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(54) NETWORK SELECTION INVOLVING GANC REDIRECTION

(75) Inventors: **Adrian Buckley**, Tracy, CA (US); **George Baldwin Bumiller**, Ramsey, NJ (US); **Paul Carpenter**, St. Margarets (GB)

Correspondence Address:
DANAMRAJ & YOUST, P.C.
PREMIER PLACE, SUITE 1450
5910 NORTH CENTRAL EXPRESSWAY
DALLAS, TX 75206 (US)

(73) Assignee: **Research In Motion Limited**

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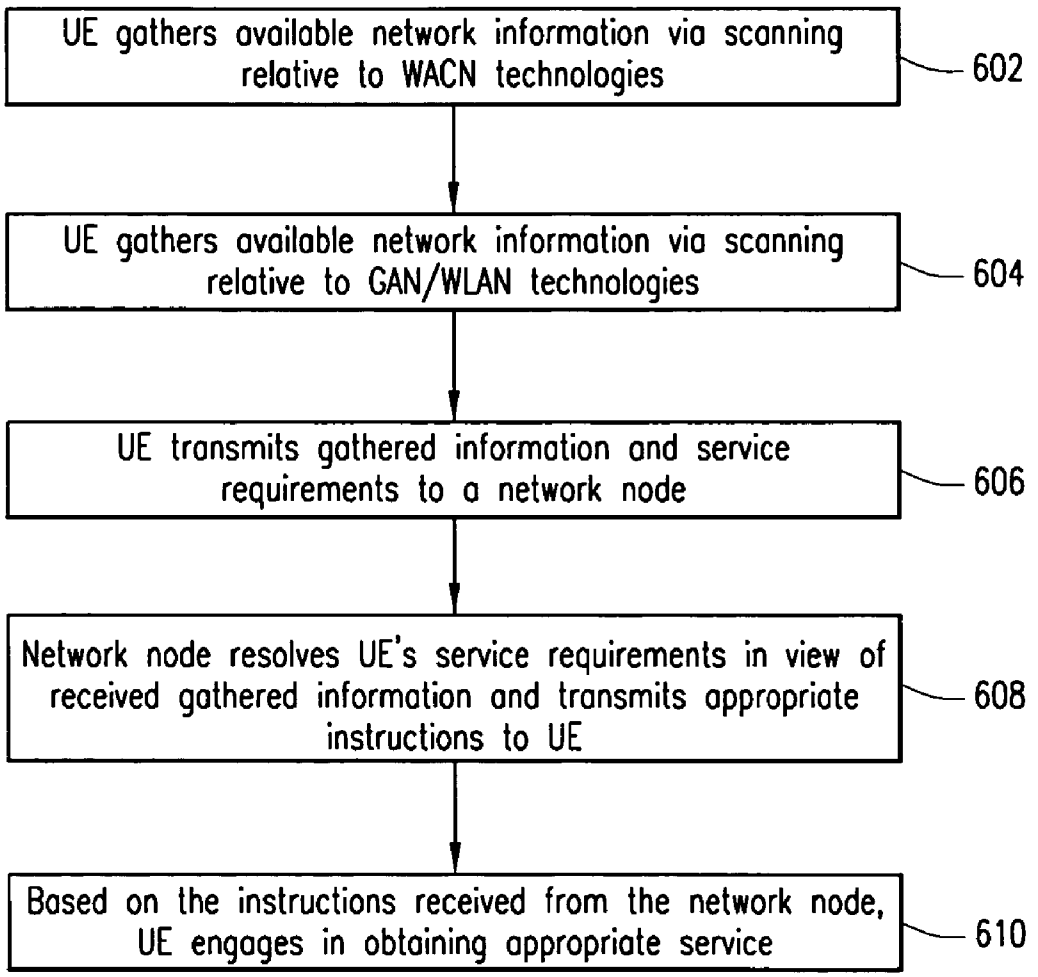
H04Q 7/24 (2006.01)

(52) **U.S. Cl.** **370/338**

(57) **ABSTRACT**

In one embodiment, a scheme is provided for effectuating generic access network (GAN) selection with respect to a user equipment (UE) device that is operable in wide area cellular network ((WACN) bands as well as in wireless access network bands (e.g., GAN bands and/or UMA bands). A network node (e.g., a GAN controller (GANC) or UMA network controller (UNC)) is equipped with logic for resolving service requirements as well as network information gathered by the UE device. Based thereon, an appropriate list of UNCs/GANCs is provided to the UE device for selection, the UNCs/GANCs being operable with one more wide area cellular networks identified for the UE device.



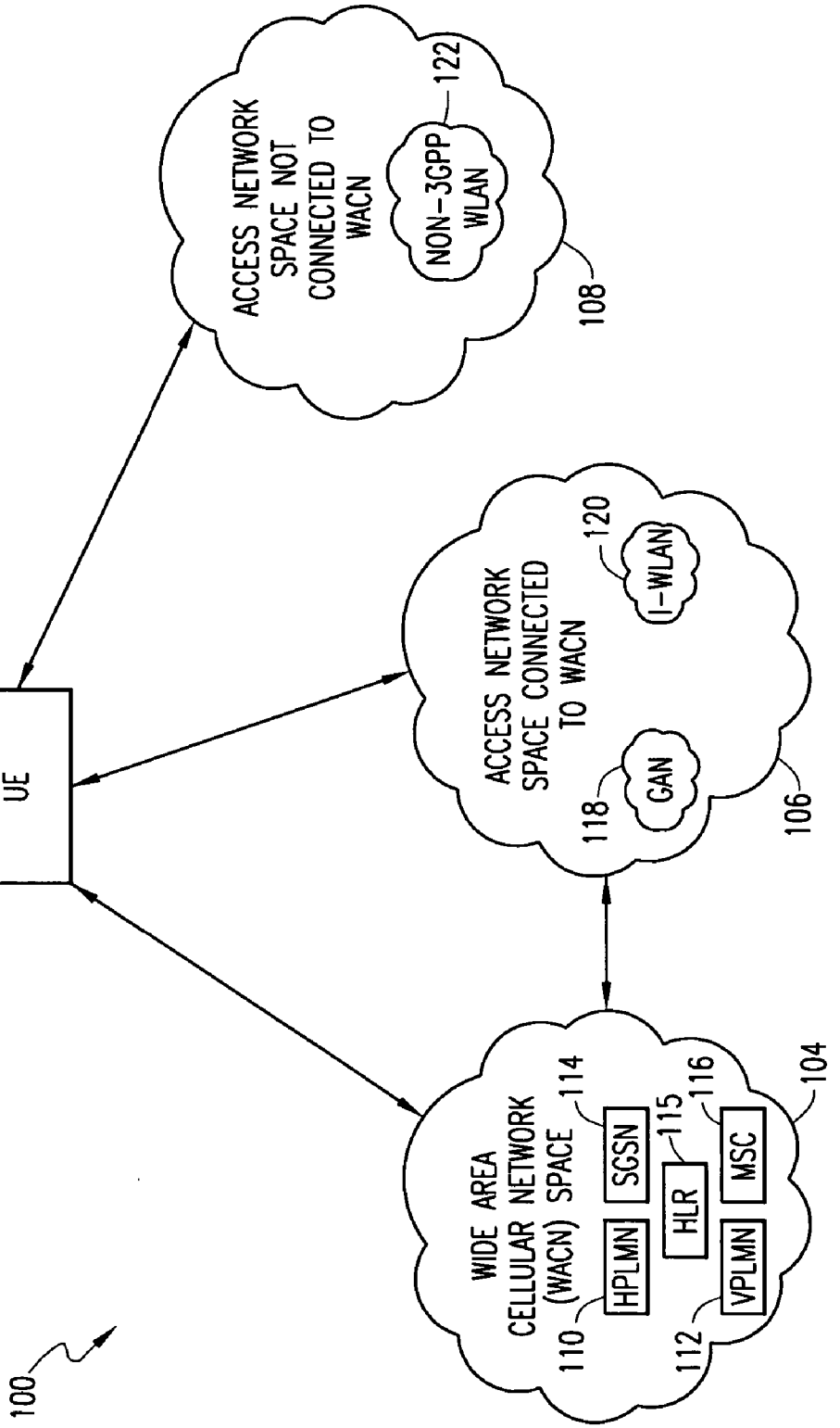

100
UE
102
ACCESS NETWORK SPACE NOT CONNECTED TO WACN
NON-3GPP WLAN
122
108
ACCESS NETWORK SPACE CONNECTED TO WACN
I-WLAN
120
GAN
118
106
WIDE AREA CELLULAR NETWORK (WACN) SPACE
114
HPLMN
110
SGSN
115
HLR
116
VPLMN
112
MSC
104

FIG. 1

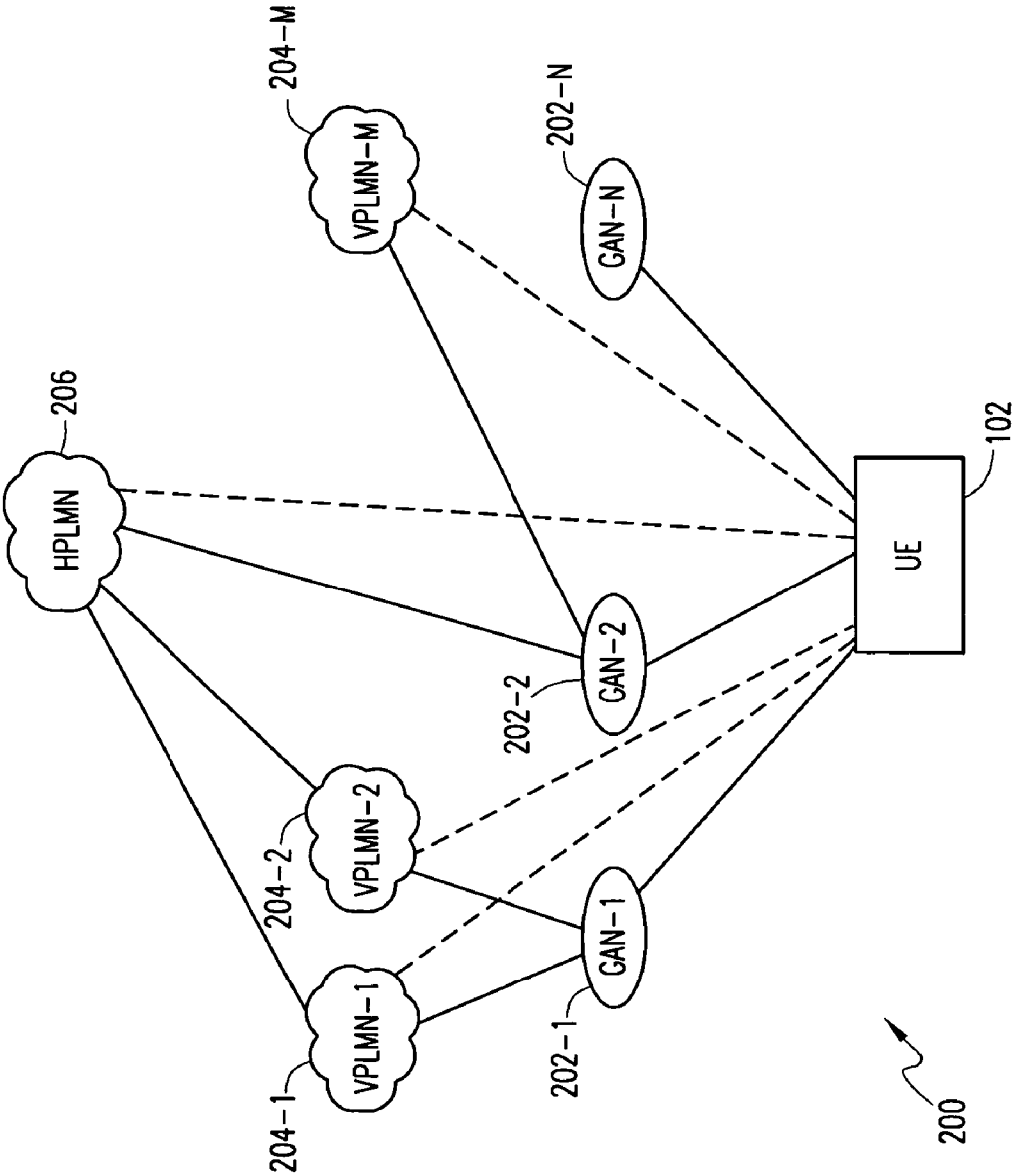

204-M
VPLMN-M
202-N
GAN-N
206
HPLMN
102
UE
GAN-2
202-2
VPLMN-2
204-2
GAN-1
VPLMN-1
202-1
204-1
200

FIG. 2

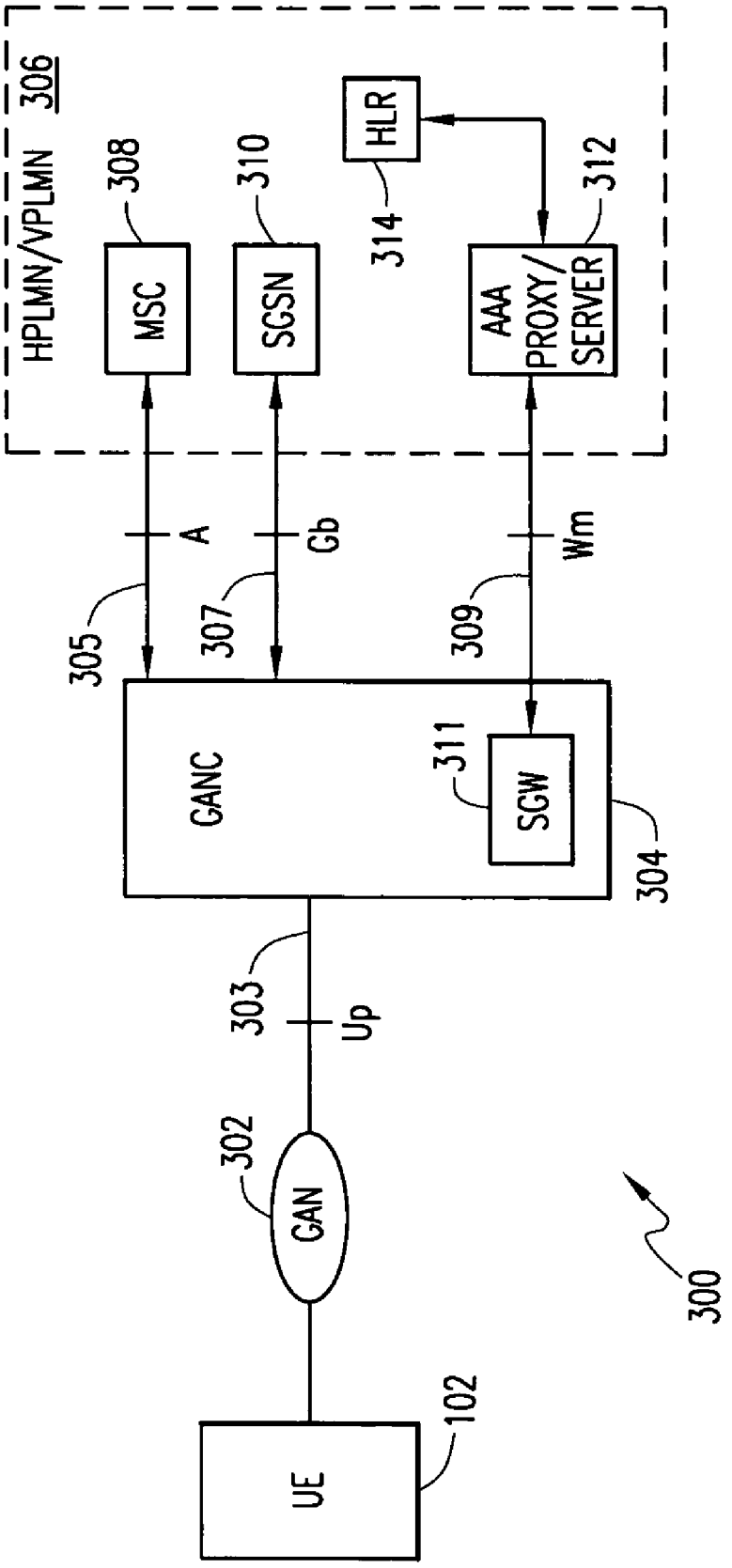

HPLMN/VPLMN 306
308
MSC
310
SGSN
HLR
314
312
AAA PROXY/ SERVER
A
Gb
Wm
305
307
309
GANC
311
SGW
304
303
Up
302
GAN
102
UE
300

FIG. 3

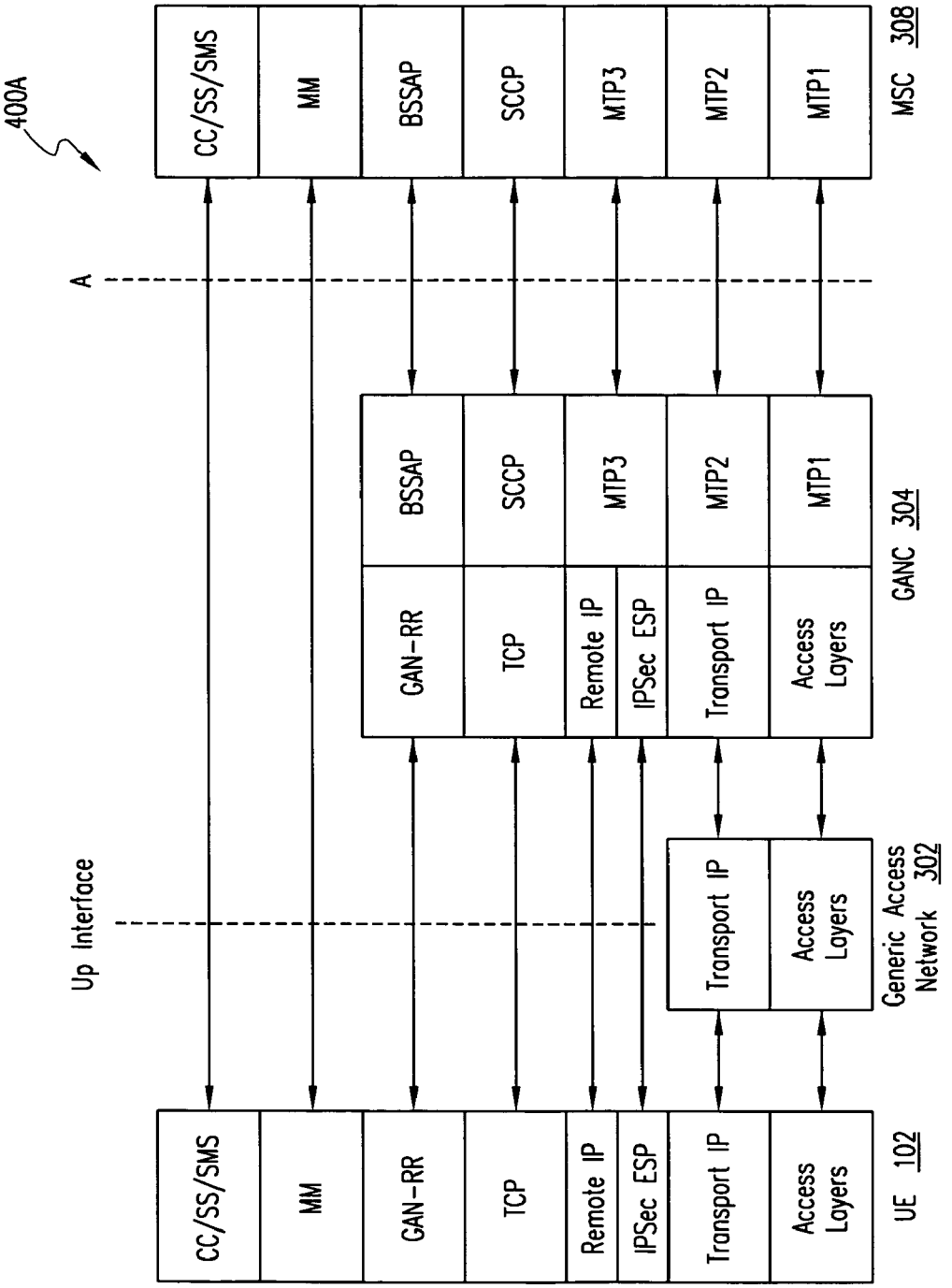

400A
CC/SS/SMS
MM
BSSAP
SCCP
MTP3
MTP2
MTP1
MSC 308
A
BSSAP
SCCP
MTP3
MTP2
MTP1
GAN-RR
TCP
Remote IP
IPSec ESP
Transport IP
Access Layers
GANC 304
Up Interface
Transport IP
Access Layers
Generic Access Network 302
CC/SS/SMS
MM
GAN-RR
TCP
Remote IP
IPSec ESP
Transport IP
Access Layers
UE 102

FIG. 4A

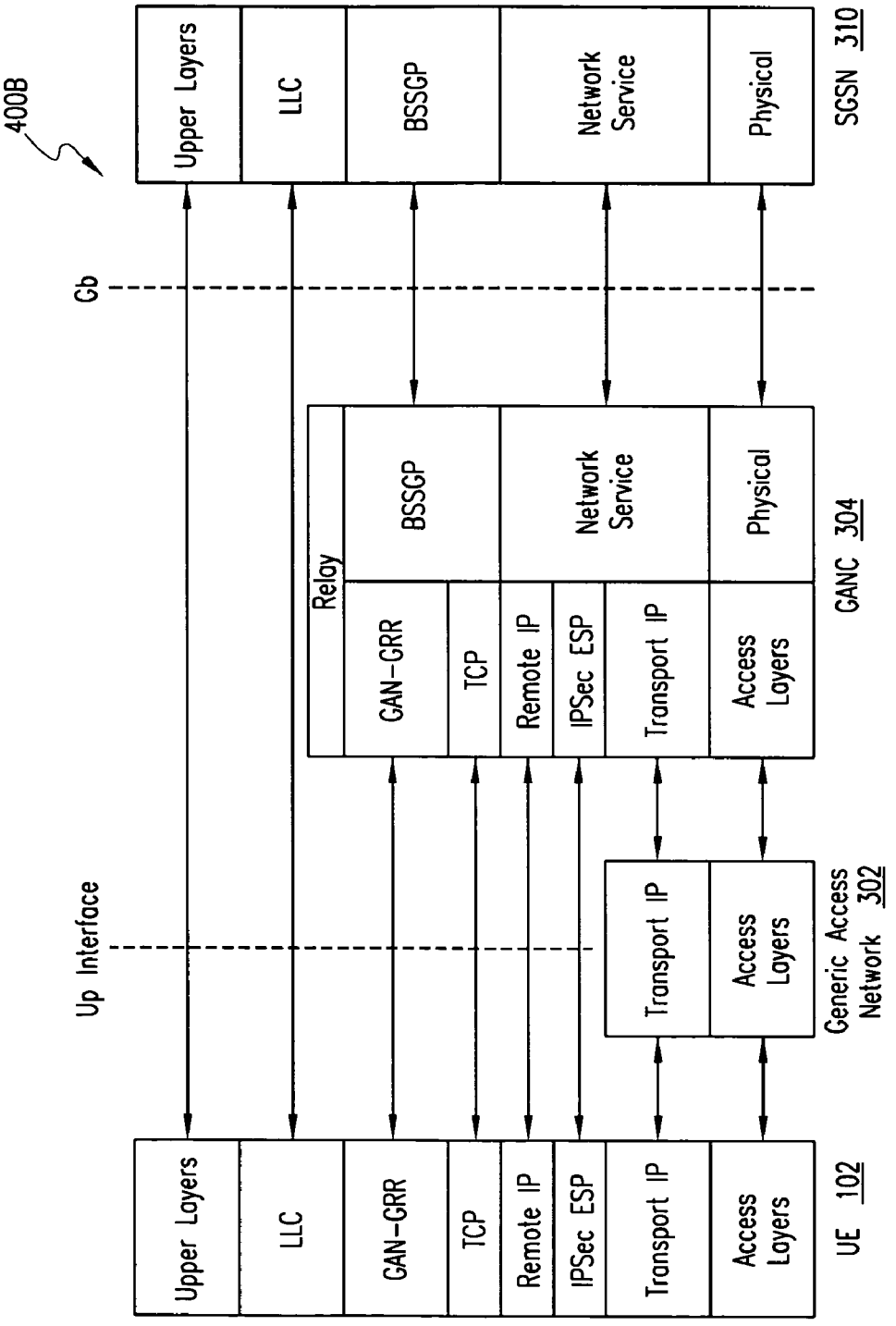

400B
Upper Layers
LLC
BSSGP
Network Service
Physical
SGSN 310
Gb
Relay
GAN-GRR
TCP
Remote IP
IPSec ESP
Transport IP
Access Layers
GANC 304
Up Interface
Generic Access Network 302
UE 102

FIG. 4B

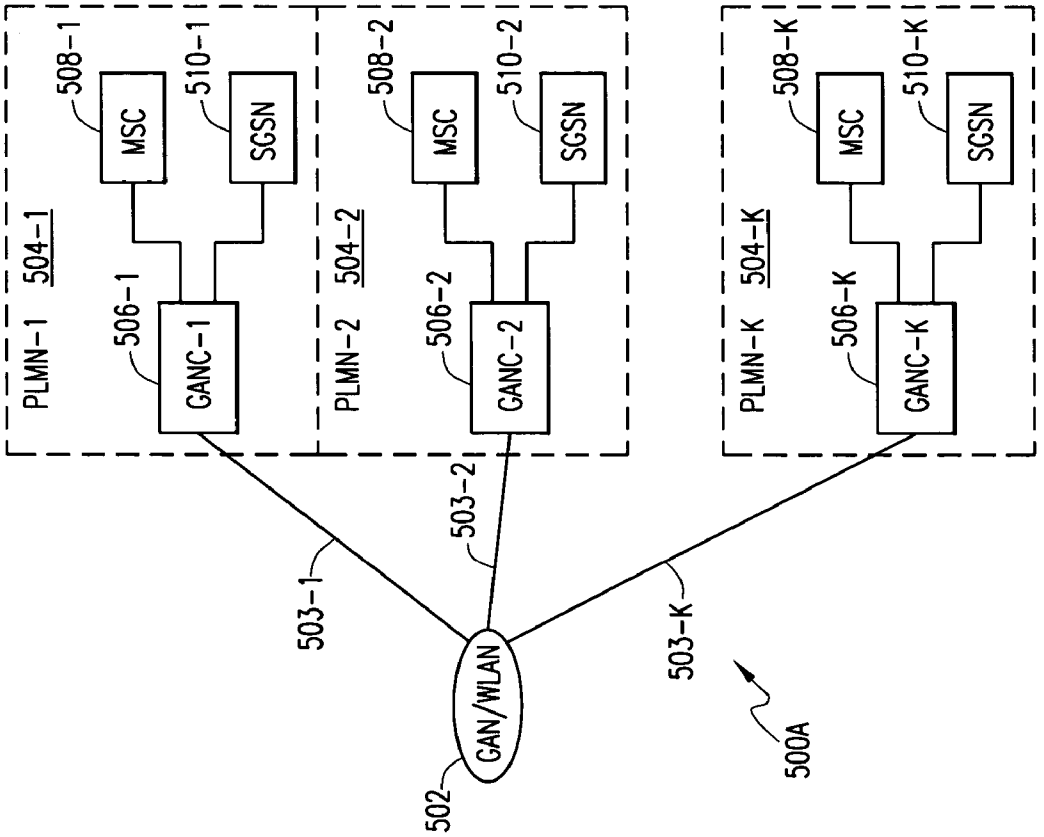

PLMN-1
504-1
508-1
MSC
510-1
SGSN
506-1
GANC-1
PLMN-2
504-2
508-2
MSC
510-2
SGSN
506-2
GANC-2
PLMN-K
504-K
508-K
MSC
510-K
SGSN
506-K
GANC-K
503-1
503-2
503-K
GAN/WLAN
502
500A

FIG. 5A

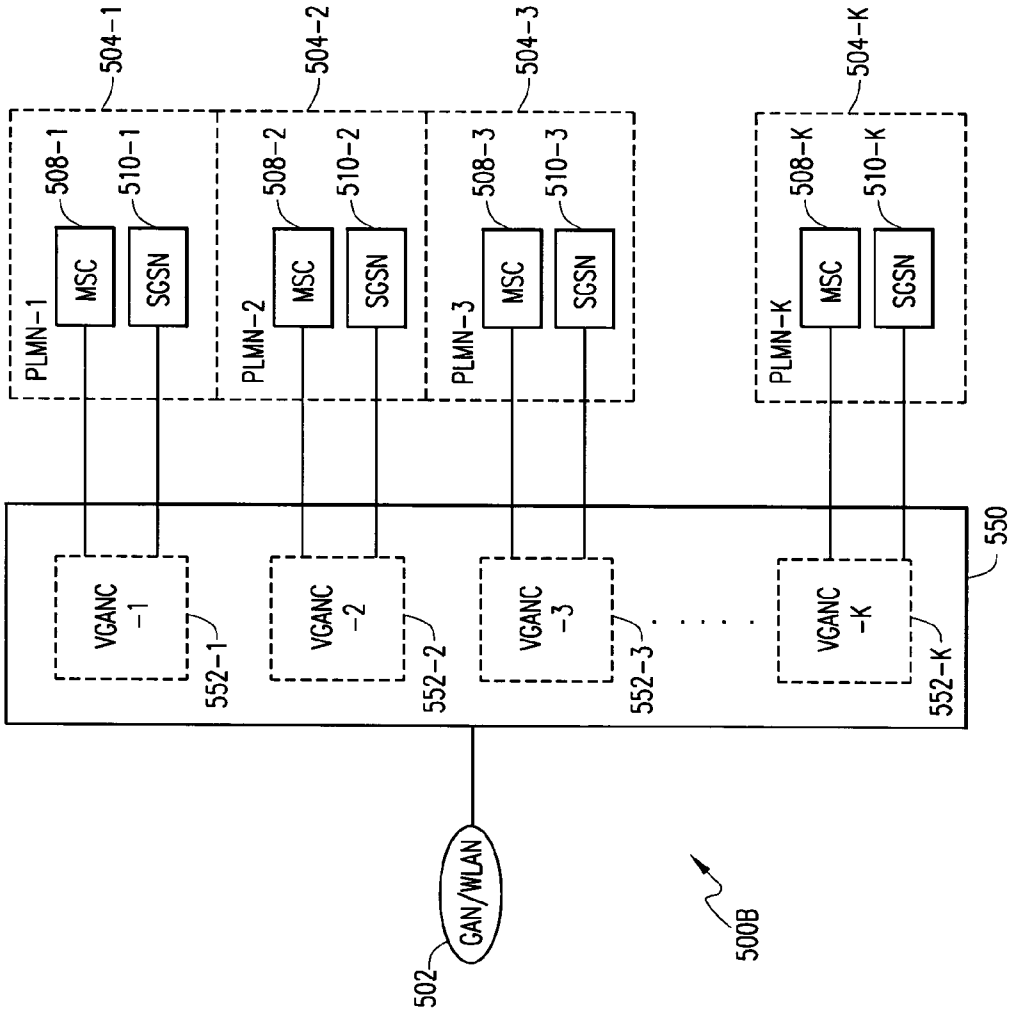

504-1
504-2
504-3
504-K
PLMN-1
PLMN-2
PLMN-3
PLMN-K
508-1
510-1
508-2
510-2
508-3
510-3
508-K
510-K
MSC
SGSN
VGANC -1
VGANC -2
VGANC -3
VGANC -K
552-1
552-2
552-3
552-K
550
GAN/WLAN
502
500B

FIG. 5B

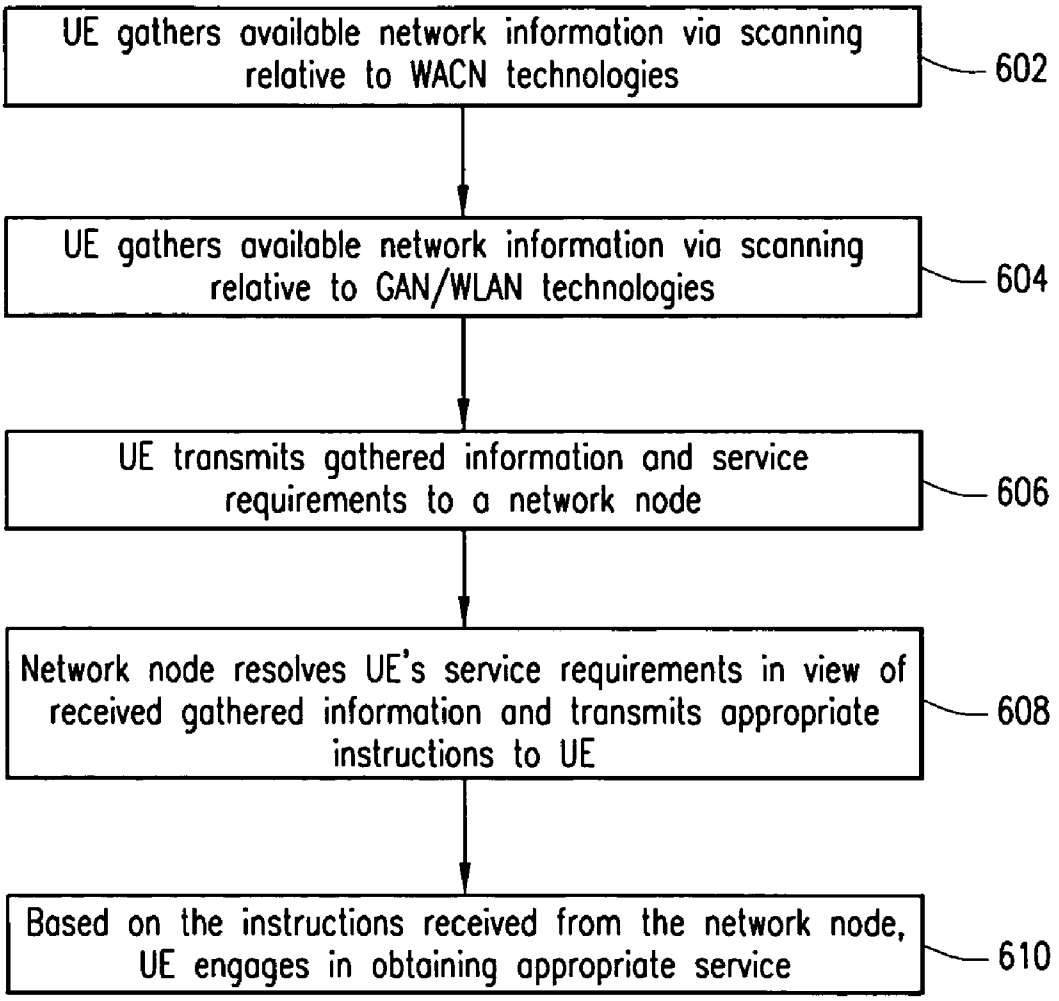

UE gathers available network information via scanning relative to WACN technologies
602
UE gathers available network information via scanning relative to GAN/WLAN technologies
604
UE transmits gathered information and service requirements to a network node
606
Network node resolves UE's service requirements in view of received gathered information and transmits appropriate instructions to UE
608
Based on the instructions received from the network node, UE engages in obtaining appropriate service
610

FIG. 6

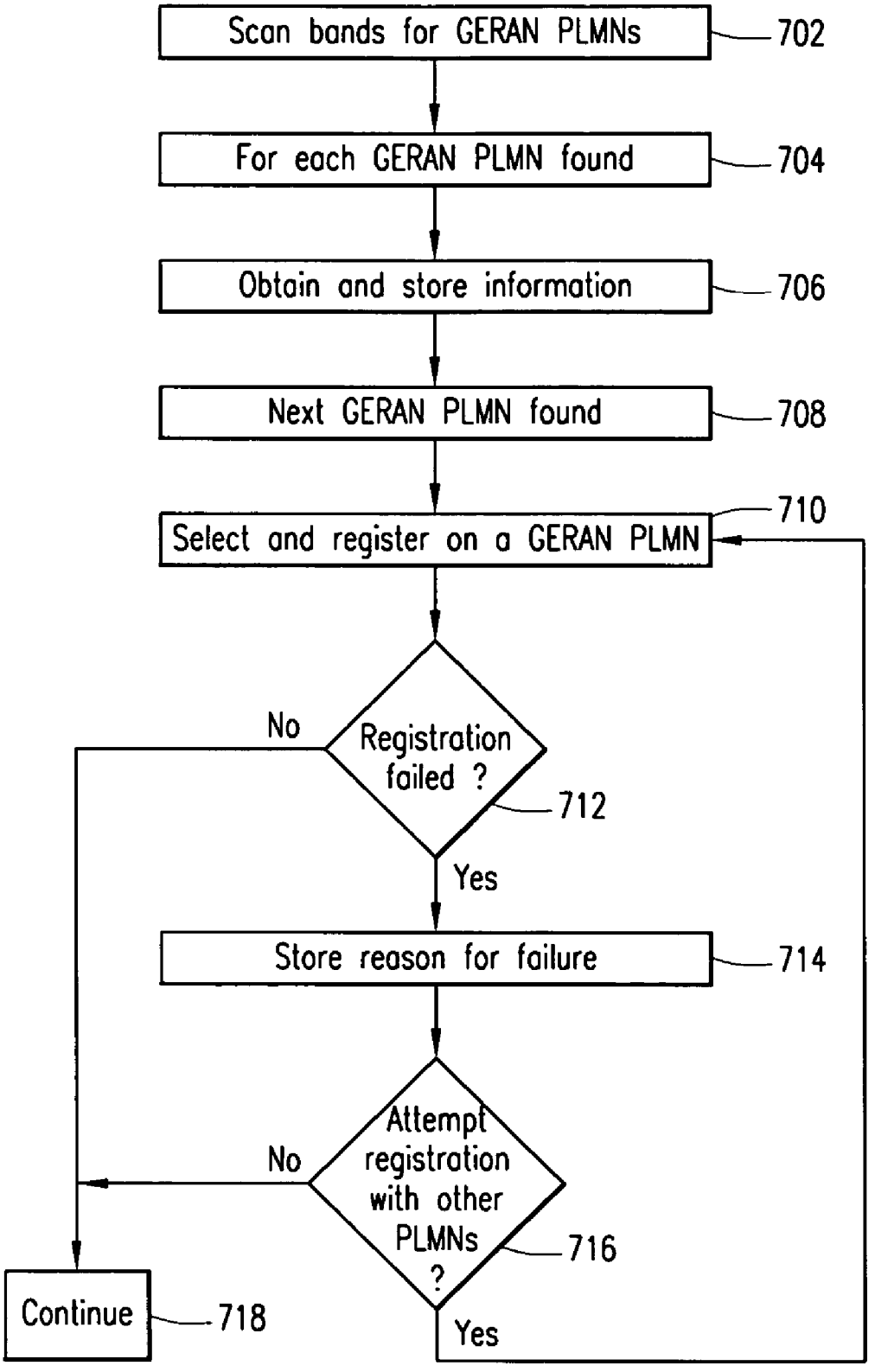

Scan bands for GERAN PLMNs
702
For each GERAN PLMN found
704
Obtain and store information
706
Next GERAN PLMN found
708
Select and register on a GERAN PLMN
710
Registration failed ?
712
No
Yes
Store reason for failure
714
Attempt registration with other PLMNs ?
716
No
Yes
Continue
718

FIG. 7A

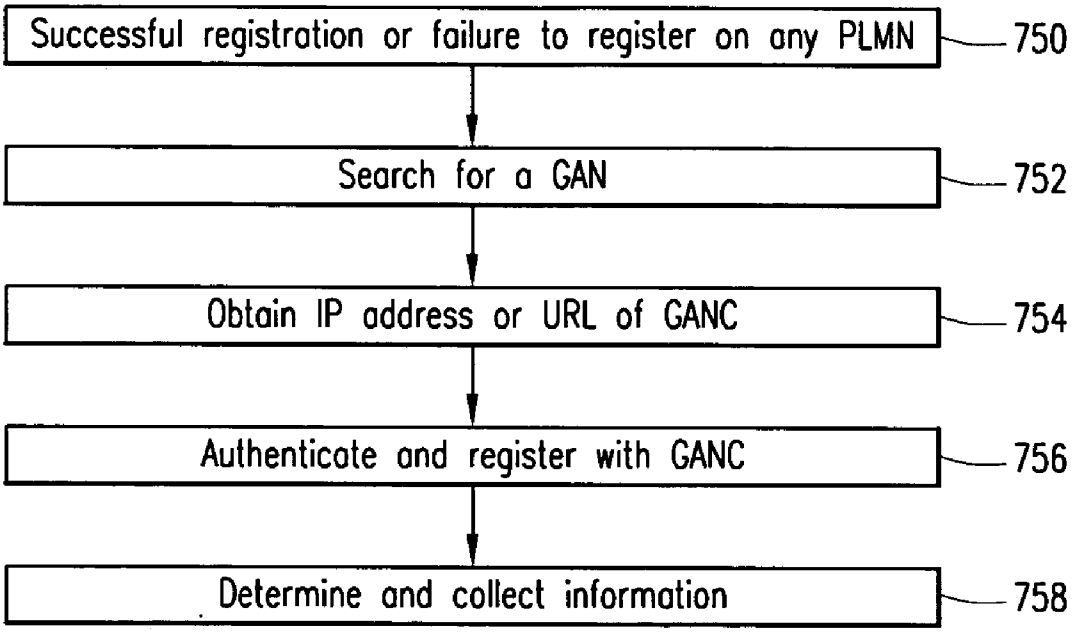

Successful registration or failure to register on any PLMN
750
Search for a GAN
752
Obtain IP address or URL of GANC
754
Authenticate and register with GANC
756
Determine and collect information
758

FIG. 7B

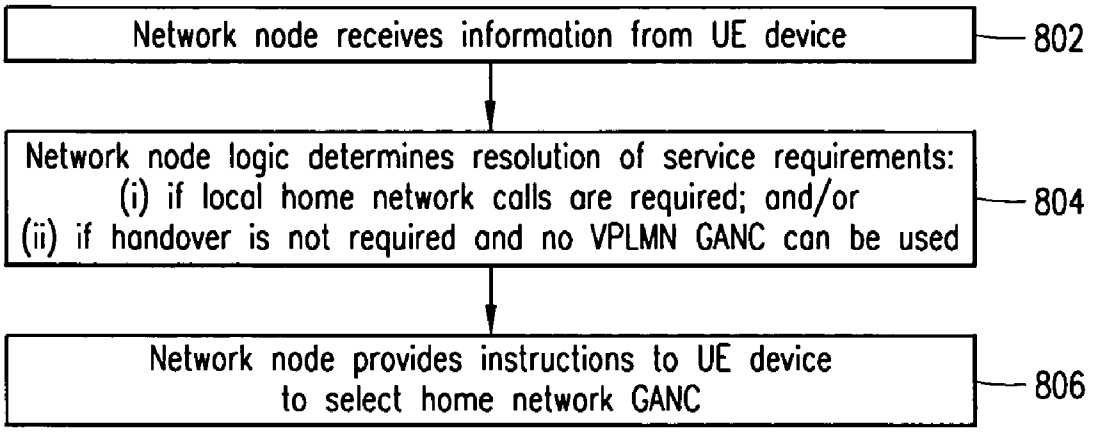

Network node receives information from UE device
802
Network node logic determines resolution of service requirements:
(i) if local home network calls are required; and/or
(ii) if handover is not required and no VPLMN GANC can be used
804
Network node provides instructions to UE device
to select home network GANC
806

FIG. 8A

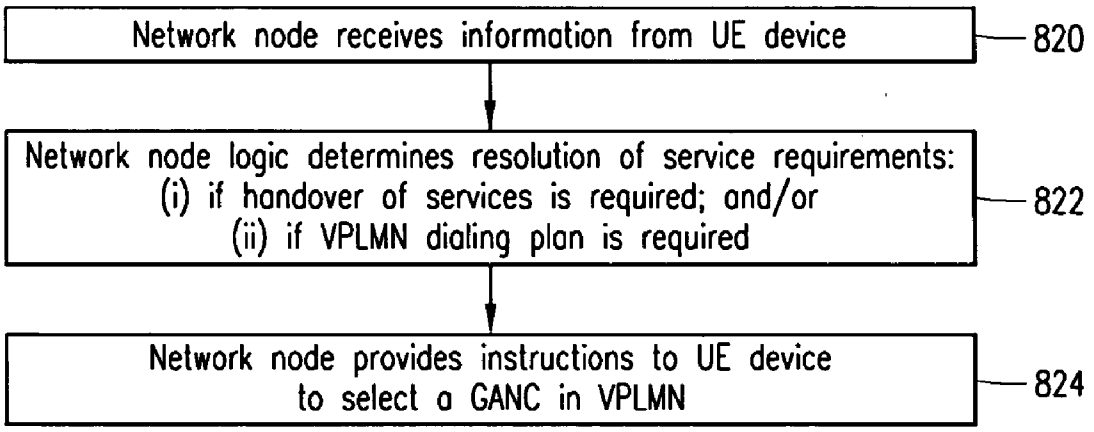

Network node receives information from UE device
820
Network node logic determines resolution of service requirements:
(i) if handover of services is required; and/or
(ii) if VPLMN dialing plan is required
822
Network node provides instructions to UE device
to select a GANC in VPLMN
824

FIG. 8B

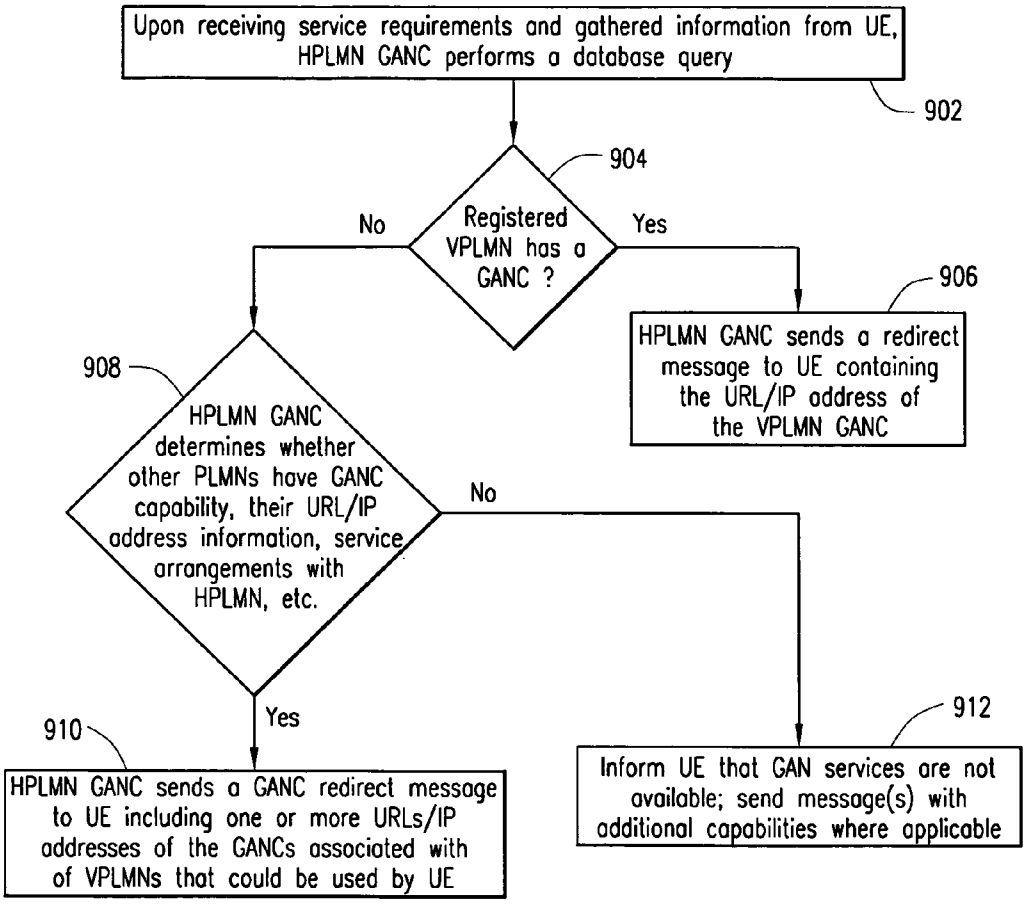
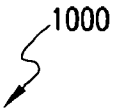

Upon receiving service requirements and gathered information from UE, HPLMN GANC performs a database query
902
904
Registered VPLMN has a GANC ?
No
Yes
906
HPLMN GANC sends a redirect message to UE containing the URL/IP address of the VPLMN GANC
908
HPLMN GANC determines whether other PLMNs have GANC capability, their URL/IP address information, service arrangements with HPLMN, etc.
No
Yes
910
HPLMN GANC sends a GANC redirect message to UE including one or more URLs/IP addresses of the GANCs associated with of VPLMNs that could be used by UE
912
Inform UE that GAN services are not available; send message(s) with additional capabilities where applicable

FIG. 9



VPLMN Identity 1002	GANC address associated with VPLMN 1004
{MCCa, MNCa}	URL and/or IP address
{MCCb, MNCb}	URL and/or IP address
{MCCc, MNCc}	<None>
{MCCd, MNCd}	URL and/or IP address
. . .	. . .
{Network ID-1}	URL and/or IP address
{Network ID-2}	URL and/or IP address
{Network ID-3}	URL and/or IP address
. . .	. . .

FIG. 10

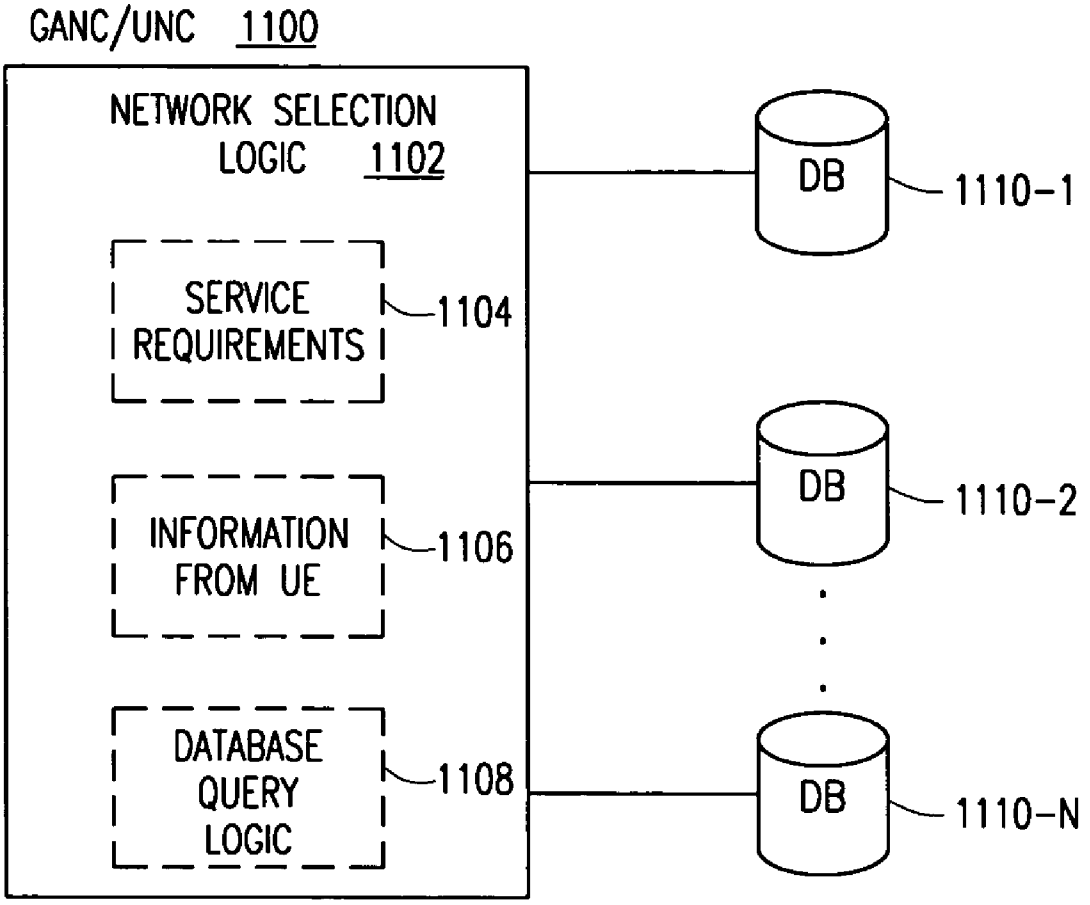

GANC/UNC 1100
NETWORK SELECTION LOGIC 1102
SERVICE REQUIREMENTS
1104
INFORMATION FROM UE
1106
DATABASE QUERY LOGIC
1108
DB
1110-1
DB
1110-2
DB
1110-N

FIG. 11

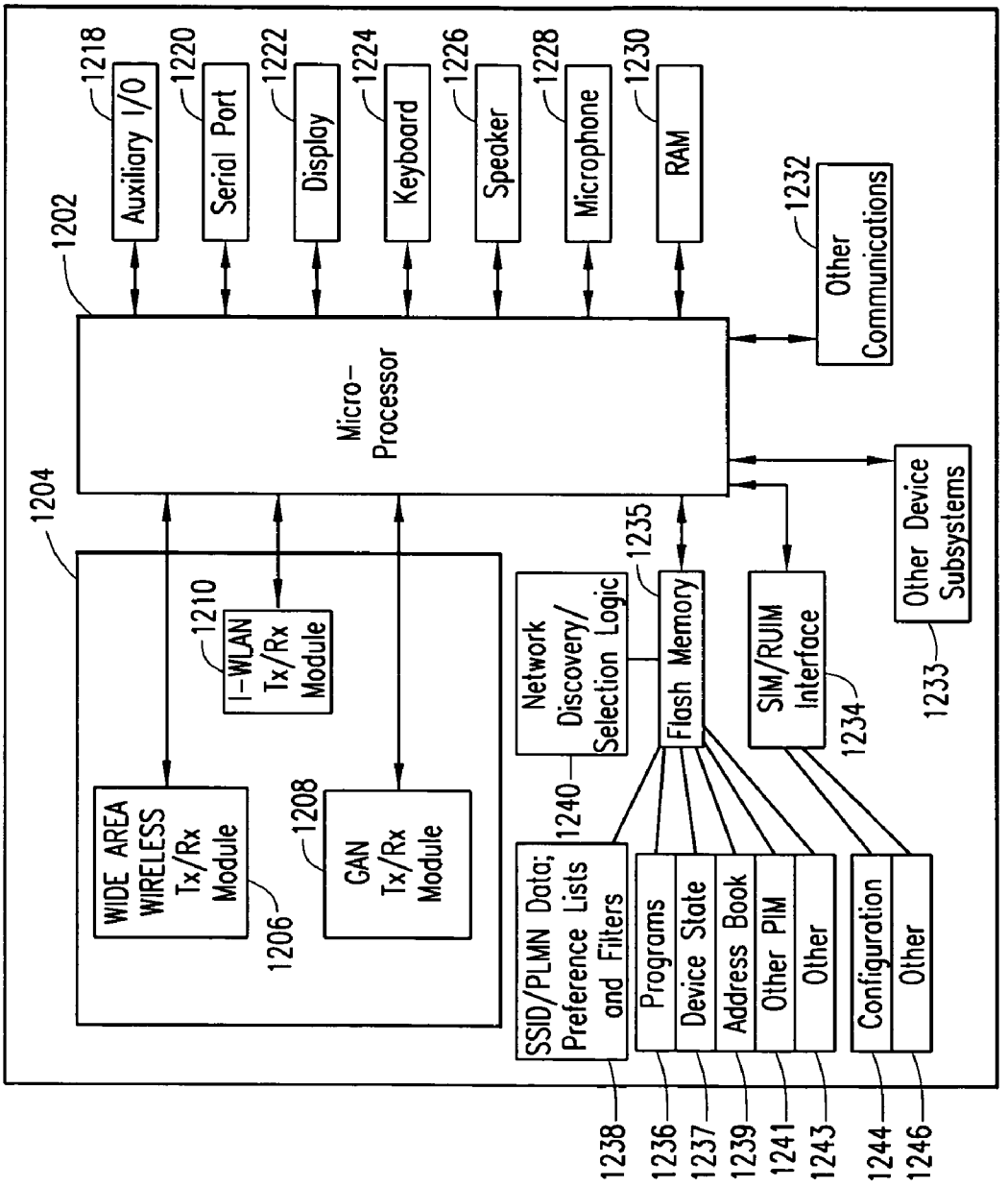

1202
1204
Micro-Processor
Auxiliary I/O
1218
Serial Port
1220
Display
1222
Keyboard
1224
Speaker
1226
Microphone
1228
RAM
1230
Other Communications
1232
Other Device Subsystems
1233
SIM/RUIM Interface
1234
Flash Memory
1235
Network Discovery/ Selection Logic
1240
I-WLAN Tx/Rx Module
1210
GAN Tx/Rx Module
1208
WIDE AREA WIRELESS Tx/Rx Module
1206
SSID/PLMN Data; Preference Lists and Filters
Programs
Device State
Address Book
Other PIM
Other
Configuration
Other
1238
1236
1237
1239
1241
1243
1244
1246

FIG. 12

NETWORK SELECTION INVOLVING GANC REDIRECTION

PRIORITY UNDER 35 U.S.C. §119(e) & 37 C.F.R. §1.78

[0001] This nonprovisional patent application claims priority based upon the following prior U.S. provisional patent application(s): (i) "SYSTEM AND METHOD OF NETWORK SELECTION," Application No.: 60/631,457, filed Nov. 29, 2004, in the name(s) of Adrian Buckley, George Baldwin Bumiller and Paul Carpenter, which is (are) hereby incorporated by reference.

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0002] This application discloses subject matter that is related to the subject matter of the following U.S. patent application(s): (i) "SYSTEM AND METHOD FOR PROVIDING OPERATOR-DIFFERENTIATED MESSAGING TO A WIRELESS USER EQUIPMENT (UE) DEVICE" (Docket No. 12613-US-PAT1), Application No.: _____, filed even date herewith; and (ii) "SYSTEM AND METHOD FOR SUPPORTING GAN SERVICE REQUEST CAPABILITY IN A WIRELESS USER EQUIPMENT (UE) DEVICE" (Docket No. 12613-US-PAT2), Application No.: _____, filed even date herewith, which is (are) hereby incorporated by reference.

FIELD OF THE DISCLOSURE

[0003] The present patent disclosure generally relates to communication networks. More particularly, and not by way of any limitation, the present patent application is directed to a scheme for network discovery and selection by a user equipment (UE) device operable in a wireless access network (AN) space that may be interconnected to a wide area cellular network (WACN) space.

BACKGROUND

[0004] Wireless access networks have become a key element of a variety of telecommunications network environments. As to enterprise networks, they provide convenient access to network resources for workers carrying portable computers and mobile handheld devices, and for guests or temporary workers similarly equipped. They also provide a cost-effective alternative to relocating physical Ethernet jacks in environments where facilities are moved or changed frequently. In addition, wireless access points operable with diverse communication/computing devices are becoming ubiquitous in public environments such as, e.g., hotels, airports, restaurants, and coffee shops. With the increase in high-speed Internet access, the use of access point(s) in the users' homes is also envisioned and has started for other applications.

[0005] Concomitantly, several developments in the user equipment (UE) arena are also taking place to take advantage of the capabilities offered by wireless access networks. Of particular interest is the integration of cellular phones with the capability to interface with a wireless access network such as a wireless Local Area Network (WLAN). With such "dual mode" devices becoming available, it should be appreciated that some interworking mechanism between the cellular network and WLAN would be required so as to facilitate efficient handover of services from one type of network to the other.

[0006] Current GAN specifications provide that a UE device (e.g., a mobile station or MS) may register on a wide area cellular network (WACN) such as a Public Land Mobile Network (PLMN) if it is discovered and allowed according to applicable 3rd Generation Partnership Project (3GPP) standards. Also, the UE device may be allowed to register on a GAN under certain circumstances where there is no WACN connectivity. Additionally, similar network connectivity behavior may be encountered where Unlicensed Mobile Access (UMA) technologies are deployed as well. However, several important issues arise in such a scenario, e.g., number plan compatibility, service handover, emergency call routing, just to name a few, especially when connectivity to a PLMN is desired via a GAN or a UMA-based access network.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] A more complete understanding of the embodiments of the present patent application may be had by reference to the following Detailed Description when taken in conjunction with the accompanying drawings wherein:

[0008] **FIG. 1** depicts a generalized network environment wherein an embodiment of the present patent disclosure may be practiced;

[0009] **FIG. 2** depicts an exemplary embodiment of a network environment where a user equipment (UE) device is operably disposed for network discovery, selection and redirection in accordance with the teachings of the present patent disclosure;

[0010] **FIG. 3** depicts a functional block diagram of a network system where a wide area cellular network (WACN) such as a Public Land Mobile Network (PLMN) is accessible through a generic access network (GAN) and associated controller (GANC);

[0011] **FIG. 4A** depicts an exemplary embodiment of a circuit-switched (CS) protocol stack operable with the network system shown in **FIG. 3**;

[0012] **FIG. 4B** depicts an exemplary embodiment of a packet-switched (PS) protocol stack operable with the network system shown in **FIG. 3**;

[0013] **FIG. 5A** depicts a network arrangement where an access network (GAN or Wireless LAN) is operable to connect to a plurality of PLMNs according to one embodiment wherein each PLMN is served by a corresponding GANC;

[0014] **FIG. 5B** depicts a network arrangement where an access network (GAN or Wireless LAN) is operable to connect to a plurality of PLMNs according to one embodiment wherein a plurality of virtual GANC partitions on a single GANC are operable to serve the corresponding PLMNs;

[0015] **FIG. 6** is a flowchart of a generalized network discovery and selection scheme according to one embodiment;

[0016] **FIG. 7A** is a flowchart of a method of gathering network information according to one embodiment for purposes of the present disclosure;

[0017] **FIG. 7B** is a flowchart of a GANC discovery and registration method according to one embodiment;

[0018] **FIGS. 8A and 8B** are flowcharts associated with a generalized GANC selection and redirection scheme according to one embodiment;

[0019] **FIG. 9** is a flowchart of a GANC selection and redirection scheme according to yet another configuration;

[0020] **FIG. 10** depicts an exemplary database structure wherein GANC information is provided by a serving node to a UE device upon resolving network information and service requirements from the UE device according to one embodiment;

[0021] **FIG. 11** depicts a functional block diagram of an exemplary GANC/UNC node according to one embodiment; and

[0022] **FIG. 12** depicts a block diagram of an embodiment of a UE device operable to perform the network discovery/selection procedures set forth according to the teachings of the present patent disclosure.

DETAILED DESCRIPTION OF THE DRAWINGS

[0023] The present patent disclosure is broadly directed to a scheme for effectuating generic access network (GAN) selection with respect to a UE device that is operable in wide area cellular network (WACN) bands as well as in GAN or UMA bands. A network node (e.g., a GAN controller (GANC) or a UMA network controller (UNC)) is equipped with logic for resolving service requirements and network information gathered by the UE device that may be transmitted via a registration request message. Based thereon, an appropriate list of UNCs/GANCs may be provided to the UE device for selection, the UNCs/GANCs being operable with one more wide area cellular networks (i.e., PLMNs) identified for the UE device.

[0024] In one aspect, an embodiment of a network selection method is disclosed which comprises: gathering network information by a UE device via scanning in at least one band; transmitting by the UE device at least one of the gathered network information and a set of service requirements to a network node; and resolving the network information and the set of service requirements by the network node to determine an appropriate list of GANCs operable with a plurality of wide area cellular networks identified for the UE device, wherein the list of GANCs is transmitted to the UE device via a response message for selection by the UE device.

[0025] In another aspect, an embodiment of a network selection system is disclosed which comprises: means associated with a UE device for gathering network information via scanning in at least one band; means associated with the UE device for transmitting at least one of the gathered network information and a set of service requirements to a network node; and means associated with the network node for resolving the network information and the set of service requirements to determine an appropriate list of GANCs operable with a plurality of wide area cellular networks identified for the UE device, wherein the list of GANCs is transmitted to the UE device via a response message for selection by the UE device.

[0026] In a still further aspect, an embodiment of a UE device is disclosed which comprises: a logic module for facilitating identification of a set of appropriate service requirements relative to operating the UE device; a communication subsystem for gathering network information via scanning in at least one band and for transmitting at least one of the gathered network information and the service requirements to a network node; and a logic module for selecting a GANC from a set of GANCs provided by the network node, the list of GANCs being determined upon resolving the network information and the service requirements by the network node. The identified GANCs are operable with at least a portion of the wide area cellular networks identified for the UE device, wherein the set of GANCs is transmitted to the UE device via a response message for selection by the UE device.

[0027] In yet another aspect, an embodiment of a GANC node operable with a UE device disposed in a wireless environment is disclosed which comprises: means for receiving at least one of network information and a set of service requirements from the UE device via a registration request message; means for resolving the network information and the set of service requirements to determine an appropriate list of GANCs operable with one or more wide area cellular networks identified for the UE device; and means for transmitting the list of GANCs to the UE device via a response message responsive to the registration request message.

[0028] A system and method of the present patent disclosure will now be described with reference to various examples of how the embodiments can best be made and used. Like reference numerals are used throughout the description and several views of the drawings to indicate like or corresponding parts, wherein the various elements are not necessarily drawn to scale. Referring now to the drawings, and more particularly to **FIG. 1**, depicted therein is an exemplary generalized network environment **100** wherein an embodiment of the present patent disclosure may be practiced. A user equipment (UE) device **102** may comprise any portable computer (e.g., laptops, palmtops, or handheld computing devices) or a mobile communications device (e.g., cellular phones or data-enabled handheld devices capable of receiving and sending messages, web browsing, et cetera), or any enhanced personal digital assistant (PDA) device or integrated information appliance capable of email, video mail, Internet access, corporate data access, messaging, calendaring and scheduling, information management, and the like, that is preferably operable in one or more modes of operation. For example, UE device **102** may operate in the cellular telephony band frequencies as well as wireless Local Area Network (WLAN) bands, or possibly in the WLAN bands alone. Further, other bands in which the UE device could operate wirelessly may comprise Wi-Max bands or one or more satellite bands. Additionally, the network environment **100** is comprised of three broad categories of communication spaces capable of providing service to UE device **102**. In wide area cellular network (WACN) space **104**, there may exist any number of Public Land Mobile Networks (PLMNs) that are operable to provide cellular telephony services which may or may not include packet-switched data services. Depending on the coverage area(s) and whether the user is roaming, WACN space **104** can include a number of cellular RANs, associated home networks (i.e., home PLMNs or HPLMNs) **110**

and visited networks (i.e., VPLMNS) **112**, each with appropriate infrastructure such as Home Location Register (HLR) nodes **115**, Mobile Switching Center (MSC) nodes **116**, and the like. Since the WACN space **104** may also include a General Packet Radio Service (GPRS) network that provides a packet radio access for mobile devices using the cellular infrastructure of a Global System for Mobile Communications (GSM)-based carrier network, a Serving GPRS Support Node (SGSN) **114** is exemplified therein. Additionally, by way of generalization, the PLMNs of the WACN space **104** may comprise networks selected from the group comprising one or more Enhanced Data Rates for GSM Evolution (EDGE) networks, Integrated Digital Enhanced Networks (IDENs), Code Division Multiple Access (CDMA) networks, Universal Mobile Telecommunications System (UMTS) networks, Universal Terrestrial Radio Access Networks (UTRANs), or any 3rd Generation Partnership Project (3GPP)-compliant network (e.g., 3GPP or 3GPP2), all operating with well known frequency bandwidths and protocols.

[0029] Further, UE device **102** is operable to obtain service from an access network (AN) space **106** that is operably associated with the WACN space **104**. In one implementation, the AN space **106** includes one or more generic access networks (GANs) **118** as well as any type of WLAN arrangements **120**. GAN **118**, described in additional detail below, is operable to provide access services between UE device **102** and a PLMN core network using a broadband Internet Protocol (IP)-based network. WLAN arrangements **120** provide short-range wireless connectivity to UE device **102** via access points (APs) or "hot spots," and can be implemented using a variety of standards, e.g., IEEE 802.11b, IEEE 802.11a, IEEE 802.11g, HiperLan and HiperLan II standards, Wi-Max standard, OpenAir standard, and the Bluetooth standard. Accordingly, it is envisaged that the AN space **106** may be inclusive of UMA-based access networks that deploy UMA network controller (UNC) nodes for effectuating seamless transitions between cellular RAN (part of the WACN space **104**) and unlicensed wireless networks.

[0030] In one embodiment, interfacing between the WACN and AN spaces may be effectuated in accordance with certain standards. For instance, GAN **118** may be interfaced with a PLMN core using the procedures set forth in the 3GPP TR 43.901 and 3GPP TS 43.xxx documents as well as related documentation. Likewise, WLAN **120** may interfaced with a PLMN core using the procedures set forth in the 3GPP TS 22.234, 3GPP TS 23.234 and 3GPP TS 24.234 documents as well as related documentation, and may therefore be referred to as an Interworking WLAN (I-WLAN) arrangement.

[0031] Additionally, there may exist an access network (AN) space **108** not interfaced to the WACN space **104** that offers short-range wireless connectivity to UE device **102**. For instance, AN space **108** may comprise WLANs **122** offering non-3GPP services, such as communications over "public" access points (hotels, coffee shops, bookstores, apartment buildings, educational institutions, etc., whether free or for fee), enterprise access points, and visited (other enterprise) access points where the user may not be a member of that enterprise but is allowed at least some services.

[0032] Given the mosaic of the wireless network environment **100** in which UE device **102** may be disposed, it is desirable that a vertical handover mechanism exists such that the user can engage in a call as it moves from a PLMN's radio access network (RAN) to a GAN (i.e., handover in) or from GAN to the PLMN's RAN (i.e., handover out). It should be recognized that for purposes of the present patent disclosure, the terms "GAN" or "WLAN" may be interchangeable, and may also include any UMA-based access networks as well. At any rate, in order to facilitate such functionality as well as to customize and enhance the overall user experience associated therewith, the present patent disclosure provides a scheme wherein network information gathered by the UE device as well as information relating to its service options, plans, features, and the like (more generally, "service requirements") is transmitted to a network node disposed in the wireless environment **100** so that suitable network-based logic is operable to respond with appropriate network selections, lists, etc. that the UE device may use. Further, as will be seen in detail below, such network-based logic may invoke procedures that involve one or more correlation and filtering schemes, database queries, such that redirection to more optimal networks may be effectuated in the generalized network environment **100**.

[0033] To formalize the teachings of the present disclosure, reference is now taken to **FIG. 2** wherein an exemplary embodiment of a network environment **200** is shown that is a more concrete subset of the generalized network environment **100** illustrated in **FIG. 1**. As depicted, UE device **102** is operably disposed for discovering a set of PLMNs that allow access via conventional RAN infrastructure in addition to having connectivity with one or more GANs accessible to UE device **102**. By way of example, GAN-**1202-1** through GAN-N **202**-N, which may be generalized for purposes of the present patent disclosure to also include any type of WLAN and/or I-WLAN arrangements (known or heretofore unknown), are operable to be discovered by UE device. A GAN may support connectivity to one or more PLMNS, or none at all, which can include VPLMNs **204-1** through **204**-M as well as HPLMNs (e.g., HPLMN **206**) with respect to UE device **102**. Where GAN-PLMN connectivity is supported, which PLMNs behind a particular GAN are visible to UE device **102** may depend on a number of commercial factors, e.g., contractual arrangements between GAN operators and PLMN operators. As illustrated, GAN-**1202-1** supports connectivity to VPLMN-**1204-1** and VPLMN-**2204-2**. Likewise, GAN-**2202-1** supports connectivity to VPLMN-M **204**-M as well as to HPLMN **206**. On the other hand, GAN-N **202**-N has no connectivity to the wide area PLMNs.

[0034] As is well known, each of the wide area cellular PLMNs may be arranged as a number of cells, with each cell having sectors (e.g., typically three 120-degree sectors per base station (BS) or cell). Each cell may be provided with a cell identity, which can vary depending on the underlying WACN technology. For example, in GSM networks, each individual cell is provided with a Cell Global Identification (CGI) parameter to identify them. A group of cells is commonly designated as a Location Area (LA) and may be identified by an LA Identifier (LAI). Further, at the macro level, the PLMNs may be identified in accordance with the underlying technology. For instance, GSM-based PLMNs may be identified by an identifier comprised of a Mobile Country Code (MCC) and Mobile Network Code (MNC). Analogously, the CDMA/TDMA-based PLMNs may be identified by a System Identification (SID) parameter.

Regardless of the cellular infrastructure, all cells broadcast the macro level PLMN identifiers such that a wireless device (e.g., UE device **102**) wishing to obtain service can identify the wireless network.

[**0035**] **FIG. 3** depicts a functional block diagram of an exemplary network system **300** where a wide area cellular PLMN **306** is accessible to UE device **102** through a GAN **302** and associated controller (GANC) **304**. Essentially, in the embodiment shown, GAN **302** is operable as a broadband IP-based access network providing access to the well known A/Gb interfaces of PLMN **306**, wherein GANC **300** is a network node coupled to GAN **302** via a Up reference point interface **303**. As provided in applicable 3GPP specification documents, the Up reference point **303** defines the interface between GANC **304** and UE device **102**. Where the GAN is operable to co-exist with the GSM/EDGE RAN (GERAN) infrastructure, it interconnects to the core PLMN via the same A/Gb interfaces used by a standard GERAN Base Station Subsystem (BSS) network element. Accordingly, the functionality of GANC **304** includes necessary protocol interworking so as to emulate the functionality of the GERAN BSS (not shown in this FIGURE). The A-interface **305** defines the interface for GSM-based circuit-switched (CS) services and is disposed between GANC **304** and an MSC **308** of PLMN **306**. The Gb-interface **307** defines the interface for GPRS-based packet-switched (PS) services and is disposed between GANC **304** and an SGSN **310** of PLMN **306**. A Security Gateway (SGW) **311** may also be included in GANC **304** that is interfaced via a Wm reference point **309** (as defined by 3GPP TS 23.234) with an Authentication, Authorization and Accounting (AAA) proxy/server node **312** disposed in PLMN **306**, wherein an HLR **316** is operably coupled to AAA node **312**. Those skilled in the art will recognize that similar infrastructure may be deployed in a UMA-based implementation wherein a UMA network controller or UNC is operable generally in the same way as GANC **304**.

[**0036**] In operation, GANC **304** appears to the core PLMN **306** as a GERAN BSS network element by mimicking the role of the Base Station Controller (BSC) in the GERAN architecture as seen from the perspective of the A/Gb interfaces. Accordingly, PLMN **306** to which GANC **304** is connected is unaware of the underlying access mechanism being supported by GANC, which is different from the radio access supported by the BSC. As alluded to before, GAN **302** disposed between generic access (GA)-enabled UE device **102** and GANC **304** may be effectuated by a suitable broadband IP network. The overall functionality provided by GANC **304** includes the following:

[**0037**] User plane CS services that involve interworking CS bearers over Up interface to CS bearers over A-interface, including appropriate transcoding of voice to/from UE and PCM voice from/to the MSC.

[**0038**] User plane PS services that involve interworking data transport channels over Up interface to packet flows over Gb interface.

[**0039**] Control plane functionality including: (i) SGW for the set-up of secure tunnel with UE for mutual authentication, encryption and data integrity; (ii) registration for GAN service access and providing system information; (iii) set-up of GAN bearer paths for CS and PS services (e.g., establishment, management, and teardown of signaling and user plane bearers between UE the GANC); and (iv) GAN functional equivalents to GSM Radio Resource (RR) management and GPRS Radio Link Control (RLC) such as for paging and handovers.

[**0040**] **FIG. 4A** depicts an exemplary embodiment of a protocol stack **400**A operable with the CS domain signaling plane associated with the network system **300** shown in **FIG. 3**. Likewise, **FIG. 4B** depicts an exemplary embodiment of a protocol stack **400**B operable with the PS domain signaling plane associated with network system **300**. Additional details regarding generic access to the A/Gb interfaces and associated architecture may be found in the applicable 3GPP specifications identified in the U.S. provisional patent applications that have been referenced and incorporated hereinabove. Furthermore, to be consistent with the broad generalization of the teachings of the present patent disclosure, an "access network server" may comprehend a network node or element operable to interface between the core PLMN and the UE as set forth above, which may include a GANC or a UNC as a specific implementation.

[**0041**] It should be apparent to those skilled in the art that given the mosaic of various GANs/WLANs and PLMNs provided within a generalized network environment such as the network environments described hereinabove with respect to **FIGS. 1 and 2**, a number of GAN/GANC configurations are possible from the perspective of providing access between a UE device and the available WACNs (i.e., PLMNs). **FIG. 5A** depicts a network arrangement **500**A where a single access network (AN) **502** is operable to connect to a plurality of PLMNs **504-1** through **504**-K according to one embodiment, wherein each PLMN is served by a corresponding GANC. By way of illustration, AN **502** may be generalized as a GAN which can be a WLAN operable with the GANC protocols described above, wherein a plurality of Up interfaces **503-1** through **503**-K are supported for coupling to the GANCs. Reference numerals **506-1** through **506**-K refer to a plurality of separate GANC nodes, each for interfacing with a particular PLMN associated therewith, wherein MSCs **508-1** through **508**-K and SGSNs **510-1** through **510**-K are illustrative of respective PLMN's infrastructure. One skilled in the art should recognize that although each PLMN is provided with a SGSN node, it is not a requirement for purposes of the present disclosure, and PLMNs **504-1** through **504**-K may be implemented in accordance with different wide area cellular technologies, protocols and standards.

[**0042**] Referring now to **FIG. 5B**, depicted therein is an alternative network arrangement **500**B where AN **502** (GAN or Wireless LAN) is operable to connect to the plurality of PLMNs **504-1** through **504**-K via a single physical GANC **550** that supports a plurality of virtual GANC partitions **552-1** through **552**-K. Each virtual GANC (VGANC) is independently operable to provide the requisite A/Gb interfacing functionality with respect to a corresponding PLMN. Accordingly, there is one logical GANC per PLMN that it connects to. Such a deployment may be used where the PLMNs supporting the WLAN connectivity do not see the need to own and operate their own GANC.

[**0043**] Based on the foregoing discussion, it should be appreciated that the GAN architecture provides a generalized framework for interworking WLANs with 3GPP-com-

pliant WACNs by utilizing existing protocols, e.g., GPRS, whereby little or no adaptation or standardization work is required to be performed in the core. This allows for services to be handed over from a GAN/WLAN to a 3GPP-compliant WACN and vice versa, keeping the signaling and user plane traffic intact. However, as CS-switched protocols and GPRS protocols (Logical Link Control or LLC and Sub-Network Dependent Convergence Protocol or SNDCP) are used, the GAN/WLAN that is chosen must be able to reach an MSC/SGSN that is in the same PLMN as the MSC/SGSN used to terminate the GAN/WLAN traffic. To further complicate matters, a GAN/WLAN could connect to many PLMNs each having a separate, independently discoverable GANC node as described hereinabove. When a user encounters such a GAN/WLAN environment, there is currently no standardized procedure to define the selection of a particular GANC. As a consequence, a number of potential issues arise wherein the overall user experience as well as call handover behavior may be negatively impacted. For instance, if a GA-compliant UE device that operates in dual mode (i.e., two different technologies, each preferably in a separate band, for example) discovers a macro PLMN or WACN and subsequently chooses a GANC that belongs to a different WACN, handover between the AN and WACN spaces would not work. Such issues may also arise in network arrangements where a single GANC is partitioned to support a number of independently discoverable VGANC partitions.

[0044] Further, because of various levels of technology penetration and deployment in different regions and countries, additional complexities can arise where the AN and WACN spaces are to be interfaced using the GAN/WLAN approach. For example, a GA-compliant UE device may find itself in an area where there is no WACN coverage but there is WLAN coverage. If one or more WLANs are based on the I-WLAN approach rather than the GAN architecture, it is preferable that the UE differentiate between GAN and I-WLAN due to the differences in various control processes, e.g., registration, de-registration, etc., in addition to whatever service differences that may exist between them. For purposes of highlighting the scope of the present patent disclosure, some of the user experience-related issues are set forth below.

[0045] The UE is not currently registered on a WACN.

[0046] Here the UE cannot check the cellular band signals to determine the country it is in (i.e., MCC is unknown) to select the best or optimal provider. Although HPLMN is usually selected first, VPLMN preference may depend on location (e.g., country). In this situation, the UE may not know which VPLMN it prefers to connect to when it is examining the available GAN/WLANs.

[0047] The operator's "Preferred PLMN" list on the Subscriber Identity Module (SIM) or Removable user Identity Module (RUIM) associated with the user does not take into account the UE's need for PS data services (e.g., GPRS capability) or other services such as Unlicensed Mobile Access (UMA) services. Such a situation may arise where the PLMN list is based only on CS voice roaming agreements and, as a result, the user may not be able to use email and other data services. One skilled in the art will note that such an issue can arise whether or not GAN or I-WLAN is used.

[0048] Some or all of the operator-controlled lists for PLMNs may not be up-to-date, or particular entries for the country the UE is operating in may not be current.

[0049] Because it takes up capacity to update lists over the cellular band, the HPLMN may wish to update lists during off-hours or when the UE is connected over I-WLAN or GAN.

[0050] When there are no WACN signals to allow the UE to determine the MCC, the availability of AGPS (Assisted Global Positioning System) in the UE, or a (manual) user input, as well as recent (i.e., time-stamped) information on WACN MCC may be helpful.

[0051] The case of operation close to country border(s) may result in the UE obtaining signals from more than one MCC, enabling user choice or "least cost" choice.

[0052] Those skilled in the art should recognize that the list set forth above is purely illustrative rather than limiting. It is envisaged that upon reference hereto various related problems may become apparent with respect to user experience and call behavior in the context of interfacing between GAN/WLAN and PLMN spaces.

[0053] For purposes of the present disclosure, the GA-capable UE may operate in either Automatic or Manual mode with certain differences in network discovery and selection procedures, although the particular features and capabilities of the two may vary depending on the applicable specification(s) as well as any modifications and changes that may be made to them. In general, the Manual mode allows the user to do more detailed selection/filtering of the available PLMNs, the bearer(s) to be used, and potentially even of the method to be used when using WLAN or other unlicensed radio technology (i.e., I-WLAN, GAN, or just a connection through the WLAN to the PLMN). Additional details regarding network discovery and selection may be found in one or more of the above-referenced U.S. provisional patent application(s) and nonprovisional patent application(s).

[0054] Referring now to **FIG. 6**, shown therein is a flowchart of a generalized network discovery and selection scheme according to one embodiment wherein a UE device is disposed in a network environment comprising a GAN/WLAN space as well as a WACN space. As illustrated, the flowchart of **FIG. 6** captures a methodology where the UE device gathers appropriate network information upon power-up and initial discovery (as per applicable 3GPP-compliant procedures), which is then transmitted to a network node for determining a more optimal network arrangement (i.e., appropriate GANC+PLMN combination), preferably in view of the UE device's service requirements that may also be advertised to the network node. Accordingly, by effectuating appropriate resolution of UE-discovered network information and its service requirements, the network node is amenable to provide suitable instructions to the UE device for obtaining better service instantiation, which may include redirection to more suitable networks, location-based filtering, and the like.

[0055] Continuing to refer to **FIG. 6**, at block **602**, the UE device gathers network information via scanning relative to one or more WACN technologies, bands, and frequencies. Additionally or alternatively, the UE device is also adapted to gather network information via scanning relative to one or

more GAN/WLAN technologies, bands, and frequencies (block **604**). Thereafter, the UE device transmits the gathered network information as well as service/feature requirements (e.g., voice-only services, data-only services, voice-and-data services, GAN services, handover services, UMA services capability, calling plans associated with said UE device, and/or location area information associated with the UE device, et cetera) to a network node (block **606**). In one embodiment, the gathered network information may comprise at least one of cell identity information of a WACN on which the UE device is registered (i.e., CGI information of a registered GSM/GERAN), CGI/cell ID information relating to other available wide area cellular networks, cause values of any prior registration failures, Broadcast Control Channel (BCCH) information of at least one available wide area cellular network, and Packet Control Channel (PCCH) information of at least one available wide area cellular network. As alluded to hereinabove, in one embodiment, WACNs may be identified by their {MCC,MNC} combinations. Also, additional features such as identifying whether a particular WACN is data-capable (e.g., GPRS-capable) may also be provided. To the extent the UE device is adapted to operate based on various network lists, stored or otherwise, additional selection criteria and filters such as Forbidden GAN/PLMN lists, Priority GAN/PLMN lists (which may be stored, for example, in a Subscriber Identity Module (SIM) or Removable user Identity Module (RUIM), or in a device memory) and the like, may also be provided to the network node. In a further implementation, the UE could also list PLMNs that only provide WACN and/or WAN coverage.

[**0056**] It should be realized that scanning operations set forth above may be performed via active scanning or passive scanning methods. Also, there may be more than one band operable with GANs and/or with PLMNs. In one instance, a frequency band may be selected from the group comprising 450 MHz, 850 MHz, 900 MHz, 1800 MHz, 1700 MHz, 1900 MHz, 2100 MHz, 2700 MHz, or other frequencies and/or any satellite bands.

[**0057**] Upon receiving the gathered network information, service requirement information and/or location information from the UE device, the service logic associated with the network node is operable to resolve the service requirements requested by the UE device in view of the other bodies of the received information so that a determination may be made as to whether additional or alternative network arrangements are available for the UE device. In some implementations, such resolution may involve interfacing with additional network nodes and databases (e.g., HPLMN and/or home GANC, service databases, roaming databases, and so on). Thereafter, appropriate instructions may be provided via a suitable response message to the UE device, including pertinent information relative to any additional or alternative network arrangements. These operations are illustrated in block **608**. Based on the instructions received from the network node, the UE device may then engage in obtaining appropriate service, which can sometimes warrant network redirection (block **610**).

[**0058**] **FIGS. 7A and 7B** depict flowcharts of exemplary scenarios of the network information collection process set forth above. Presently, applicable GAN specifications state that a UE device, e.g., a mobile station (MS), shall first register on a GSM/GERAN PLMN if found and allowed according to current 3GPP network selection procedures. Accordingly, the process flow exemplified in **FIG. 7A** begins with scanning available bands for GERAN PLMN networks (block **702**). For each GERAN PLMN found, information is obtained and stored (blocks **704**, **706** and **708**), e.g., CGI information, BCCH and/or PCCH information, etc. The UE device then selects and registers on a GERAN PLMN (block **710**) according to 3GPP specifications, which may be mediated by the UE device's network lists, preferences, and other filters. If the registration with a particular PLMN fails, the reason for failure is stored as a cause value (blocks **712** and **714**). Once the reason for failure is stored, the registration process may repeat with respect to the additional PLMNs discovered according to 3GPP specifications (block **716**). On the other hand, if the PLMN registration is successful or if registration with no PLMN has been successful and the UE device is allowed to operate in GAN-only mode, further process flow may accordingly follow (block **718**). However, if the PLMN registration is successful but that PLMN does not support GAN connectivity, various concerns might arise that could negatively impact the service selection behavior of the UE device.

[**0059**] With respect to operating in GAN-mode, the UE device is operable to provide a number of information elements to a GANC node with which it establishes initial connectivity. Preferably, as pointed out in the foregoing discussion, such information can include network information gathered via scanning in other bands or modes as well as service requirements. Referring to **FIG. 7B** in particular, upon successful registration a PLMN or failure to register on any PLMN (block **750**), the UE device is operable to search for a GAN network (block **752**), preferably according to applicable 3GPP specifications. Once a Uniform Resource Locator (URL) or IP address of a GANC node has been obtained (block **754**), the UE device authenticates and registers with the GANC using, for instance, known Generic Access—Resource Control (GA-RC) REGISTER REQUEST messaging (block **756**). In accordance with the discussion set forth in the foregoing sections, such a registration message to the GANC may include information elements pertaining to any of the following in any combination:

[**0060**] registered GERAN CGI information if available;

[**0061**] if the registration is for voice and/or data;

[**0062**] services and features requested by the UE device, e.g., voice-only services, data-only services, voice-and-data services, GAN services, multimedia services, value-added services, etc.;

[**0063**] if handover is required;

[**0064**] if home-country-calls-only calls are required;

[**0065**] prior GERAN PLMN registration attempts and associated cause values for failure;

[**0066**] the registration request may also include GERAN PLMN information for which registration was successful but a GANC redirect was received. Any VPLMN information identified therein may be marked as such (described in detail hereinbelow);

[**0067**] CGI information for other PLMNs available; and

[0068] BCCH/PCCH information for available PLMNs. For instance, in one implementation, BCCH/PCCH information for all available PLMNs are included. In other implementations, BCCH/PCCH information for a portion of available PLMNs may be included.

Further, upon successful authentication and registration with the GANC, additional network information may be collected by the UE device (e.g., appropriate network arrangement via a suitable response message), as illustrated in block **758**.

[0069] Those skilled in the art should recognize upon reference hereto that additional operations and/or information elements may be involved if the registration processes take place after the initial network discovery and registration process by the UE device as set forth above. For instance, with respect to WACN space (e.g., GERAN), if the UE device receives a redirect message from a GANC node (which could be a separate message or part of a general redirect message, as will be set forth in further detail below), the UE device may deregister from the current serving GERAN VPLMN and attempt registration on the VPLMNs in a number of ways. By way of illustration, the VPLMNs may be provided by the GANC in some priority order which may be followed by the UE device. Alternatively, if no order has been provided, a VPLMN may be chosen from the supplied list at random. With respect to subsequent registrations in GAN space, if the UE device has been redirected to another VPLMN and registration with that new VPLMN is successful, the UE device may be required to re-register with the home GANC using the same GAN as before. Alternatively, the UE device may register with the GANC associated with the new VPLMN if that information has been made available by the redirecting GANC. In a still further variation, there may be no subsequent GANC registration pursuant to instructions from the GANC.

[0070] Given the interfacing between the WACN and GAN spaces as described in the foregoing sections, selecting a proper PLMN and GANC combination that allows optimal service may be modulated based on a number of factors, e.g., service requirements, available network information, service capabilities, location information, and the like. When a serving network node (e.g., a default GANC or a provisioning GANC) receives appropriate information from the UE device, at least part of the service logic involves resolving whether a home GANC or a GANC associated with a VPLMN should provide service to the UE device. **FIGS. 8A and 8B** are two flowcharts associated with GANC selection and optional redirection in accordance with an embodiment of the present patent disclosure. When the serving network node receives information from a UE device (block **802**), the service logic associated with the node determines (i) if local home network calls are required; and/or (ii) if handover is not required and no VPLMN GANC can be used (block **804**). If so, the network node provides instructions to the UE device to select a home network GANC (block **806**). On the other hand, based on the received information from the UE device (block **820**), the network node service logic determines (i) handover of services is required; and/or (ii) VPLMN dialing plan is required (block **822**). In that case, the network node provides instructions to the UE device to select a VPLMN-associated GANC (block **824**).

[0071] It should be apparent that the service logic is preferably operable to evaluate and resolve a number of service scenarios based on the combinations of service and feature requirements as well as the network information received from the UE device. Additional details and flowcharts regarding exemplary service scenarios may be found in one or more of the above-referenced U.S. provisional patent applications and nonprovisional patent applications, which are incorporated by reference. Set forth below is a discussion on a generalized service scenario wherein redirection may be employed by a GANC node (regardless of whether it is a home GANC, a default GANC or some other provisioning GANC).

[0072] Referring now to **FIG. 9**, shown therein is a flowchart of a GANC selection and redirection scheme in one embodiment. For purposes of illustration, an HPLMN GANC node is provided as the network node that eventually resolves the various service and feature requirements as well as the network information gathered by a UE device. Upon receiving the pertinent information from the UE device (e.g., via a REGISTER REQUEST message, as alluded to previously), the GANC node may perform one or more database queries involving local and/or remote databases in order to evaluate roaming service agreements, service capabilities, address lookup, etc. (block **902**). If the VPLMN that the UE device is registered on is determined to have GAN connectivity (block **904**), then the HPLMN GANC is operable to send a redirect message to the UE device (e.g., a GA-RC REGISTER REDIRECT message) which contains the URL/IP address of the VPLMN GANC node (block **906**). On the other hand, where the registered VPLMN does not have GAN connectivity, the service logic is operable to determine whether there exist other PLMNs that support GANCs. If so, their URL/IP address information may also be determined by performing appropriate database queries. Additionally, such determinations may be evaluated responsive to other information such as the UE's location, existence of applicable service arrangements, etc. These determinations are consolidated in block **908**. In one embodiment, it may involve verifying that the cells identified in received broadcast information still include cells that are available for use. The VPLMNs that are still available after this initial investigation may optionally be sent to a roaming database to determine of a roaming agreement exists between the HPLMN and VPLMN(s). If a suitable roaming agreement exists, preferred PLMN information may also be returned to the HPLMN GANC. After these optional procedures, the service logic of the GANC may transmit the filtered VPLMN information to another database to determine the URLs/IP addresses of available GANCs. Where redirection is established to be appropriate, a suitable redirect message (e.g., a GA-RC REGISTER REDIRECT message) may be transmitted to the UE device which includes one or more URLs/IP addresses of GANCs associated with a plurality of available VPLMNs (block **910**). Otherwise, a response message may be provided to the UE device that indicates a number of options (block **912**). For example, the response message may include an indication that no GAN services are available to the UE device. Alternatively or additionally, the response message may include one or more supplementary fields which indicate additional capabilities, service requests, etc. where applicable, as explained in one or more related patent applications cross-referenced hereinabove.

[0073] With respect to the general syntax of the redirect messages set forth above, one embodiment may include a list of PLMN Identities (e.g., {MCC,MNC} combinations)

as well as supported services and/or features that may be mandatory or optional. In another embodiment, the redirect message may include a list of GANC addresses (i.e., URLs, IP addresses) as well as supported services and/or features. In this case, only GANC address information is mandatory, the other elements may be optional.

[0074] If a redirect message is received, the UE device's behavior may be modulated accordingly as set forth in the following. For instance, if the message contains only URL/IP address information, the UE may register with the GANC having highest priority URL/IP address. If this registration fails, then registration with additional GANCs may be attempted based on their priority order (which may be indicated by means of a flag or other indicium). Likewise, if the redirect message contains WACN/PLMN information only, the UE device may attempt successive registrations with the PLMNs received based on their priority as well. On the other hand, if the redirect message includes both GANC addresses as well as PLMN information, an exemplary embodiment may require that the UE device first register with a network in the PLMN space. Upon successful registration therewith, the UE device may then register with the GANC associated with the selected PLMN.

[0075] **FIG. 10** depicts an exemplary database structure **1000** associated with a serving network node that may be developed upon resolving network information and service requirements of a UE device. Additionally, the database structure information **1000** may be used as the structure of the data sent in a redirect message such as, e.g., the GA-RC REGISTER REDIRECT message described above. A VPLMN Identity column **1002** includes network identities based on the underlying WACN technology for the available PLMNs. For GERAN, as an example, the Identities are comprised of {MCC,MNC} combinations. Other Identities (e.g., Network ID-**1** through Network ID-**3**) may also be provided in some implementations. Reference numeral **1004** refers to a column of GANCs that identifies one or more URL/IP addresses of GANCs that provide GAN connectivity with respect to the VPLMNs identified in column **1002**. It should be noted that not all PLMNs may have corresponding GANC address information, however. For instance, the GERAN PLMN identified as {MCCc,MNCc} does not have any corresponding GANC address information, indicating that such VPLMN information may not be transmitted as part of a redirect message to a UE device.

[0076] Although not explicitly provided in the database structure **1000**, the VPLMN Identities and corresponding GANC addresses may be listed in a particular priority. Furthermore, the VPLMN and GANC information may be filtered based on application of location information associated with the UE device as well. It should also be noted that there are multiple types of location and identification information, and multiple uses of such location and identification. This information is generally lacking in non-cellular wireless access technologies; typically only a Service Set ID (SSID) may be provided, and there is no regulatory requirement for that SSID to be registered or to provide defined information to the user, or even to provide unique information to the user. Exemplary location and identification information may include:

[0077] A. Cellular/WACN

[0078] 1. MCC

[0079] a. Cellular MCC (e.g., GSM)

[0080] b. Country code associated with a microcell (or even a small macrocell) on a vehicle (e.g., ships, planes, trains, buses, etc.)

[0081] 2. MNC

[0082] 3. LAI

[0083] 4. CGI, etc.

[0084] 5. Network generated information such as current cell (and sector)

[0085] 6. Geolocation based on network information, of varying degrees of accuracy

[0086] 7. Geolocation based on handset assisted GPS or other positioning system

[0087] B. WLAN/GAN

[0088] Service Set ID (SSID)

[0089] Other

[0090] C. Manual input information and other information

[0091] 1. AP building and floor and room location and similar descriptive information.

[0092] 2. AP information based on location information derived from dual mode handsets, where the location of the handset is then transferred to a database to provide some (perhaps gross or rough) information on the location of the AP. Could be geographic information or could indicate the LAI or CGI of cellular systems.

[0093] 3. AP information, as in (2), but derived from recent information from the handset, e.g., the cell and network that the handset was viewing a few minutes ago before the user walked into a building and lost coverage. The time between loss of cellular or other information and the connection to the access point is a means of further identifying the potential lack of accuracy of the information.

[0094] 4. Indication of the type of AP.

[0095] a. small, potentially easily moved

[0096] b. fixed in place (at least initially)

[0097] c. mobile, as on a ship or in a plane or on a train—there may be specific types of country codes when the devices in part of a vehicle

[0098] 5. Whether the connectivity of the AP has changed.

[0099] 6. Location (GPS or other, even manual entry) of the ship, plane or vehicle with an AP or microcell.

[0100] It should be realized by those skilled in the art that the location information may be developed by one element (i.e., a UE device) and stored in another element (AP, or microcell or base station controller or GANC), or even in a "universal" database within a PLMN or operator. Further, it should be recognized that location of an AP and its relation to the elements of other (even competing) networks is useful for many purposes, such as assisting in handover (or similar) transition of the handset connectivity, which may include

"roving" as defined in 3GPP documentation. By way of illustration, exemplary uses of location and identification information include:

[0101] Identification of the operator and/or PLMN or otherwise defined network

[0102] Identification of relationship with an operator or PLMN or otherwise defined network

[0103] Identification of location

[0104] a. For E911 and public safety purposes

[0105] b. Including passing of information to the PSAP (Public Safety Answer Point)

[0106] c. For commercial purposes

[0107] Operation of a cellular network or of an unlicensed network.

[0108] The brief taxonomy set forth above suggests that there could be additional information and categories of information passed to the PSAP on emergency calls, to assist the public safety forces. This information may be derived from the UE device, from the actual AP such as a microcell (cellular) or a GAN/WLAN AP. There may be more than one element of location information that is applicable to a specific UE device and user. That information may have been developed by another device on the same AP or microcell, or by database lookup of processed and combined data. It may include recent data, perhaps minutes or tens of minutes or older, or when current information is lacking or when the recent data is imprecise, it may be extrapolated to improve upon the current data. For example, the AGPS, CGI, or other location information may be captured by the UE and time-stamped. When a subscriber brings the UE into a building or vehicle, the UE may no longer be able to provide location information due to lack of a signal. But the prior information may be useful, and may be transferred to the WLAN/GAN AP, microcell, and to the database in the PLMN and associated with the AP.

[0109] The PLMN or other network provider or manager may utilize this information in the operation of the network, to identify the location of the user (i.e., UE), to allow or disallow service, to redirect the user to another AP, microcell, network or GANC, or other means of defining acceptable uses, connectivity, and E911/PSAP operation, for example. Additionally, there is use of connectivity information for handoff from cell to cell and between location areas, where connectivity has been narrowly defined. With the use of alternative (non-cellular) networks for access to cellular networks and services as well as additional non-cellular services, some of the defined cellular location information may not be available, although a large variety of other direct and indirect information may be available. This variety of information may be used to significantly enhance the overall network operation and provision (and restriction) of services within the context of the present patent disclosure.

[0110] Referring now to **FIG. 11**, shown therein is a functional block diagram of an exemplary AN server node **1100**, e.g., GANC/UNC node **1100** according to one embodiment. Those skilled in the art should appreciate that AN server node **1100** may be provided in any of the configurations depicted in **FIGS. 5A and 5B** described hereinabove. Regardless, AN server node **1100** includes appropriate network selection logic **1102** operable to perform one or more of the procedures set forth above with respect to resolving gathered network information and service/feature requirement information that is provided by a UE device. Accordingly, in one embodiment, suitable storage areas may be provided for storing service/feature requirements **1104** as well as gathered network information **1106**. Database query logic **1108** is provided to facilitate database query and interrogation of local and/or remote databases, e.g., DB **1110-1** through DB **1110**-N.

[0111] **FIG. 12** depicts a block diagram of an embodiment of a UE device operable to perform the network discovery/selection procedures set forth according to the teachings of the present patent disclosure. It will be recognized by those skilled in the art upon reference hereto that although an embodiment of UE **102** may comprise an arrangement similar to one shown in **FIG. 12**, there can be a number of variations and modifications, in hardware, software or firmware, with respect to the various modules depicted. Accordingly, the arrangement of **FIG. 12** should be taken as illustrative rather than limiting with respect to the embodiments of the present patent disclosure. A microprocessor **1202** providing for the overall control of an embodiment of UE **102** is operably coupled to a communication subsystem **1204** which includes transmitter/receiver (transceiver) functionality for effectuating multi-mode communications over a plurality of bands. By way of example, a wide area wireless Tx/Rx module **1206**, a GAN Tx/Rx module **1208** and an I-WLAN Tx/Rx module **1210** are illustrated. Although not particularly shown, each Tx/Rx module may include other associated components such as one or more local oscillator (LO) modules, RF switches, RF bandpass filters, A/D and D/A converters, processing modules such as digital signal processors (DSP), local memory, etc. As will be apparent to those skilled in the field of communications, the particular design of the communication subsystem **1204** may be dependent upon the communications networks with which the UE device is intended to operate. In one embodiment, the communication subsystem **1204** is operable with both voice and data communications.

[0112] Microprocessor **1202** also interfaces with further device subsystems such as auxiliary input/output (I/O) **1218**, serial port **1220**, display **1222**, keyboard **1224**, speaker **1226**, microphone **1228**, random access memory (RAM) **1230**, a short-range communications subsystem **1232**, and any other device subsystems generally labeled as reference numeral **1233**. To control access, a SIM/RUIM interface **1234** is also provided in communication with the microprocessor **1202**. In one implementation, SIM/RUIM interface **1234** is operable with a SIM/RUIM card having a number of key configurations **1244** and other information **1246** such as identification and subscriber-related data as well as one or more SSID/PLMN lists and filters alluded to hereinabove.

[0113] Operating system software and other control software may be embodied in a persistent storage module (i.e., non-volatile storage) such as Flash memory **1235**. In one implementation, Flash memory **1235** may be segregated into different areas, e.g., storage area for computer programs **1236** as well as data storage regions such as device state **1237**, address book **1239**, other personal information manager (PIM) data **1241**, and other data storage areas generally labeled as reference numeral **1243**. Additionally, appropriate network discovery/selection logic **1240** may be provided as

part of the persistent storage for executing the various procedures, correlation techniques, service/feature requirement selection and identification processes as well as GANC selection mechanisms set forth in the preceding sections. Associated therewith is a storage module **1238** for storing the SSID/PLMN lists, selection/scanning filters, capability indicators, et cetera, also alluded to hereinabove.

[**0114**] Based on the foregoing, it should be clear that the UE device logic and hardware includes at least the following: a logic module for facilitating identification of a set of appropriate service requirements relative to operating the UE device; a communication subsystem for gathering network information via scanning in at least one band and for transmitting at least one of the network information and the service requirements to a network node; and a logic module for selecting a GANC from a set of GANCs provided by the network node, the list of GANCs being determined upon resolving the network information and the service requirements by the network node to determine an appropriate list of GANCs operable with a plurality of wide area cellular networks identified for the UE device, wherein the list of GANCs is transmitted to the UE device via a response message for selection by the UE device.

[**0115**] It is believed that the operation and construction of the embodiments of the present patent disclosure will be apparent from the Detailed Description set forth above. While the exemplary embodiments shown and described may have been characterized as being preferred, it should be readily understood that various changes and modifications could be made therein without departing from the scope of the present invention as set forth in the following claims.

What is claimed is:

1. A network selection method, comprising:

gathering network information by a user equipment (UE) device via scanning in at least one band;

transmitting by said UE device at least one of said network information and a set of service requirements to a network node; and

resolving said network information and said set of service requirements by said network node to determine an appropriate list of generic access network controllers (GANCs) operable with a plurality of wide area cellular networks identified for said UE device, wherein said list of GANCs is transmitted to said UE device via a response message for selection by said UE device.

2. The network selection method as recited in claim 1, wherein said wide area cellular networks comprise at least one of a General Packet Radio Service (GPRS) network, an Enhanced Data Rates for Global System for Mobile Communications (GSM) Evolution (EDGE) network, a 3rd Generation Partnership Project (3GPP)-compliant network, an Integrated Digital Enhanced Network (IDEN), a Code Division Multiple Access (CDMA) network, a Universal Mobile Telecommunications System (UMTS) network, and a Universal Terrestrial Radio Access Network (UTRAN).

3. The network selection method as recited in claim 1, wherein each of said GANCs is identified with a corresponding Uniform Resource Locator (URL).

4. The network selection method as recited in claim 1, wherein each of said GANCs is identified with a corresponding Internet Protocol (IP) address.

5. The network selection method as recited in claim 1, wherein said network information comprises at least one of Cell Global Identification (CGI) information of a registered wide area cellular network, CGI information relating to available wide area cellular networks, cause values of any prior registration failures, Broadcast Control Channel (BCCH) information of at least one available wide area cellular network, and Packet Control Channel (PCCH) information of at least one available wide area cellular network.

6. The network selection method as recited in claim 1, wherein said service requirements comprise at least one of voice-only services, data-only services, voice-and-data services, GAN services, handover services, calling plans associated with said UE device, and location area information associated with said UE device.

7. The network selection method as recited in claim 1, wherein said network node comprises a default GANC associated with said UE device.

8. The network selection method as recited in claim 1, wherein said network node comprises a home network GANC associated with said UE device.

9. The network selection method as recited in claim 1, wherein said network node comprises a provisioning GANC associated with said UE device.

10. The network selection method as recited in claim 1, wherein at least one of said network information and said set of service requirements is transmitted by said UE device via a Generic Access—Resource Control (GA-RC) REGISTER REQUEST message.

11. The network selection method as recited in claim 10, wherein said response message comprises a GA-RC REGISTER REDIRECT message.

12. A network selection system, comprising:

means associated with a user equipment (UE) device for gathering network information via scanning in at least one band;

means associated with said UE device for transmitting at least one of said network information and a set of service requirements to a network node; and

means associated with said network node for resolving said network information and said set of service requirements to determine an appropriate list of generic access network controllers (GANCs) operable with a plurality of wide area cellular networks identified for said UE device, wherein said list of GANCs is transmitted to said UE device via a response message for selection by said UE device.

13. The network selection system as recited in claim 12, wherein said wide area cellular networks comprise at least one of a General Packet Radio Service (GPRS) network, an Enhanced Data Rates for Global System for Mobile Communications (GSM) Evolution (EDGE) network, a 3rd Generation Partnership Project (3GPP)-compliant network, an Integrated Digital Enhanced Network (IDEN), a Code Division Multiple Access (CDMA) network, a Universal Mobile Telecommunications System (UMTS) network, and a Universal Terrestrial Radio Access Network (UTRAN).

14. The network selection system as recited in claim 12, wherein each of said GANs is identified with a corresponding Uniform Resource Locator (URL).

15. The network selection system as recited in claim 12, wherein each of said GANs is identified with a corresponding Internet Protocol (IP) address.

16. The network selection system as recited in claim 12, wherein said network information comprises at least one of Cell Global Identification (CGI) information of a registered wide area cellular network, CGI information relating to available wide area cellular networks, cause values of any prior registration failures, Broadcast Control Channel (BCCH) information of at least one available wide area cellular network, and Packet Control Channel (PCCH) information of at least one available wide area cellular network.

17. The network selection system as recited in claim 12, wherein said service requirements comprise at least one of voice-only services, data-only services, voice-and-data services, GAN services, handover services, calling plans associated with said UE device, and location area information associated with said UE device.

18. The network selection system as recited in claim 12, wherein said network node comprises a default GANC associated with said UE device.

19. The network selection system as recited in claim 12, wherein said network node comprises a home network GANC associated with said UE device.

20. The network selection system as recited in claim 12, wherein said network node comprises a provisioning GANC associated with said UE device.

21. The network selection system as recited in claim 12, wherein at least one of said network information and said set of service requirements is transmitted by said UE device via a Generic Access—Resource Control (GA-RC) REGISTER REQUEST message.

22. The network selection system as recited in claim 21, wherein said response message comprises a GA-RC REGISTER REDIRECT message.

23. A user equipment (UE) device, comprising:

a logic module for facilitating identification of a set of appropriate service requirements relative to operating said UE device;

a communication subsystem for gathering network information via scanning in at least one band and for transmitting at least one of said network information and said service requirements to a network node; and

a logic module for selecting a generic access network controller (GANC) from a set of GANCs provided by said network node, said list of GANCs being determined upon resolving said network information and said service requirements by said network node, wherein said list of GANCs is transmitted to said UE device via a response message for selection by said UE device.

24. The UE device as recited in claim 23, wherein said GANCs are identified with Uniform Resource Locators (URLs) corresponding to a set of GANCs that provide connectivity to wide area cellular networks (WACNs) identified for said UE device.

25. The UE device as recited in claim 23, wherein said GANCs are identified with Internet Protocol (IP) addresses corresponding to a set of GANCs that provide connectivity to wide area cellular networks (WACNs) identified for said UE device.

26. The UE device as recited in claim 23, wherein said network information comprises at least one of Cell Global Identification (CGI) information of a wide area cellular network on which said UE device is registered, CGI information relating to available wide area cellular networks, cause values of any prior registration failures, Broadcast Control Channel (BCCH) information of at least one available wide area cellular network, and Packet Control Channel (PCCH) information of at least one available wide area cellular network.

27. The UE device as recited in claim 23, wherein said service requirements comprise at least one of voice-only services, data-only services, voice-and-data services, GAN services, handover services, calling plans associated with said UE device, packet data services capability, and Unlicensed Mobile Access (UMA) services capability, said service requirements being selectable based on location area information associated with said UE device.

28. The UE device as recited in claim 23, wherein said network node comprises a default GANC associated with said UE device.

29. The UE device as recited in claim 23, wherein said network node comprises a home network GANC associated with said UE device.

30. The UE device as recited in claim 23, wherein said network node comprises a provisioning GANC associated with said UE device.

31. The UE device as recited in claim 23, wherein at least one of said network information and said set of service requirements is transmitted by said communication subsystem via a Generic Access—Resource Control (GA-RC) REGISTER REQUEST message.

32. The UE device as recited in claim 31, wherein said response message comprises a GA-RC REGISTER REDIRECT message.

33. A generic access network controller (GANC) operable with a user equipment (UE) device disposed in a wireless environment, comprising:

means for receiving at least one of network information and a set of service requirements from said UE device via a registration request message;

means for resolving said network information and said set of service requirements to determine an appropriate list of generic access network controllers (GANCs) operable with one or more wide area cellular networks identified for said UE device; and

means for transmitting said list of GANCs to said UE device via a response message responsive to said registration request message.

34. The GANC as recited in claim 33, wherein said wide area cellular networks comprise at least one of a General Packet Radio Service (GPRS) network, an Enhanced Data Rates for Global System for Mobile Communications (GSM) Evolution (EDGE) network, a 3rd Generation Partnership Project (3GPP)-compliant network, an Integrated Digital Enhanced Network (IDEN), a Code Division Multiple Access (CDMA) network, a Universal Mobile Telecommunications System (UMTS) network, and a Universal Terrestrial Radio Access Network (UTRAN).

35. The GANC as recited in claim 33, wherein said GANCs are identified with Uniform Resource Locators (URLs).

36. The GANC as recited in claim 33, wherein said GANCs are identified with Internet Protocol (IP) addresses.

37. The GANC as recited in claim 33, wherein said network information comprises at least one of Cell Global Identification (CGI) information of a registered wide area cellular network, CGI information relating to available wide

area cellular networks, cause values of any prior registration failures, Broadcast Control Channel (BCCH) information of at least one available wide area cellular network, and Packet Control Channel (PCCH) information of at least one available wide area cellular network.

38. The GANC as recited in claim 33, wherein said service requirements comprise at least one of voice-only services, data-only services, voice-and-data services, GAN services, handover services, calling plans associated with said UE device, packet data services capability, and Unlicensed Mobile Access (UMA) services capability, said service requirements being selectable based on location area information associated with said UE device.

39. The GANC as recited in claim 33, wherein said network information is gathered by said UE device via scanning in at least one band.

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