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(54) **METHOD AND SYSTEM FOR MAINTAINING MULTIPLE PDN NETWORK CONNECTION DURING INTER-TECHNOLOGY HANDOVER IN THE IDLE MODE**

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H04W 36/14 (2009.01)
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CPC ***H04W 36/14*** (2013.01); ***H04W 36/00*** (2013.01); ***H04W 36/0033*** (2013.01); *H04W 48/18* (2013.01); *H04W 76/04* (2013.01)

(58) **Field of Classification Search**
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See application file for complete search history.

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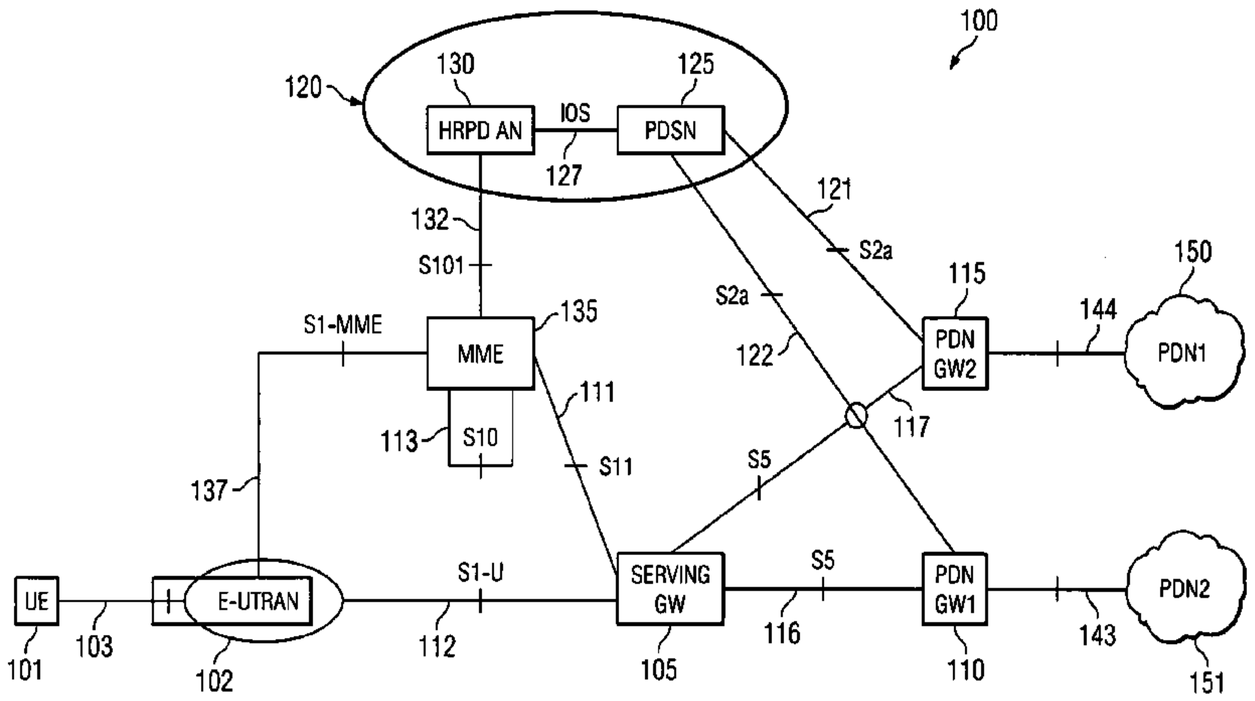
(57) **ABSTRACT**

Supporting an optimized idle mode handoff of user equipment from a 3GPP to a non-3GPP system. Namely, during an idle mode registration of the user equipment with the non-3GPP system, the user equipment may provide an indication to the access node on the non-3GPP system so that the access point in that non-3GPP system contacts the appropriate entity (HSS or AAA) on the home network for the user equipment to download the addresses of the multiple PDN gateway addresses that are currently in use by the user equipment. This indication to the non-3GPP access node, the contact message from the access node to the home network, and the response from the home network to the access node on the non-3GPP system provide the access node with sufficient information to maintain multiple PDN connectivity to the user equipment during an idle mode handover.

17 Claims, 2 Drawing Sheets



(51) **Int. Cl.**

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H04W 76/04	(2009.01)
H04W 48/18	(2009.01)

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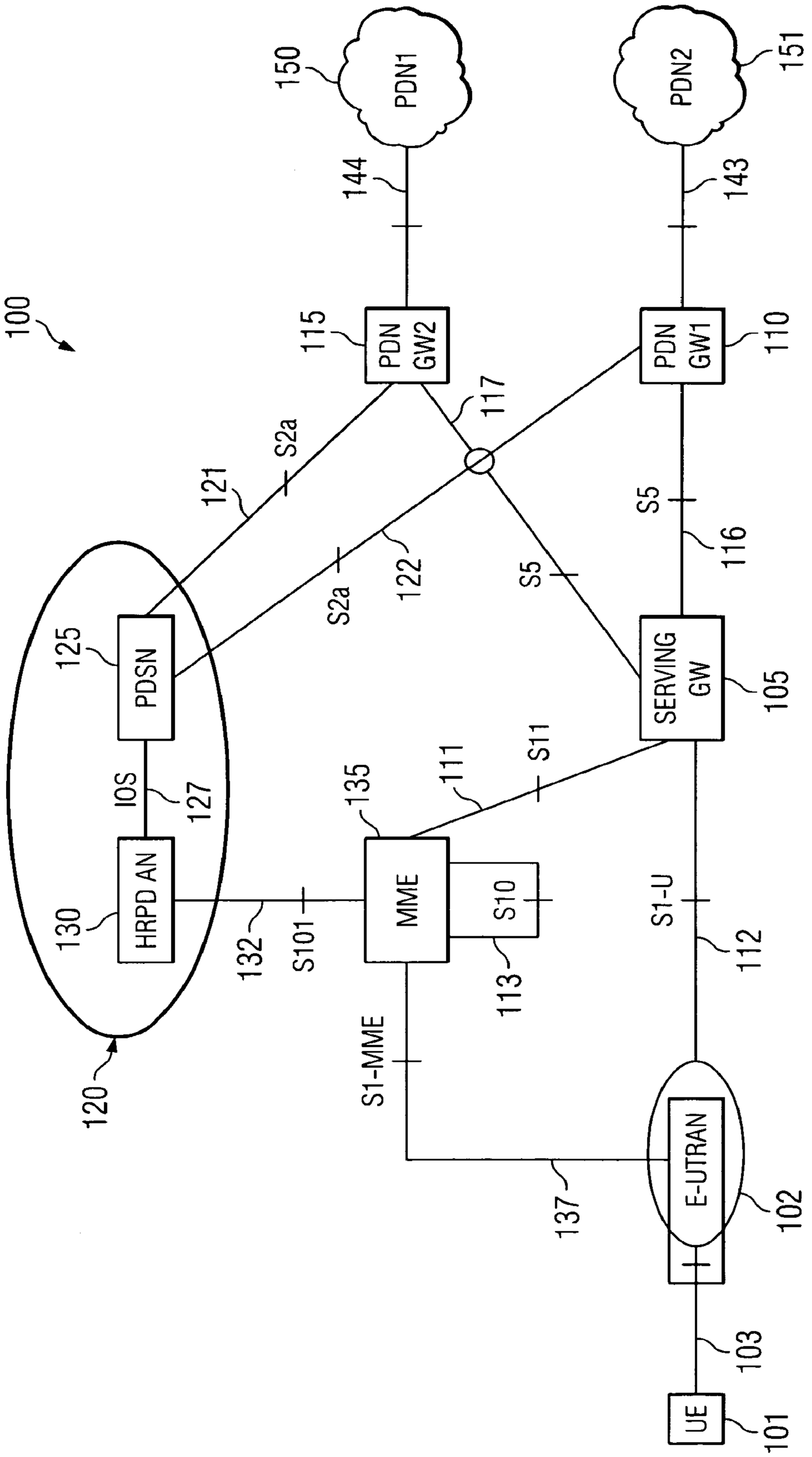
100
120
150
PDN1
144
115
PDN GW2
121
S2a
117
PDN2
151
143
PDN GW1
110
125
PDSN
IOS
127
130
HRPD AN
132
S101
135
MME
111
S11
S10
113
S2a
122
S5
S5
116
SERVING GW
105
S1-U
112
S1-MME
137
E-UTRAN
102
UE
103
101

FIG. 1

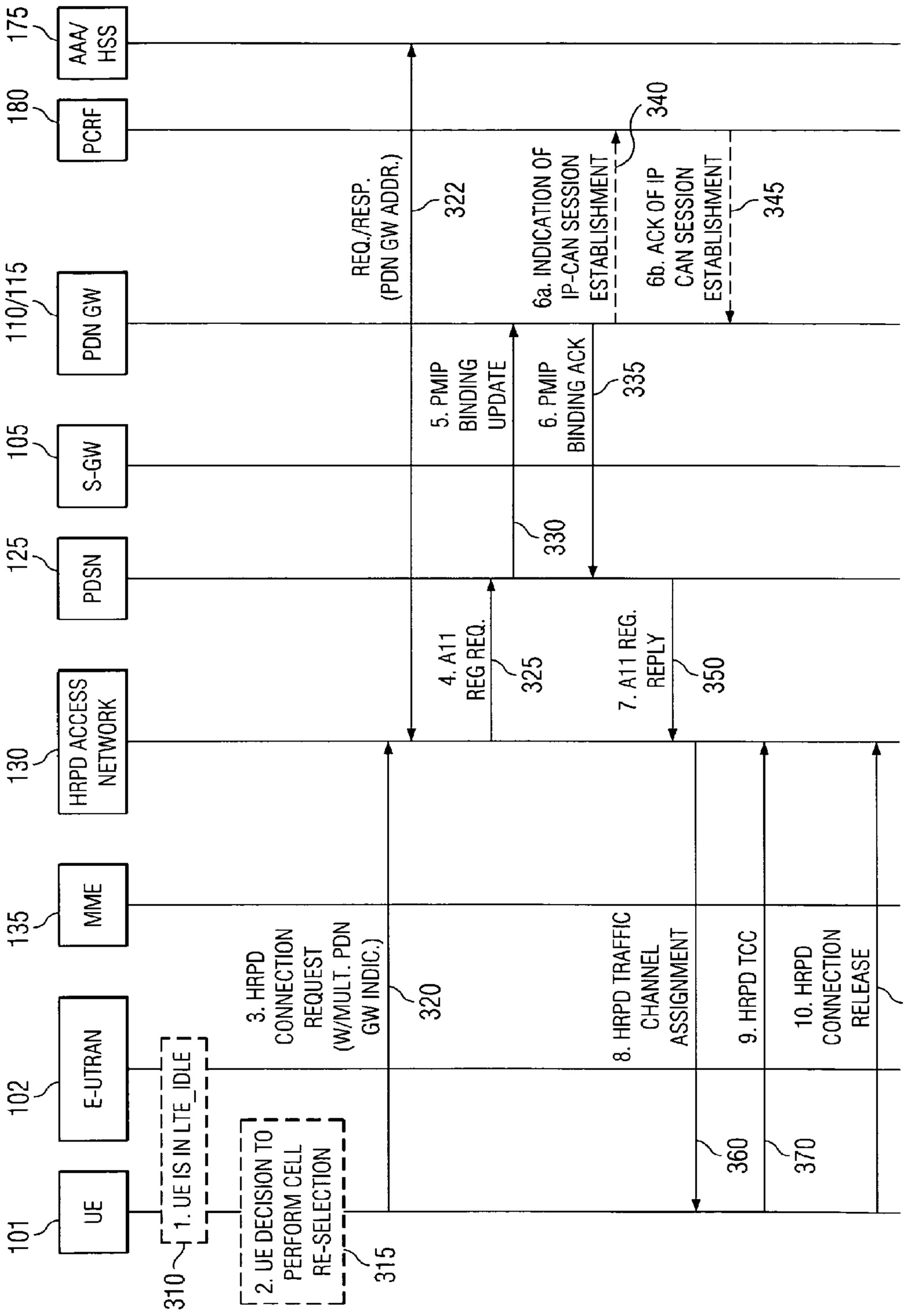
101 UE
102 E-UTRAN
135 MME
130 HRPD ACCESS NETWORK
125 PDSN
105 S-GW
110/115 PDN GW
180 PCRF
175 AAA/ HSS
310 1. UE IS IN LTE_IDLE
2. UE DECISION TO PERFORM CELL RE-SELECTION
315
3. HRPD CONNECTION REQUEST (W/MULT. PDN GW INDIC.)
320
4. A11 REG REQ.
325
5. PMIP BINDING UPDATE
330
6. PMIP BINDING ACK
335
REQ./RESP. (PDN GW ADDR.)
322
6a. INDICATION OF IP-CAN SESSION ESTABLISHMENT
340
6b. ACK OF IP CAN SESSION ESTABLISHMENT
345
7. A11 REG. REPLY
350
8. HRPD TRAFFIC CHANNEL ASSIGNMENT
360
9. HRPD TCC
370
10. HRPD CONNECTION RELEASE
380

FIG. 2

METHOD AND SYSTEM FOR MAINTAINING MULTIPLE PDN NETWORK CONNECTION DURING INTER-TECHNOLOGY HANDOVER IN THE IDLE MODE

RELATED APPLICATION DATA

This application is a continuation of U.S. patent application Ser. No. 13/734,067, filed Jan. 4, 2013, which is a continuation of U.S. patent application Ser. No. 12/934,452, filed Sep. 24, 2010 which is a Submission Under 35 U.S.C. §371 for U.S. National Stage Patent Application PCT/IB2009/005654, filed Mar. 25, 2009, which claims priority to Provisional Patent Application No. 61/039,252 filed on Mar. 25, 2008, all of which are incorporated by reference in their entirety as if fully and completely set forth herein.

TECHNICAL FIELD OF THE INVENTION

A method and system for maintaining multiple PDN network connections during inter-technology wireless handover in idle mode.

BACKGROUND OF THE INVENTION

When a mobile unit is traveling, it may need to be handed off from one network to another. There are different types of wireless communication systems, such as general packet radio service (GPRS), global system for mobile (GSM)/enhanced data rates for GSM evolution (EDGE) radio access network (GERAN), and long term evolution (LTE) evolved universal terrestrial radio access network (EUTRAN). LTE/EUTRAN system has a different physical layer and a different architecture from those systems preceding it, i.e., GPRS, GERAN, or UTRAN. Since not all networks are identical, a method for supporting the handoff between systems would be beneficial.

U.S. Patent Publication Nos. US 2008/0268846A1 and 2008/0192697A1 describe a prior art method and system for supporting a handoff of user equipment from a GPRS/GERAN system to an LTE EUTRAN system, and vice versa, respectively. These references include a FIG. **1** exemplary diagram of a system including an LTE system architecture shown by an LTE/EUTRAN and its evolved packet core interworking with an existing GERAN, UTRAN, and their GPRS Core. The LTE/EUTRAN comprises an E-Node B that is connected (S**1**) to an evolved packet core containing a mobility management entity/user plane entity (MMETUPE) and an inter AS anchor Gateway. The Evolved Packet Core connects (S**6**) to a home subscriber service (HSS), and connects (S**7**) to a Policy and Charging Rules (PCRF). The inter AS Anchor gateway connects (Gi) to Operator IP Servers (such as IMS, PSS), connects (S**2**) to a Non-3GPP IP Access network **108**, and connects (S**2**) to a WLAN 3GPP IP Access network **109**.

The GPRS Core shown in FIG. **1** of these prior art references comprises a Serving GPRS Support Node (SGSN) which is responsible for Mobility Management, Access Procedures, and User Plane Control. The GPRS Core also comprises a Gateway GPRS Support Node (GGSN), where the network is connected to external networks and other operator servers. The Non-3GPP IP access network **108** includes connections to other technologies that are developed in other standard Forums such as 3GPP2 (CDMA2000) and WiMAX (IEEE 802.16 system). The WLAN 3GPP IP access network has WLANs incorporated into 3GPP systems via interworking architecture defined in 3GPP. These identified patent references, however, do not address the optimized handover procedures and system for an idle mode handover of user equipment from a 3GPP (EUTRAN) to a non-3GPP (HRPD cdma2000) system where the user equipment wishes to maintain connectivity with multiple PDN networks.

The Technical Specification 3GPP TS 23.402 V8.1.1 (2008-03) describes a 3rd Generation Partnership Project (3GPP) Technical Specification for enhancements and interactions with non-3GPP accesses. The particular version of the Technical Specification is Release 8, which describes the general network resources, entities, functions, and handover procedures for certain inter-technology combination handover systems, protocols, and procedures. Like the above-identified references, this Technical Specification also fails to address the optimized handover procedures and system for an idle mode handoff of user equipment from a 3GPP (EUTRAN) to a non-3GPP system (HRPD cdma 2000) where the user equipment wishes to maintain connectivity with multiple PDN networks. It would be beneficial to have a method and system that could support such an idle mode handover while maintaining the user equipment's connectivity to multiple PDN networks.

SUMMARY OF THE INVENTION

The present invention provides a method and system for supporting an optimized idle mode handoff of user equipment from a 3GPP (EUTRAN) to a non-3GPP system (HRPD, cdma2000) where the user equipment wishes to maintain connectivity with multiple PDN networks. Namely, when the user equipment establishes its presence with the non-3GPP system in idle mode, the user equipment will provide an indication to the access node on the non-3GPP system so that the access node in that non-3GPP system contacts the appropriate entity (HSS or AAA) on the home network for the user equipment to download the addresses of the multiple PDN gateway that are currently in use by the user equipment. This indication to the non-3GPP access node, the contact message from the access node to the home network, and the response from the home network to the access node on the non-3GPP system are novel features that are not shown in the prior art, and provide the access node with sufficient information to maintain multiple PDN connectivity to the user equipment during an idle mode handover.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and features of the invention will become more readily understood from the following detailed description and appended claims when read in conjunction with the accompanying drawings in which like numerals represent like elements and in which:

FIG. **1** is a mobile IP-based communication system showing the user equipment, the 3GPP based network, the non-3GPP network and the multiple PDN connections to the user equipment, and,

FIG. **2** is a handover protocol of the user equipment to the non-3GPP system with the disclosure of the indication message, the access node request message to the home network, and the response to the access node.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. **1**, the present invention proposes a solution to the idle mode handover of user equipment from a 3GPP network to a non-3GPP network that includes provid-

ing the access node on the non-3GPP network with the addresses for the multiple PDN gateway connections currently being used by the user equipment, which are shown as PDN Gateway 1 **110** and PDN Gateway 2 **115**. The handover occurs in FIG. **1** from the E-UTRAN network **102** to the HRPD network **120** in the present invention so that multiple PDN network connectivity can be maintained with the user equipment **101** during the idle mode handover. In this example, the E-UTRAN network **102** is a 3GPP network called the source network, and the HRPD network **120** is a non-3GPP network called the target network.

In the prior art, the HSS on the home network (not shown in FIG. **1**) receives the values of the addresses of all allocated PDN Gateways (**110** and **115**) and the corresponding PDN information for a given user equipment **101** assigned to the HSS's home network from both the 3GPP AAA (not shown) and also from the MME **135**, depending on the currently in-use access. The HSS on the home network is responsible for the storage of PDN Gateway address information. In an active mode handover in the prior art, if user equipment is attached to a non-3GPP access and it already has assigned PDN Gateways (**110** and **115**) due to a previous attach in a 3GPP access, the HSS on the home network provides the IP address(es) of the already allocated PDN Gateway(s) (**110** and **115**) with the corresponding PDN information to the 3GPP AAA server over the SWx reference point. The PDN gateway's address(es) is sent during the attach procedure in the non-3GPP access. Also in active mode, if user equipment **101** attaches to a 3GPP access and it already has an assigned PDN Gateway(s) **110** and **115** due to a previous attach in a non-3GPP access, the HSS provides the IP address(es) of the already allocated PDN Gateway(s) (**110** and **115**) with the corresponding PDN information to the MME over the S**6***a* reference point, and the PDN gateway address(es) is sent during the attach procedure in the 3GPP access.

No prior art procedures support the handover of user equipment in a non-active, idle mode so that connectivity can be maintained with multiple PDN connections, and no prior art procedures allow for the direct interaction between the access node of the non-3GPP network and the HSS entity/AAA server on the home entity to acquire the multiple PDN gateway addresses. By "idle mode," the applicant means that the system is not operating in an active or connected mobility mode procedure, and the "idle mode" can be characterized by an idle mobility procedure or a radio link failure scenario. The present invention supports such an "idle mode" transfer of user equipment with multiple PDN gateway connections.

Referring to FIG. **1**, the network **100** shows the various network components involved with the idle mode inter-technology handover with connectivity to multiple PDN networks. The user equipment **101** is coupled to the E-UTRAN network (3GPP) **102** through connection **103**. When referred to hereafter, the terminology user equipment (UE) includes, but is not limited to, a mobile station, a fixed or mobile subscriber unit, a pager, a cellular telephone, a personal digital assistant (PDA), a computer, or any other type of user device capable of operating in a wireless environment.

The E-UTRAN network **102** is coupled through S**1**-U connection **112** to the Serving Gateway **105**, which is coupled to PDN Gateway 1 **110** and PDN Gateway 2 **115** through connections S**5** **116** and **117**, respectively. The PDN Gateway 1 **110** and PDN Gateway 2 **115** couple the multiple PDN networks **150** and **151**, which are coupled by connections **143** and **144**, respectively. SGi**1** **142** and SGi**2** **141** interfaces are coupled to PDN sources of data located on the Internet **150** through connections **151** and **152**, respectively. Maintaining these multiple PDN connections during an idle handover of the user equipment **101** from the E-UTRAN **102** system to a non-3GPP system, such as the HRPD system **120** shown in FIG. **1** is the primary focus of the present invention.

The E-UTRAN network **102** is coupled through S**1**-MME connection **137** to the Mobility Management Entity (MME) **135**, which has an internal S**10** connection **113**. The MME **135** is coupled to the Serving Gateway **105** through connection S**11** **111**, and the MME **135** is couple to the HRPD Access Node **130** on the HRPD system **120** through S**101** connection **132**. The HRPD Access Node **130** is coupled to the Packet Data Switching Node (PDSN) **125** through the Interoperability Specification (IOS) connection **127**. The PDSN **125** is sometimes called the HRPD Serving Gateway (HSGW), which is coupled to the PDN Gateway 1 **110** and PDN Gateway 2 **115** through the S**2***a* connections **122** and **121**, respectively.

The HRPD Access Node **130** will be provided with a connection request in idle mode from the user equipment **101**, and the connection request will include an indication from the user equipment **101** that multiple PDN connections are in use by the user equipment **101**. This indication will prompt the HRPD Access Node **130** to send a request to the home subscriber storage (HSS) entity and/or Authentication, Authorization and Accounting (AAA) server located on the home network (not shown in FIG. **1**) assigned to the user equipment **101** to request the addresses of all PDN gateways (**110** and **115**) currently in use by the user equipment. The HSS entity and/or AAA server on the home network will respond to the request with the addresses of all PDN gateways currently in use by the user equipment **101** so the multiple PDN connectivity with the user equipment **101** can be maintained during the idle mode handover.

In FIG. **2**, the handover communication protocol is shown starting at step **310** when the user equipment is designated as being in idle mode. The user equipment makes a decision to "re-select" its cell location in step **315** to the non-3GPP network, and the user equipment **101** sends a HRPD Connection Request message in step **320** to the HRPD Access Node **130**. This HRPD Connection Request message in step **320** would include an indication that the user equipment **101** is currently using multiple PDN connections.

In response to this indication, the HRPD Access Node **130** will send a request message **322** to the AAA server/HSS entity **175** located on the home network assigned to the user equipment in step **322**. In step **322**, the AAA server/HSS entity **175** will respond to that request with the addresses for the multiple PDN gateways and any other relevant information regarding the PDN connections currently in use by the user equipment **101**, such as IP addresses of the already allocated PDN Gateway(s) (**110** and **115**) and corresponding PDN information.

The HRPD Access Node will transmit an A**11** registration request message to the PDSN **125** on the non-3GPP network in step **325**, which will include the address information for the multiple PDN gateways **110** and **115** currently in use by the user equipment. The PDSN **125** will use the address information to send a PMIP message to the PDN gateways **110** and **115** in step **330**, which will be acknowledged by response messages to the PDSN **125** from the PDN gateways **110** and **115** in step **335**. The PDN gateways **110** and **115** will send messages to the PCRF entities in step **340**, and receive a response from the PCRF entities in step **345**.

After receiving the response from the PDN gateways **110** and **115** in step **335**, the PDSN on the non-3GPP network will send an A**11** registration reply to the HRPD Access Node **130** in step **350**. The HRPD Access Node will send the user equipment **101** an HRPD Traffic Channel Assignment in step

360 to establish the connection with the user equipment **101**. The user equipment **101** will then send an HRPD TCC (traffic channel complete) message to the HRPD Access Node **130** in step **370**. The user equipment **101** may also send an HRPD Connection Release message to the HRPD Access Node **130** in step **380**. After these connections are established, any future user equipment **101** communication traffic may flow in both the uplink and downlink directions via the non-3GPP network, including traffic through the multiple PDN connections which have been maintained after the handover to the non-3GPP network.

While preferred embodiments of the invention have been shown and described, modifications thereof can be made by one skilled in the art without departing from the spirit and teachings of the invention. The embodiments described herein are exemplary only, and are not intended to be limiting. Many variations and modifications of the invention disclosed herein are possible and are within the scope of the invention.

Having described the invention, we claim:

1. A method for maintaining connectivity between user equipment and multiple packet data network (PDN) connections during an idle mode handover from a source network operating under the 3GPP communications protocol to a target network operating under a non-3GPP communications protocol, comprising the steps of:

at one or more nodes of the target network:

receiving a connection request message from the user equipment;

transmitting a request message to an authentication, authorization, and accounting (AAA) server on a home network assigned to the user equipment;

receiving a response message from the AAA server on the home network assigned to the user equipment, wherein the response message comprises the addresses for all PDN gateways currently in use by the user equipment;

using the addresses for all PDN gateways currently in use by the user equipment to exchange messages with the PDN gateways to maintain PDN connections with the user equipment after handover of user equipment communications to the target network, wherein said using the addresses for all PDN gateways currently in use by the user equipment to exchange messages with the PDN gateways to maintain PDN connections with the user equipment is performed by a serving gateway node of the target network.

2. The method of claim **1**, wherein the connection request message establishes the presence of the user equipment with the target network and comprises an indication that multiple PDN connections are currently in use by the user equipment.

3. The method of claim **1**, wherein the first node comprises a high rate packet data (HRPD) node.

4. The method of claim **1**, wherein the one or more nodes of the target network comprises an access network node and a serving gateway node.

5. The method of claim **1**, wherein said receiving the connection request message is performed by an access network node of the target network.

6. The method of claim **1**, wherein the AAA server is coupled with a home subscriber storage (HSS) entity on the home network.

7. The method of claim **1**, wherein the address information for the PDN gateways also includes all IP addresses of the PDN gateways with corresponding PDN information.

8. The method of claim **1**, wherein the connection request message is a high rate packet data (HRPD) connection request message.

9. The method of claim **1**, wherein the source network and the home network are the same.

10. A target communications network operating under a non-3GPP communications protocol used to maintain connectivity between user equipment and multiple PDN connections during an idle mode handover, comprising:

an access network node; and

a serving gateway node coupled to the access network node;

wherein at least the access network node and the serving gateway node are configured to operate together to:

receive a connection request message from the user equipment;

transmit a request message to an authentication, authorization, and accounting (AAA) server on a home network assigned to the user equipment;

receive a response message from the AAA server on the home network assigned to the user equipment, wherein the response message comprises the addresses for all PDN gateways currently in use by the user equipment;

use the addresses for all PDN gateways currently in use by the user equipment to exchange messages with the PDN gateways to maintain PDN connections with the user equipment after handover of user equipment communications to the target network, wherein said using the addresses for all PDN gateways currently in use by the user equipment to exchange messages with the PDN gateways to maintain PDN connections with the user equipment is performed by a serving gateway node of the target network.

11. The target communications network of claim **10**, wherein the connection request message establishes the presence of the user equipment with the target network and comprises an indication that multiple PDN connections are currently in use by the user equipment.

12. The target communications network of claim **10**, wherein the first node comprises a high rate packet data (HRPD) node.

13. The target communications network of claim **10**, wherein receiving the connection request message is performed by an access network node of the target network.

14. The target communications network of claim **10**, wherein the AAA server is coupled with a home subscriber storage (HSS) entity on the home network.

15. The target communications network of claim **10**, wherein the address information for the PDN gateways also includes all IP addresses of the PDN gateways with corresponding PDN information.

16. The target communications network of claim **10**, wherein the connection request message is a high rate packet data (HRPD) connection request message.

17. The target communications network of claim **10**, wherein the source network and the home network are the same.

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