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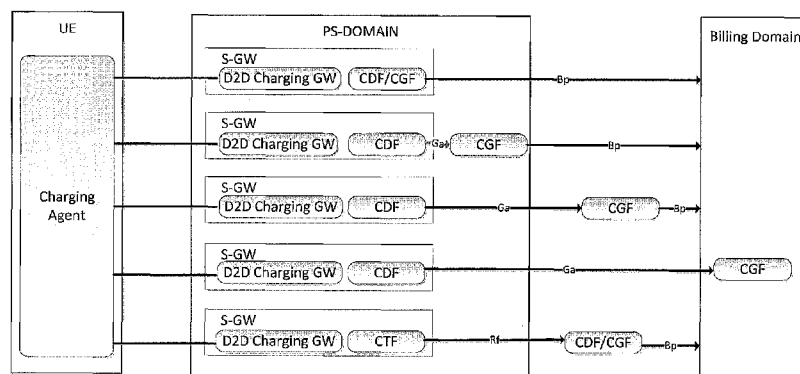


Figure 7

(57) Abstract: A method and apparatus for charging device to device traffic are provided. The method comprises the following steps: receiving a non-access stratum (NAS) connection establishment confirmation message comprising charging related information, and collecting charging data regarding a device to device communication based on said charging related information.

METHOD AND APPARATUS FOR CHARGING DEVICE TO DEVICE TRAFFICField

5 The present invention relates to charging device to device traffic. More specifically, the present invention exemplarily relates to measures (including methods, apparatuses and computer program products) for realizing charging device to device traffic.

10 Background

The present specification generally relates to the field of device to device (device-to-device, D2D) data communication. D2D data communication is within the scope of 3rd Generation Partnership Project (3GPP) Proximity
15 Service (ProSe). ProSe is a highly active topic in Long Term Evolution (LTE) Release 12 (Rel-12).

According to 3GPP packet switched (PS) domain charging standard, charging information in the PS domain network is collected for each mobile
20 station (MS)/user equipment (UE) by packet switched core network (PCN) nodes including e.g. serving GPRS support nodes (SGSN), serving gateways (S-GW) and packet data network gateways (P-GW), which are serving that MS/UE. The SGSN and the S-GW collect charging information for each MS/UE related to the radio network usage, and the P-GW collects charging
25 information for each MS related to the external data network usage.

In the following, the S-GW is taken as an example. However, the problems addressed herein also apply to other PCN nodes, including SGSN and P-GW. Accordingly, the solutions proposed herein also apply or can be easily
30 extended to SGSN and P-GW.

According to 3GPP technical specifications, an S-GW should collect a set of charging information for a UE. One piece thereof is usage information of the radio interface. The information includes the amount of data transmitted in
35 mobile-originated and mobile-terminated directions categorized with quality

of service (QoS) and user protocols. S-GW may simply implement a solution to collect this information, as UE-originated and/or UE-terminated data traffic goes through the S-GW node.

5 Figure 4 shows a simplified illustration of data communication between two UEs under the simplifying assumption that they are served by the same evolved Node B (eNodeB, eNB) via 3GPP network. When a packet is generated from a UE1, it flows through eNodeB, S-GW, P-GW, S-GW, eNodeB, and arrives at a UE2. It is straightforward for the S-GW to collect
10 the incoming and outgoing data volume of UE1 and UE2.

The straightforward implementation of S-GW counting data volume becomes infeasible when UE1 and UE2 conduct D2D data communication. Figure 5 shows a simplified illustration of D2D data communication between
15 two UEs. In this case, data packets are exchanged directly over the radio, thereby bypassing the network. Accordingly, since the network (including the S-GW) is bypassed, it is infeasible for the S-GW to directly count data volume flowing in and out of the two UEs performing a D2D communication.

20 D2D data communication may offer great benefit of reducing radio interface load, and it is therefore highly attractive to service operators. On the other hand, it is critical for a service operator to find an appropriate method for accurately collecting charging information. Namely, such method should satisfy at least two requirements. First, such method should support the
25 existing business model. For example, a majority of service providers support volume based billing for data traffic. Accordingly, D2D data communication should support the volume-based billing. Second, the new charging method should be transparent to the end user. The billing should use the same form no matter whether D2D data communication is adopted
30 or not. For example, in Figure 5, the billing for UE1 and UE2 should be of the same form no matter if they are far away or close to each other (D2D communication takes place). The users usually have no interest to know whether their traffic has gone through a D2D path (according to Figure 5) and a traditional public land mobile network (PLMN) path (according to
35 Figure 4).

Currently, charging in case of D2D data communication is sparsely discussed.

5 In document US 2010/0009675, basic options for billing of D2D data communications are mentioned. According to one option, a fixed billing or a flat-rate contract is applied. According to a further option, a time-based charging is proposed. Namely, the billing is a rate times the duration of D2D connections (collected by a PCN node). As a further option, it is proposed
10 that the UE may locally maintain billing information and forward it when the D2D connection ends.

While the first two options may satisfy many charging situations and may be relatively easy implemented, they cannot support the most pervasive
15 billing model, namely, volume-based billing.

Although the third option points out the direction of a volume-based billing solution, i.e., that a UE may collect the inbound and outbound traffic in case of D2D data communication and feed the charging information to the S-GW,
20 the document handles that option only peripherally and the design challenges are left unresolved.

Hence, there is a need to provide for charging device to device traffic. In particular, there is a need for a charging that enables a volume-based
25 billing, and that handles at least some of the above mentioned problems.

Summary

Various exemplary embodiments of the present invention aim at addressing
30 at least part of the above issues and/or problems and drawbacks.

Various aspects of exemplary embodiments of the present invention are set out in the appended claims.

According to an exemplary aspect of the present invention, there is provided a method comprising receiving a nas connection establishment confirmation message comprising charging related information, and collecting charging data regarding a device to device communication based on said charging related information.

According to an exemplary aspect of the present invention, there is provided a method comprising receiving a charging delegation request message comprising charging related information for an upcoming device to device communication connection establishment, and transmitting a nas connection establishment confirmation message comprising said charging related information.

According to an exemplary aspect of the present invention, there is provided a method comprising receiving a connection establishment indication message indicative of an upcoming device to device communication connection establishment, and transmitting a charging delegation request message comprising charging related information for said upcoming device to device communication connection establishment.

According to an exemplary aspect of the present invention, there is provided an apparatus comprising at least one processor, at least one memory including computer program code, and at least one interface configured for communication with at least another apparatus, the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform receiving a nas connection establishment confirmation message comprising charging related information, and collecting charging data regarding a device to device communication based on said charging related information.

According to an exemplary aspect of the present invention, there is provided an apparatus comprising at least one processor, at least one memory including computer program code, and at least one interface configured for communication with at least another apparatus, the at least one processor, with the at least one memory and the computer program

code, being configured to cause the apparatus to perform receiving a charging delegation request message comprising charging related information for an upcoming device to device communication connection establishment, and transmitting a nas connection establishment
5 confirmation message comprising said charging related information.

According to an exemplary aspect of the present invention, there is provided an apparatus comprising at least one processor, at least one memory including computer program code, and at least one interface
10 configured for communication with at least another apparatus, the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform receiving a connection establishment indication message indicative of an upcoming device to device communication connection establishment, and transmitting
15 a charging delegation request message comprising charging related information for said upcoming device to device communication connection establishment.

According to an exemplary aspect of the present invention, 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
20 aforementioned apparatus-related exemplary aspects of the present invention), is configured to cause the computer to carry out the method according to any one of the aforementioned method-related exemplary
25 aspects of the present invention.

Such computer program product may comprise (or be embodied) a (tangible) computer-readable (storage) medium or the like on which the
30 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.

Any one of the above aspects enables an efficient determination of relevant
35 charging information related to device to device communications to thereby

solve at least part of the problems and drawbacks identified in relation to the prior art.

By way of exemplary embodiments of the present invention, there is
5 provided charging device to device traffic. More specifically, by way of
exemplary embodiments of the present invention, there are provided
measures and mechanisms for realizing charging device to device traffic.

Thus, improvement is achieved by methods, apparatuses and computer
10 program products enabling/realizing charging device to device traffic.

Brief description of the drawings

In the following, the present invention will be described in greater detail by
15 way of non-limiting examples with reference to the accompanying drawings,
in which

Figure 1 is a schematic diagram of a procedure according to exemplary
embodiments of the present invention,
20

Figure 2 is a schematic diagram of a procedure according to exemplary
embodiments of the present invention,

Figure 3 is a schematic diagram of a procedure according to exemplary
25 embodiments of the present invention,

Figure 4 is a schematic diagram of signaling sequences of a simplified data
communication not implementing device to device mechanisms,

30 Figure 5 is a schematic diagram of signaling sequences of a simplified data
communication implementing device to device mechanisms,

Figure 6 shows a schematic diagram illustrating charging design options,

Figure 7 shows a schematic diagram illustrating charging design options according to exemplary embodiments of the present invention,

5 Figure 8 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention,

Figure 9 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention,

10 Figure 10 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention,

Figure 11 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention,

15

Figure 12 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention,

20 Figure 13 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention,

Figure 14 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention,

25 Figure 15 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention,

Figure 16 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention,

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Figure 17 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention, and

35 Figure 18 shows a schematic block diagram illustrating exemplary apparatuses according to exemplary embodiments of the present invention.

Detailed description of drawings and embodiments of the present invention

The present invention is described herein with reference to particular non-limiting examples and to what are presently considered to be conceivable embodiments of the present invention. A person skilled in the art will appreciate that the invention 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 invention and its embodiments mainly refers to specifications being used as non-limiting examples for certain exemplary network configurations and deployments. Namely, the present invention and its embodiments are mainly described in relation to 3GPP specifications being used as non-limiting examples for certain exemplary network configurations and deployments. As such, the description of exemplary embodiments 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 invention in any way. Rather, any other communication or communication related system deployment, etc. may also be utilized as long as compliant with the features described herein.

Hereinafter, various embodiments and implementations of the present invention and its aspects or embodiments are described using several variants and/or alternatives. It is generally noted that, according to certain needs and constraints, all of the described variants and/or alternatives may be provided alone or in any conceivable combination (also including combinations of individual features of the various variants and/or alternatives).

According to exemplary embodiments of the present invention, in general terms, there are provided measures and mechanisms for (enabling/realizing) charging device to device traffic.

According to exemplary embodiments of the present invention, the 3GPP PS domain offline charging architecture for D2D data communication is enhanced. In this architectural enhancement, a D2D charging agent module (residing in UEs) collects charging-relevant information, and feeds the information to PCN nodes. The PCN nodes process the collected charging information for charging service, such as generating Charging Data Record (CDR).

Hence, according to exemplary embodiments of the present invention, offline charging solutions for D2D data communications are provided.

In particular, according to exemplary embodiments of the present invention, a solution for volume-based charging of D2D data communication is provided. Specifically, the following aspects are provided.

For a D2D session, the S-GW delegates the task of collecting charging-relevant info to UEs before data is/are exchanged. According to exemplary embodiments of the present invention, respective signaling for several scenarios is proposed.

Further, UEs collect charging-relevant information, and report them to the S-GW. According to exemplary embodiments of the present invention, respective signaling for several reporting solutions is proposed.

The 3GPP PS domain offline charging architecture includes four important logical charging functions, namely, charging trigger function (CTF), charging data function (CDF), charging gateway function (CGF), and billing domain.

According to 3GPP PS domain charging standards, the S-GW may include the CTF to generate charging events and forward them to the CDF. The CDF, in turn, may generate CDRs which may then be transferred to the CGF. Finally, the CGF may create CDR files and may forward them to the billing domain.

The above mentioned architecture may be modified in that the S-GW may integrate CDF and/or CGF function as shown in Figure 6.

In Figure 6, five (exemplary) different S-GW offline charging architectural options are illustrated. One common feature is that S-GW collects charging information including received and transmitted data volume of individual UEs.

However, as already mentioned above, it may be infeasible for the S-GW to collect charging information for D2D data communication between UEs, as the data traffic does not go through S-GW in the D2D communication mode, i.e. bypassing the network.

According to exemplary embodiments of the present invention, an architectural enhancement for D2D data communication offline charging is proposed as illustrated in Figure 7. In Figure 7, five (exemplary) different S-GW offline charging architectural options according to exemplary embodiments of the present invention are illustrated.

In the proposed architecture according to exemplary embodiments of the present invention, a D2D charging gateway (GW) module is implemented in S-GW, and a D2D charging agent function is implemented in UE. The D2D charging GW may delegate the task of collecting charging information to the charging agent function within a UE. When data is/are exchanged, the D2D charging agent is responsible for collecting charging data, including but not limited to, received data volume, transmitted data volume and connection duration. It further reports the charging data to the D2D charging GW. A UE may report the charging data periodically, upon event/condition, or at the end of D2D communication. The charging data may be used to generate billing information at a later time.

According to exemplary embodiments of the present invention, several mechanisms are proposed according to which an S-GW may assign the charging task to a charging agent (in a UE).

A D2D charging GW arranges a charging agent to conduct a charging task during the D2D connection setup procedure. The D2D connection setup procedure may vary, depending on a number of factors, such as whether UEs are under 3GPP network coverage, whether network control exists during the D2D communication setup, which device (UE or eNB) initiates the D2D connection setup, how D2D radio resource is configured (eNB configured or UE configured), etc. The D2D establishment signaling (signaling sequence, signaling parameters) may also vary from one technical proposal to another.

The solutions according to exemplary embodiments of the present invention are proposed considering D2D scenarios, D2D communication setup scenarios and D2D setup signaling under following conditions.

Namely, eNB detects the opportunities for D2D communications, and initiates the setup process, and the network nodes control the communication setup process, and further, the UEs are under 3GPP network coverage, and under continuous network control.

These conditions fall into the scope of 3GPP ProSe feasibility studies. A person skilled in the art will, however, appreciate that exemplary embodiments of the present invention are by no means limited to these D2D communication scenarios, and may be applied/extended to other D2D communication scenarios beyond the conditions above.

Figure 1 is a schematic diagram of a procedure according to exemplary embodiments of the present invention.

As shown in Figure 1, a procedure according to exemplary embodiments of the present invention comprises an operation of receiving (S11) a nas (non-access stratum (NAS)) connection establishment confirmation message comprising charging related information, and an operation of collecting (S12) charging data regarding a device to device communication based on said charging related information.

Figure 2 is a schematic diagram of a procedure according to exemplary embodiments of the present invention.

As shown in Figure 2, a procedure according to exemplary embodiments of the present invention comprises an operation of receiving (S21) a charging delegation request message comprising charging related information for an upcoming device to device communication connection establishment, and an operation of transmitting (S22) a nas connection establishment confirmation message comprising said charging related information.

Figure 3 is a schematic diagram of a procedure according to exemplary embodiments of the present invention.

As shown in Figure 3, a procedure according to exemplary embodiments of the present invention comprises an operation of receiving (S31) a connection establishment indication message indicative of an upcoming device to device communication connection establishment, and an operation of transmitting (S32) a charging delegation request message comprising charging related information for said upcoming device to device communication connection establishment.

Figure 8 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention.

In particular, Figure 8 depicts a D2D radio bearer setup initiated by the eNodeB that detects potential D2D traffic within the cell served by the eNodeB. In this case, UE1 and UE2 are served by the same eNodeB (wherein the eNB configures the UE1 and the UE2 for D2D setup) and are within the D2D range.

The setup process has four stages (a description of a non-D2D communication setup process is omitted for reasons of legibility). At stage 1, UE1 and UE2 exchange data via the core network. At this stage, S-GW directly collects various charging relevant information, including UE1-

originated, UE1-terminated, UE2-originated, and UE2-terminated traffic volume.

At stage 2, the eNodeB detects the presence of internet protocol (IP) traffic between devices in its cell and requests measurements from the UE1 to determine whether they are within D2D range (and whether both of them are D2D capable). Optionally, the eNodeB may request the UE2 to conduct the measurement too. The eNodeB decides to set up D2D connection based on the D2D measurement response from UEs and/or local policy.

At stage 3, the eNodeB sends D2D RADIO BEARER EST REQ (establishment request) message to UE1. The REQ message may include some parameters of UE2. UE1 sends NAS: D2D CONNECTION EST IND (establishment indication) message to mobility management entity (MME). This message informs that MME that a D2D bearer is to be established for UE1. It may contain information including the identifier (ID) of the corresponding non-D2D session. The MME further notifies S-GW about the D2D bearer by sending a D2D CONNECTION EST IND message. The S-GW responds with a D2D CHARGING DG REQ (delegation request) message. The message may include a charging ticket. The charging ticket describe the charging related information, including the charging ticket number, IDs of relevant (non-D2D) sessions, the ID of involved UEs, the method and policy for reporting charging data, etc. The MME then sends NAS: D2D CONNECTION CONF (confirmation) message to UE1. The message should at least include the charging ticket information.

According to exemplary embodiments of the present invention, an UE may report its charging data to the S-GW for example as session-end report, proactive report, reactive report, or piggyback report, as explained later.

The steps in stage 4 are similar to steps in stage 3, except that it applies to UE2.

At the end, UE1 and UE2 are ready to collect charging information for their inbound and outbound D2D traffic.

Hence, according to a variation of the procedure shown in Figure 1, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of transmitting a nas connection establishment indication message indicative of an upcoming device to device communication connection establishment.

Further, according to a variation of the procedure shown in Figure 2, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a nas connection establishment indication message indicative of said upcoming device to device communication connection establishment, and an operation of transmitting a connection establishment indication message including at least part of information of said nas connection establishment indication message.

Figure 9 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention.

In particular, Figure 9 depicts a D2D radio bearer setup initiated by the eNodeB that detects potential D2D traffic within the cell served by the eNodeB. The steps are similar to those described in relation to Figure 8 except the way UE2 is configured for D2D communication. In Figure 8, both UEs are configured by the same eNodeB. In Fig. 9, the eNodeB configures UE1 first, and UE1 configures UE2 at the stage 4.

Figure 10 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention.

In particular, Figure 10 depicts a D2D radio bear setup initiated by the eNodeB. In this case, UE1 is served by eNodeB1 and UE2 is served by eNodeB2 with eNode1 and eNode2 serving neighboring cells.

5 Compared with Figures 8 and 9, Figure 10 shows an additional step, in which eNodeB1 finds (determines) its neighboring eNodeB2, as depicted by stage 1.1 ENodeB1 detects IP traffic between devices in the same subnet (e.g. by sniffing IP packets). If the traffic fulfills certain criteria, the eNodeB1 contacts the S-GW to determine whether UE2 is served by a neighboring eNodeB2. If the device is served by a neighboring eNodeB2, as indicated in the response, the eNodeB1 sends a request for D2D setup to the eNodeB2. The setup request contains at least the IP address (or other identifier that is known to the eNodeB1) of UE2. If the eNodeB2 agrees to the request, it sends an affirmative response.

15

The process in stage1, stage 2, stage 3, and stage 4 is the same as shown in Figure 8.

20 As mentioned above, according to exemplary embodiments of the present invention, an UE may report its charging data to the S-GW for example as session-end report, proactive report, reactive report, or piggyback report.

Namely, during the connection setup stage, an S-GW may indicate to the UE how it would like to receive the charging data in the charging ticket. A UE may also decide its report method according to its local policy.

25

In the following, four reporting methods are proposed, namely, session-end report, proactive report, reactive report, and piggyback report. A UE may also adopt a combination of multiple methods.

30

According to a variation of the procedure shown in Figure 1, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of transmitting said collected charging data.

35

According to a variation of the procedure shown in Figure 2, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according
5 to exemplary embodiments of the present invention may comprise an operation of receiving charging data, and an operation of forwarding said charging data.

According to a variation of the procedure shown in Figure 3, exemplary
10 additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving charging data.

15 Session-end charging data report means that a UE reports its charging data when a session ends.

Figure 11 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention.

20 In particular, Figure 11 depicts the process of UE1 and UE2 updating charging data to the S-GW at the end of session, assuming that UE1 initiates the connection release.

25 UE1 first sends NAS: D2D CONNECTION DEL IND (deletion indication) message to MME. The message includes the charging data information. The MME forwards the charging data to S-GW by sending a D2D CONNECTION DEL IND message. In response, the S-GW sends a D2D CONNECTION DEL RSP (deletion response) message to MME, and then MME sends NAS: D2D
30 CONNECTION DEL CONF (deletion confirmation) message to UE1. The UE1 continues to release the radio bearer resource by sending a D2D RADIO BEARER DEL REQ (deletion request) message to eNodeB, and eNodeB responds by sending a D2D RADIO BEARER DEL RSP message.

Further, the eNodeB sends a D2D RADIO BEARER DEL REQ message to UE2. UE2 sends a NAS: D2D CONNECTION DEL IND message with its charging data to MME. The MME forwards the charging data to the S-GW by sending a D2D CONNECTION DEL IND message. In response, the S-GW
5 sends a D2D CONNECTION DEL RSP message to the MME, and MME sends a NAS: D2D CONNECTION DEL CONF message to UE2. The UE2 then sends a D2D RADIO BEARER DEL RSP message. The D2D connection release is completed.

10 Hence, according to a variation of the procedure shown in Figure 1, exemplary details of the transmitting operation (transmitting said collected charging data) are given, which are inherently independent from each other as such.

15 Such exemplary transmitting operation according to exemplary embodiments of the present invention may comprise an operation of transmitting a nas connection deletion indication message indicative of termination of said device to device communication including said collected charging data.

20

Further, according to a variation of the procedure shown in Figure 1, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present
25 invention may comprise an operation of receiving a nas connection deletion confirmation message.

Further, according to a variation of the procedure shown in Figure 1, exemplary additional operations are given, which are inherently
30 independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of transmitting a device to device radio bearer deletion request message, and an operation of receiving a device to device radio bearer deletion response message.

35

Further, according to a variation of the procedure shown in Figure 1, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a device to device radio bearer deletion request message, and an operation of transmitting a device to device radio bearer deletion response message.

Further, according to a variation of the procedure shown in Figure 2, exemplary details of the receiving operation (receiving said charging data) and the forwarding operation (forwarding said charging data) are given, which are inherently independent from each other as such.

Such exemplary receiving operation according to exemplary embodiments of the present invention may comprise an operation of receiving a nas connection deletion indication message indicative of termination of a device to device communication including said charging data. Further, such exemplary forwarding operation according to exemplary embodiments of the present invention may comprise an operation of transmitting a connection deletion indication message including at least said charging data.

Further, according to a variation of the procedure shown in Figure 2, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a connection deletion response message, and an operation of transmitting a nas connection deletion confirmation message.

Further, according to a variation of the procedure shown in Figure 3, exemplary details of the receiving operation (receiving said charging data) are given, which are inherently independent from each other as such.

Such exemplary receiving operation according to exemplary embodiments of the present invention may comprise an operation of receiving a

connection deletion indication message indicative of termination of a device to device communication including said charging data.

Further, according to a variation of the procedure shown in Figure 3, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of transmitting a connection deletion response message.

Hence, according to exemplary embodiments of the present invention, a simple design for reporting charging data can be provided.

If, for example, a UE device has been in a D2D session for a long period of time and have incurred a large traffic volume, in case it then fails accidentally and does not have a chance to finish the normal session-end signaling exchange, the operator may miss a significant amount of revenue. The following solutions according to exemplary embodiments address also this issue.

Figure 12 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention.

Proactive report means that a UE decides when to report the charging data autonomously. Reports may take place periodically or when certain conditions are satisfied (e.g. when certain amount of traffic volume has received/sent since the last report). The conditions and/or the report period may be defined in the charging ticket received from the S-SW.

Figure 12 depicts the process of UE1 updating charging data to the S-GW proactively. The update is conducted in the following steps. First, UE1 sends NAS: D2D CONNECTION STATUS UPDATE message to the MME. The message includes the charging data. The MME then sends the charging data to S-GW in the D2D CONNECTION STATUS UPDATE message. The S-GW may optionally send a D2D CONNECTION STATUS UPDATE CONF message

to the MME. In turn, the MME may send a NAS: D2D CONNECTION STATUS UPDATE CONF message to UE1.

Hence, according to a variation of the procedure shown in Figure 1,
5 exemplary details of the transmitting operation (transmitting said collected charging data) are given, which are inherently independent from each other as such.

Such exemplary transmitting operation according to exemplary
10 embodiments of the present invention may comprise an operation of transmitting, upon a predetermined update condition, a nas connection status update message indicative of an update of said collected charging data including said collected charging data. According to exemplary
15 embodiments of the present invention, the predetermined update condition may be at least one of an elapsed predetermined period of time, a received predetermined amount of traffic volume, and a transmitted predetermined amount of traffic volume.

Further, according to a variation of the procedure shown in Figure 1,
20 exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a nas connection status update confirmation message.

Further, according to a variation of the procedure shown in Figure 2,
exemplary details of the receiving operation (receiving said charging data) and the forwarding operation (forwarding said charging data) are given, which are inherently independent from each other as such.

Such exemplary receiving operation according to exemplary embodiments
of the present invention may comprise an operation of receiving a nas connection status update message indicative of an update of said charging data including said charging data. Further, such exemplary forwarding
35 operation according to exemplary embodiments of the present invention

may comprise an operation of transmitting a connection status update message including at least said charging data.

Further, according to a variation of the procedure shown in Figure 2,
5 exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a connection status update confirmation message, and an operation of transmitting a nas
10 connection status update confirmation message including at least part of information of said connection status update confirmation message.

Further, according to a variation of the procedure shown in Figure 3,
15 exemplary details of the receiving operation (receiving said charging data) are given, which are inherently independent from each other as such.

Such exemplary receiving operation according to exemplary embodiments of the present invention may comprise an operation of receiving a connection status update message indicative of an update of said charging
20 data including said charging data.

Further, according to a variation of the procedure shown in Figure 3,
25 exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of transmitting a connection status update confirmation message.

At the cost of potentially more traffic load, this solution is safer against
30 accidental data loss as charging data are updated along the session.

Figure 13 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention.

Reactive report means that a UE report its charging data upon receiving an S-GW inquiry.

Figure 13 depicts the process of UE1 updating charging data to the S-GW reactively. In this Figure, the S-GW initiates a charging data update process by sending a D2D CONNECTION STATUS POLL message to MME, and the MME then sends a NAS: D2D CONNECTION STATUS POLL message to UE1.

The actual report signaling, upon receipt of said NAS: D2D CONNECTION STATUS POLL message, is similar to that shown in Figure 12.

Hence, according to a variation of the procedure shown in Figure 1, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a nas connection status poll message indicative of a request for said collected charging data, wherein said predetermined update condition is a receipt of said connection status poll message.

Further, according to a variation of the procedure shown in Figure 2, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a connection status poll message indicative of a request for said charging data, and an operation of transmitting a nas connection status poll message including at least part of information of said connection status poll message.

Further, according to a variation of the procedure shown in Figure 3, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of transmitting a connection status poll message indicative of a request for said charging data.

This solution is also safer against accidental data loss and additionally offers chances to the S-GW to obtain/request charging data proactively.

5 Figure 14 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention.

A UE may also send its charging data to the S-GW by piggyback the charging data in other NAS messages exchanged between UE and MME. For
10 example, a UE may embed its charging data in the messages exchanged for tracking area update (TAU) procedure.

Figure 14 depicts a process of piggybacking charging data in TAU signaling exchange. The UE inserts the charging data in NAS: TAU Request message.
15 The MME exchanges the TAU Request and TAU Accept messages with the HSS to update the tracking area of UE. Optionally, the MME may send D2D CONNECTION STATUS UPDATE message to S-GW. The S-GW may optionally send a D2D CONNECTION STATUS UPDATE CONF message to the MME. Finally, the MME may send a NAS: TAU Accept message to UE. The message
20 may include a confirmation with regard to charging data.

Hence, according to a variation of the procedure shown in Figure 1, exemplary details of the transmitting operation (transmitting said collected charging data) are given, which are inherently independent from each other
25 as such.

Such exemplary transmitting operation according to exemplary embodiments of the present invention may comprise an operation of embedding said collected charging data into a scheduled control message,
30 and an operation of transmitting said control message according to its schedule.

Further, according to a variation of the procedure shown in Figure 1, exemplary additional operations are given, which are inherently
35 independent from each other as such. According to such variation, an

exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a response message corresponding to said control message including charging data confirmation information.

5

Further, according to a variation of the procedure shown in Figure 2, exemplary details of the receiving operation (receiving said charging data) and the forwarding operation (forwarding said charging data) are given, which are inherently independent from each other as such.

10

Such exemplary receiving operation according to exemplary embodiments of the present invention may comprise an operation of receiving a control message including said charging data, and an operation of extracting said charging data from said control message. Further, such exemplary forwarding operation according to exemplary embodiments of the present invention may comprise an operation of transmitting a connection status update message indicative of an update of said charging data including said charging data.

15

Further, according to a variation of the procedure shown in Figure 2, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a connection status update confirmation message, an operation of embedding charging data confirmation information into a response message corresponding to said control message, and an operation of transmitting said response message.

20

This solution updates charging data in the middle of the session, and incurs much less traffic load compared the two recently discussed solutions. However, as its operation depends on other NAS procedures (e.g. TAU signaling exchange), no guarantee can be achieved in terms of the maximum time gaps between two updates.

25

30

The ongoing 3GPP ProSe standardization effort may require the evolved packet system (EPS) be able to collect charging data for ProSe discovery features including the ability of a ProSe-enabled UE to be discoverable (including based on the range class), the ability to discover other ProSe-enabled UEs (including based on the range class), and the event of discovering a ProSe-enabled UE (including based on the range class).

Figure 15 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention.

Figure 15 depicts how an EPS may collect ProSe feature related charging data according to exemplary embodiments of the present invention.

A MME updates its record of ProSe capability and configuration for a UE from time to time. The update may be caused by a UE device is turned on/off. The update may take place when a UE enables ProSe UE discovery capability. The update may also incur when a ProSe UE enables its being discoverable feature.

When the MME get a new update, it may send UE D2D CAPABILITY UPDATE message to S-GW. The S-GW may generate charging data according to the charging policy.

If the message indicates that a UE is capable of discover ProSe enabled UEs, it may send a D2D EVENT CHARGING DG REQ message to MME. The message includes a charging ticket. The MME further sends a NAS:D2D EVENT ACCOUNTING REQ (UE CHARGING TICKET) message to the UE. Hereafter, the UE may account the UE discovery events according to the charging ticket.

Hence, according to a variation of the procedure shown in Figure 1, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a device to device event

accounting request message indicative of an instruction to collect device to device event charging data, said device to device event accounting request message comprising said charging related information, and an operation of collecting device to device event charging data based on said charging related information.

Further, according to a variation of the procedure shown in Figure 2, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of transmitting a device to device capability update message indicative of device to device capability of a communication endpoint.

Further, according to a variation of the procedure shown in Figure 2, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a device to device event charging delegation request message indicative of an instruction to collect device to device event charging data, said device to device event charging delegation request message comprising said charging related information, and an operation of transmitting a device to device event accounting request message comprising said charging related information.

Further, according to a variation of the procedure shown in Figure 3, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a device to device capability update message indicative of device to device capability of a communication endpoint.

Further, according to a variation of the procedure shown in Figure 3, exemplary additional operations are given, which are inherently

independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of transmitting a device to device event charging delegation request message indicative of an instruction to collect device to device event charging data, said device to device event charging delegation request message comprising said charging related information.

The UE may report the D2D discovery charging data to the network proactively.

The report may take place periodically or when certain conditions are satisfied (e.g. when certain amount of discovery events has been counted since the last report). The conditions and/or the report period may be defined in the charging ticket received from the S-SW. The report may also take place when a UE is disabled of ProSe UE discovery capability (by the user, or the operator). The report may also take place when a UE is turned off.

Accordingly, Figure 16 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention.

Figure 16 depicts the process of UE reporting D2D discovery charging data to the S-GW proactively. The report is conducted in the following steps. First, UE1 sends NAS: D2D EVENT CHARGING DATA UPDATE message to the MME. The message includes the charging data. The charging data may include the number of UE discovery events. The MME then sends the charging data to S-GW in the D2D EVENT CHARGING DATA UPDATE message. The S-GW may optionally send a D2D EVENT CHARGING DATA UPDATE CONF message to the MME. Finally, the MME may send a NAS: D2D EVENT CHARGING DATA UPDATE CONF message to UE.

Hence, according to a variation of the procedure shown in Figure 1, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an

exemplary method according to exemplary embodiments of the present invention may comprise an operation of transmitting, upon a predetermined event report condition, a nas device to device event charging data update message indicative of an update of said collected device to device event charging data. According to exemplary embodiments of the present invention, the predetermined event report condition may be at least one of an elapsed predetermined period of time, a counted predetermined amount of device to device discovery events, a disabling of a proximity service discovery capability of a communication endpoint, and a turning off of a communication endpoint.

Further, according to a variation of the procedure shown in Figure 1, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a nas device to device event charging data update confirmation message.

Further, according to a variation of the procedure shown in Figure 2, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a nas device to device event charging data update message indicative of an update of said device to device event charging data, and an operation of transmitting a device to device event charging data update message including at least part of information of said nas device to device event charging data update message.

Further, according to a variation of the procedure shown in Figure 2, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a device to device event charging data update confirmation message, and an operation of

transmitting a nas device to device event charging data update confirmation message including at least part of information of said device to device event charging data update confirmation message.

5 Still further, according to a variation of the procedure shown in Figure 3, exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a device to device event
10 charging data update message indicative of an update of said device to device event charging data.

Further, according to a variation of the procedure shown in Figure 3, exemplary additional operations are given, which are inherently
15 independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of transmitting a device to device event charging data update confirmation message.

20 The UE may report the D2D discovery charging data to the network in a reactive manner.

Accordingly, Figure 17 shows a schematic diagram of signaling sequences according to exemplary embodiments of the present invention.

25 Figure 17 depicts the process of the UE updating charging data to the S-GW reactively. In this Figure, the S-GW initiates a charging data update process by sending a D2D EVENT CHARGING DATA POLL message to MME, and the MME then sends a NAS: D2D EVENT CHARGING DATA POLL message to UE.

30 The actual report signaling is similar to what is shown in and discussed with reference to Figure 16.

Hence, according to a variation of the procedure shown in Figure 1,
35 exemplary additional operations are given, which are inherently

independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a nas device to device event charging data poll message indicative of a request for said collected
5 device to device event charging data, wherein said predetermined event report condition is a receipt of said device to device event charging data poll message.

Further, according to a variation of the procedure shown in Figure 2,
10 exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of receiving a device to device event charging data poll message indicative of a request for said device to device
15 event charging data, and an operation of transmitting a nas device to device event charging data poll message including at least part of information of said device to device event charging data poll message.

Further, according to a variation of the procedure shown in Figure 3,
20 exemplary additional operations are given, which are inherently independent from each other as such. According to such variation, an exemplary method according to exemplary embodiments of the present invention may comprise an operation of transmitting a device to device event charging data poll message indicative of a request for said device to
25 device event charging data.

In view of the above, it is noted (as in some cases above already mentioned) that said charging data is at least one of a received data volume, a transmitted data volume, and a device to device connection
30 duration, a number of UE discovery events, and/or said charging related information is at least one of a charging ticket number, an identifier of at least one corresponding non device to device session, identifiers of communication endpoints involved in said device to device communication, and information regarding reporting said charging data, and/or said
35 connection establishment indication message comprises an identifier of at

least one corresponding non device to device session, and/or said predetermined update condition is at least one of an elapsed predetermined period of time, a received predetermined amount of traffic volume, and a transmitted predetermined amount of traffic volume, and/or said
5 predetermined event report condition is at least one of an elapsed predetermined period of time, a counted predetermined amount of device to device discovery events, a disabling of a proximity service discovery capability of a communication endpoint, and a turning off of a communication endpoint.

10

Further, In case of roaming situation, visited S-GW should be able to send tickets to charging entity of billing system in home network according to the requirement in 3GPP specifications.

15 To implement proposed charging model, according to exemplary embodiments of the present invention the CTF function may be introduced into UE and CDF function into S-GW, and a new Rf reference point may be introduced between the UE and S-GW using control plane. CTF may collect ProSe specific events in the UE and forward the events to the CDF.

20

Although the technical complexity of the proposals according to exemplary embodiments of the present invention is medium, since a critical technical challenge at least from the operators view is handled therewith and currently the problem is only little considered, the fact that a moderate
25 amount of signaling (i.e. standardization work) is proposed is highly valuable.

The number of exemplary embodiments of the present invention provides multiple technical alternatives supporting different standardization
30 strategies.

It is again noted that S-GW is taken only as an example, and the solution according to exemplary embodiments of the present invention may also be applied/extended to P-GW and SGSN.

35

A potential problem raised because UEs are not as robust and safe as PCN nodes (charging data may possibly be lost when exception occurs at UEs) is overcome by reporting charging data in the middle of D2D session according to exemplary embodiments of the present invention.

5

Generally, the above-described procedures and functions may be implemented by respective functional elements, processors, or the like, as described below.

10 While in the foregoing exemplary embodiments of the present invention are described mainly with reference to methods, procedures and functions, corresponding exemplary embodiments of the present invention also cover respective apparatuses, network nodes and systems, including both software, algorithms, and/or hardware thereof.

15

Respective exemplary embodiments of the present invention are described below referring to Figure 18, while for the sake of brevity reference is made to the detailed description with regard to Figures 1 to 17.

20 In Figure 18 below, which is noted to represent a simplified block diagram, the solid line blocks are basically configured to perform respective operations as described above. The entirety of solid line blocks are basically configured to perform the methods and operations as described above, respectively. With respect to Figure 18, it is to be noted that the individual
25 blocks are meant to illustrate respective functional blocks implementing a respective function, process or procedure, respectively. Such functional blocks are implementation-independent, i.e. may be implemented by means of any kind of hardware or software, respectively. The arrows and lines interconnecting individual blocks are meant to illustrate an operational
30 coupling there-between, which may be a physical and/or logical coupling, which on the one hand is implementation-independent (e.g. wired or wireless) and on the other hand may also comprise an arbitrary number of intermediary functional entities not shown. The direction of arrow is meant to illustrate the direction in which certain operations are performed and/or
35 the direction in which certain data is transferred.

Further, in Figure 18, only those functional blocks are illustrated, which relate to any one of the above-described methods, procedures and functions. A skilled person will acknowledge the presence of any other
5 conventional functional blocks required for an operation of respective structural arrangements, such as e.g. a power supply, a central processing unit, respective memories or the like. Among others, memories are provided for storing programs or program instructions for controlling the individual functional entities to operate as described herein.

10 Figure 18 shows a schematic block diagram illustrating exemplary apparatuses according to exemplary embodiments of the present invention.

In view of the above, the thus described apparatuses 10 (10 A and 10B), 20
15 (20A and 20B), 30 and 40 are suitable for use in practicing the exemplary embodiments of the present invention, as described herein.

The thus described apparatus 10 may represent a (part of a) device or terminal such as a mobile station MS or user equipment UE (for example a
20 mobile phone) or a modem (which may be installed as part of a MS or UE, but may be also a separate module, which can be attached to various devices), and may be configured to perform a procedure and/or functionality as described in conjunction with Figure 1. The thus described apparatus 20 may represent a (part of a) network entity, such as a base
25 station or access node or any network-based controller, e.g. an eNB, and may be configured to perform a procedure and/or functionality as indicated above, while no further details thereof are given. The thus described apparatus 30 may represent a (part of a) network node such as a mobile management entity MME or a modem (which may be installed as part of a
30 MME, but may be also a separate module, which can be attached to various devices), and may be configured to perform a procedure and/or functionality as described in conjunction with Figure 2. The thus described apparatus 40 may represent a (part of a) network node such as a serving gateway S-GW or a modem (which may be installed as part of a S-GW, but
35 may be also a separate module, which can be attached to various devices),

and may be configured to perform a procedure and/or functionality as described in conjunction with Figure 3.

As indicated in Figure 18, according to exemplary embodiments of the present invention, the apparatus 10 comprises a processor 15, a memory 16 and an interface 17, which are connected by a bus 18 or the like. Further, according to exemplary embodiments of the present invention, the apparatus 20 comprises a processor 25, a memory 26 and an interface 27, which are connected by a bus 28 or the like. Further, according to exemplary embodiments of the present invention, the apparatus 30 comprises a processor 35, a memory 36 and an interface 37, which are connected by a bus 38 or the like. Further, according to exemplary embodiments of the present invention, the apparatus 40 comprises a processor 45, a memory 46 and an interface 47, which are connected by a bus 48 or the like. The apparatuses may be connected via links 40, 41, 42 and/or 43.

The processor 15/25/35/45 and/or the interface 17/27/37/47 may also include a modem or the like to facilitate communication over a (hardwire or wireless) link, respectively. The interface 17/27/37/47 may include a suitable transceiver coupled to one or more antennas or communication means for (hardwire or wireless) communications with the linked or connected device(s), respectively. The interface 17/27/37/47 is generally configured to communicate with at least one other apparatus, i.e. the interface thereof.

The memory 16/26/36/46 may store respective programs assumed to include program instructions or computer program code that, when executed by the respective processor, enables the respective electronic device or apparatus to operate in accordance with the exemplary embodiments of the present invention.

In general terms, the respective devices/apparatuses (and/or parts thereof) may represent means for performing respective operations and/or exhibiting respective functionalities, and/or the respective devices (and/or parts thereof) may have functions for performing respective operations and/or exhibiting respective functionalities.

When in the subsequent description it is stated that the processor (or some other means) is configured to perform some function, this is to be construed to be equivalent to a description stating that at least one processor, potentially in cooperation with computer program code stored in the memory of the respective apparatus, is configured to cause the apparatus to perform at least the thus mentioned function. Also, such function is to be construed to be equivalently implementable by specifically configured means for performing the respective function (i.e. the expression “processor configured to [cause the apparatus to] perform xxx-ing” is construed to be equivalent to an expression such as “means for xxx-ing”).

According to exemplary embodiments of the present invention, an apparatus representing the terminal 10 comprises at least one processor 15, at least one memory 16 including computer program code, and at least one interface 17 configured for communication with at least another apparatus. The processor (i.e. the at least one processor 15, with the at least one memory 16 and the computer program code) is configured to perform receiving a nas connection establishment confirmation message comprising charging related information, and to perform collecting charging data regarding a device to device communication based on said charging related information.

In its most basic form, stated in other words, the apparatus 10 may thus comprise respective means for receiving and means for collecting.

As outlined above, the apparatus 10 may further comprise one or more of respective means for transmitting and means for embedding.

According to exemplary embodiments of the present invention, an apparatus representing the network node 30 comprises at least one processor 35, at least one memory 36 including computer program code, and at least one interface 37 configured for communication with at least another apparatus. The processor (i.e. the at least one processor 35, with the at least one memory 36 and the computer program code) is configured

to perform receiving a charging delegation request message comprising charging related information for an upcoming device to device communication connection establishment, and to perform transmitting a nas connection establishment confirmation message comprising said charging
5 related information.

In its most basic form, stated in other words, the apparatus 30 may thus comprise respective means for receiving and means for transmitting.

10 As outlined above, the apparatus 30 may further comprise one or more of respective means for forwarding, means for extracting, and means for embedding.

According to exemplary embodiments of the present invention, an
15 apparatus representing the network node 40 comprises at least one processor 45, at least one memory 46 including computer program code, and at least one interface 47 configured for communication with at least another apparatus. The processor (i.e. the at least one processor 45, with the at least one memory 46 and the computer program code) is configured
20 to perform receiving a connection establishment indication message indicative of an upcoming device to device communication connection establishment, and to perform transmitting a charging delegation request message comprising charging related information for said upcoming device to device communication connection establishment.

25 In its most basic form, stated in other words, the apparatus 40 may thus comprise respective means for receiving and means for transmitting.

For further details regarding the operability/functionality of the individual
30 apparatuses, reference is made to the above description in connection with any one of Figures 1 to 17, respectively.

According to exemplarily embodiments of the present invention, a system may comprise any conceivable combination of the thus depicted

devices/apparatuses and other network elements, which are configured to cooperate with any one of them.

For the purpose of the present invention as described herein above, it should be noted that

- method steps likely to be implemented as software code portions and being run using a processor at a network server or network entity (as examples of devices, apparatuses and/or modules thereof, or as examples of entities including apparatuses and/or modules therefore), are software code independent and can be specified using any known or future developed programming language as long as the functionality defined by the method steps is preserved;

- generally, any method step is suitable to be implemented as software or by hardware without changing the idea of the embodiments and its modification in terms of the functionality implemented;

- method steps and/or devices, units or means likely to be implemented as hardware components at the above-defined apparatuses, or any module(s) thereof, (e.g., devices carrying out the functions of the apparatuses according to the embodiments as described above) are hardware independent and can 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;

- devices, units or means (e.g. the above-defined network entity or network register, or any one of their respective units/means) can be implemented as individual devices, units or means, but this does not exclude that they are implemented in a distributed fashion throughout the system, as long as the functionality of the device, unit or means is preserved;

- an apparatus like the user equipment and the network entity /network register may be represented by a semiconductor chip, a chipset, or a (hardware) module comprising such chip or chipset; this, however, does not

exclude the possibility that a functionality of an 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

5 run on a processor;

- a device may be regarded as an apparatus or as an assembly of more than one apparatus, whether functionally in cooperation with each other or functionally independently of each other but in a same device housing, for example.

10

In general, it is to be noted that respective functional blocks or elements according to above-described aspects can 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 can be realized in individual functional blocks or by

15 individual devices, or one or more of the method steps can be realized in a single functional block or by a single device.

20

Generally, any method step is suitable to be implemented as software or by hardware without changing the idea of the present invention. Devices and means can be implemented as individual devices, but this does not exclude that they are 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.

25

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.

30

The present invention 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.

In view of the above, there are provided measures for charging device to device traffic. Such measures exemplarily comprise receiving a nas connection establishment confirmation message comprising charging related information, and collecting charging data regarding a device to device communication based on said charging related information.

Even though the invention is described above with reference to the examples according to the accompanying drawings, it is to be understood that the invention is not restricted thereto. Rather, it is apparent to those skilled in the art that the present invention can be modified in many ways without departing from the scope of the inventive idea as disclosed herein.

List of acronyms and abbreviations

3GPP	3 rd Generation Partnership Project
CDF	charging data function
CDR	Charging Data Record
CGF	charging gateway function
CTF	charging trigger function
D2D	device to device, device-to-device
eNB	eNodeB, evolved Node B
EPS	evolved packet system
GW	gateway
ID	identifier
IP	internet protocol
LTE	Long Term Evolution
NAS	non-access stratum
MME	mobility management entity
MS	mobile station

	P-GW	packet data network gateway
	PCN	packet switched core network
	PLMN	public land mobile network
	ProSe	Proximity Service
5	PS	packet switched
	QoS	quality of service
	S-GW	serving gateway
	SGSN	serving GPRS support node
	TAU	tracking area update
10	UE	user equipment

WHAT IS CLAIMED IS:

1. A method comprising
receiving a nas connection establishment confirmation message
5 comprising charging related information, and
collecting charging data regarding a device to device communication
based on said charging related information.
2. The method according to claim 1, further comprising
10 transmitting a nas connection establishment indication message
indicative of an upcoming device to device communication connection
establishment.
3. The method according to any of claims 1 or 2, further comprising
15 transmitting said collected charging data.
4. The method according to claim 3, wherein
in relation to said transmitting said collected charging data, said
method further comprises
20 transmitting a nas connection deletion indication message indicative
of termination of said device to device communication including said
collected charging data.
5. The method according to claim 4, further comprising
25 receiving a nas connection deletion confirmation message.
6. The method according to claim 4 or 5, further comprising
transmitting a device to device radio bearer deletion request
message, and
30 receiving a device to device radio bearer deletion response message.
7. The method according to claim 4 or 5, further comprising
receiving a device to device radio bearer deletion request message,
and

transmitting a device to device radio bearer deletion response message.

8. The method according to claim 3, wherein

5 in relation to said transmitting said collected charging data, said method further comprises

transmitting, upon a predetermined update condition, a nas connection status update message indicative of an update of said collected charging data including said collected charging data.

10

9. The method according to claim 8, further comprising

receiving a nas connection status update confirmation message.

10. The method according to claim 8 or 9, further comprising

15 receiving a nas connection status poll message indicative of a request for said collected charging data, wherein

said predetermined update condition is a receipt of said connection status poll message.

20 11. The method according to claim 3, wherein

in relation to said transmitting said collected charging data, said method further comprises

embedding said collected charging data into a scheduled control message, and

25 transmitting said control message according to its schedule.

12. The method according to claim 11, further comprising

receiving a response message corresponding to said control message including charging data confirmation information.

30

13. The method according to any of claims 1 to 12, further comprising

receiving a device to device event accounting request message indicative of an instruction to collect device to device event charging data, said device to device event accounting request message comprising said
35 charging related information, and

collecting device to device event charging data based on said charging related information.

14. The method according to claim 13, further comprising

5 transmitting, upon a predetermined event report condition, a nas device to device event charging data update message indicative of an update of said collected device to device event charging data.

15. The method according to claim 14, further comprising

10 receiving a nas device to device event charging data update confirmation message.

16. The method according to claim 14 or 15, further comprising

15 receiving a nas device to device event charging data poll message indicative of a request for said collected device to device event charging data, wherein

 said predetermined event report condition is a receipt of said device to device event charging data poll message.

20 17. A method comprising

 receiving a charging delegation request message comprising charging related information for an upcoming device to device communication connection establishment, and

25 transmitting a nas connection establishment confirmation message comprising said charging related information.

18. The method according to claim 17, further comprising

30 receiving a nas connection establishment indication message indicative of said upcoming device to device communication connection establishment, and

 transmitting a connection establishment indication message including at least part of information of said nas connection establishment indication message.

35 19. The method according to claim 17 or 18, further comprising

receiving charging data, and
forwarding said charging data.

20. The method according to claim 19, wherein

5 in relation to said receiving said charging data, said method further comprises

receiving a nas connection deletion indication message indicative of termination of a device to device communication including said charging data, and

10 in relation to said forwarding said charging data, said method further comprises

transmitting a connection deletion indication message including at least said charging data.

15 21. The method according to claim 20, further comprising

receiving a connection deletion response message, and
transmitting a nas connection deletion confirmation message.

22. The method according to claim 19, wherein

20 in relation to said receiving said charging data, said method further comprises

receiving a nas connection status update message indicative of an update of said charging data including said charging data, and

25 in relation to said forwarding said charging data, said method further comprises

transmitting a connection status update message including at least said charging data.

23. The method according to claim 22, further comprising

30 receiving a connection status update confirmation message, and
transmitting a nas connection status update confirmation message including at least part of information of said connection status update confirmation message.

35 24. The method according to claim 22 or 23, further comprising

receiving a connection status poll message indicative of a request for said charging data, and

transmitting a nas connection status poll message including at least part of information of said connection status poll message.

5

25. The method according to claim 19, wherein

in relation to said receiving said charging data, said method further comprises

receiving a control message including said charging data, and

10

extracting said charging data from said control message, and

in relation to said forwarding said charging data, said method further comprises

transmitting a connection status update message indicative of an update of said charging data including said charging data.

15

26. The method according to claim 25, further comprising

receiving a connection status update confirmation message,

embedding charging data confirmation information into a response message corresponding to said control message, and

20

transmitting said response message.

27. The method according to any of claims 17 to 26, further comprising

transmitting a device to device capability update message indicative of device to device capability of a communication endpoint.

25

28. The method according to claim 27, further comprising

receiving a device to device event charging delegation request message indicative of an instruction to collect device to device event charging data, said device to device event charging delegation request message comprising said charging related information, and

30

transmitting a device to device event accounting request message comprising said charging related information.

29. The method according to claim 27 or 28, further comprising

receiving a nas device to device event charging data update message indicative of an update of said device to device event charging data, and

transmitting a device to device event charging data update message including at least part of information of said nas device event charging data update message.

30. The method according to claim 29, further comprising

receiving a device to device event charging data update confirmation message, and

transmitting a nas device to device event charging data update confirmation message including at least part of information of said device to device event charging data update confirmation message.

31. The method according to claim 29 or 30, further comprising

receiving a device to device event charging data poll message indicative of a request for said device to device event charging data, and

transmitting a nas device to device event charging data poll message including at least part of information of said device to device event charging data poll message.

32. A method comprising

receiving a connection establishment indication message indicative of an upcoming device to device communication connection establishment, and

transmitting a charging delegation request message comprising charging related information for said upcoming device to device communication connection establishment.

33. The method according to claim 32, further comprising

receiving charging data.

34. The method according to claim 33, wherein

in relation to said receiving said charging data, said method further comprises

receiving a connection deletion indication message indicative of termination of a device to device communication including said charging data.

5 35. The method according to claims 34, further comprising transmitting a connection deletion response message.

36. The method according to claim 33, wherein
in relation to said receiving said charging data, said method further
10 comprises
receiving a connection status update message indicative of an update of said charging data including said charging data.

37. The method according to claim 36, further comprising
15 transmitting a connection status update confirmation message.

38. The method according to claim 36 or 37, further comprising
transmitting a connection status poll message indicative of a request for said charging data.
20

39. The method according to any of claims 32 to 38, further comprising
receiving a device to device capability update message indicative of device to device capability of a communication endpoint.

25 40. The method according to claim 39, further comprising
transmitting a device to device event charging delegation request message indicative of an instruction to collect device to device event charging data, said device to device event charging delegation request message comprising said charging related information.
30

41. The method according to claim 39 or 40, further comprising
receiving a device to device event charging data update message indicative of an update of said device to device event charging data.

35 42. The method according to claim 41, further comprising

transmitting a device to device event charging data update confirmation message.

43. The method according to claim 41 or 42, further comprising

5 transmitting a device to device event charging data poll message indicative of a request for said device to device event charging data.

44. The method according to claims 1 to 16, 17 to 31, or 32 to 43, wherein

10 said charging data is at least one of a received data volume, a transmitted data volume, a device to device connection duration, and a number of user equipment discovery events, and/or

15 said charging related information is at least one of a charging ticket number, an identifier of at least one corresponding non device to device session, identifiers of communication endpoints involved in said device to device communication, and information regarding reporting said charging data, and/or

 said connection establishment indication message comprises an identifier of at least one corresponding non device to device session, and/or

20 said predetermined update condition is at least one of an elapsed predetermined period of time, a received predetermined amount of traffic volume, and a transmitted predetermined amount of traffic volume, and/or

25 said predetermined event report condition is at least one of an elapsed predetermined period of time, a counted predetermined amount of device to device discovery events, a disabling of a proximity service discovery capability of a communication endpoint, and a turning off of a communication endpoint.

45. An apparatus comprising

30 at least one processor,
 at least one memory including computer program code, and
 at least one interface configured for communication with at least another apparatus,

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

receiving a nas connection establishment confirmation message comprising charging related information, and

collecting charging data regarding a device to device communication based on said charging related information.

5

46. The apparatus according to claim 45, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

transmitting a nas connection establishment indication message indicative of an upcoming device to device communication connection establishment.

47. The apparatus according to any of claims 45 or 46, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

transmitting said collected charging data.

48. The apparatus according to claim 47, wherein

in relation to said transmitting said collected charging data, the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

transmitting a nas connection deletion indication message indicative of termination of said device to device communication including said collected charging data.

25

49. The apparatus according to claim 48, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a nas connection deletion confirmation message.

30

50. The apparatus according to claim 48 or 49, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

transmitting a device to device radio bearer deletion request message, and

35

receiving a device to device radio bearer deletion response message.

51. The apparatus according to claim 48 or 49, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a device to device radio bearer deletion request message, and

transmitting a device to device radio bearer deletion response message.

52. The apparatus according to claim 47, wherein

in relation to said transmitting said collected charging data, the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

transmitting, upon a predetermined update condition, a nas connection status update message indicative of an update of said collected charging data including said collected charging data.

53. The apparatus according to claim 52, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a nas connection status update confirmation message.

54. The apparatus according to claim 52 or 53, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a nas connection status poll message indicative of a request for said collected charging data, wherein

said predetermined update condition is a receipt of said connection status poll message.

55. The apparatus according to claim 47, wherein

in relation to said transmitting said collected charging data, the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

embedding said collected charging data into a scheduled control message, and

transmitting said control message according to its schedule.

5 56. The apparatus according to claim 55, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a response message corresponding to said control message including charging data confirmation information.

10

57. The apparatus according to any of claims 45 to 56, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

15 receiving a device to device event accounting request message indicative of an instruction to collect device to device event charging data, said device to device event accounting request message comprising said charging related information, and

collecting device to device event charging data based on said charging related information.

20

58. The apparatus according to claim 57, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

25 transmitting, upon a predetermined event report condition, a nas device to device event charging data update message indicative of an update of said collected device to device event charging data.

59. The apparatus according to claim 58, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

30 receiving a nas device to device event charging data update confirmation message.

60. The apparatus according to claim 58 or 59, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a nas device to device event charging data poll message
5 indicative of a request for said collected device to device event charging data, wherein

said predetermined event report condition is a receipt of said device to device event charging data poll message.

10 61. The apparatus according to any of claims 45 to 60, wherein

the apparatus is operable as or at a terminal, user equipment, mobile station, mobile phone or modem of a cellular system, and/or

the apparatus is operable in at least one of a LTE and a LTE-A cellular system.

15

62. An apparatus comprising

at least one processor,

at least one memory including computer program code, and

at least one interface configured for communication with at least
20 another apparatus,

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

receiving a charging delegation request message comprising charging
25 related information for an upcoming device to device communication connection establishment, and

transmitting a nas connection establishment confirmation message comprising said charging related information.

30 63. The apparatus according to claim 62, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a nas connection establishment indication message
indicative of said upcoming device to device communication connection
35 establishment, and

transmitting a connection establishment indication message including at least part of information of said nas connection establishment indication message.

5 64. The apparatus according to claim 62 or 63, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving charging data, and
forwarding said charging data.

10

65. The apparatus according to claim 64, wherein

in relation to said receiving said charging data, the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

15 receiving a nas connection deletion indication message indicative of termination of a device to device communication including said charging data, and

in relation to said forwarding said charging data, the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

20

transmitting a connection deletion indication message including at least said charging data.

66. The apparatus according to claim 65, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

25

receiving a connection deletion response message, and
transmitting a nas connection deletion confirmation message.

30 67. The apparatus according to claim 64, wherein

in relation to said receiving said charging data, the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

35 receiving a nas connection status update message indicative of an update of said charging data including said charging data, and

in relation to said forwarding said charging data, the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

5 transmitting a connection status update message including at least said charging data.

68. The apparatus according to claim 67, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

10 receiving a connection status update confirmation message, and transmitting a nas connection status update confirmation message including at least part of information of said connection status update confirmation message.

15 69. The apparatus according to claim 67 or 68, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a connection status poll message indicative of a request for said charging data, and
20 transmitting a nas connection status poll message including at least part of information of said connection status poll message.

70. The apparatus according to claim 64, wherein

25 in relation to said receiving said charging data, the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a control message including said charging data, and extracting said charging data from said control message, and
in relation to said forwarding said charging data, the at least one
30 processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

transmitting a connection status update message indicative of an update of said charging data including said charging data.

71. The apparatus according to claim 70, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a connection status update confirmation message,

5 embedding charging data confirmation information into a response message corresponding to said control message, and

transmitting said response message.

72. The apparatus according to any of claims 62 to 71, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

transmitting a device to device capability update message indicative of device to device capability of a communication endpoint.

73. The apparatus according to claim 72, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a device to device event charging delegation request message indicative of an instruction to collect device to device event charging data, said device to device event charging delegation request message comprising said charging related information, and

transmitting a device to device event accounting request message comprising said charging related information.

74. The apparatus according to claim 72 or 73, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a nas device to device event charging data update message indicative of an update of said device to device event charging data, and

30 transmitting a device to device event charging data update message including at least part of information of said nas device event charging data update message.

75. The apparatus according to claim 74, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

5 receiving a device to device event charging data update confirmation message, and

transmitting a nas device to device event charging data update confirmation message including at least part of information of said device to device event charging data update confirmation message.

10 76. The apparatus according to claim 74 or 75, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a device to device event charging data poll message indicative of a request for said device to device event charging data, and

15 transmitting a nas device to device event charging data poll message including at least part of information of said device to device event charging data poll message.

77. The apparatus according to any of claims 62 to 76, wherein

20 the apparatus is operable as or at a network node or mobility management entity of a cellular system, and/or

the apparatus is operable in at least one of a LTE and a LTE-A cellular system.

25 78. An apparatus comprising

at least one processor,

at least one memory including computer program code, and

at least one interface configured for communication with at least another apparatus,

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

receiving a connection establishment indication message indicative of an upcoming device to device communication connection establishment, and

transmitting a charging delegation request message comprising charging related information for said upcoming device to device communication connection establishment.

5 79. The apparatus according to claim 78, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving charging data.

10 80. The apparatus according to claim 79, wherein

in relation to said receiving said charging data, the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

15 receiving a connection deletion indication message indicative of termination of a device to device communication including said charging data.

81. The apparatus according to claims 80, wherein the at least one processor, with the at least one memory and the computer program code, 20 being configured to cause the apparatus to perform:

transmitting a connection deletion response message.

82. The apparatus according to claim 79, wherein

25 in relation to said receiving said charging data, the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

receiving a connection status update message indicative of an update of said charging data including said charging data.

30 83. The apparatus according to claim 82, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

transmitting a connection status update confirmation message.

84. The apparatus according to claim 82 or 83, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

5 transmitting a connection status poll message indicative of a request for said charging data.

85. The apparatus according to any of claims 78 to 84, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

10 receiving a device to device capability update message indicative of device to device capability of a communication endpoint.

86. The apparatus according to claim 85, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

15 transmitting a device to device event charging delegation request message indicative of an instruction to collect device to device event charging data, said device to device event charging delegation request message comprising said charging related information.

20

87. The apparatus according to claim 85 or 86, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

25 receiving a device to device event charging data update message indicative of an update of said device to device event charging data.

88. The apparatus according to claim 87, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

30 transmitting a device to device event charging data update confirmation message.

89. The apparatus according to claim 87 or 88, wherein the at least one processor, with the at least one memory and the computer program code, being configured to cause the apparatus to perform:

35

transmitting a device to device event charging data poll message indicative of a request for said device to device event charging data.

90. The apparatus according to any of claims 78 to 89, wherein

5 the apparatus is operable as or at a network node or serving gateway of a cellular system, and/or

 the apparatus is operable in at least one of a LTE and a LTE-A cellular system.

10 91. The apparatus according to claims 45 to 61, 62 to 77, or 78 to 90, wherein

 said charging data is at least one of a received data volume, a transmitted data volume, a device to device connection duration, and a number of user equipment discovery events, and/or

15 said charging related information is at least one of a charging ticket number, an identifier of at least one corresponding non device to device session, identifiers of communication endpoints involved in said device to device communication, and information regarding reporting said charging data, and/or

20 said connection establishment indication message comprises an identifier of at least one corresponding non device to device session, and/or

 said predetermined update condition is at least one of an elapsed predetermined period of time, a received predetermined amount of traffic volume, and a transmitted predetermined amount of traffic volume, and/or

25 said predetermined event report condition is at least one of an elapsed predetermined period of time, a counted predetermined amount of device to device discovery events, a disabling of a proximity service discovery capability of a communication endpoint, and a turning off of a communication endpoint.

30

92. A computer program product comprising computer-executable computer program code which, when the program is run on a computer, is configured to cause the computer to carry out the method according to any one of claims 1 to 16, 17 to 31, or 32 to 44.

35

93. The computer program product according to claim 92, wherein the computer program product comprises a computer-readable medium on which the computer-executable computer program code is stored, and/or wherein the program is directly loadable into an internal memory of the
5 processor.

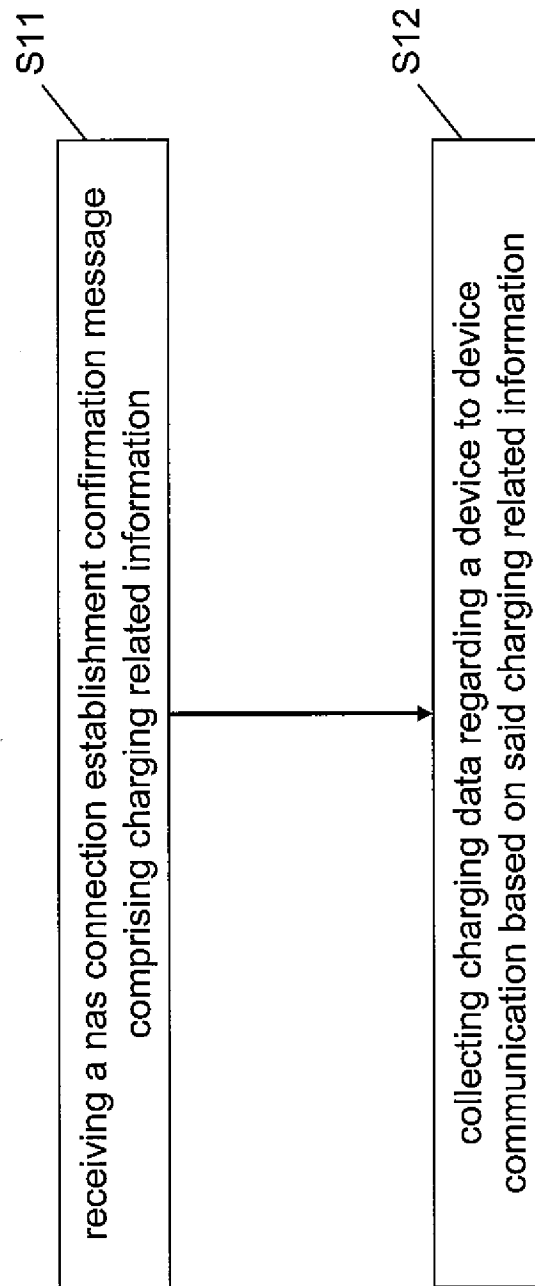


Figure 1

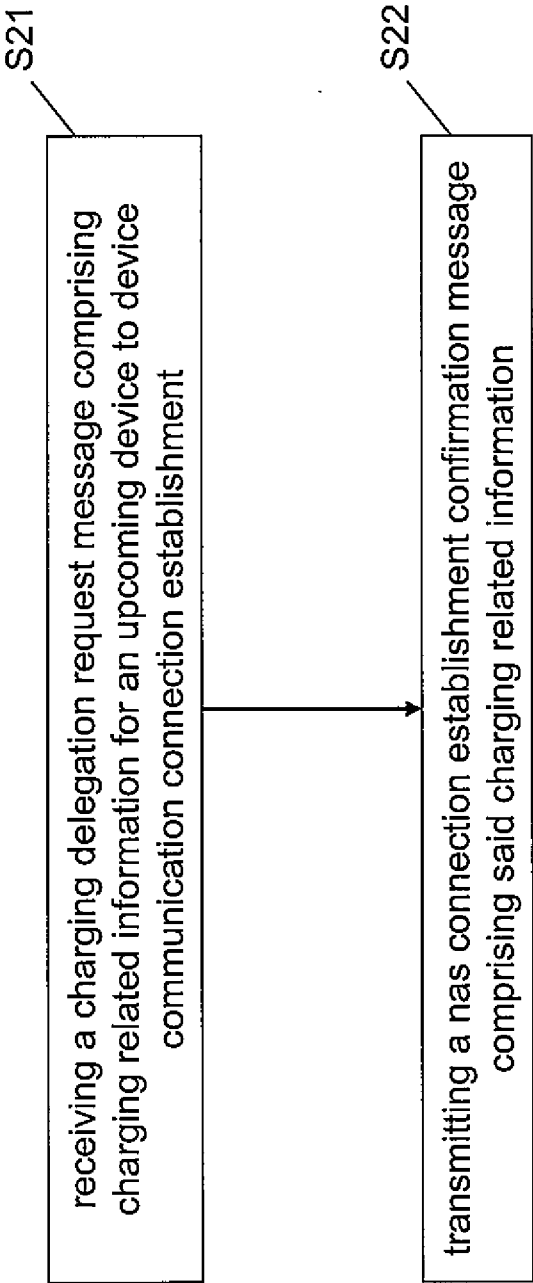


Figure 2

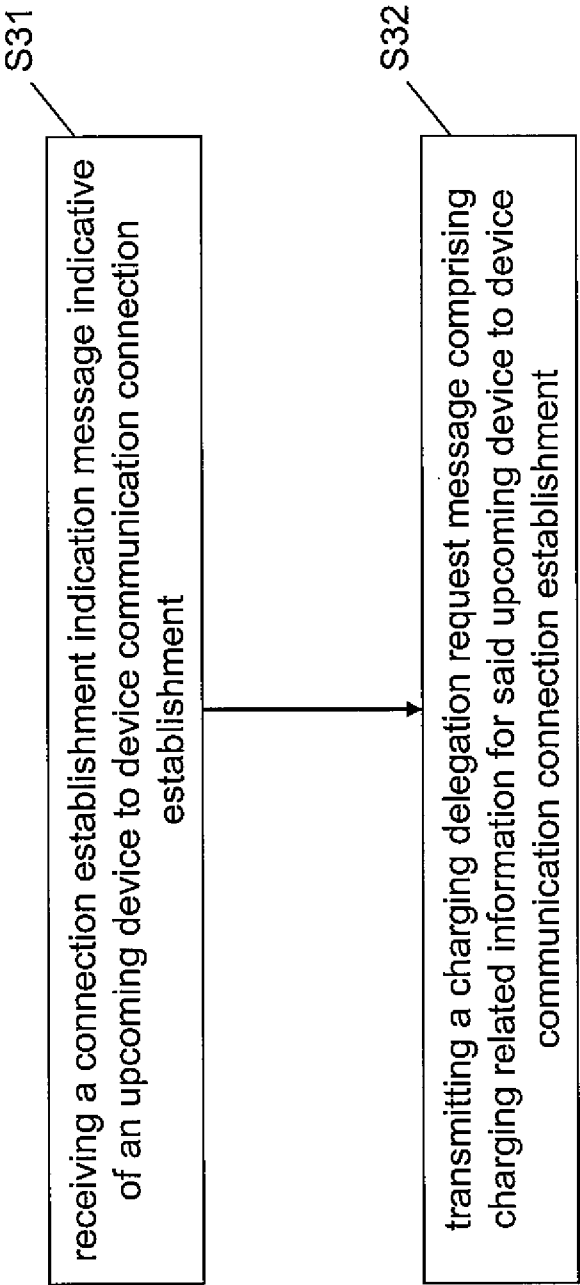


Figure 3

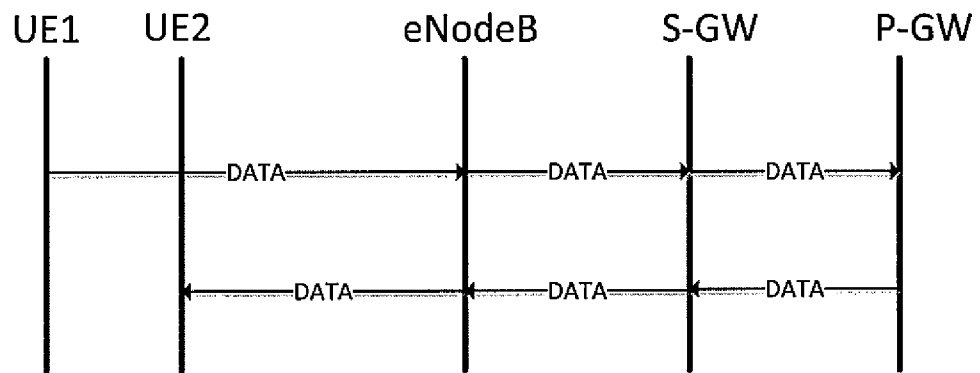


Figure 4

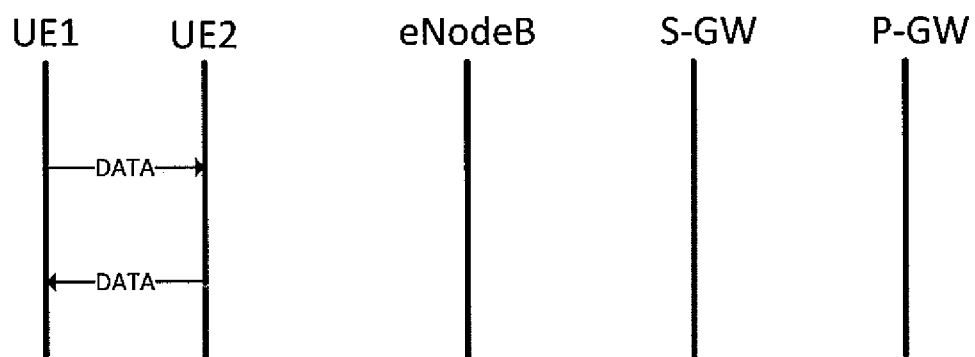


Figure 5

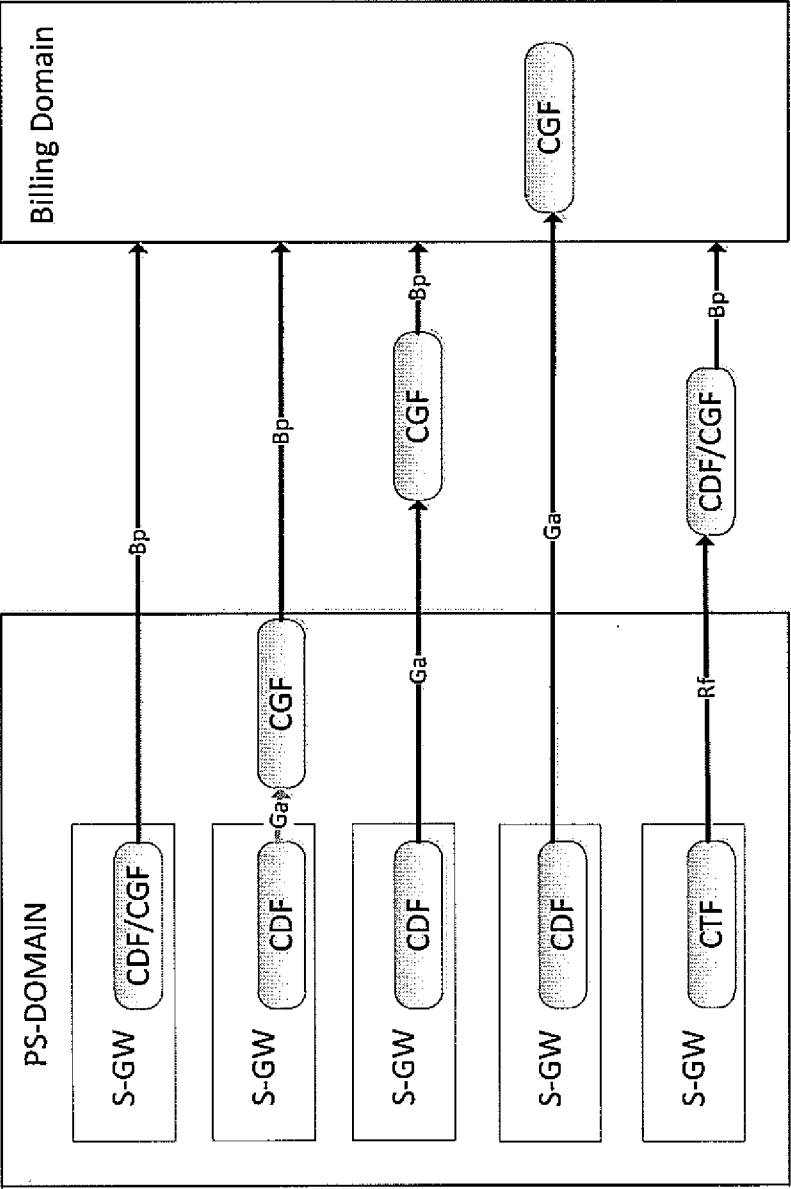


Figure 6

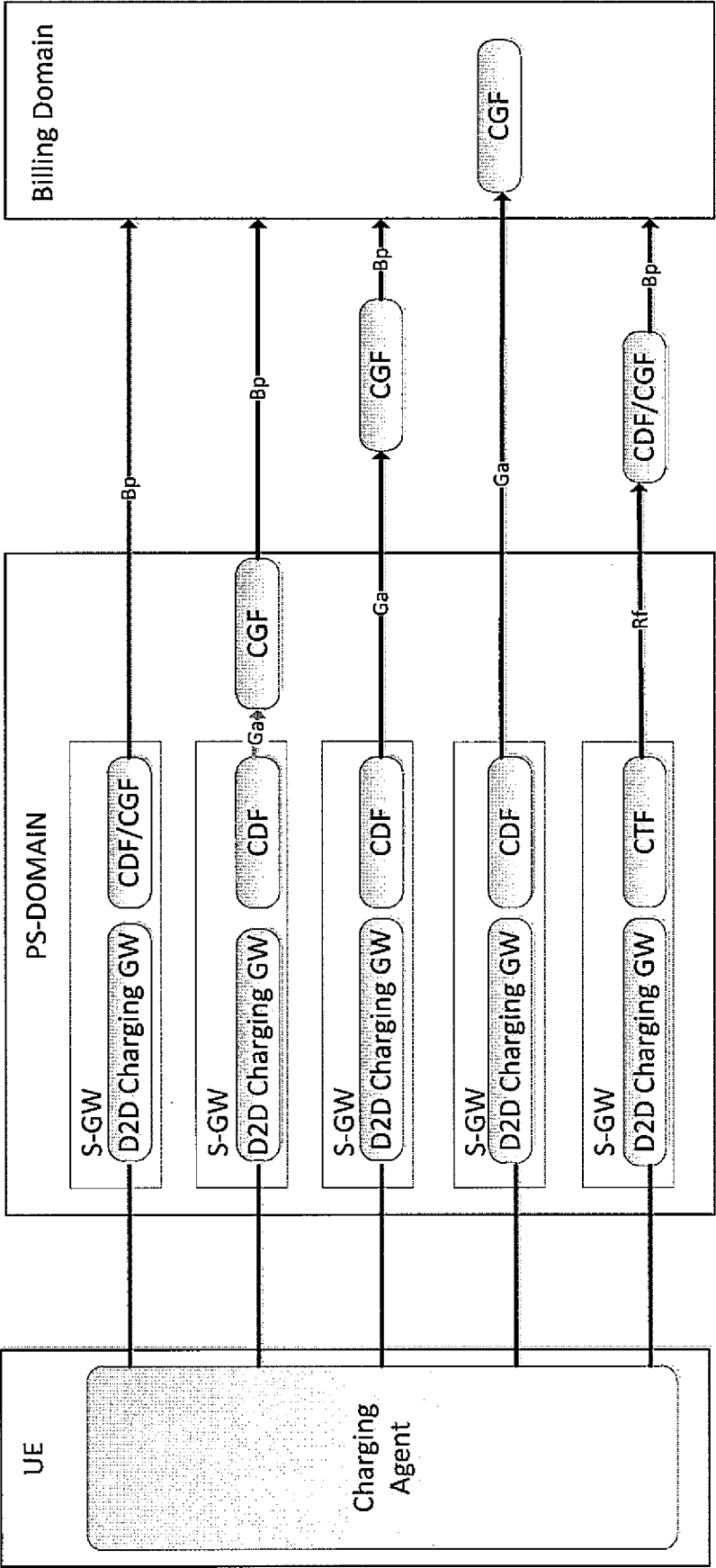


Figure 7

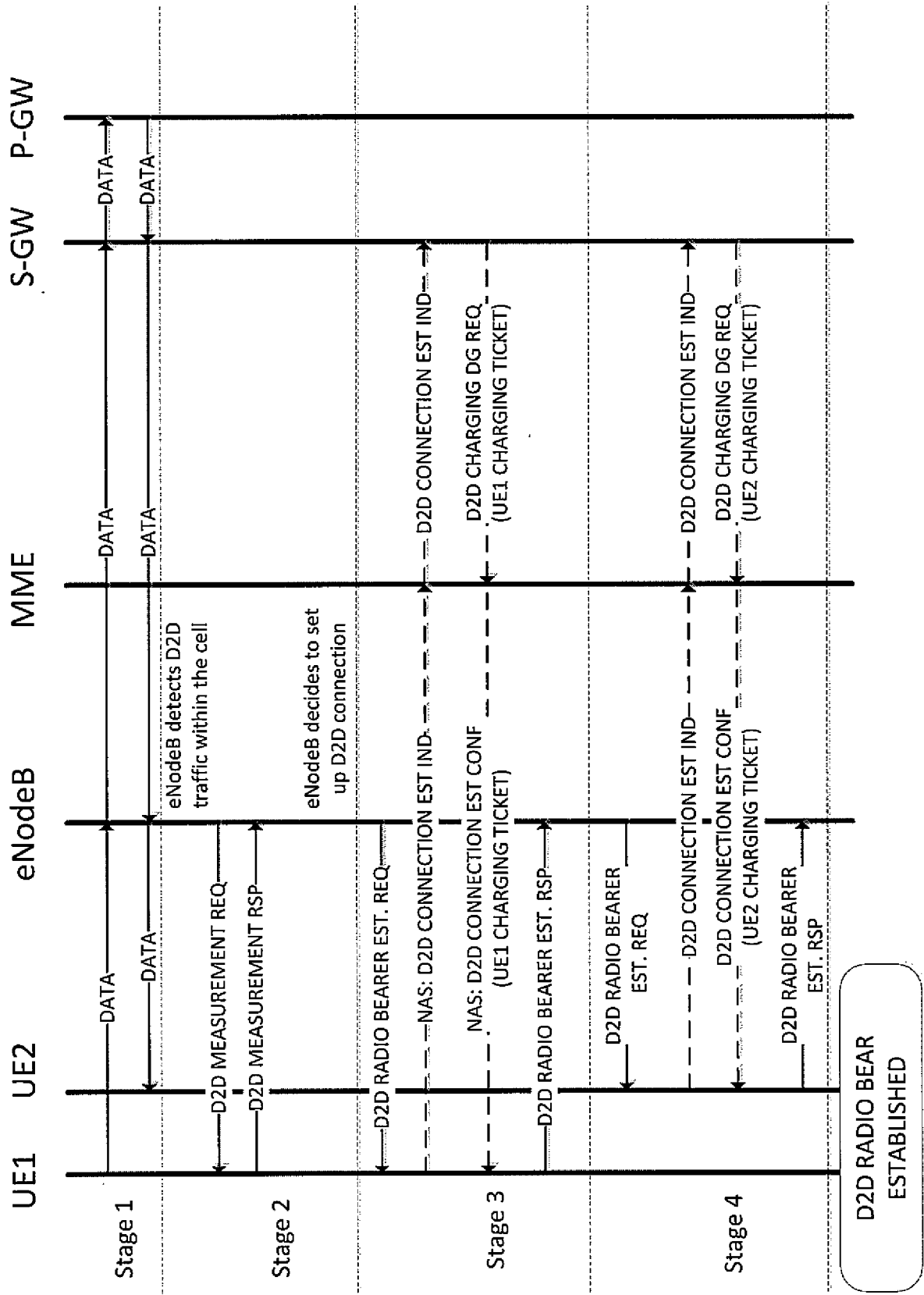


Figure 8

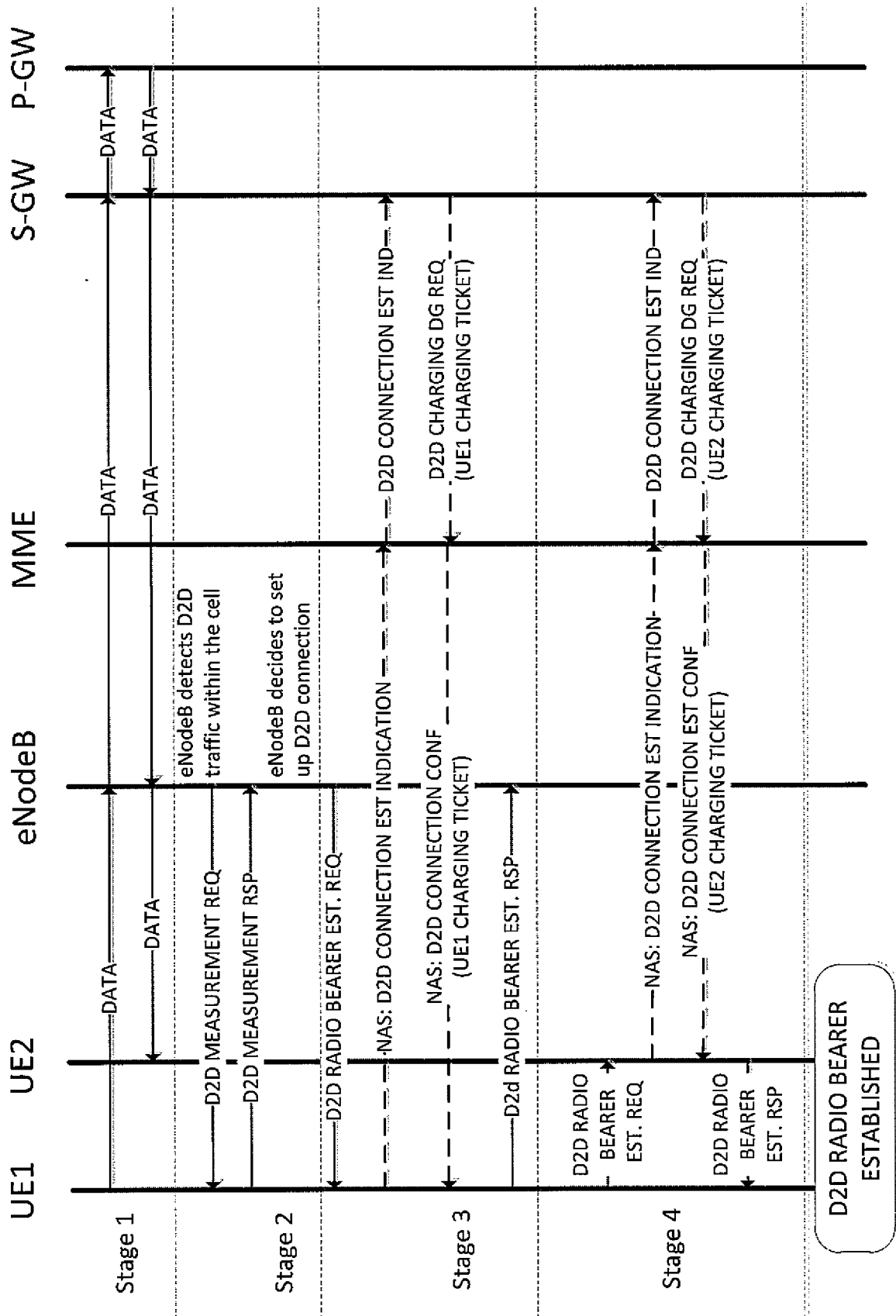


Figure 9

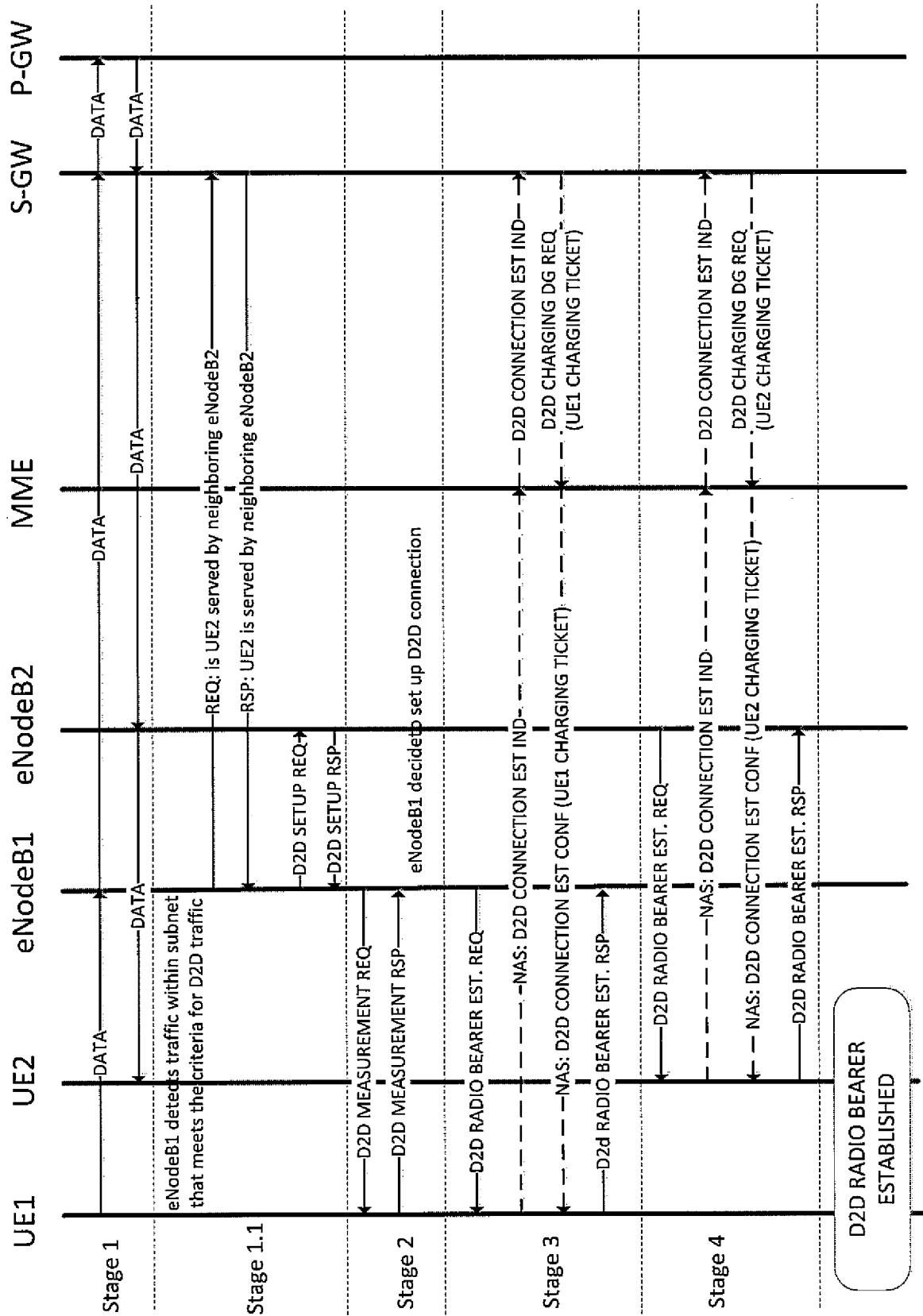


Figure 10

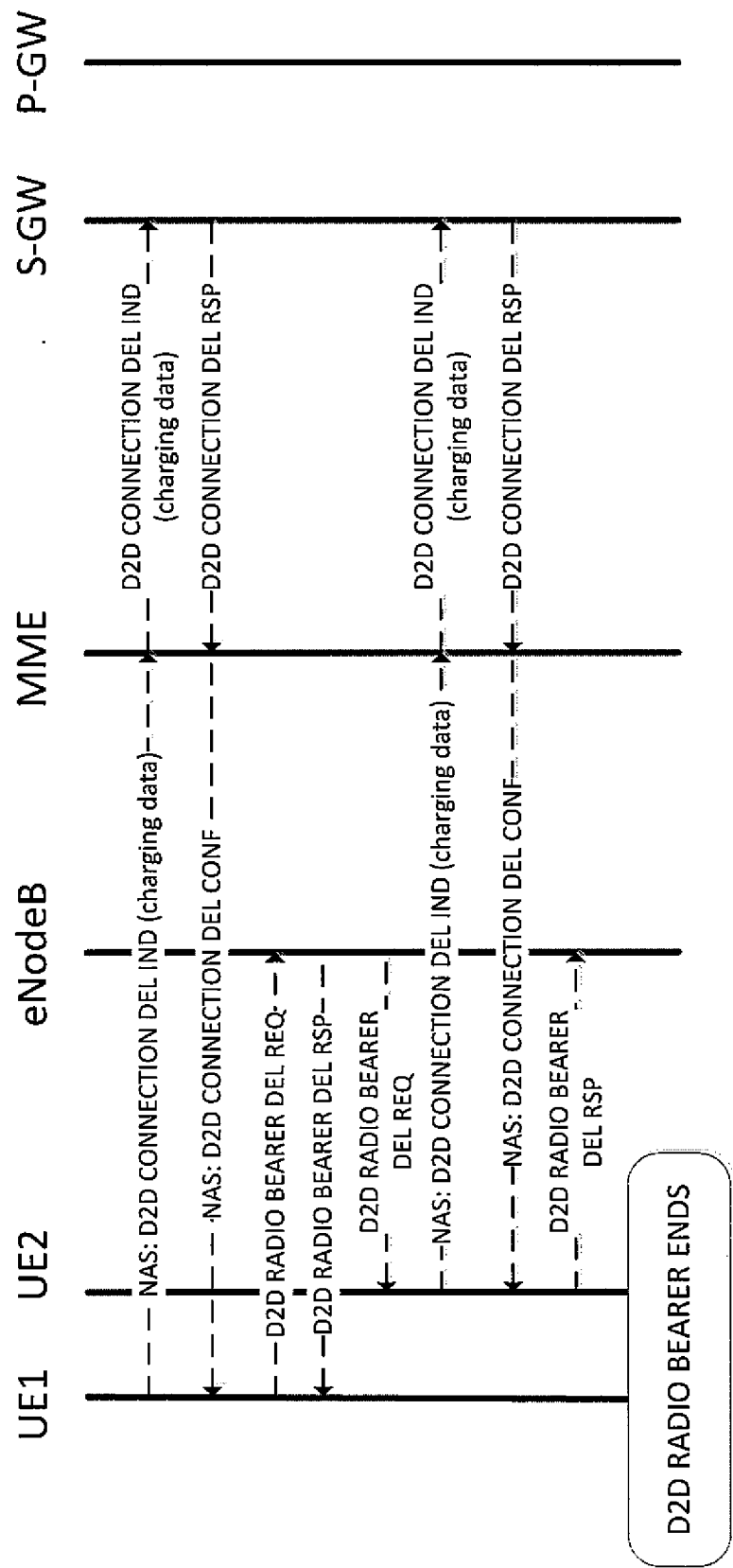


Figure 11

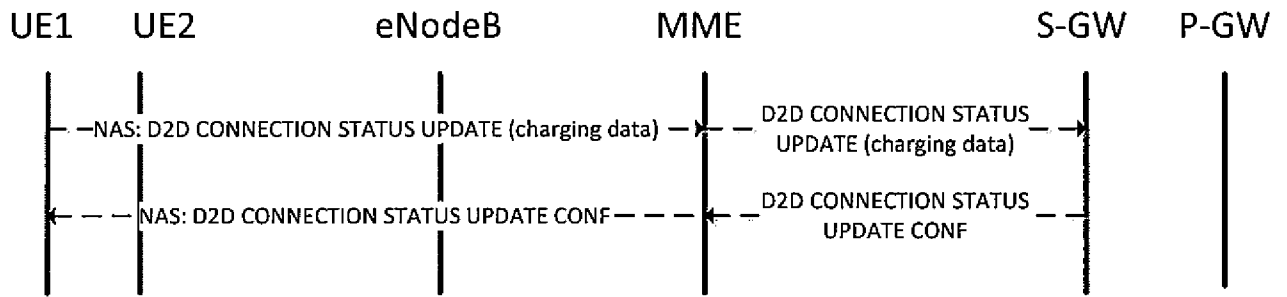


Figure 12

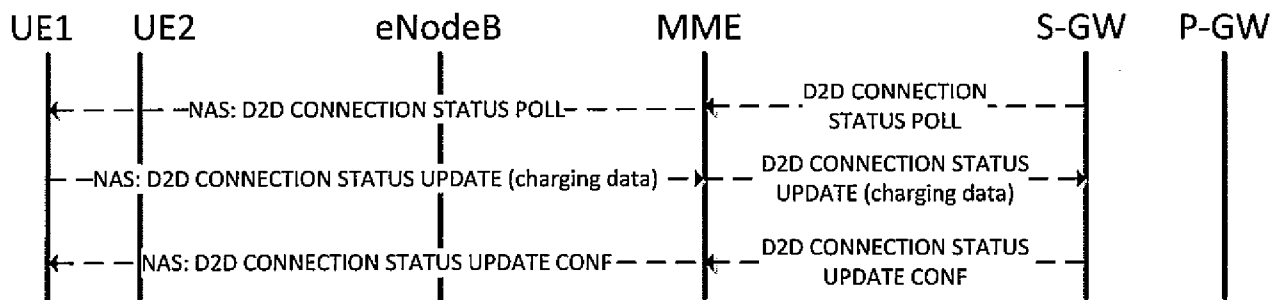


Figure 13

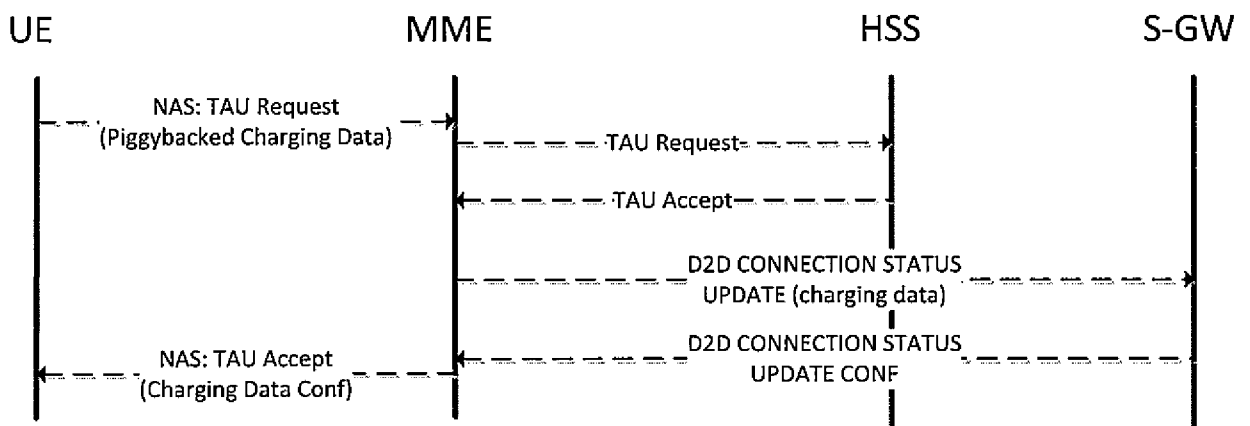


Figure 14

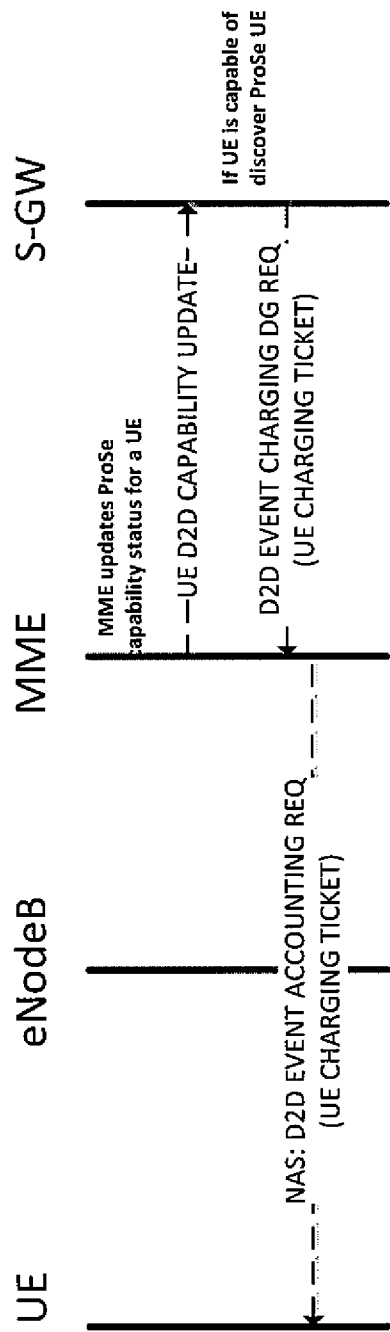


Figure 15

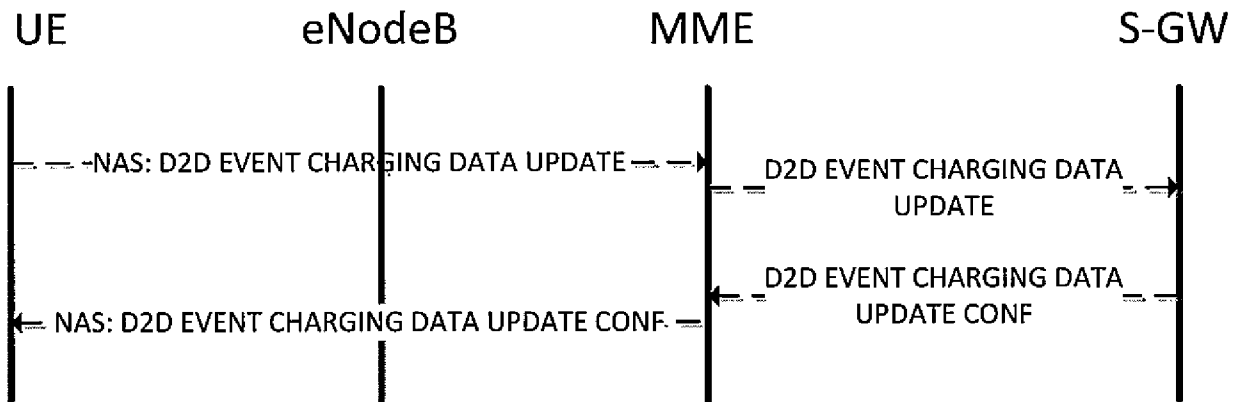


Figure 16

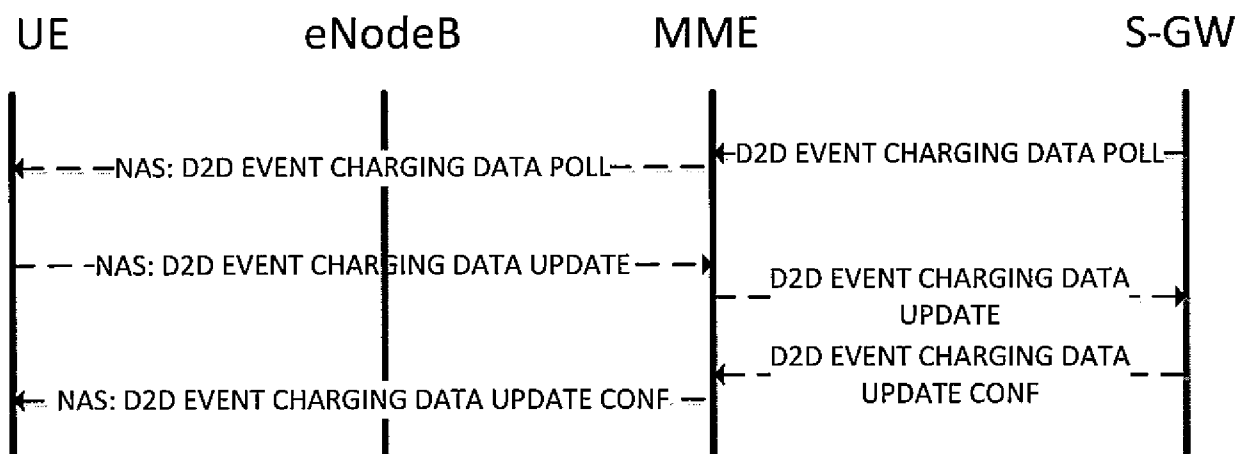


Figure 17

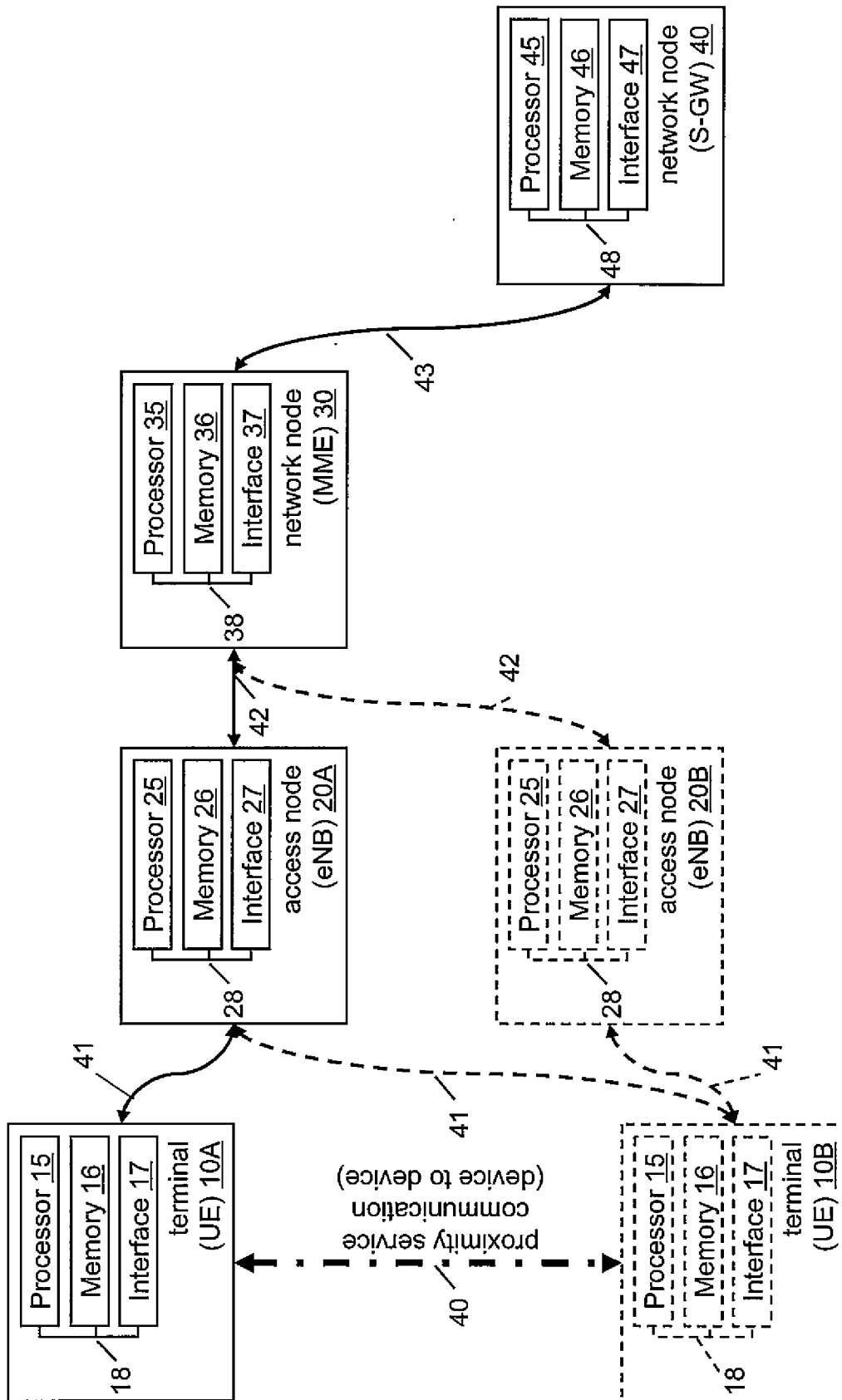


Figure 18

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2013/000378

A. CLASSIFICATION OF SUBJECT MATTER

H04W 4/24 (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: H04W H04L

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)

VEN, CPRSABS, CNKI, IEEE: NAS CONNCTION NON-ACCESS STRATUM NON ACCESS CHARG+ D2D DEVICE
TO DEVICE-TO-DEVICE BILL+ ESTABLISH+ MESSAGE?

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2011147462 A1 (NOKIA SIEMENS NETWORKS OY) 01 December 2011 (01.12.2011) description, page 15, line 20 to page 17, line 4; page 21, line 10 to page 22, line 1; and figures 3 and 5b	1-9, 11, 12, 45-53, 55, 56, 92, 93
A		10, 13-44, 54, 57-91
A	CN 102714861 A (NOKIA CORP) 03 October 2012 (03.10.2012) the whole document	1-93
A	US 2010009675 A1 (NOKIA CORP) 14 January 2010 (14.01.2010) the whole document	1-93

☐ 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

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