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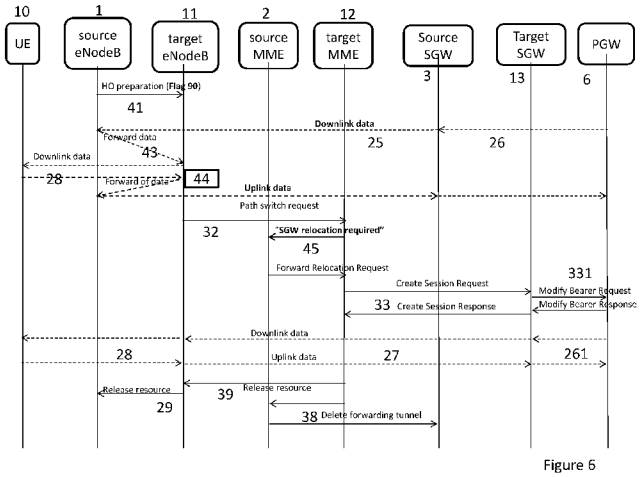

Figure 6

(57) Abstract: A handover process for enabling a user terminal (10) to transfer a connect to a network (6) from a route by way of a source access node (1) to a route by way of a target access node (11), where the nodes (1, 11) are controlled by different respective control systems (2, 12) is initiated by establishing a link (28) between the terminal (10) and the target node (11) and a data forwarding tunnel (43) between the access nodes (1, 11) to allow data transmitted over a link 25 from the network (6) to the source node (1) to continue to be transmitted to the terminal. The backhaul connection (25) is then re-routed by co-ordination between the access control systems (2, 12). The source node (1) transmits a flag (90) to the target node (11) which identifies its respective access control system (2). This flag is forwarded by the target node (11) to its respective access control system (12) to allow it to set up a data link (5) over which relocation instructions (45, 38) can be co-ordinated to set up a data link (27) between the network (6) and the target node (11), and to close the data link (25) between the network (6) and the source node (1).

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Mobile Handover

This invention relates to improvements to the handover process that takes place when a mobile communications device (user terminal) is required to cease communicating with a core network through one access node (also known as a base station) and begin communication through another access node. The most common reasons for such handovers to be required are because either the user terminal or the access node detects deterioration of the signal quality on the wireless communications link between them. This can be because the mobile device is moving out of range of the access node, but other changes in the wireless environment, such as changes in congestion or interference levels, may also make a handover appropriate. Handover may also occur when a user "roaming" on a network other than his "home network" (the one to which he subscribes) moves into range of an access node of his home network: in such a case a handover to the home network is desirable as soon as signal quality between the user terminal and the home network meets a predetermined threshold, regardless of the signal quality on the other network, because this will allow the user to use any facilities specific to his "home" network, and avoid paying the higher charges usually required for connection through a network other than the user's home network.

Unless the context requires otherwise, the term "access node" should be interpreted in this specification to mean any device or apparatus with which a terminal may communicate wirelessly in order to allow the terminal to communicate with a backhaul connection to a core communications network. It includes, for example, access points (wireless routers) for "WiFi" (IEEE 802.11 standard) access networks, as well as the base stations used in cellular telephony.

The decision to initiate a handover, and the selection of a new link to which to hand over, is typically based on signal strength and a connection is established with the access node generating the strongest signal (subject to the access node's capacity and authority to accept a connection with the mobile unit).

. For present purposes the access node to which the user terminal is initially connected will be referred to as the "source" node, and the node to which handover is to be made will be referred to as the "target" node. There is in general no significant difference in practice between the nodes – in any particular session an individual node may be the target node in a first handover and the source node in a subsequent handover, either back to the original source node (now acting as a target node) or to a third node.

The invention will be described herein using the terminology of the 4G or Long Term Evolution (LTE) standard, but the underlying principles are applicable to other mobile communications systems and the use of this terminology should not be taken as limiting.

In most network architectures the connections between individual access nodes (also known as base stations or, in the LTE standard, as eNodeB's or eNBs) and the rest of the network are controlled by access control systems, also known as in the LTE standard as MMEs (mobile management entities), Typically, several access nodes may be controlled by the same access control system, and when a handover is arranged between two of those nodes the whole process can be managed by the access controller. In a cellular system with access nodes in permanent locations, it is conventional to maintain a "neighbour list" for each access node which can be used to inform the mobile unit of the base stations to which handover is most likely to be possible. However, when both source and target access nodes are associated with the same access control system, and a suitable interface exists between the nodes, a so-called X2-based handover can be affected. This enables faster handover for latency-critical applications such as voice services and gaming as well as less load on the core network components.

However, in the general case, if the source and target nodes are associated with different access control systems (MMEs) there is normally no direct signalling interface between the source and target access nodes and all handover messages

are conventionally passed via the access control systems (MMEs) associated with the respective access nodes (herein referred to respectively as the source access control system or source MME and the target access control system or target MME), and the data path is also tunnelled by way of the respective source and target Service Gateways (SGWs) through which the respective access nodes are connected to the rest of the network. This implies longer latency for data traffic during handover as well as longer handover times and additional load on the core network. As national roaming agreements are becoming more common (that is, handing off between different operators in the same region) handovers between different access control systems (MMEs) are becoming more common. For example when a user leaves a home environment where he has a private hotspot connection from his service provider into a public wide-area macrocell operated by a cellular partner, the signal strength drops very rapidly so fast handover is needed to maintain the session.

If the MMEs are both controlled by the same user plane entity, as is described for example in United States Patent application US2007/254667 (Jokinen), the handover can be mediated by that user plane, which can determine whether both the target and source MMEs support the "X2"-based handover. However, in general the MMEs will be associated with different control planes and will therefore not have visibility of each other's capabilities. In the absence of such information, the MMEs default to the less efficient "S1" handover process in which data is redirected by way of a tunnel from one MME to the other by way of the gateways.

According to the invention, there is provided a handover process for causing a communications access connection between a user terminal and a core network to be diverted from a first routing by way of a source access node controlled by a first handover control system to a second routing by way of a target access node controlled by a second handover control system, in which the source access node transmits a path switch request to the target access node, wherein at least one of the source access node and the target access node is capable of generating and detecting flags indicative of the identity of the first control system from which the

source access node is controlled, and wherein the source access node initiates forwarding of data received from the network and destined for the user terminal, such that data is routed from the source access node to the target access node for onward transmission to the user terminal, wherein if flag data is generated by the source access node and detected by the target access node it the data is forwarded to the second access control system to initiate a co-operative process between the source access control system and the target access control system to establish the second routing between the user terminal and the network, and if the target access node does not detect a flag in the handover request, the path switch request is rejected and a path switch request is transmitted from the source node to its respective access control system to initiate a path switch process mediated through the core network

In one embodiment, if the target access node is enabled to initiate a path switch request, it responds to detection of the flag in a path switch request by retransmitting the said flag to the source access node, and on detection of the retransmitted flag the source access node initiates the establishment of the second routing, and if the source node does not detect a retransmitted flag it initiates a path switch process mediated through the core network. This allows each of the access nodes to determine, by the successful exchange of flag signals, that the other access node is enabled to initiate a direct path switch. If either access node fails to receive a flag signal from the other, either in a path switch request or in an acknowledgement of such a request, it recognises that the other access node does not have the necessary capability to initiate a direct transfer of data, so instead initiates a path switch process mediated through the core network

In another aspect, the invention provides a mobile communications access node for providing a communications connection between a user terminal and a network, the access node having a handover processor for processing handover requests,

wherein the handover processor is configured to detect a signal, received from another access node associated with a first handover control system, to hand

over a connection with a user terminal, and to forward the request to a second handover control system associated with the mobile communications access node,

a monitor to identify the presence of a flag in the request, the flag identifying the access node transmitting the request and a first handover control system with that access node, and indicative that the first handover control system is capable of co-operation with handover control systems of a class to which the second handover system belongs to effect a handover,

the handover processor being responsive to handover requests in which the flag is not present to cause data destined for the user terminal to be redirected to a gateway for forwarding to a redirection address subsequent to completion of a handover,

the handover processor being responsive to a request in which the flag is present to forward data to the access node identified by the flag;

a data receiver to receive data destined for the user terminal from the other access node

a data transmitter to transmit data, received from the other access node, to the user terminal;

and wherein the handover processor is configured to generate a path switch request flagged to indicate to a further handover control system that the handover processor is capable of co-operation with another access point to effect a handover.

Such an access node is thus capable of operation as a target node in the process defined above.

In the preferred embodiment the mobile communications access node also comprises a handover processor for generating a handover request for transmission to another access node in order to transfer a connection between a user terminal and a network currently routed by way of the access node such that it is routed by way of the other access node,

having a flag generator to generate a flag in the request, the flag identifying a first handover control system associated with the access node transmitting the request, and indicative that the first handover control system is

capable of co-operation with another handover control system to effect a handover.

Such an access node is therefore also capable of operating as a source node, in co-operation with another acting as the target node, in the process defined above.

An embodiment of the invention will now be described by way of example with reference to the drawings, in which:

Figure 1 is a schematic depiction of the elements which co-operate to perform the invention

Figure 2 is a sequence diagram for the conventional "S1" handover process between nodes both managed by a single mobile management entity

Figure 3 is a sequence diagram for the conventional "X2" handover process between nodes both managed by a single mobile management entity

Figure 4 is a schematic depiction of the principal elements of the S1 process of Figure 2

Figure 5 is a schematic depiction of the principal elements of the X2 process of Figure 3

Figure 6 is a sequence diagram depicting the operation of this embodiment of the invention, which is a modification of the conventional X2 process of Figure 5.

Figure 7 is a flow diagram illustrating the operation of the nodes (access points) capable of interacting according to the invention

Figure 8 is a diagram illustrating schematically he functional elements of an access node according to the invention

Figure 9 is a diagram illustrating schematically the functional elements of an access control system according to the invention

Figure 1 depicts a user equipment (UE) 10 in the process of handing over between two base stations (eNodeB) 1, 11. The base stations are connected to through respective mobile management entities (2, 12) to respective serving gateways 3, 13. The mobile management entities 2, 12 are also in communication with a HSS (Home Subscriber Server) and policy and charging rule function (PCRF) 4 which handles permanent user data, charging policies, limitations on access to the

system etc. The serving gateways 3, 13 and HSS/PCRF 4 are also in communication with a public data network gateway (PGW) 6 which gives access to a public data network (PDN) such as the Internet 7.

In existing signalling interface 5 known as S10 interfaces are present between the MMEs 2, 12, used for example when a user moves between areas served by different MMEs.

Figure 2, Figure 4 and the left hand side of Figure 7 illustrate the conventional S1 handover process. The solid lines in Figure 2 and the heavy arrows in Figure 4 indicate control signalling managed by the MME, and the dashed lines indicate the data connections.

The process is described in detail in 3GPP TS 23.401 and steps not relevant to the present invention are not labelled or described in detail here.

This process allows co-operation between MMEs in the general case where the two nodes 1, 11 are not managed by the same MME 2. As will be seen, the original data connection between the mobile unit 10 and the PDN gateway 6 is made by a connection 24 to the source node 1, and a GTP (GPRS tunnelling protocol) connection 25, 26 from the base station 1 to the PDN gateway 6 by way of the serving gateway 3. When a handover is to be arranged, the initial step 21 is an interaction between the source node 1 and the source MME 2. This handover request is forwarded to the target MME 12 (step 210). The target MME 12 operates a resource allocation interaction 22 with the target base station 11 and an interaction with the target gateway 13 to modify the bearer links 25, 24 such that a new GTP link 261, 27, 28 is connected between the PDN gateway 6 and the user terminal 10 by way of the target gateway 13, target MME 12 and target node 11.

The source MME 2 passes the handover instruction to the user terminal 10 (steps 221, 222) after which data can be transmitted over the new connection 27, 28 to and from the user terminal 10.

Downlink data already received by the source node 1 over the old data link 25 from the source gateway 3 has to be forwarded to the target node 11 for onward transmission over the new link 28. This is generally achieved by creating a "tunnel" between the source eNodeB 1 and the taregt eNodeB 11. The tunnel is set up by a control message 211, 212 from the MMEs 2, 12 to their associated gateways 3,13 allowing data received by the source node 1 to be returned to the source gateway 3, and transmitted over a link 251 to the target gateway 13 from where it can be forwarded over the new links 27, 28 This may be either directly between the nodes 1, 11 or, as shown, by way of the gateway 3 (or gateways 3, 13) and the links 25, 27 between the gateway and the respective nodes 1, 11.

The target MME 12 transmits signals 232, 23 to the source MME 2, and target gateway 13 indicating that the routing is to be modified. The target gateway 13 forwards this routing change signal 231 to the PDN gateway 6 to cause incoming data destined for the terminal 10 to be routed to the target gateway 13 (link 261) instead of the source gateway (link 26). The source MME 2 signals to the source node 1, source gateway 3 and PDN gateway that the links can be released and the forwarding tunnel shut down (step 39)

It will be noted that the new link 28 cannot be established in this process until the handover instructions 21, 210, 22 have been passed by way of the MMEs 2, 12. If signal strength over the initial link 24 is being lost rapidly this can result in a loss of signal, resulting in an interruption or increased latency to the session.

Figure 3, Figure 5 and the right hand side of Figure 7 illustrate the prior art X2 handover process. The solid lines in Figure 3 and the heavy arrows in Figure 5 indicate control signalling managed by the MME, and the dashed lines indicate data links.

The process is described in detail in 3GPP TS 23.401 section 5.5.1.1. Steps not relevant to the present invention are not labelled or described in detail here.

This process provides a simpler handover procedure than the S1 process described above when the two nodes 1, 11 are managed by the same MME 2.

Therefore if the target node 11 is identified as working to the same MME 2 as the source node 1 (step 410), the X2 handover process can be mediated directly between the nodes (eNode B) 1, 11 involved in the handover. In this process the initial handover step 31 is an interaction between the nodes 1, 11. Downlink data received by the source node 1 over the initial downlink 25 can be forwarded 310 to the target node 11 for downlink 28 to the terminal before the change is reported to the MME 2 (step 32).

In this system the handover is arranged between the access nodes 1, 11, and downlink data can be forwarded from the source node 1 to the target node 11 before a message is sent to the source MME 2 to establish new backhaul connections 261, 27 and close the original connections 25, 26. Therefore, unlike in the S1 situation, the MME 2 only gets involved after the new wireless connection 28 has been established. This allows much faster handover.

Once the source MME 2 is informed of the handover (step 32) it transmits a session request 33 to the target gateway 13 to set up a new direct link 27 to the target node 11, and will in turn send a message 331 to the PDN gateway 6 to divert traffic for the user terminal 1 to be routed via the target gateway 13. Once this link 27 is established a further signal 332 is sent to the source gateway to close the bearer link 25 to the source node 1. (This is the general case – as the nodes 1, 11 are both served by the same MME 2, in many circumstances the source and target gateways 3, 13 will be one and the same, so the MME 2 will send both the create and delete session requests 33, 332 to the same gateway and the PDN gateway 6 makes no change

This sequence provides for better continuity of service as the link 28 between the terminal 10 and the target node 11 is established earlier in the procedure, reducing the risk of the session dropping out if the link 24 is lost..

The X2 mode is quicker than S1, but current standards do not allow for X2-based handover unless both eNBs 1, 11 are connected to the same MME (2). The present invention provides for handovers between nodes 1, 11 working to different MMEs 2, 12.

Referring now to Figure 6 and figure 7, the process operates as a modification of the X2 process depicted in Figure 3 and Figure 5. However, two MMEs 2, 12 are involved in this process, and this requires extra signalling. According to the invention, when a node 1 (hereinafter referred to as the source node, and indicated by dashed lines in Figure 7) initiates a handover (step 41) it transmits a flag 90 to the target node 11 indicating that it is capable of supporting an inter-MME handover process, and identifying the address of its associated MME 2. In a preferred embodiment the source node 1 will be aware, from an internal database 841 of neighbouring nodes, whether the target node is also capable of supporting the inter-MME process, and will only initiate the process if that is the case: otherwise initiating an S1 Type handover as illustrated in Figures 2 and 3 (steps 22 onwards). Alternatively, if a target node 11 not capable of supporting the inter-MME handover process receives a message with the flag 90 it will detect the flag as an error and reject the handover, after which the source node will attempt an S1 type handover. The former process is preferred as it reduces the delay caused by the rejection and re-attempt.

When a target node 11 (indicated by solid lines in Figure 7) capable of supporting the inter-MME handover process receives a handover request 21/31/41 it first determines whether the source node 1 works to the same MME 2, as the target node 12 does (step 410, and see figure 3), and if this is the case it initiates a normal X2 handover process 31, 32, 33. Otherwise, if the source node 1 does not support the process step 42 it initiates the S1-type process described with respect to Figures 2 and 3 (steps 22, 23, 25). Consequently, if either of the nodes is not capable of supporting the inter-MME handover process of the invention, the flag is either not sent, or is rejected, and the source node then either initiates a normal S1 handover, or an X2 handover if both nodes work to the same MME.

However, when both the source node 1 and target node 11 are capable of operating the process of the invention, the flag 90 is both generated by the source node 1 and detected by the target node 11, and a data link 43 is established over which data may be forwarded to the target node.

The target node, on detecting the flag indicating an inter-MME handover (step 44) establishes a new downlink 28 with the terminal over which data received over a link 43 from the source node 1 may be forwarded. It should be noted that at this stage the actual handover of the wireless connection of the terminal 10 from source node 1 target node 11 has already taken place. The remaining process is required to transfer the backhaul connections 25, 26, between the nodes and the PDN gateway 6 to operate by the new route 27, 261.

In order to do this, the target node 11 transmits a change path request 32 to its respective MME 12, together with the information 44 carried by the flag 90 relating to the source MME 2.

On receiving a change path request 32 with the flag 90, the target MME 12 extracts the address data of the source MME 2 (step 44) and sets up an interface with the source MME 2 to allow the relocation (path change) to be co-ordinated (step 43). The target MME 12 can process the session request with its associated serving gateway 13 (step 33), allowing the PDN gateway 6 to modify the bearer data (step 331).

The remainder of the handover is managed by the target MME 12, with the additional step of transmitting a notification 45 to the source MME 2 to indicate that the session has been transferred to the target MME 12, allowing the source MME to close down the original session with its serving gateway 3 (step 46). It also informs the source MME 2 of the identity of the gateway 13 associated with the target MME 12 so that, if it is different, the source MME 2 can instruct its own associated gateway 3 to drop the session (step 38).

Once the new path is established the target MME 12 can forward an acknowledgement to the target node 11 (step 29) which can then instruct the source node to release its resources (step 39)

Figure 8 is a diagram illustrating schematically the functional elements of an access node capable of operation according to the invention. Figure 9 is a diagram illustrating schematically the functional elements of an access control system according to the invention. It will be appreciated that these elements may be

implemented by software. The handover process involves co-operation between two access nodes of the general type depicted in Figure 8, operating through two access control systems of the general type depicted in Figure 9, although in both cases the nodes and access control systems may differ in detail.

The access node in figure 8 can operate the process described above acting as either a source node 1 or a target node 11. It comprises a wireless interface 80 for communicating with one or more co-operating user terminals 10, and a network connection 82 through which the access node may be connected to other access nodes 1, 11, a network gateway (SGW) 3, 13, and a handover control system (MME) 2, 12. A switching system 81 controls the routing of data from the various inputs and addressing for onward transmission. A data receiving function 88 and data transmission function 89 process data being passed through the access point, providing functions such as buffering or reformatting.

A handover processing unit 8 comprises a quality monitoring function 83 for measuring the quality of the wireless link 24, 28 between the interface 80 and any user terminal 10 currently connected to the access node, providing an input to a handover initiation processor 84. The handover initiation processor transmits a handover initiation signal over the network connection 82, and virtual link 5 to a target access node 11. This signal includes a flag generated by a flag generation unit 85 indicating that the access point is associated with a handover control system 2 capable of supporting a handover, and identifying that handover control system. This identity will have been provided to the flag generator 85 by the handover control system (MME) 2 by way of the link 32 and the network connection 82, as will be described with reference to Figure 9.

The handover processor 8 also has an incoming handover processor 86 for processing handover requests generated by other access points 1, and received over the virtual connection 5 through the network connection 82, allowing the access point to operate as a target node 11. Associated with this processor 86 is a flag monitor 87. If the flag monitor detects a flag in an incoming request, it forwards the data in the flag, which includes the identity of the source handover control unit 3, to its associated access control system (MME) 12.

Figure 9 depicts an access control system capable of operation as either a source MME 2 or a target MME 12 according to the invention. It has signalling connections 21, 22 to the access nodes 1, 11 under its control, a further connection 211, 212 to one or more service gateways 3,13 and a further connection 210 to other access control systems 2,12. It has a handover processing function 9, 19 which generates instructions to the access nodes 1, 11, gateways 3,13 and other access control systems 2 in order to establish and release communications links between them as part of the handover process, in response to handover requests transmitted from another access control system 1 either directly, or by way of a gateway 13 or another handover control system 12. Separate functions 9, 19 are depicted, respectively for operation of the system as a source or a target. When operating as a target MME 12, instructions received from a target access node 1 are processed by a path switch request-receiving function 96 which has an associated monitoring function 97 to identify whether a source MME 2 is identified in a flag carried by the path switch data. If such data are present, the handover processor 19 mediates the handover process with that other access control system (MME) 2. If no such flag data is present, the request is forwarded by way of a gateway interface 98 to the associated gateway 3.

When operating as a source handover control unit 2 the handover processing unit 9 may receive requests for handover either from the associated gateway 3 or from another access control system 12, depending on whether the target system 12 is also enabled to operate the inter MME handover process of the invention. The access control system also has a flag generation unit 95 for generating data identifying the unit as having the capability to co-operate directly with similar units and transmitting that data to access nodes 1,11 to which it is connected in order to programme their flag generators 8 (Figure 8)

CLAIMS

1. A mobile communications access node for providing a communications connection between a user terminal and a network, the access node having a handover processor for processing handover requests,

wherein the handover processor is configured to detect a signal, received from another access node associated with a first handover control system, to hand over a connection with a user terminal, and to forward the request to a second handover control system associated with the mobile communications access node,

a monitor to identify the presence of a flag in the request, the flag identifying the access node transmitting the request and a first handover control system with that access node, and indicative that the first handover control system is capable of co-operation with handover control systems of a class to which the second handover system belongs to effect a handover,

the handover processor being responsive to handover requests in which the flag is not present to cause data destined for the user terminal to be redirected to a gateway for forwarding to a redirection address subsequent to completion of a handover,

the handover processor being responsive to a request in which the flag is present to forward data to the access node identified by the flag a data receiver to receive data destined for the user terminal from the other access node

a data transmitter to transmit data, received from the other access node, to the user terminal

and wherein the handover processor is configured to generate a path switch request flagged to indicate to a further handover control system that the handover processor is capable of co-operation with another access point to effect a handover.

2. A mobile communications access node according to claim 1 comprising a handover processor for generating a handover request for transmission to another access node in order to transfer a connection between a user

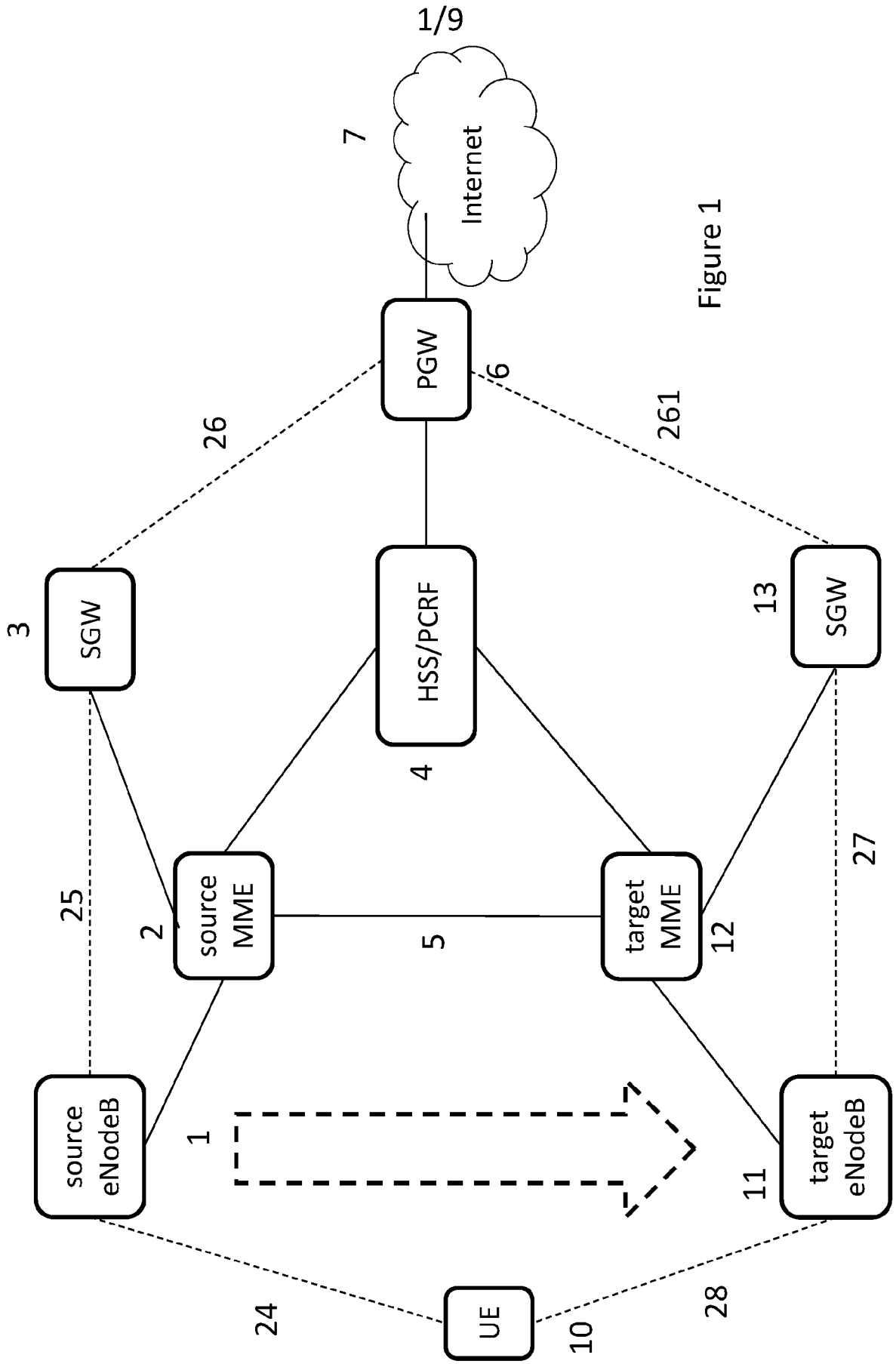
terminal and a network currently routed by way of the access node such that it is routed by way of the other access node,

having a flag generator to generate a flag in the request, the flag identifying a handover control system associated with the access node transmitting the request, and indicative that the handover control system is capable of co-operation with another handover control system to effect a handover,

3. A handover process for causing a communications access connection between a user terminal and a core network to be diverted from a first routing by way of a source access node controlled by a first handover control system to a second routing by way of a target access node controlled by a second handover control system, in which the source access node transmits a path switch request to the target access node, wherein at least one of the source access node and the target access node is capable of generating and detecting flags indicative of the identity of the first control system from which the source access node is controlled, and wherein the source access node initiates forwarding of data received from the network and destined for the user terminal, such that data is routed from the source access node to the target access node for onward transmission to the user terminal, wherein if flag data is generated by the source access node and detected by the target access node it the data is forwarded to the second access control system to initiate a co-operative process between the source access control system and the target access control system to establish the second routing between the user terminal and the network, and if the target access node does not detect a flag in the handover request, the path switch request is rejected and a path switch request is transmitted from the source node to its respective access control system to initiate a path switch process mediated through the core network.

4. A handover process according to Claim 4 wherein if the target access node is enabled to initiate a path switch request, it responds to detection of the flag in a path switch request by retransmitting the said flag to the

source access node, and on detection of the retransmitted flag the source access node initiates the establishment of the second routing, and if the source node does not detect a retransmitted flag it initiates a path switch process mediated through the core network.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27
source eNodeB
1
target eNodeB
11
UE
24
10
28

Figure 1

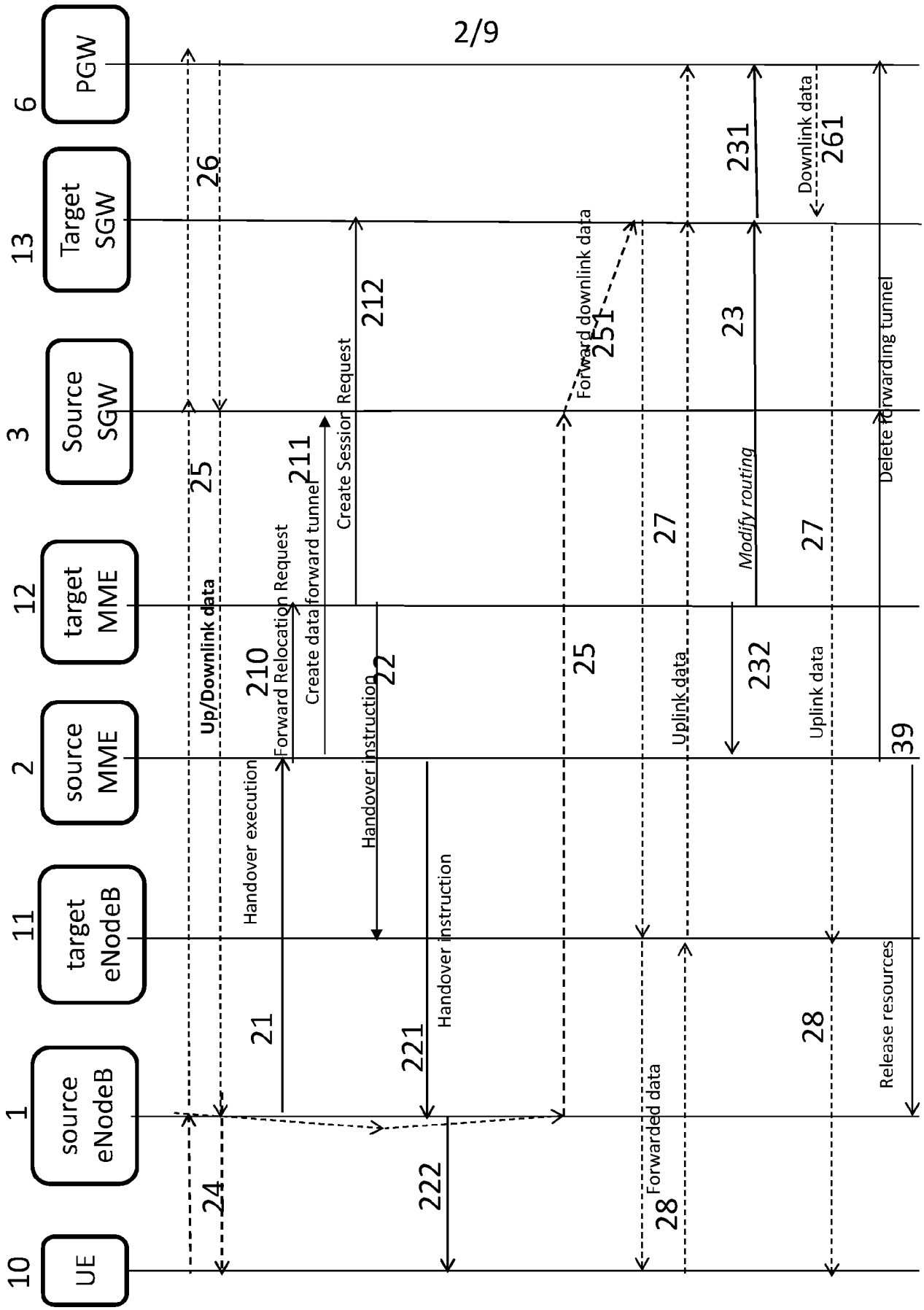

10 UE
1 source eNodeB
11 target eNodeB
2 source MME
12 target MME
3 Source SGW
13 Target SGW
6 PGW
24
25
Up/Downlink data
26
21
Handover execution
210
Forward Relocation Request
211
Create data forward tunnel
Create Session Request
212
221
Handover instruction
22
Handover instruction
222
251
Forward downlink data
23
Modify routing
231
Downlink data
261
25
27
Uplink data
232
27
Uplink data
28
Forwarded data
28
Release resources
39
Delete forwarding tunnel

Figure 2

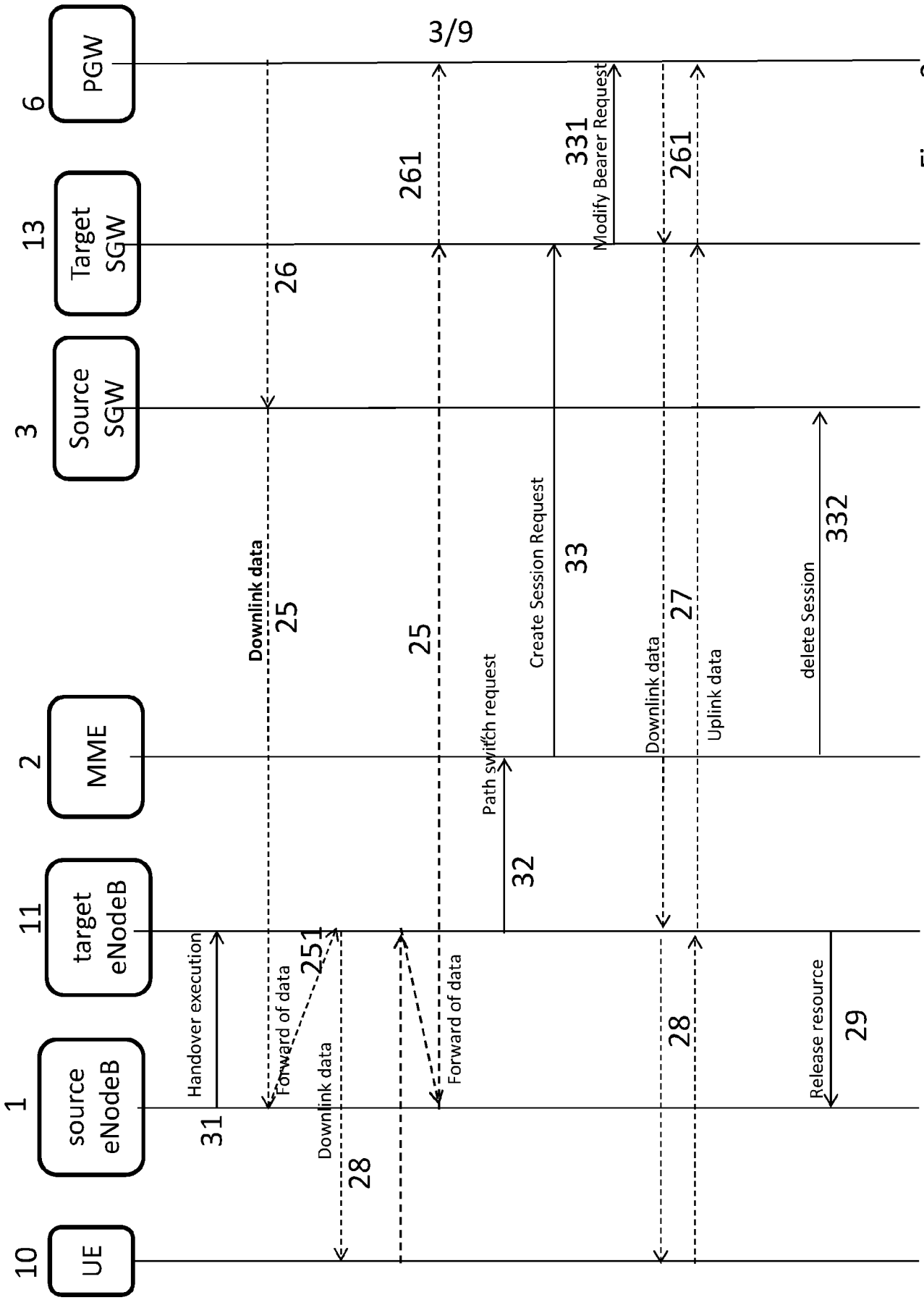

10
UE
1
source eNodeB
11
target eNodeB
2
MME
3
Source SGW
13
Target SGW
6
PGW
Handover execution
31
Forward of data
251
Downlink data
28
Forward of data
Path switch request
32
Downlink data
25
Create Session Request
33
261
Modify Bearer Request
331
261
Downlink data
25
27
Uplink data
28
delete Session
332
Release resource
29

Figure 3

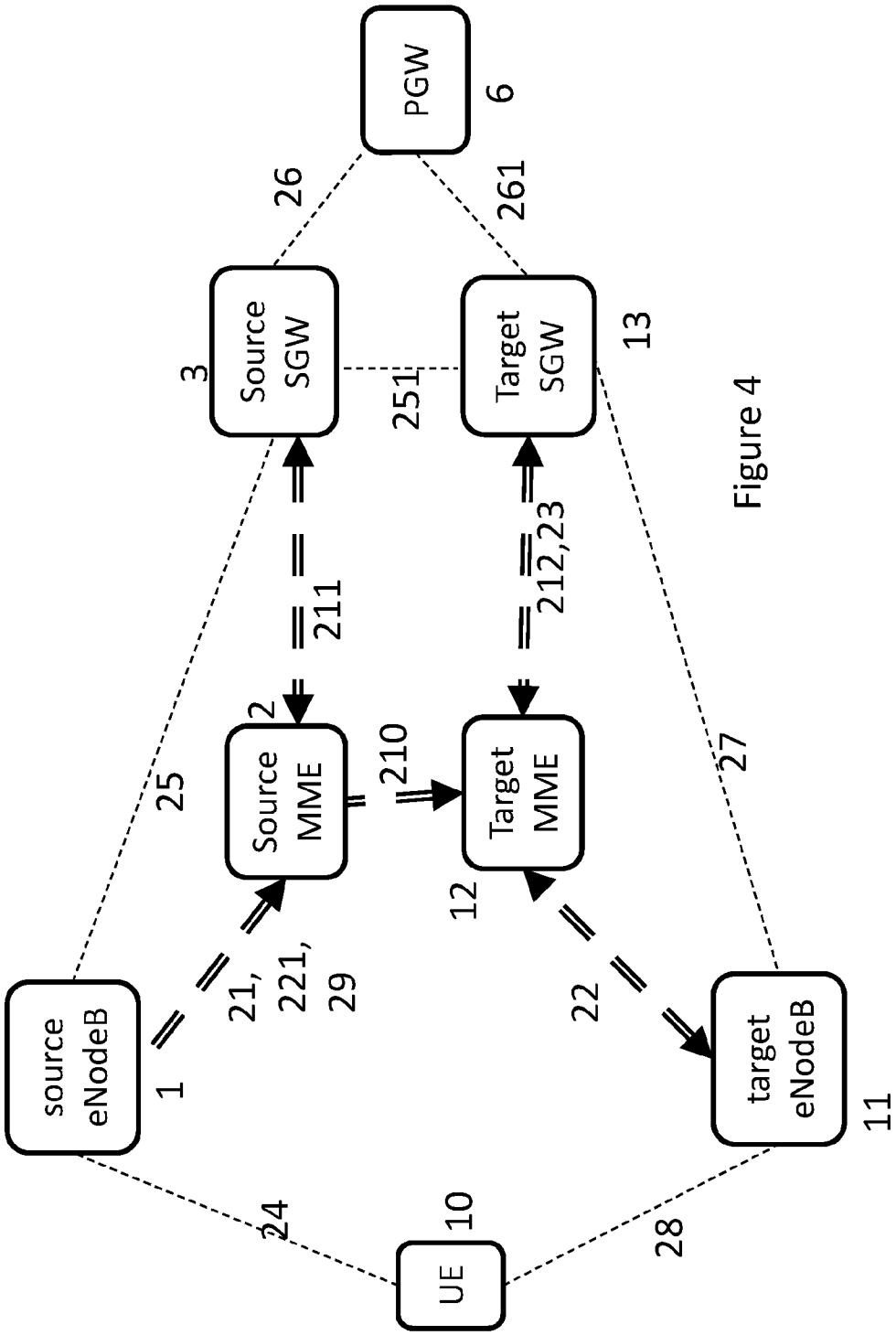

PGW
6
26
261
Source SGW
3
Target SGW
13
251
211
212,23
Source MME
2
210
Target MME
25
27
12
source eNodeB
1
21, 221, 29
22
target eNodeB
11
24
UE
10
28

Figure 4

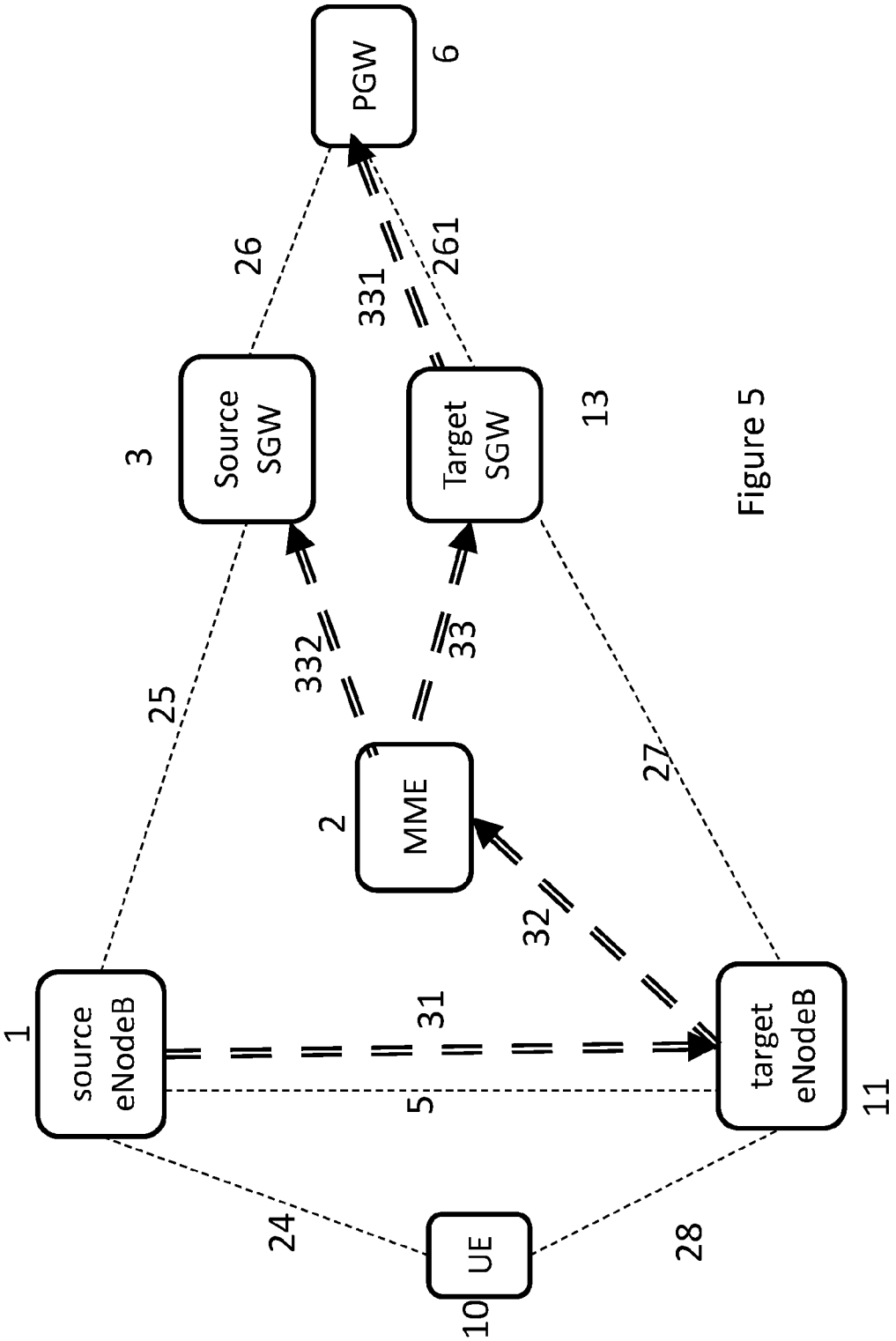

PGW
6
26
331
261
Source SGW
3
Target SGW
13
332
33
25
27
MME
2
32
source eNodeB
1
31
target eNodeB
11
5
24
UE
10
28

Figure 5

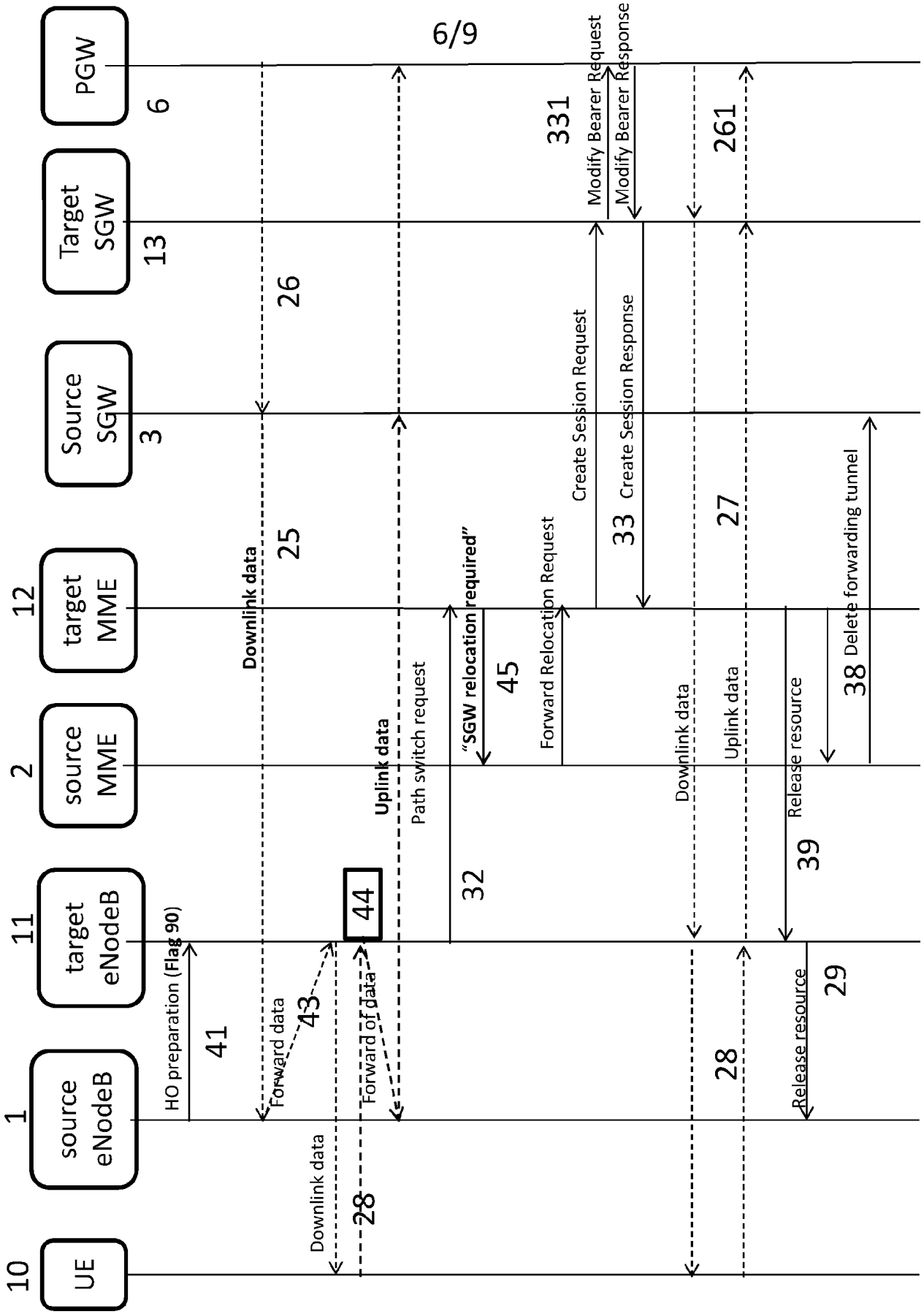

10
UE
1
source eNodeB
11
target eNodeB
2
source MME
12
target MME
3
Source SGW
13
Target SGW
6
PGW
HO preparation (Flag 90)
41
Forward data
43
Forward of data
Downlink data
28
Downlink data
25
Uplink data
Path switch request
32
"SGW relocation required"
45
Forward Relocation Request
Create Session Request
33
Create Session Response
331
Modify Bearer Request
Modify Bearer Response
261
Downlink data
27
Uplink data
Release resource
39
Release resource
28
Delete forwarding tunnel
38
29
26
44

Figure 6

Figure 7

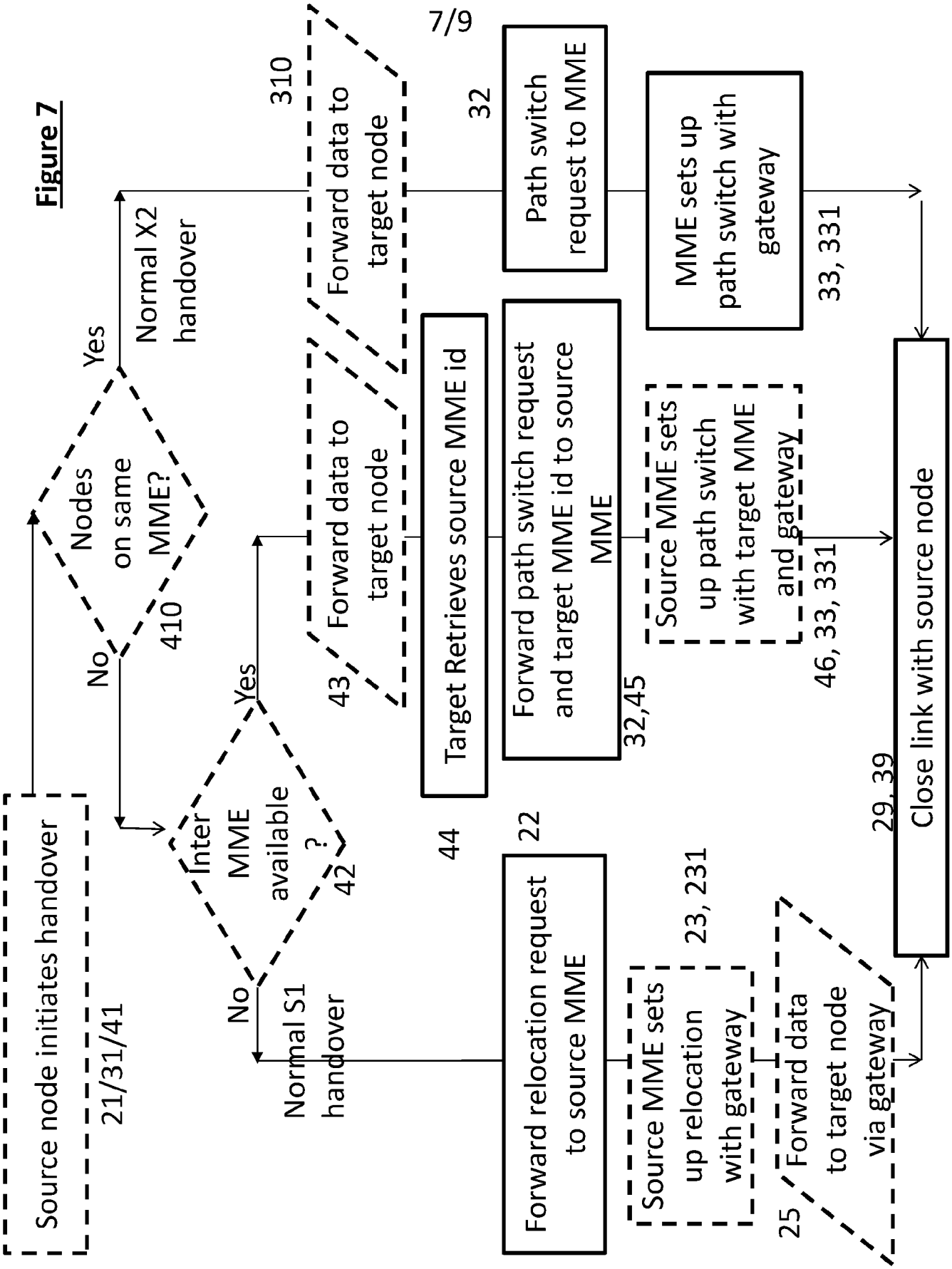
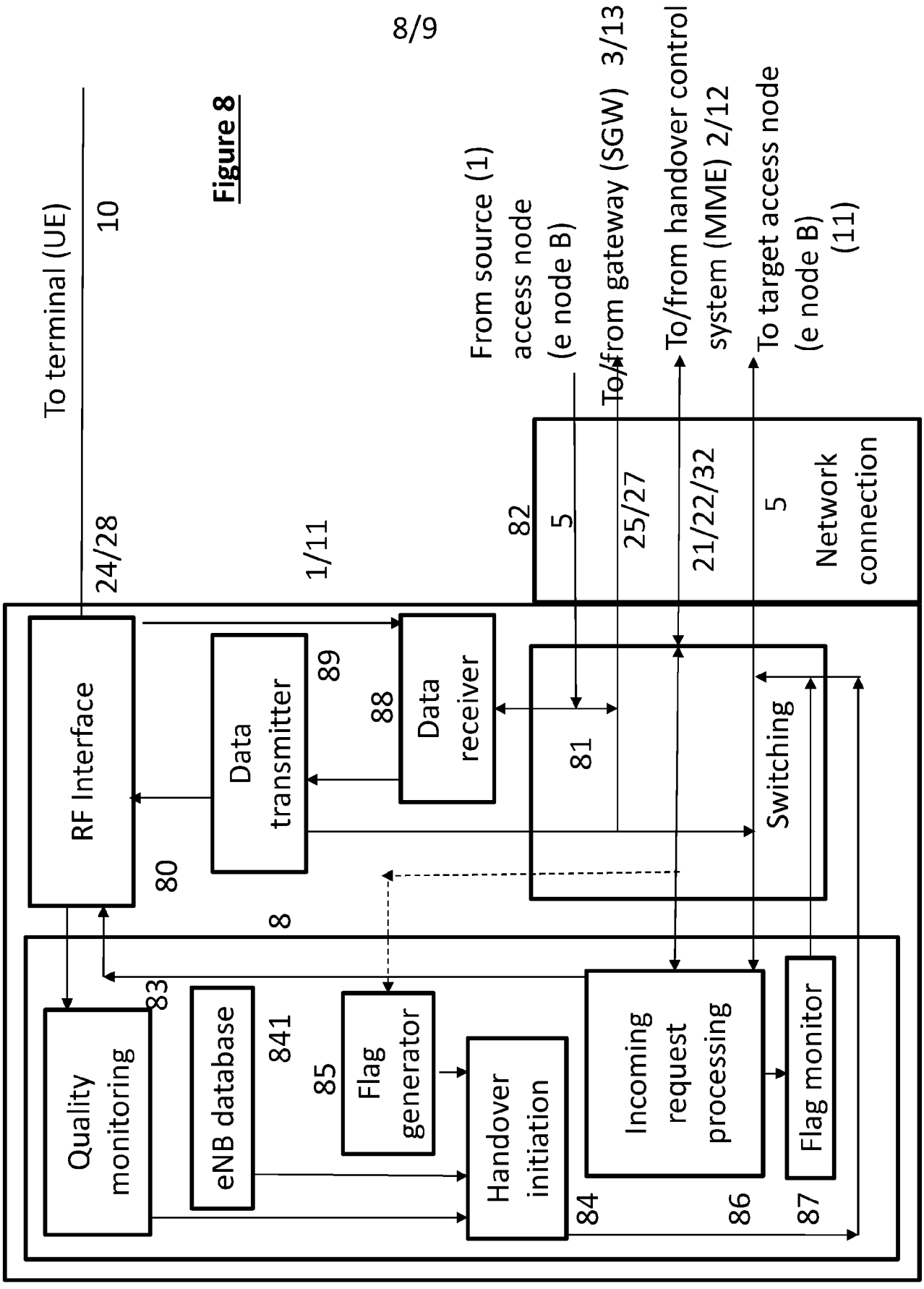

Source node initiates handover
21/31/41
Nodes on same MME? 410
Yes
Normal X2 handover
No
Inter MME available ? 42
Yes
No
Normal S1 handover
310
Forward data to target node
43
Forward data to target node
Target Retrieves source MME id
44
Forward path switch request and target MME id to source MME
32,45
Forward relocation request to source MME
22
Path switch request to MME
32
MME sets up path switch with gateway
33, 331
Source MME sets up path switch with target MME and gateway
46, 33, 331
Source MME sets up relocation with gateway
23, 231
Forward data to target node via gateway
25
Close link with source node
29, 39

Figure 8


To terminal (UE)
10
24/28
1/11
From source (1) access node (e node B)
To/from gateway (SGW) 3/13
To/from handover control system (MME) 2/12
To target access node (e node B) (11)
82
5
25/27
21/22/32
5
Network connection
RF Interface
80
Data transmitter
89
88
Data receiver
81
Switching
8
83
Quality monitoring
eNB database
841
85
Flag generator
Handover initiation
84
Incoming request processing
86
Flag monitor
87

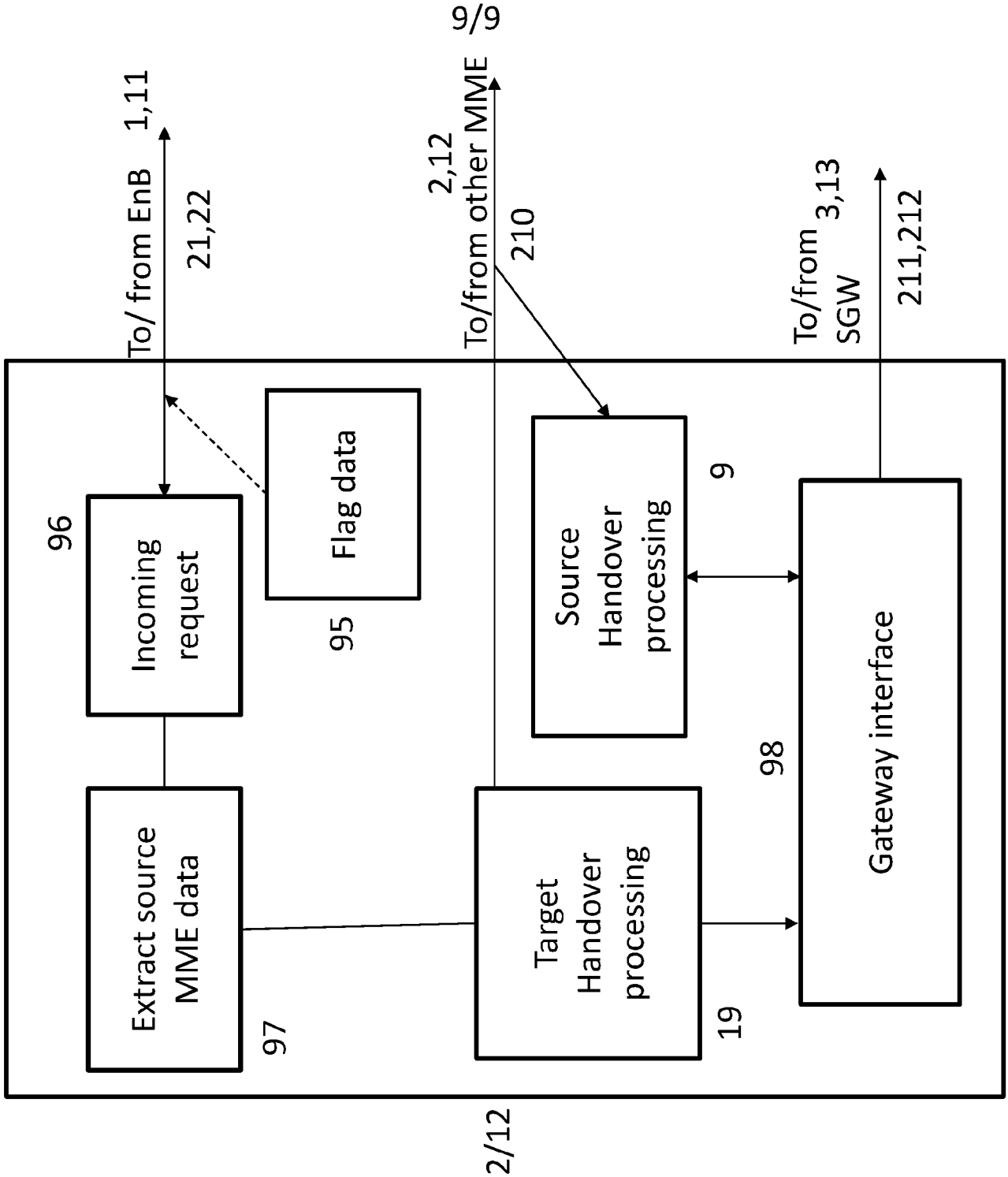

9/9
To/ from EnB
1,11
21,22
2,12
To/from other MME
210
To/from SGW
3,13
211,212
96
Incoming request
Flag data
95
Source Handover processing
9
Gateway interface
98
Extract source MME data
97
Target Handover processing
19
2/12

Figure 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2015/050626

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W36/12
ADD.

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

B. FIELDS SEARCHED

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

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007/254667 A1 (JOKINEN JOANNA [FI]) 1 November 2007 (2007-11-01) abstract paragraph [0008] - paragraph [0010] paragraph [0015] - paragraph [0021] paragraph [0055] - paragraph [0056] paragraph [0065] - paragraph [0072] figure 3 -----	1-4
X	EP 1 892 993 A2 (NEC CORP [JP]) 27 February 2008 (2008-02-27) abstract paragraph [0028] paragraph [0035] paragraph [0040] - paragraph [0046] figures 4, 5 ----- -/--	1-4

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

[X] See patent family annex.

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 May 2015	01/06/2015

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

1

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

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 2 645 774 A1 (HUAWEI TECH CO LTD [CN]) 2 October 2013 (2013-10-02) abstract paragraph [0080] - paragraph [0097] paragraph [0120] - paragraph [0124] figures 3, 5	1-4
A	"3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access (Release 8)", 3GPP STANDARD; 3GPP TS 23.401, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. SA WG2, no. V8.18.0, 5 March 2013 (2013-03-05), pages 1-238, XP050691822, paragraph [5.5.1.2.2]	1-4
A	US 2007/213060 A1 (SHAHEEN KAMEL M [US]) 13 September 2007 (2007-09-13) abstract paragraph [0039] - paragraph [0066] figure 12	1-4

1

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Information on patent family members

International application No
PCT/GB2015/050626

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		US 2007213060 A1	13-09-2007
		WO 2007103369 A2	13-09-2007