC devices is considered mostly low priority. However, generally the default QoS for the aggregation bearer will be subject to operator policy, e.g. based on configuration. Policy and/or QoS control may be performed at each time a new terminal joins the aggregation bearer or leaves the aggregation bearer, wherein leaving the aggregation bearer may be a detach of a terminal from the network or releasing the PDN connection.

According to further preferred embodiments the number of terminals that form a group for which an aggregation bearer is created is limited to a predefined maximum value. Based on the subscription data of a terminal, it may be decided to initiate a new aggregation bearer e.g. because the maximum number of terminals associated with an already existing aggregation bearer is already exceeded.

According to further preferred embodiments it may be provided that for downlink data delivery to terminals/UEs in IDLE state, the base station/eNB generates a paging message (according to 3GPP TS36.331 paging procedures) based on the UE's context stored in the base station/eNB and performs paging of the UE. This paging can be performed without involving the MME, e.g. with the stored S-TMSI.

There are several ways how to design and further develop the teaching of the present invention in an advantageous way. To this end it is to be referred to the patent claims subordinate to patent claim 1 on the one hand and to the following explanation of preferred embodiments of the invention by way of example, illustrated by the drawing on the other hand. In connection with the explanation of the preferred embodiments of the invention by the aid of the drawing, generally preferred embodiments and further developments of the teaching will be explained. In the drawing

Fig. 1 is a schematic view of the ECM state model in UE according to prior art,

Fig. 2 is a schematic view of the ECM state model in MME according to prior art,

Fig. 3 is a schematic view illustrating the EPS bearer concept for bearer on Radio, S1 and S5/S8 interfaces according to prior art,

Fig. 4 is a message exchange diagram regarding an S1 Release Procedure according to prior art,

Fig. 5 is a schematic view illustrating bearer aggregation on S1 and S5/S8 interfaces in accordance with an embodiment of the present invention,

Fig. 6 is a message exchange diagram illustrating an initial attach procedure in EPS according to prior art,

Fig. 7 is a message exchange diagram illustrating an initial attach procedure of a first UE of a group in EPS in accordance with an embodiment of the present invention,

Fig. 8 is a message exchange diagram illustrating an attach procedure of subsequent UEs of a group in EPS in accordance with an embodiment of the present invention, and

Fig. 9 is a schematic view illustrating bearer aggregation of attached UEs of the same group at eNodeB accordance with an embodiment of the present invention.

Fig. 5 schematically illustrates a first embodiment of the present invention in which bearer aggregation is performed on both S1 and S5/S8 interfaces. Specifically, Fig. 5 shows that many radio bearers are aggregated into a single or few S1 aggregation bearers, which are further aggregated to one S5/S8 aggregation bearer, resulting in corresponding aggregation of the frequent small data traffic from all the UEs. This solution addresses the problem of signaling overhead in case of small data transmission by using one dedicated bearer for all UEs on S1 and S5/S8 reference points, alternatively for all UEs belonging to the same group identified by a unique ID across the network. Aggregation of traffic from all UEs at one particular eNB towards the PGW via SGW on a permanent bearer that is pretending to be established for the group of UEs comes along with the effect that no individual bearer handling per UE needs to be performed. The aggregation bearers are not released, even if all associated UEs are ECM-IDLE at this point in time.

The illustrated embodiment is based on the following assumptions:

- Many UEs of a specific group are camping on one eNB
- The UEs send frequently/periodically, independently of each other, and at uncorrelated or correlated points in time small amounts of data
- The UEs are not moving or with low mobility feature without handing over to another cell.

Since many UEs are camping on cells of the same eNB, it is not beneficial to have a bearer setup per each single UE, which then has to transmit only small amount of data. Furthermore, it is assumed here that an eNB can provide the binding of the radio bearers of the UEs to the aggregation bearer on the S1 reference point, e.g. based on a group ID, IMSI etc. Furthermore, it is assumed that UEs belong to the same group identified with the same group ID. The group ID could be also a

special IMSI, denoted Group IMSI hereinafter, which enables them to reuse all existing bearer related procedures and to share one aggregation bearer in the core network. If a Group IMSI is used, then each UE belonging to the IMSI group may have an additional sub-identifier for differentiated paging.

A UE in a group is therefore identified either with a Group IMSI with a UE individual Sub-ID or with a Group ID and its "normal" IMSI.

Fig. 6, which corresponds to Figure 5.3.2.1-1 of 3GPP TS 23.401, shows the general initial attach procedure in E-UTRAN. For the sake of brevity, since skilled artisans are familiar with this procedure, only those aspects of the attach procedure will be described in detail hereinafter that are essential in the context of the present invention.

The UEs discussed in connection with the following embodiments are considered to be not moving fast or to be of low mobility and most likely not handing over to another cell. Therefore, the MME knows at which eNB a particular UE is located. It is noted that the above assumptions are typically valid for MTC devices.

When the MME receives the subscriber information in step 8, it can detect that the device which performs an Attach is a device of a specific group. The MME knows from which eNB the Attach request is coming from and knows also whether there are other devices from the same group camping in the same cell as well, due to previous Attach requests and their low mobility or even immobility. In accordance with the present invention the MME does therefore not create an own bearer for each device, as shown in Fig. 3. Instead, the MME creates only one aggregation bearer for all UEs that reside at this particular eNB on the S1 reference point. This could be further optimized by further aggregation of the (already aggregated) bearers on the S5/S8 interface as shown in Fig. 5. It is noted that in accordance with an embodiment of the invention a UE may explicitly request that the MME creates a bearer for its own use, e.g., through a flag in the Attach Request, in which case special charging and handling may take place.

This aggregation S1 bearer shall be used now for the aggregated small data traffic of all UEs from the same eNB. If one of the UEs changes from ECM-CONNECTED to ECM-IDLE mode, the aggregation S1 bearer will not be released, even if none of the other UEs at the same eNB are in ECM-CONNECTED mode. Based on operator policy, a timeout may be provided such that the aggregation bearer will be released based on inactivity for a certain time. This method relies on de-multiplexing capabilities in the eNB.

If UEs have different QoS requirements on their small data traffic, then they should mark it accordingly so that their data packets are treated with priority. Since, assuming uncorrelated transmission between all UEs of this type, the next UE will be transmitting data soon, the aggregation bearer per group of UEs will be kept and thus no signaling for setup (and equally tear down) of bearers is necessary. From eNB, MME, SGW and PGW perspective, it looks like the Group IMSI session is always in ECM-CONNECTED mode. The default QoS for the aggregated bearer depends on the operator policy, e.g. based on configuration, but it is assumed to be Best Effort without Guaranteed Bitrate (GBR), or very low GBR since traffic is considered mostly low priority. Based on the received subscription data, the MME may decide to initiate a new aggregation bearer e.g. because the maximum number of UEs associated with the existing one is already exceeded.

Fig. 7, which is a simplification of Fig. 6, shows in detail how an initial attach of a device of the category described above, in particular MTC device, is performed in accordance with an embodiment of the present invention:

Up to step 11, the normal procedure of the Attach procedure is executed, with the only change being that the UE may indicate in the Attach Request in step 1 / step 2 that it wants to join an aggregated bearer at this eNB, e.g. by setting a flag.

In step 11, the HSS acknowledges the Update Location message by sending an Update Location Ack (Group IMSI with Sub-ID, Subscription data) message to the MME. Depending on the used addressing scheme, either a Group IMSI plus an Sub-ID is used or a normal IMSI for the UE and a Group ID. Alternatively, the MME may derive a group ID from one or more features of the UE received in the

subscription data, and either create a new group to which this UE will be associated with or make the UE join an already existing group. In step 12, the MME selects a Serving GW and a PDN GW, sends a Create Session Request message including Group IMSI with Sub-ID or IMSI, Group ID, EPS Bearer QoS and EPS Bearer Identity to the selected Serving GW. The MSISDN (Mobile Subscriber ISDN Number) is not necessarily required. The MME may have a dedicated APN for this small data traffic and may use this APN in the request. Also the MME may directly want to send specific QoS parameters for the aggregation bearer.

In step 14, if dynamic PCC (Policy and Charging Coordination) is deployed, then the PDN GW performs an IP-CAN (IP-Connectivity Access Network) Session Establishment procedure as defined in 3GPP TS 23.203, and thereby obtains the PCC rules for the UE, and/or in general for the group the UE belongs to. The PDN GW provides several parameters including IMSI, APN, UE IP address, and EPS Bearer QoS, to the PCRF. The PCRF may modify the APN-AMBR and the QoS parameters (QCI and ARP) associated with the aggregation bearer in the response to the PDN GW as defined in 3GPP TS 23.203.

While the PDN GW/PCEF may be configured to activate predefined PCC rules for the aggregation bearer, the interaction with the PCRF is still required to provide e.g. the UE IP address information to the PCRF.

If dynamic PCC is not deployed, the PDN GW may apply local QoS policy and establishes a dedicated aggregation bearer.

In step 15, the PDN GW creates a new entry in its EPS aggregation bearer context table for this UE and adds the UEs IP address, Group IMSI with Sub-ID or IMSI with Group ID to the table and generates a Charging Id for the aggregation Bearer. This table may be similar to the one defined in 3GPP TS 23.401, clause 5.7.4 with the additional entries under “For each EPS Bearer within the PDN Connection:”. The Group IMSI or Group ID is stored only one time, since it is the same for all UEs in the group. The PDN GW returns a Create Session Response message including PDN GW Address for the user plane, PDN GW TEID of the user plane,

PDN GW TEID of the control plane, PDN Type, PDN Address, EPS Bearer Identity, EPS Bearer QoS, Group IMSI or Group ID and Protocol Configuration Options to the Serving GW. The Group IMSI/Group ID and Sub-ID could be also sent in the Protocol Configuration Options to the UE in case these IDs are dynamic and not known by the UE yet. The UE needs to store the IDs and use them for RRC Connection Requests.

In step 16, the SGW creates a new entry in its EPS aggregation bearer context table for this UE and adds the Sub-ID or IMSI to the table. This table may be similar to the one defined in 3GPP TS 23.401, clause 5.7.3 with the additional entries under “For each EPS Bearer within the PDN Connection:”. The Serving GW returns a Create Session Response message including PDN Address, Serving GW address for User Plane, Serving GW TEID for S1-U User Plane, Serving GW TEID for control plane, EPS Bearer Identity, EPS Bearer QoS, and TEID (GTP-based S5/S8) or GRE keys (PMIP-based S5/S8) at the PDN GW for uplink traffic, Protocol Configuration Options to the MME. The TEIDs on S1 and S5/S8 are the ones of the aggregation bearer and are the same for all UEs of the same group at the same eNB.

In step 17, the MME determines the UE AMBR to be used by the eNodeB based on the subscribed UE-AMBR and the APN AMBR for the APN.

The MME sends an Attach Accept message including APN, PDN Address, EPS Bearer Identity, and Protocol Configuration Options, to the eNodeB. This message is contained in an S1_MME control message Initial Context Setup Request. This S1 control message also includes the AS (Application Server) security context information for the UE, the Handover Restriction List, the EPS Bearer QoS, the UE-AMBR, EPS Bearer Identity, Group IMSI with Sub-ID or IMSI with Group ID as well as the TEID at the Serving GW used for user plane and the address of the Serving GW for user plane.

In step 18, the eNodeB sends the RRC Connection Reconfiguration message including the EPS Radio Bearer Identity to the UE, and the Attach Accept message will be sent along to the UE.

The following steps 19 to 26 are according to the attach call flow in 3GPP TS 23.401.

The aggregation bearer that got established now is the default bearer for the UE to transmit the data to the Application Server and vice versa. This bearer may be retained all the time in the network or can time out in case of no activity based on operator configuration. The eNB may decide to turn down the RRC connection for specific UEs in order to let the UEs go back to ECM-IDLE.

In step 21, the UE sends a Direct Transfer message to the eNodeB, which includes the Attach Complete (EPS Bearer Identity, NAS sequence number, NAS-MAC) message.

Since the aggregation bearer is shared by a number of UEs, the attach procedure for the following UEs for the same group is slightly different, as shown Fig. 8:

Once the first UE of a group attached to the network and an aggregation bearer is created for the group of the UE identified by a Group ID according to the procedure described in connection with Fig. 7, all the following UEs can reuse the already established aggregation bearer on S1/S5/S8. From UE perspective it looks like a normal attach procedure. The difference to this is that after the MME received the Update Location ACK with the Group IMSI with Sub-ID or IMSI with Group ID, then it recognizes that it has already established a aggregation bearer for this group. Instead of sending another Create Session Request, the MME sends a Modify Bearer Request to the SGW and further the PGW. Based on the received subscription data, the MME may decide to initiate a new aggregation bearer e.g. because the maximum number of UEs associated with the existing one is already exceeded, then it would proceed as described in Fig. 7. The message includes the EPS Bearer Identity and the EPS Bearer QoS. The MME may decide to change the EPS Bearer QoS at this point in time.

In step 5, if PCC infrastructure is deployed, the PDN GW informs the PCRF about the updated EPS Bearer QoS and APN-AMBR. The PCRF sends new updated PCC decision to the PDN GW.

In step 6, the PGW creates a new entry in its EPS aggregation bearer context table for this UE and adds the UEs IP address, Sub-ID or IMSI to the table. This table is similar to the one defined in 3GPP TS 23.401, clause 5.7.4 with the additional entries under “For each EPS Bearer within the PDN Connection:”. The PDN GW then sends the Update Bearer Request message including EPS Bearer Identity, EPS Bearer QoS, Group IMSI with Sub-ID or IMSI with Group ID, IP Address to the Serving GW. The Group IMSI/ Group ID and Sub-ID could be also sent in the Protocol Configuration Options to the UE in case these IDs are dynamic and not known by the UE yet. The UE needs to store the IDs and use them for RRC Connection Requests.

In step 7, the SGW creates a new entry in its EPS aggregation bearer context table for this UE and adds the Sub-ID or IMSI to the table. This table is similar to the one defined in 3GPP TS 23.401, clause 5.7.3 with the additional entries under “For each EPS Bearer within the PDN Connection:”. The Serving GW sends the Update Bearer Request (PTI, EPS Bearer Identity, APN-AMBR, TFT, Retrieve Location) message to the MME.

In step 8, the MME determines the UE AMBR to be used by the eNodeB based on the subscribed UE-AMBR and the APN AMBR for the APN.

The MME sends an Attach Accept message including APN, PDN Address, EPS Bearer Identity, Protocol Configuration Options message to the eNodeB. GUTI (Globally Unique Temporary Identity) is included if the new MME allocates a new GUTI. This message is contained in an S1_MME control message Initial Context Setup Request. This S1 control message also includes the AS security context information for the UE, the Handover Restriction List, the EPS Bearer QoS, the UE-AMBR, EPS Bearer Identity, Group IMSI with Sub-ID or IMSI with Group ID as well as the TEID at the Serving GW used for user plane and the address of the Serving GW for user plane.

In step 9, the eNodeB maps the EPS Bearer QoS to the Radio Bearer QoS. The eNodeB uses the IMSI or Sub-ID for mapping of the EPS bearer ID to the Radio Bearer/RRC Connection, since the EPS aggregation bearer ID is the same for all UEs at this eNodeB. The eNodeB sends the RRC Connection Reconfiguration message including the EPS Radio Bearer Identity to the UE, and the Attach Accept message will be sent along to the UE.

Downlink data packets to individual UEs of the group need to have a Sub-ID or IMSI in the GTP-U Header so that the eNB can map the packets to the right Radio Bearer/RRC Connection (CRNTI).

The following steps are executed according to the normal attach flow of Figure 5.3.2.1-1 of 3GPP TS 23.401:

In step 10, the UE acknowledges the radio bearer activation to the eNodeB with a RRC Connection Reconfiguration Complete message.

In step 11, the eNodeB sends the Initial Context Response message to the new MME. This Initial Context Response message includes the TEID of the eNodeB and the address of the eNodeB used for downlink traffic on the S1_U reference point.

In step 12, the UE sends a Direct Transfer message to the eNodeB, which includes the Attach Complete (EPS Bearer Identity, NAS sequence number, NAS-MAC) message.

In step 13, the eNodeB forwards the Attach Complete message to the new MME in an Uplink NAS Transport message.

In step 14 upon reception of the Initial Context Response message in step 11 and the Attach Complete message in step 13, the MME acknowledges the bearer modification to the Serving GW by sending an Update Bearer Response (EPS Bearer Identity, User Location Information (ECGI)) message.

In step 15, the Serving GW acknowledges the bearer modification to the PDN GW by sending an Update Bearer Response (EPS Bearer Identity, User Location Information (ECGI)) message.

Now all attached UEs at the eNodeB share the same aggregation bearer on S1 and S5/S8 as shown in Fig. 9:

All UEs have received different IP addresses and SGW and P GW create a new entry for each UE in their EPS aggregation bearer context table and adds the relevant information like UEs IP address, Sub-ID or IMSI to the table beside the Group ID or Group IMSI that is shared.

Since the devices are considered to be not moving fast or of low mobility and most likely not handing over to another cell, the MME knows at which eNB a particular UE is located.

Also even the eNB can send the UE to ECM-IDLE right after a small amount of data is transmitted, the S1 and S5/S8 aggregation bearer is maintained to allow other UEs at the same eNB to send data directly.

Terminating data retrieval is done as for normal bearers and UEs. Since all UEs have an own IP address, terminating data is directly forwarded to the SGW. The SGW sends a Downlink Data Notification message to the MME for which it has control plane connectivity for the given UE. In Downlink Data Notification, the ARP and EPS Aggregation Bearer ID including the Group IMSI with Sub-ID or IMSI with Group ID are always set. The MME and SGSN respond to the SGW with a Downlink Data Notification Ack message. The priority indicator, i.e. ARP is derived from the bearer triggering the Downlink Data Notification. The MME sends a Paging message (NAS ID for paging, TAI(s), UE identity based DRX index, Paging DRX length, list of CSG IDs for paging, Paging Priority indication, IMSI or Sub-ID) to the eNodeB belonging to the EPS Aggregation Bearer of the group in which the UE is registered. The UE includes then in the RRC Connection Request its IMSI or Sub-ID, dependent what is used in the eNB for mapping the Radio Bearers/RRC

Connection to the EPS Aggregation Bearer. The Service Request procedure can be immediately acknowledged. Since the path is known at the SGW to the particular eNB, the SGW could send the packets to the eNB which now can deliver them to the UE.

In another embodiment, policy and QoS control is performed at each time a new UE joins the aggregation bearer or leaves the aggregation bearer. Leaving the aggregation bearer may be a detach of a UE from the network or releasing the PDN connection. At any of those events, the MME sends a Modify Bearer Request as shown in Fig. 8, step 3. The MME accumulates the maximum bitrates of the UEs that belong to the same aggregation bearer and sets it as the Aggregated Maximum BitRate (AMBR) for the EPS Bearer QoS in the Modify Bearer Request. The AMBR indicates the maximum bitrate when all UEs would actively transmit data within the Aggregation Bearer at the same time. Nevertheless it is assumed that small data is transmitted frequently or infrequently within the aggregation bearer so that multiplexing effects smooth the traffic to a much lower but more constant bitrate. The AMBR for the Aggregation Bearer will be installed by the PCRF on the S1/S5/S8 bearers.

Further, the AMBR of the aggregated S5 bearer may be used as parameter to solve the requirement for limited maximum transmission or reception bitrate for a whole MTC group (for reference, see 3GPP TS22.368 section 7.2.14.2). The PCRF takes into consideration the subscription parameters for the MTC group when determining the S5 AMBR of the aggregated bearer. There are the following cases:

- If all UE members of the MTC group are attached to the same Serving Gateway (SGW), then the S5 AMBR of the aggregated bearer would be equal to the possible limitation for the maximum transmission or reception bitrate for a whole MTC group.

- If the UE members of the MTC group are distributed and served by multiple SGWs, there will be several S5 aggregated bearers. In such a case the sum of all S5 AMBRs (of the corresponding S5 aggregated bearers) should

not exceed the maximum transmission or reception bitrate for a whole MTC group. The PCRF takes into consideration each S5 AMBR parameter of the S5 aggregated bearers when determining the possible modification of the S5 aggregated bearers (when requested by the MME upon attach of a new UE or establishment of PDN connection).

In still another embodiment, the eNB may decide to move UEs with long idle cycles, i.e. no small data transmission, into IDLE mode. When the eNB first assigned a C-RNTI (Cell Radio Network Temporary Identity) to a UE then the eNB needs to store the mapping of the UEs C-RNTI for the radio bearer and the GPRS Tunneling Protocol (GTP) Tunnel Endpoint ID (TEID) for the Aggregation bearer on S1 for the complete duration the UE is in IDLE mode. The TEID of the Aggregation Bearer is ambiguous since it is used for all UEs in the same group at the same eNB. For this reason it is recommended that an additional UE specific information element is used in the GTP-U packets as described in 3GPP TS 29.281. Once the UE performed an ATTACH according to Figs. 7 or 8, the PGW shall assign to each UE of an Aggregation Bearer a different IP address and another identifier, which could be the MSISDN, IMSI, an allocated port number, etc. Therefore the PGW adds to each GTP-U packet either an UDP Port extension header and allocate different UDP ports for different UEs of the Aggregation Bearer or a private extension information element indicating the UEs IP address from the PGW or any other UE specific identifier, e.g. IMSI, MSISDN, etc. These extensions are signaled back in the Modify Bearer Response message to the MME and from there to the eNB in the Attach Accept message, where the eNB stores the binding of C-RNTI, UE GTP Identifier in a look-up table. Additional other UE parameters, like the TMSI (Temporary Mobile Subscriber Identity), are stored in the eNB. Each downlink packet is marked in the PGW with the appropriate extension header in the GTP-U header and is forwarded to the eNB where it is mapped from the aggregation bearer TEID to the C-RNTI. An eNB stores the UE's context after the UE transits from CONNECTED to IDLE state, if the UE uses the aggregate S1/S5 bearer. It is assumed that such UEs have low mobility profile, i.e. they do not change their location frequently. For this purpose the eNB is able to mark such a UE's context as inactive and takes into consideration its parameters when assigning parameters to other UEs (e.g. C-RNTI). If a UE is in IDLE mode and wants to transmit uplink data, then it sets up the RRC connection, the eNB

allocates the same C-RNTI as used before. The UE does not need to perform any service request, since the S1 and S5/S8 aggregation bearers are ready to be used. The eNB maps all uplink data from the C-RNTI to the TEID and sets the appropriate extension header with the UDP port or the UE ID as done by the PGW before at the time of the Attach.

If a UE is in IDLE mode and receives downlink data, then the packets are forwarded directly to the eNB since the S5/S8 and S1 aggregation bearers are already in place. The eNB needs to perform paging of the UE, without involving the MME, e.g. with the stored S-TMSI. For this purpose the eNB is extended to be able to generate a paging message (according to 3GPP TS36.331 paging procedures) based on the UE's context stored in the eNB while the UE is in IDLE state. If needed, MME may give to the eNB UE's information that may be required to generate the NAS Paging message that is included in the broadcasted RRC paging message. When the UE setup the RRC connection ,the eNB allocates the same C-RNTI to the UE and maps the packets from the GTP TEID + UDP port/UE ID to the C-RNTI of the radio bearers.

Many modifications and other embodiments of the invention set forth herein will come to mind the one skilled in the art to which the invention pertains having the benefit of the teachings presented in the foregoing description and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

Claims

1. Method for performing bearer configurations in a 3GGP access network, comprising at least one base station being capable of serving a number of terminals,
characterized in the steps of
grouping of terminals that reside at said base station according to configurable criteria, and
creating only a single bearer – aggregation bearer – per group of terminals.

2. Method according to claim 1, wherein said terminals transmit independently of each other at uncorrelated or correlated points in time small amount of data.

3. Method according to claim 1 or 2, wherein said terminals are immobile or at least have a low mobility characteristic without handing over to another base station.

4. Method according to any of claims 1 to 3, wherein said terminals include MTC (Machine-Type-Communication) devices.

5. Method according to any of claims 1 to 4, wherein said base station provides the binding of the radio bearers of said terminals to said aggregation bearer on the S1 reference point.

6. Method according to any of claims 1 to 5, wherein said aggregation bearer is created by the MME for the S1 reference point.

7. Method according to any of claims 1 to 6, wherein aggregation bearers on S1 reference points are further aggregated on the S5/S8 reference point.

8. Method according to any of claims 1 to 7, wherein the aggregation bearer on the S1 reference point is released based on inactivity for a configurable time period.

9. Method according to any of claims 1 to 8, wherein the creation of groups of terminals is performed by the MME on the basis of one or more features received in the subscription data of said terminals.

10. Method according to any of claims 1 to 9, wherein a group of terminals is addressed by using a group IMSI, wherein a terminal within said group is identified via said group IMSI together with a terminal specific Sub-ID.

11. Method according to any of claims 1 to 9, wherein a group of terminals is addressed by using a group ID, wherein a terminal within said group is identified via said group ID together with its conventional IMSI.

12. Method according to any of claims 1 to 11, wherein said terminals are configured to indicate whether they prefer to join an aggregation bearer or whether they prefer the creation of a bearer for their own, in particular by setting a corresponding flag in the Attach Request.

13. Method according to any of claims 1 to 12, wherein the default QoS for said aggregation bearer is set to be Best Effort without Guaranteed Bitrate.

14. Method according to any of claims 1 to 13, wherein policy and/or QoS control is performed at each time a new terminal joins the aggregation bearer.

15. Method according to any of claims 1 to 14, wherein the number of terminals that form a group for which an aggregation bearer is created is limited to a predefined maximum value.

16. Method according to any of claims 1 to 15, wherein for downlink data delivery to terminals in IDLE state, said base station generates a paging message based on the UE's context stored in said base station and performs paging of the UE.

17. System for performing bearer configurations in a 3GGP access network, comprising at least one base station being capable of serving a number of terminals,

c h a r a c t e r i z e d i n at least one entity is provided that is configured

to group terminals that reside at said base station according to configurable criteria, and

to create only a single bearer – aggregation bearer – per group of terminals.

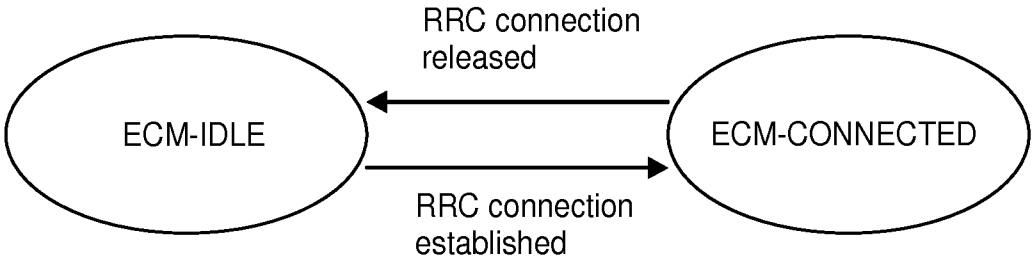

Fig. 1
Prior art

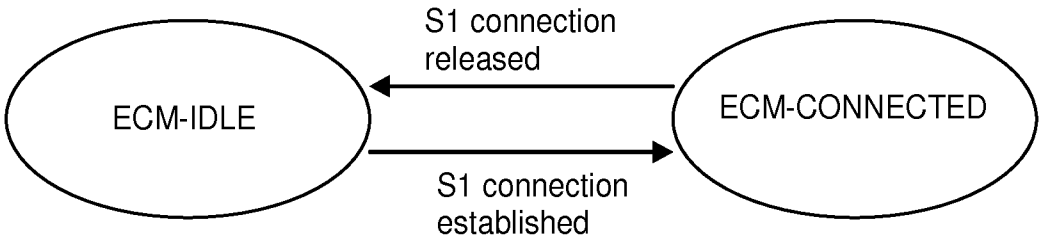

Fig. 2
Prior art

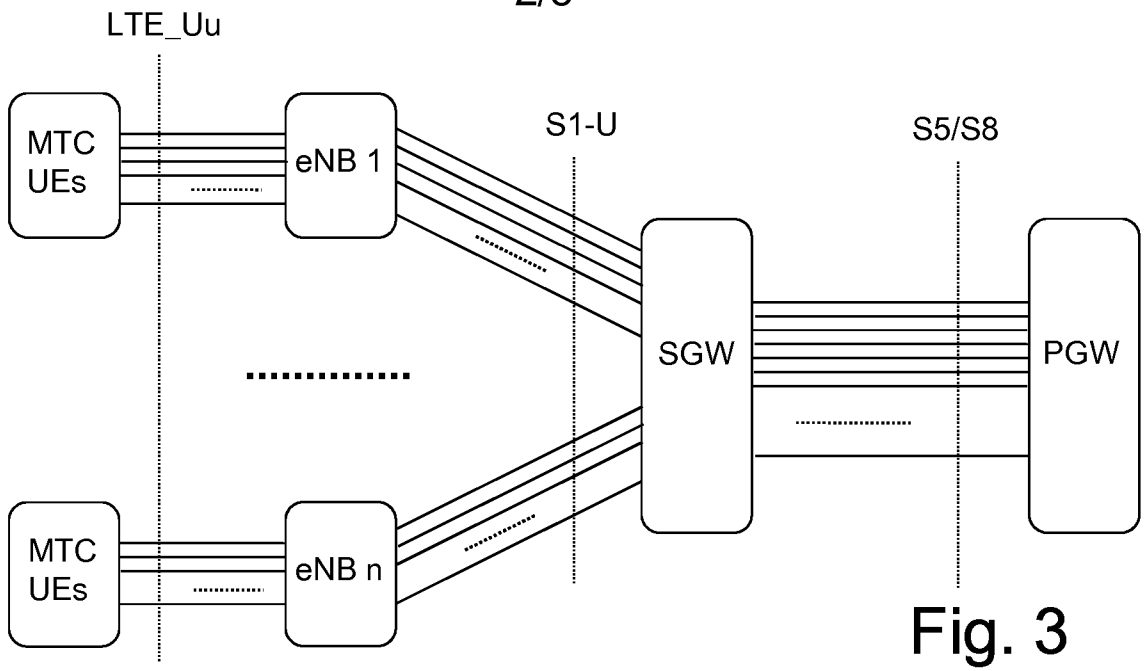

Fig. 3
Prior art

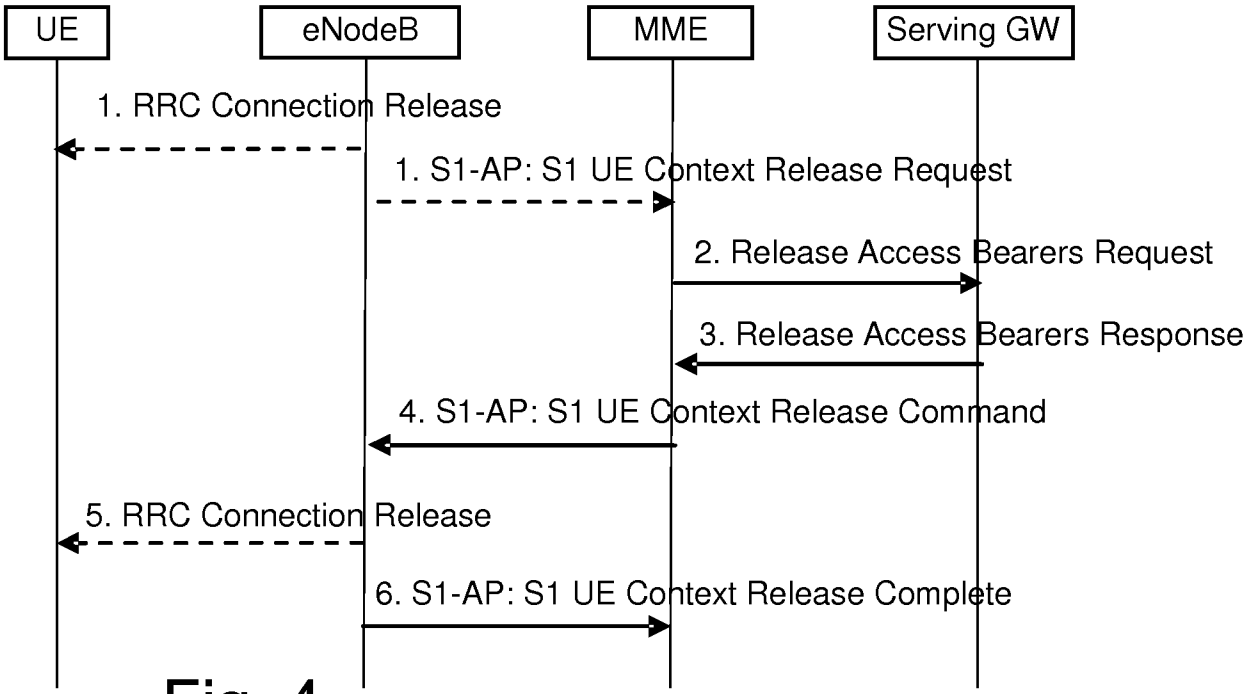

Fig. 4
Prior art

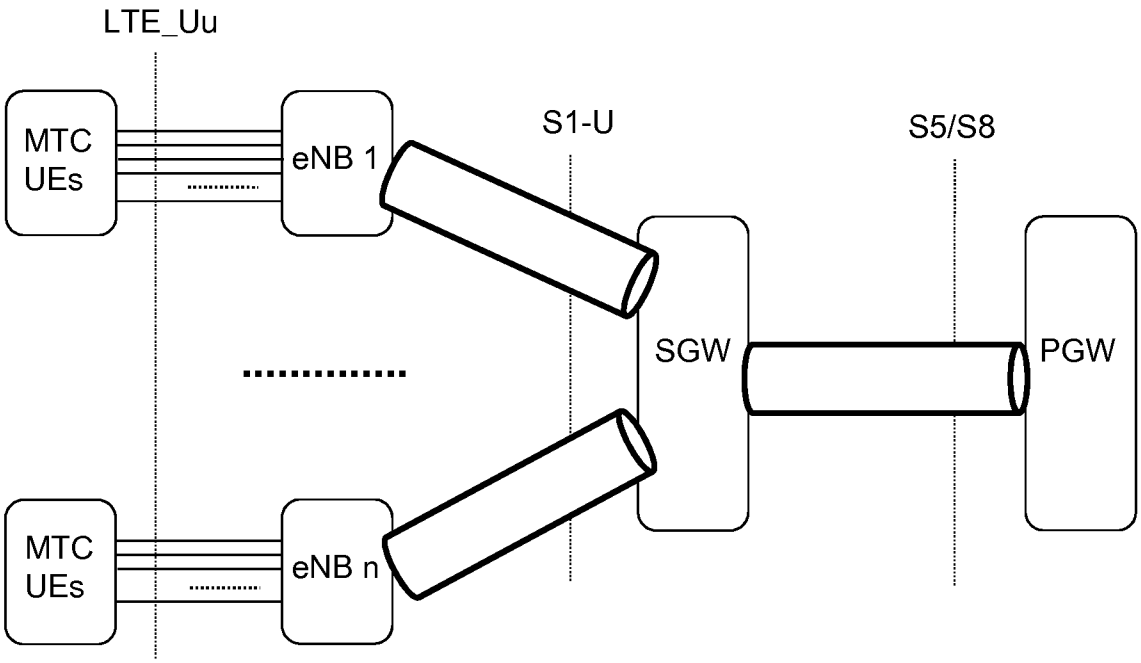

Fig. 5

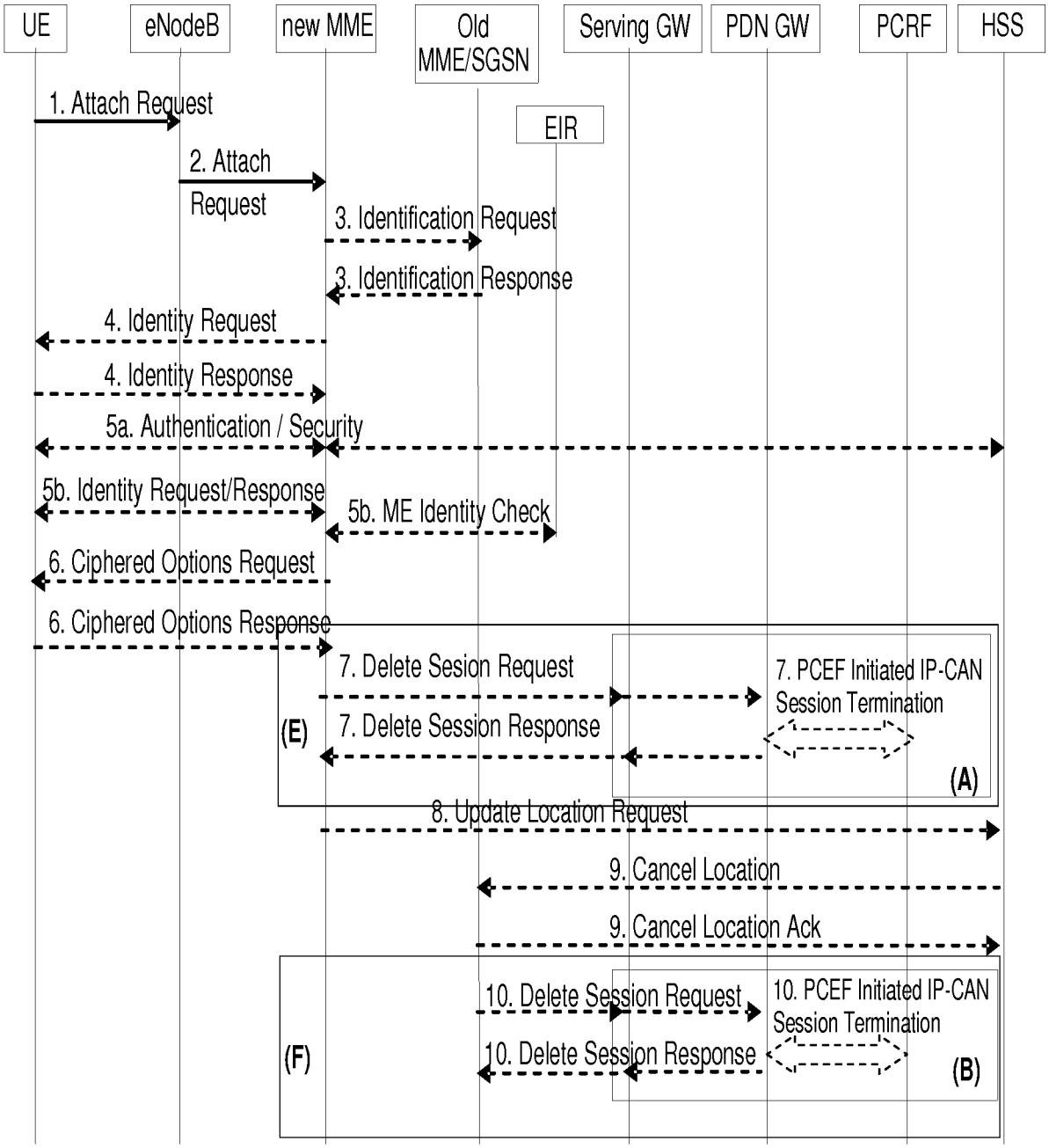

Fig. 6a
Prior art

continuation in Fig. 6b

continuation from Fig. 6a

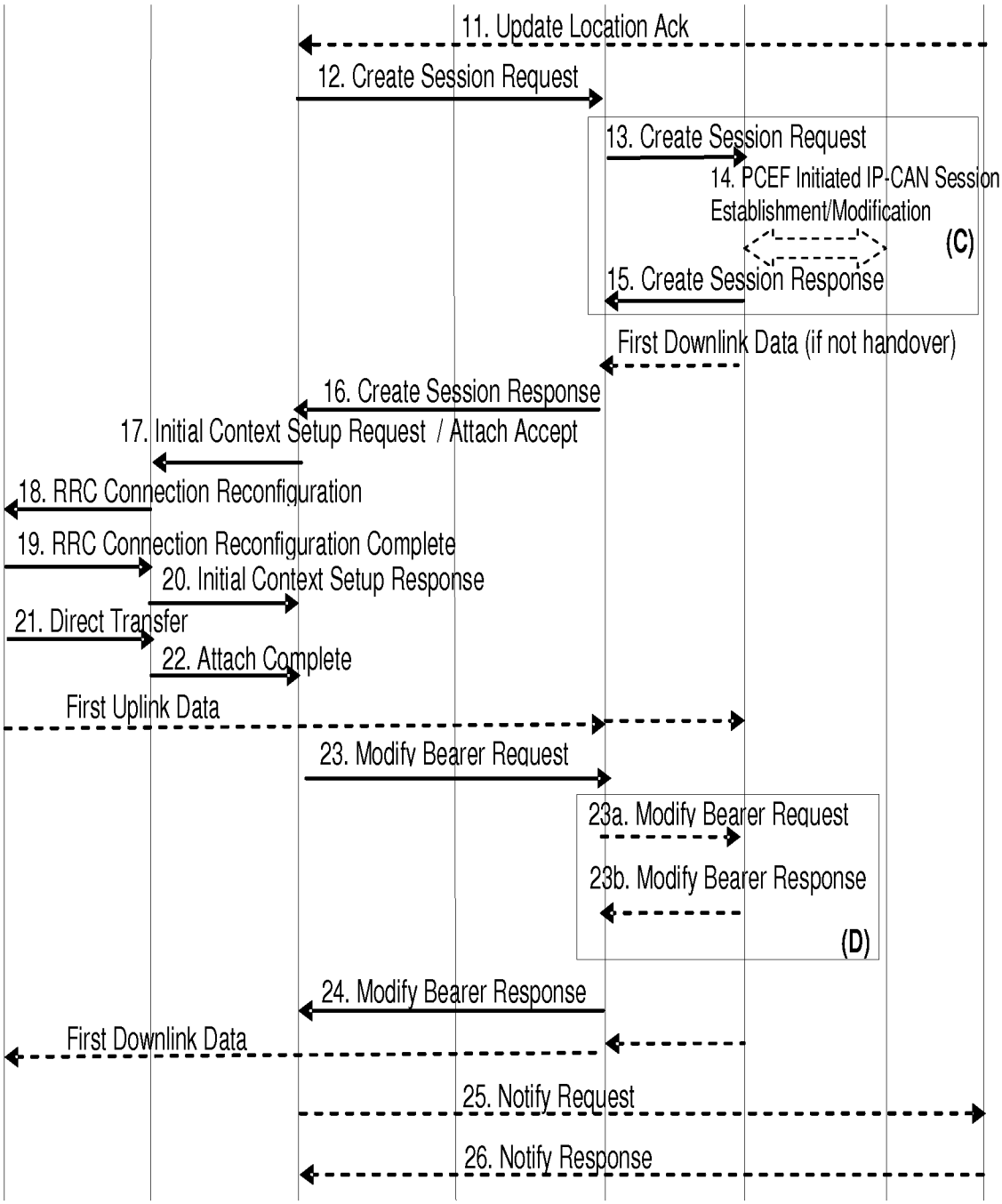

Fig. 6b
Prior art

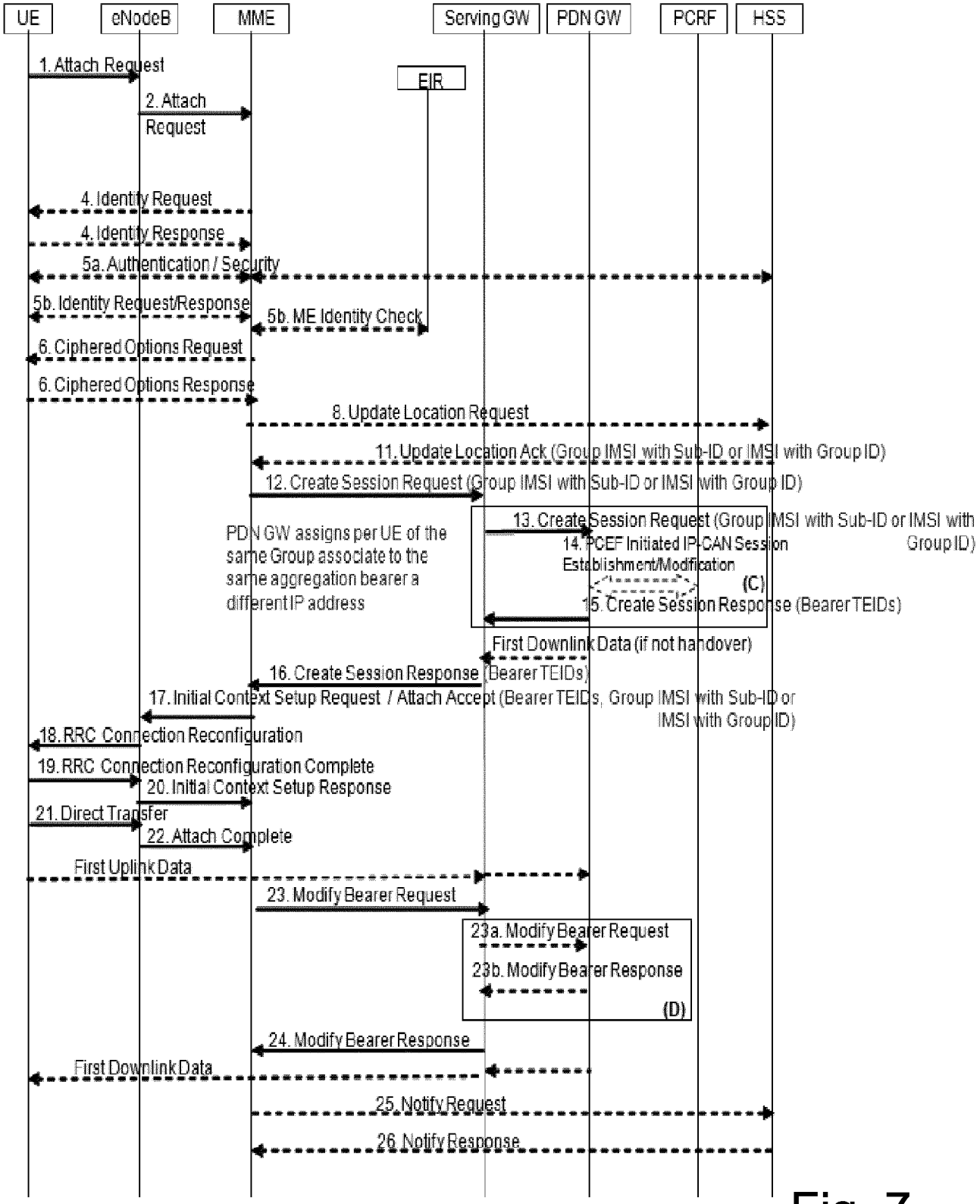
UE
eNodeB
MME
EIR
Serving GW
PDN GW
PCRF
HSS
1. Attach Request
2. Attach Request
4. Identity Request
4. Identity Response
5a. Authentication / Security
5b. Identity Request/Response
5b. ME Identity Check
6. Ciphered Options Request
6. Ciphered Options Response
8. Update Location Request
11. Update Location Ack (Group IMSI with Sub-ID or IMSI with Group ID)
12. Create Session Request (Group IMSI with Sub-ID or IMSI with Group ID)
13. Create Session Request (Group IMSI with Sub-ID or IMSI with Group ID)
PDN GW assigns per UE of the same Group associate to the same aggregation bearer a different IP address
14. PCEF Initiated IP-CAN Session Establishment/Modification
(C)
15. Create Session Response (Bearer TEIDs)
First Downlink Data (if not handover)
16. Create Session Response (Bearer TEIDs)
17. Initial Context Setup Request / Attach Accept (Bearer TEIDs, Group IMSI with Sub-ID or IMSI with Group ID)
18. RRC Connection Reconfiguration
19. RRC Connection Reconfiguration Complete
20. Initial Context Setup Response
21. Direct Transfer
22. Attach Complete
First Uplink Data
23. Modify Bearer Request
23a. Modify Bearer Request
23b. Modify Bearer Response
(D)
24. Modify Bearer Response
First Downlink Data
25. Notify Request
26. Notify Response

Fig. 7

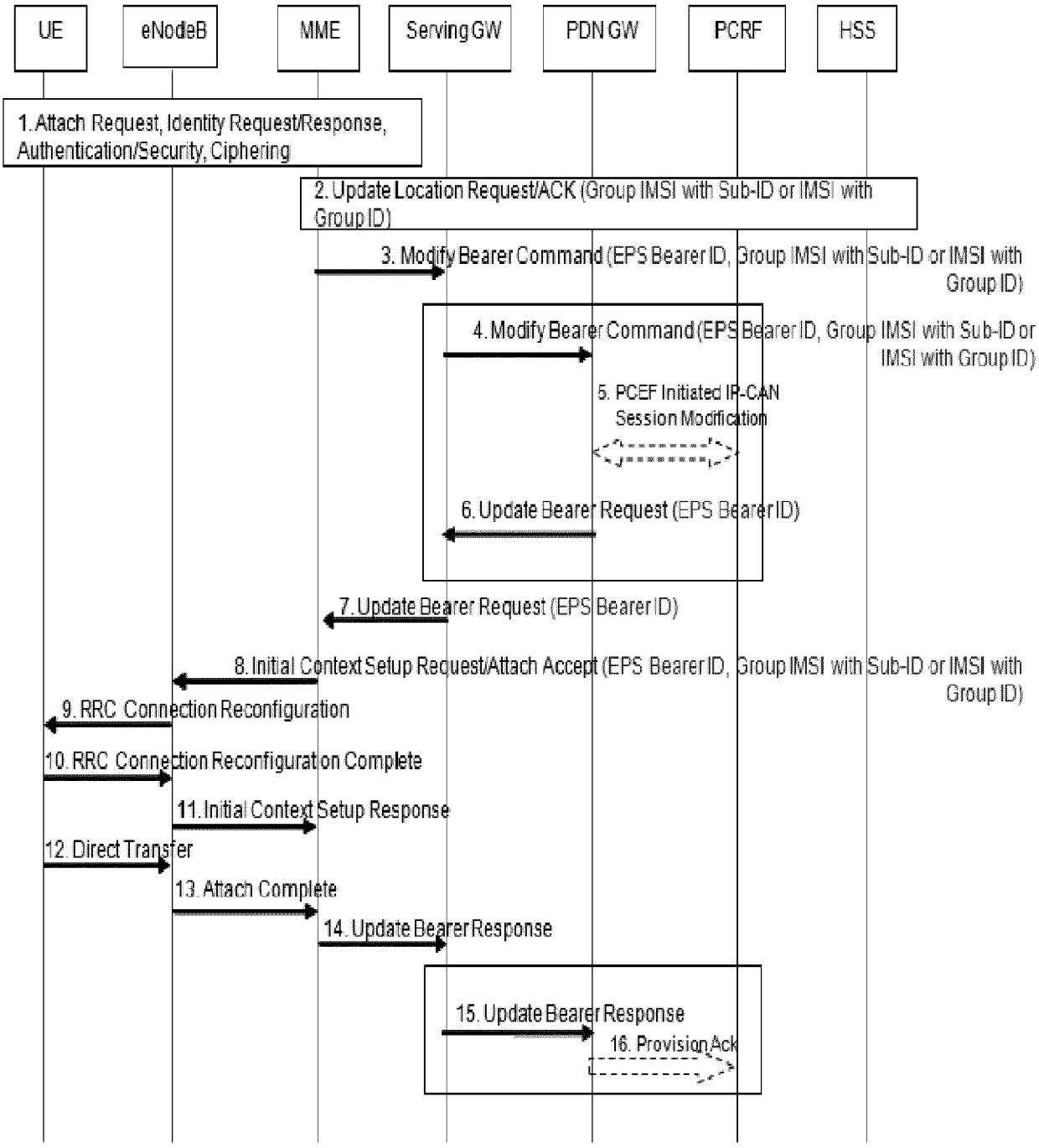
UE
eNodeB
MME
Serving GW
PDN GW
PCRF
HSS
1. Attach Request, Identity Request/Response, Authentication/Security, Ciphering
2. Update Location Request/ACK (Group IMSI with Sub-ID or IMSI with Group ID)
3. Modify Bearer Command (EPS Bearer ID, Group IMSI with Sub-ID or IMSI with Group ID)
4. Modify Bearer Command (EPS Bearer ID, Group IMSI with Sub-ID or IMSI with Group ID)
5. PCEF Initiated IP-CAN Session Modification
6. Update Bearer Request (EPS Bearer ID)
7. Update Bearer Request (EPS Bearer ID)
8. Initial Context Setup Request/Attach Accept (EPS Bearer ID, Group IMSI with Sub-ID or IMSI with Group ID)
9. RRC Connection Reconfiguration
10. RRC Connection Reconfiguration Complete
11. Initial Context Setup Response
12. Direct Transfer
13. Attach Complete
14. Update Bearer Response
15. Update Bearer Response
16. Provision Ack

Fig. 8

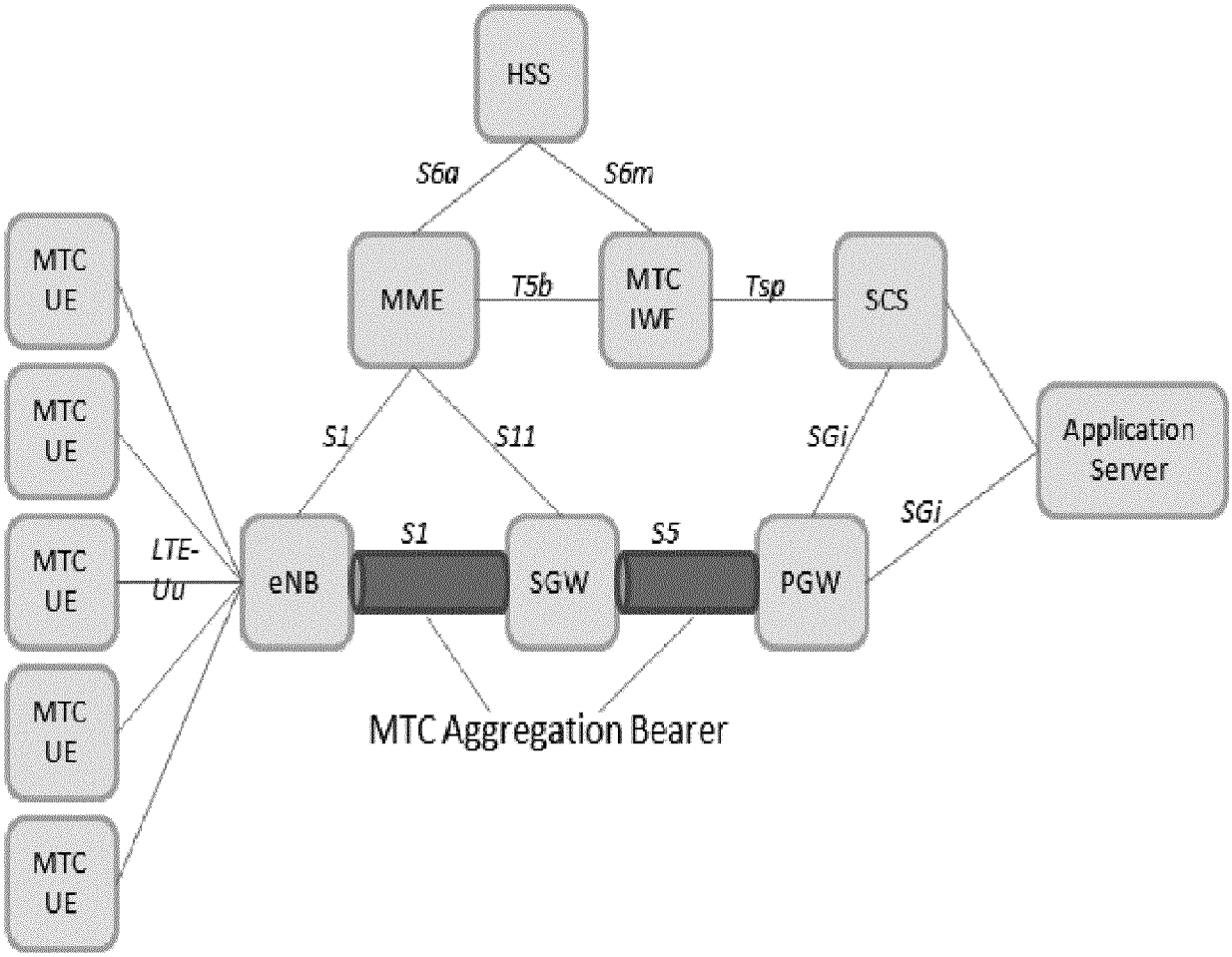
HSS
S6a
S6m
MTC UE
MTC UE
MTC UE
MTC UE
MTC UE
MME
T5b
MTC IWF
Tsp
SCS
Application Server
S1
S11
SGi
LTE-Uu
eNB
S1
SGW
S5
PGW
SGi
MTC Aggregation Bearer

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/065306

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W76/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, COMPENDEX, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	ZTE: "The group bearer for MTC", 3GPP DRAFT; S2-100094_GROUP BEARER, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. SA WG2, no. Shenzhen; 20100118, 12 January 2010 (2010-01-12), XP050432722, [retrieved on 2010-01-12]	1-7,17
Y	the whole document	8-16

X	WO 2012/050360 A2 (SAMSUNG ELECTRONICS CO LTD [KR]; JAMADAGNI SATISH NANJUNDA SWAMY [IN];) 19 April 2012 (2012-04-19) paragraph [0005] paragraph [0016] - paragraph [0024] figures 1, 3, 4	1-6,17

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

[X] See patent family annex.

* Special categories of cited documents :

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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 November 2013	19/11/2013

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

1

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	NTT DOCOMO ET AL: "Inactivity timer management function", 3GPP DRAFT; S2-120475, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. SA WG2, no. Vancouver Canada; 20120206 - 20120210, 31 January 2012 (2012-01-31), XP050576350, [retrieved on 2012-01-31] page 52, paragraph 5.XX --- WO 2012/041363 A1 (FUJITSU LTD [JP]; BUCKNELL PAUL [GB]; LI ZHAOJUN [GB]) 5 April 2012 (2012-04-05) page 1, line 5 - line 8 page 3, line 23 - page 4, line 35 page 6, line 31 - page 7, line 4 page 12, line 21 - line 31 page 17, line 15 - line 30 figures 10, 12 --- US 2012/155391 A1 (KIM CHANG KI [KR] ET AL) 21 June 2012 (2012-06-21) paragraphs [0003], [0006] paragraph [0012] - paragraph [0014] paragraph [0018] - paragraph [0019] paragraph [0047] - paragraph [0052] paragraph [0058] - paragraph [0062] paragraph [0076] - paragraph [0085] figures 1, 2, 4, 5 --- HUAWEI: "Network Improvement for Group Based Policing", 3GPP DRAFT; S2-100243_NETWORK IMPROVEMENTS FOR GROUP BASED POLICING, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. SA WG2, no. Shenzhen, China; 20100118 - 20100122, 12 January 2010 (2010-01-12), XP050630465, [retrieved on 2010-01-12] page 1, paragraph 2 page 2, paragraph 5.x.3.1.1 --- -/--	8 9-11,16 12 13-15

1

International application No
PCT/EP2013/065306

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	NEC: "Solution for Frequent Small Data with S1/S5/S8 Bearer Aggregation", 3GPP DRAFT; S2-123887_SDDTE, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. SA WG2 2 October 2012 (2012-10-02), XP050683583, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_93_Sofia/Docs/ [retrieved on 2012-10-02] the whole document -----	1-17

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2013/065306

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2012050360 A2	19-04-2012	AU 2011314515 A1	04-04-2013
		CN 103155636 A	12-06-2013
		EP 2628288 A2	21-08-2013
		US 2013195017 A1	01-08-2013
		WO 2012050360 A2	19-04-2012
WO 2012041363 A1	05-04-2012	CN 103120004 A	22-05-2013
		EP 2622923 A1	07-08-2013
		US 2013286957 A1	31-10-2013
		WO 2012041363 A1	05-04-2012
US 2012155391 A1	21-06-2012	KR 20120070442 A	29-06-2012
		US 2012155391 A1	21-06-2012