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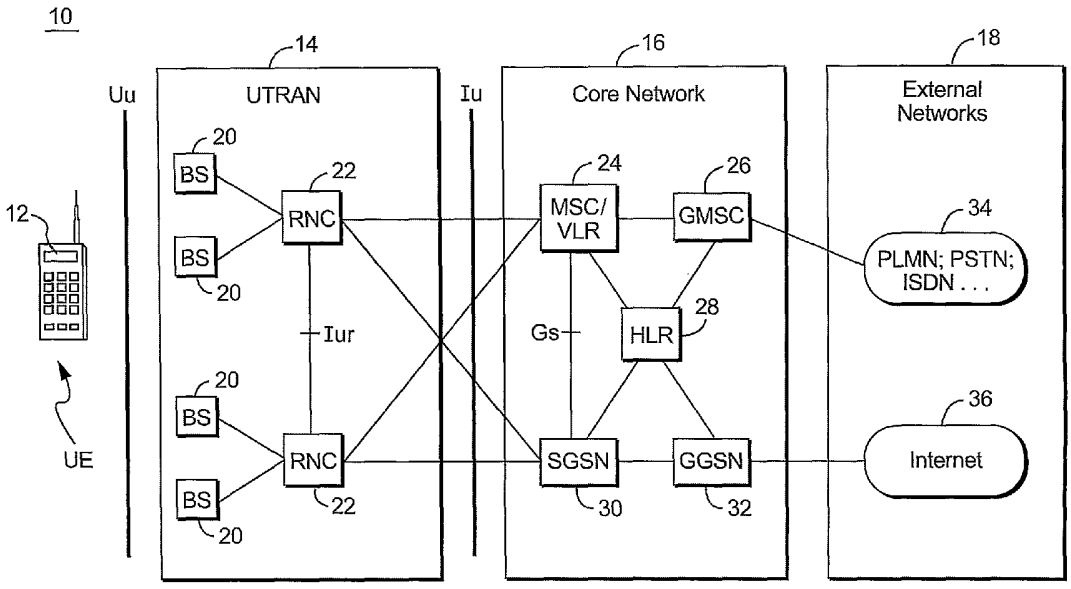
(54) Title: CONNECTION-ORIENTED PAGING BETWEEN CORE NETWORK AND RADIO ACCESS NETWORK NODES



(57) Abstract: A paging message from a circuit-switched core network node is sent to a packet-switched core network node for handling. The packet-switched core network node determines whether the mobile station to be paged is in an idle or connected state. For an idle state mobile, the packet-switched node sends a connectionless page to the radio access network. If the mobile station is in a connected state, the packet-switched node sends a simplified, connection-oriented page message over an existing signaling connection to the radio access network. This approach permits paging messages from the core network to the radio access network to be handled efficiently.

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Connection-Oriented Paging Between Core Network and Radio Access Network Nodes

TECHNICAL FIELD

[0001] The technical field relates to efficient location management in a mobile radio communications network.

BACKGROUND OF THE INVENTION

[0002] Mobile radio communication systems have progressed through three generations including analog (first generation), digital (second generation), and multi-media (third generation). Third generation systems are typically associated with universal mobile telecommunication systems (UMTS). One example of a UMTS radio-access network is the UMTS terrestrial radio access network (UTRAN) which has been specified by various 3GPP standards (third generation partnership project).

[0003] A key advantage of any mobile communications network is that the mobile subscribers may be reached for an incoming call in any service area as long as the mobile station is powered on and has registered its current location. Mobility management functions including paging of mobile stations or terminals (which are referred to in 3GPP language as user equipment (UE)) are coordinated by a core network node such as a mobile switching center (MSC) or a serving GPRS support node (SGSN) (GPRS stands for general packet radio system) and a radio network controller (RNC) in the UTRAN. The core network supports connection-oriented services, sometimes called circuit-switched services, via the MSC node and connectionless services, sometimes referred as packet-switched services, via the SGSN core network node.

[0004] The RNC nodes in the UTRAN communicate with the core network nodes using radio access network application protocol (RANAP) formatted messages sent over what is referred to as an Iu interface. RANAP functionality is implemented by various RANAP elementary procedures (EPs) including for example relocation functions, radio access network management functions, and paging functions. At a simple level, when a core network node receives a service request, such as a voice call, for a mobile station, the core network node sends a paging message to UTRAN with a

mobile station identifier and typically a paging area identifier. The UTRAN then broadcasts a paging message identifying that mobile station in the requested paging area.

[0005] In order for paging to be successful, mobile stations must provide location updates to each of the core network nodes, i.e., MSC and the SGSN. These location updates occur every time that a mobile moves to a different paging area which could be a different cell, a different location area, a different routing area, or a different service area. Each time one of these updates occurs, an update message must be sent to both of the circuit-switched and packet-switched core network nodes in order for them to be able to know where the mobile stations are located. To decrease the amount of location update information that must be communicated over the Iu interface and reduce the duplicative mobility management functions being performed in both the packet-switched and circuit-switched core network nodes, a signaling interface Gs may be configured between the circuit-switched MSC node and the packet-switched SGSN node. Paging updates as well as actual pages may then be handled through only one of the core network nodes to substantially reduce the signaling and processing load.

[0006] The current 3GPP standards specify the SGSN to handle the core network communications with the UTRAN. 3GPP TS 23.060, section 6.3.4, indicates that when the SGSN receives a page from the MSC over the Gs interface, the SGSN sends an RANAP paging message to the radio network controller in the UTRAN. In 3GPP TS 25.413, section 9.1.23, the RANAP paging message is always sent using a connectionless signaling bearer over the Iu interface. In other words, the RANAP paging message is sent packet-switched and not over a dedicated connection.

[0007] When the SGSN receives an RANAP paging message over the Gs interface from the MSC, the SGSN processes that paging message differently depending upon the "state" of the paged mobile station. Various mobility management states are defined in 3GPP TS 23.060, section 6.1.2, and are referred to as packet mobility management (PMM) states. In a PMM-detached state, there is no communication between the mobile station and the SGSN, and the mobile station is not reachable by the SGSN because the mobile station's location is not known. In a PMM-

idle state, the mobile station is attached to the UTRAN, and its location is known at the level of a particular routing area. In a PMM-connected state, the mobile station location is known in the SGSN at a level that a serving RNC knows the location of the connected mobile station, which is typically at the routing area level. Moreover, there is a dedicated signaling connection established between the mobile station and the SGSN via the UTRAN for each mobile station in the PMM-connected state. Each RNC stores a database record for every PMM-connected state mobile station in its coverage area.

[0008] A RANAP paging message format is specified in 3GPP TS 25.413, section 9.1.23, and includes a number of information elements (IEs). One of those IEs is a "non-searching indication." When that IE is set, the RNC does not need to perform an extensive database search to determine if there is an existing signaling connection for the mobile to be paged. That search is typically carried out using the paged mobile station's identifier such as its IMSI. Assume that the SGSN receives a page request for a mobile station in the PMM-idle state. In that state, there is no signaling connection established for the mobile station between the SGSN and the RNC or between the RNC and the mobile station. Accordingly, the SGSN sets the non-searching indication IE in the RANAP paging message to non-searching. The RNC then has a paging message for this idle mobile station broadcast over the radio Uu interface via one or more radio paging channels. Having the SGSN include a routing area ID associated with the mobile station's current location in the RANAP paging message reduces the amount of page-related signaling over the radio interface because routing areas are typically smaller than location areas.

[0009] If the non-searching indicator is not set upon receiving the RANAP paging message, the RNC would have to search its entire PMM-connected mobile station database to determine if the paged mobile station's IMSI matches with one of the database records. This searching can be take quite a bit of time and data processing resources, particularly if the database is large. So avoiding this search, if it is unnecessary, is desirable. That is why the non-search indicator is set in the RANAP message for idle mobile stations because the SGSN knows, based on the PMM-idle

state of the mobile station being paged, that there is no signaling connection record in the RNC database.

[0010] But these benefits are not attained when the mobile station is in a PMM-connected state. In the PMM-connected state, a packet-switched signaling connection is established between the mobile station and the SGSN including a dedicated signaling connection for this mobile station between the SGSN and the mobile station's serving RNC. In this situation, when the SGSN receives a page request from the MSC for the mobile station, the SGSN sends an RANAP paging message over a connectionless signaling bearer as currently specified the 3GPP standard. A connectionless page is sent even though there is a dedicated signaling connection that already exists between the SGSN and the RNC for this mobile station. It would be more efficient if the RANAP paging message were sent over the already-established, circuit-switched signaling connection that exists for this mobile station.

[0011] Compounding this inefficiency is the fact that when the RNC receives the connectionless RANAP paging message over the Iu interface, the non-searching indication information element will not be set because the RNC needs to locate the active signaling connection for this mobile station. As a result, the RNC must search all of the PMM-connected mobile records in its database to find the signaling connection for this particular mobile station over which the page message is to be routed for use in paging to that mobile station. Identifying that existing signaling connection is necessary because when the mobile station is in a PMM-connected state with an RNC-to-mobile station signaling connection established, the mobile station no longer listens to paging broadcast channels for pages. Thus, the only way to effectively page this PMM-connected state mobile station when a connectionless RANAP paging message is sent over the Iu interface is to reset the non-searching indicator so that the RNC searches and finds the existing signaling connection to this mobile station. That way, the RNC can locate and send the paging message over the existing RNC-to-mobile station signaling connection. Accordingly, sending MSC paging messages from the SGSN using a connectionless RANAP paging message is inefficient consuming considerable time and resources needlessly.

SUMMARY OF THE INVENTION

[0012] The invention recognizes the fact that resources could be conserved and the paging process could be made more efficient for pages to PMM-connected mobile stations by making the RANAP paging message from the SGSN to the RNC connection-oriented rather than connectionless. By employing connection-oriented paging, the RNC can take advantage of the fact that there is already an Iu interface signaling connection associated with a PMM-connected mobile station between the SGSN and the RNC. There is no need for the RNC to perform any searching or other paging coordination functions. The RNC simply forwards the page message to the appropriate base station(s) over the existing signaling connection.

[0013] In one example embodiment, a packet-switched core network node receives a page request for a mobile station from a circuit-switched core network node. The packet-switched core network node determines that the mobile station is in a connected state where an existing signaling connection is established for the mobile station between a radio network controller in a radio access network and the packet-switched core network node. In response to the received page request, the packet-switched core network node sends a first type paging message over the existing signaling connection to a radio network controller serving the mobile station. In response to the first type paging message, the radio network controller sends the paging message to the mobile station over an existing radio access network signaling connection established between the radio network controller and the mobile station.

[0014] If the packet-switched core network node determines that the mobile station is in an idle state where there is no existing signaling connection established for the idle mobile station between a radio network controller in the radio access network and the packet-switched core network node, the packet-switched core network node sends a second type paging message to the radio access network in response to a page request received from the circuit-switched core network node for the idle mobile radio. In the main example, the first type paging message is connection-oriented, and the second type paging message is connectionless. The first type message is transmitted

over a dedicated, circuit-switched connection while the second type message is transmitted over a packet-switched connection. One of the benefits of the connection-oriented paging message is that is requires less information than the connectionless paging message for MSC-paged mobiles in the connected state. The radio network controller, upon receiving either the first type or second type of paging message, does not search to determine whether there is an existing signaling connection for the mobile station. In general, the radio network controller does not need to perform paging coordination functions that would otherwise need to be performed if the first type of paging message were connectionless.

[0015] An advantageous but still example implementation is in a serving GPRS support node (SGSN) for use in a UMTS communications system. A mobile switching center (MSC) is coupled to the SGSN over a Gs interface. The SGSN receives a page request for a mobile station from the MSC over the Gs interface and determines whether the mobile station is in a packet mobility management (PMM)-idle state or a PMM-connected state. The SGSN conducts connection-oriented paging over a radio access network application part (RANAP) protocol for the mobile station in response to the page request when the mobile station is determined to be in the PMM-connected state and connectionless paging when the mobile station is determined to be in the PMM-idle state. The connection-oriented RANAP paging message includes fewer information elements than the connectionless RANAP paging message.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIGURE 1 is an example mobile communication system;

[0017] FIGURE 2 is a flow chart diagram illustrating example procedures for handling page requests from the MSC via the SGSN;

[0018] FIGURE 3 is a diagram illustrating signals for a connectionless page message; and

[0019] FIGURE 4 is a diagram illustrating signals for a connection-oriented page message.

DETAILED DESCRIPTION

[0020] The following description sets forth specific details, such as particular embodiments, procedures, techniques, etc., for purposes of explanation and not limitation. It will be appreciated by one skilled in the art that other embodiments may be employed apart from these specific details. For example, although the following description is facilitated using non-limiting UMTS examples, radio access technologies other than UMTS may be used.

[0021] In some instances, detailed descriptions of well-known methods, interfaces, circuits, and signaling messages are omitted so as not to obscure the description with unnecessary detail. Moreover, individual blocks are shown in the figures. Those skilled in the art will appreciate that the functions of those blocks may be implemented using individual hardware circuits, using software programs and data in conjunction with a suitably programmed digital microprocessor or general purpose computer, using application specific integrated circuitry (ASIC), and/or using one or more digital signal processors (DSPs).

[0022] Although applicable to any radio access network architecture, for purposes of illustration, the description is given in the context of a UMTS system 10 shown in Fig. 1. A User Equipment (UE) 12 communicates over a radio interface *Uu* with a UMTS Terrestrial Radio Access Network (UTRAN) 14. The UTRAN 14 communicates with a core network 16 coupled to an external network 18. Communication over the radio interface *Uu* is based upon Wideband Code Division Multiple access (WCDMA) radio technology.

[0023] The UTRAN 14 includes one or more Radio Network Controllers (RNCs) 22 which control radio resources of the radio Base Stations (BSs) 20 coupled to it. The RNC 22 is the service access point (SAP) for all services that the UTRAN provides to the core network 16, e.g., management of connections to the mobile station referred to as user equipment (UE) 12. The core network 16 includes a Home Location Register (HLR) 28, which is a database provided in the mobile user's home system that stores a master copy of the user's service profile and subscription. For the purposes of routing incoming transactions to the mobile station, e.g., calls, short messages, and data

communications, the HLR 28 also stores the mobile station location for the MSC/VLR 24 and the SGSN 30. The Mobile Services Switching Center/Visitor Location Register 24 (MSC/VLR) 24 indicates the switch (MSC) and database (VLR) that serves the mobile station 12 in its current location for circuit-switched (CS) services. The MSC switches the CS transactions, and the VLR holds a copy of the visiting user service profile, along with more precise information on the mobile station's location within the servicing system. The Gateway MSC (GMSC) 26 is the switch where the UMTS network connects to external circuit-switched networks such as a Public Land Mobile Network (PLMN), a Public-Switched Telephone Network (PSTN), Integrated Services Data Network (ISDN), etc. 34. The Serving GPRS (General Packet Radio Service) Support Node (SGSN) 30 functions like the MSC/VLR 24 but in the context of packet-switched (PS) services. The Gateway GPRS Support Node (GGSN) 32 functions much like the GMSC 26 but in relation to PS services coupled to an external PS network such as the Internet 36.

[0024] A Gs interface is configured to permit communications between the MSC 24 and the SGSN 30. Communications between the core network and the UTRAN are transacted over an Iu interface. For purposes of this description, the SGSN communicates pages from the core network to the UTRAN for both itself and the MSC 24. When a page request is received from the MSC 24 over the Gs interface, the SGSN sends an RANAP paging message to the serving RNC in UTRAN 14. A non-limiting, example is an RANAP paging message having a format as shown in Table 1 below in accordance with the current 3GPP specification TS 25.413.

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.1.1		YES	ignore
CN Domain Indicator	M		9.2.1.5		YES	ignore
Permanent NAS UE Identity	M		9.2.3.1		YES	ignore
Temporary UE Identity	O		9.2.3.2		YES	ignore
Paging Area ID	O		9.2.1.21		YES	ignore
Paging Cause	O		9.2.3.3		YES	ignore
Non Searching Indication	O		9.2.1.22		YES	ignore
DRX Cycle Length Coefficient	O		9.2.1.37		YES	ignore
Global CN-ID	O		9.2.1.46		YES	ignore

Table 1

[0025] The RANAP paging message includes a number of information elements including three mandatory (M) information elements: message type, core network (CN) domain indicator, permanent NAS UE identity. The core network domain indicator is used by the RNC to identify from which core network domain (packet-switched SGSN or circuit-switched MSC) the paging request originates. The permanent NAS UE identity corresponds to the mobile identifier IMSI (international mobile subscriber identifier) and is used by the UTRAN paging coordination function (performed by the RNC) to search the UTRAN mobile record database to determine if a signaling connection already exists for this mobile station.

[0026] There are several optional (O) information elements including a temporary UE identity. For example, a TMSI may be allocated by the core network which can be used in a radio interface paging message; otherwise, the RNC uses the IMSI. A paging area identifier may be used by the RNC to identify the area in which the radio interface paging message will be broadcasts assuming no signaling connection exists for the mobile station. Absent such a paging area identifier, the whole RNC area must be paged. A paging cause information element indicates to the RNC the reason for sending the paging message. A non-searching indication information element is used by the RNC to decide whether the UTRAN paging coordination function must be activated or not. As explained above, if the non-searching indication element is reset, the UTRAN paging coordination functions must be performed. One of the more time and resource consuming functions is the search of existing signaling connection records in the RNC for the paged mobile station. A DRX cycle length coefficient may be included, and if present, UTRAN uses it to calculate specific times for paging the UE. A global core network identifier information element identifies the core network which originated the page.

[0027] As described in the background, the current 3GPP TS 25.413 specification requires the SGSN to send an RANAP page, in response to a page request from the MSC, in a "connectionless" fashion over the Iu interface. This is not a problem when the mobile station being paged is in a PMM-idle state. The SGSN simply sends the connectionless RANAP paging message with the no search indicator

set. Because there is no signaling connection to the mobile station, the RNC has the mobile station paged over one or more radio paging channels, and if a routing area is specified, the paging message is sent only in cells in that routing area. Since the mobile is idle, there is no need for the RNC to search its database records to determine whether there is a current signaling connection established. As a result, the RNC does not waste resources and time performing an extensive database records search.

[0028] But when the mobile station is in a PMM-connected mode, and thus has a signaling connection already established, this presents a problem. If the RNC tries to reach the mobile station simply by generating a page over a radio paging channel, it will not be successful because the mobile station is in the PMM-connected state and is not listening to any paging broadcast channel. Rather than sending a connectionless paging message from the SGSN to the RNC which results in the RNC having to perform extensive paging coordination functions, including searching for existing signaling connections already established with the paged mobile station, the SGSN generates a connection-oriented paging message and sends it over the already-established signaling connection between the SGSN and the RNC currently serving this mobile station. That serving RNC then forwards the paging information over the already existing radio resource control (RRC) signaling connection between the RNC and the mobile station.

[0029] Sending a connection-oriented paging message over the already-existing signaling connection allows for a simplified RANAP paging message. For example, there is no need to include any search indication field since no mobile record search is necessary. The SGSN already knows that a signaling connection exists for this mobile station. As a result, the only mandatory information message elements in the connection-oriented RANAP paging message include the message type (i.e., paging) and the core network domain indicator (i.e, the MSC which sent the page request). Because the message is sent by the SGSN over the already-existing signaling connection, there is also no need to include any temporary mobile station identity or paging area identifier. It may be beneficial (but still optional) to send the mobile station's IMSI in a connection-oriented RANAP paging message. The RNC need not

perform any paging coordination functions for this paging message thereby avoiding the delays and processing resources required to search the mobile records for an existing signaling connection. An example non-limiting format for a connection-oriented RANAP paging message is set forth in Table 2 below.

IE/Group Name	Presence	Range	IE type and reference	Semantics description	Criticality	Assigned Criticality
Message Type	M		9.2.1.1		YES	ignore
CN Domain Indicator	M		9.2.1.5		YES	ignore
Permanent NAS UE Identity	~~MO~~		9.2.3.1		YES	ignore
~~Temporary UE Identity~~	~~O~~		~~9.2.3.2~~		~~YES~~	~~ignore~~
~~Paging Area ID~~	~~O~~		~~9.2.1.21~~		~~YES~~	~~ignore~~
Paging Cause	O		9.2.3.3		YES	ignore
~~Non Searching Indication~~	~~O~~		~~9.2.1.22~~		~~YES~~	~~ignore~~
DRX Cycle Length Coefficient	O		9.2.1.37		YES	ignore
Global CN-ID	O		9.2.1.46		YES	ignore

Table 2

[0030] Reference is made now to the flowchart diagram in Figure 2 illustrating example procedures for implementing both connectionless and connection-oriented paging from the SGSN. First, the MSC sends a page for a mobile radio (UE) over the Gs interface to the SGSN (step S2). The SGSN determines whether the paged mobile station is in a PMM-idle state or a PMM-connected state (step S4). The SGSN determines the state of the UE based on information in the page received from the MSC and from records already stored in the SGSN regarding this terminal's connection state. If the SGSN determines that the mobile station is in an idle state, it sends paging information as a connectionless RANAP paging message with a "no search indicator" field set. The no search indicator field is set because it will be necessary to page this mobile station, and thus, it is unnecessary for the RNC to take the time to search its database to determine whether there is an existing signaling connection to this mobile station. The RNC responsible for the cells specified in the routing area of the paging message sends a paging message to those cells (step S6). Because there is no current radio resource control (RRC) connection between the RNC and the mobile terminal, the idle mobile station is paged over those paging channels in the routing areas specified in the page message from the SGSN (step S8).

[0031] On the other hand, if the SGSN determines that the mobile station is in the PMM-connected state, then the SGSN generates and sends a connection-oriented RANAP paging message over the existing signaling channel for this mobile station to the RNC serving that mobile station (step S10). Because an RRC signaling connection exists to the mobile station, the RNC sends an RRC paging message to the mobile station over that RRC connection (step S12). Again, because the SGSN sends the connection-oriented page over the existing signaling connection to the RNC, the RNC need not search for the mobile station's record in its signaling connections database or perform other time consuming paging coordination functions.

[0032] Figure 3 illustrates an example of a connectionless page message signal flow for an idle mobile station. The MSC 24 sends a page request over the Gs interface to the SGSN 30. The SGSN sends a connectionless page message over the Iu interface to the serving RNC 22. In this particular example, a page message is sent to two RNCs where it is assumed that the mobile station 12 is in an routing area serviced by two RNCs, RNC1 and RNC2, via respective base stations BS1 and BS2.

[0033] Figure 4 is a similar diagram illustrating a connection-oriented page message signal flow for a connected mobile station. The original page request from the MSC 24 is sent over the Gs interface to the SGSN 30. The SGSN 30, recognizing that there is an existing signaling connection with the mobile station, generates a connection-oriented page message and sends it over the Iu interface to the RNC1. RNC1 then sends a page message over the existing RRC connection via base station BS1 to the mobile station over the Uu interface. Signaling to and paging from the RNC2 is avoided.

[0034] Pages for idle state mobile stations are sent using a connectionless page message that specifies that no search should be made for an RNC record corresponding to the mobile station being paged. For mobile stations in a connected state, the SGSN generates and sends a simplified paging message that is connection-oriented over the existing signaling channel for the paged mobile station. In both cases, the RNC does not have to perform the time consuming search of mobile station records to determine

whether a signaling connection exists. By avoiding the record search and other paging coordination operations in the RNC, paging operations are performed more efficiently.

[0035] While the invention has been described in connection with an example, non-limiting embodiment, it is to be understood that the invention is not to be limited by the above description. On the contrary, the invention is defined by the claims.

CLAIMS:

1. A packet-switched core network node for receiving a page request for a mobile station from a circuit-switched core network node, the packet-switched core network node c h a r a c t e r i z e d i n:

means for determining that the mobile station is in a connected state where an existing signaling connection is established for the mobile station between a radio network controller in a radio access network and the packet-switched core network node, and

means for sending a connection-oriented paging message over the existing signaling connection to the radio network controller in response to the received page request.

2. The packet-switched core network node according to claim 1, wherein the means for determining is configured to determine that the mobile station is in an idle state where there is no existing signaling connection established for the mobile station between a radio network controller in the radio access network and the packet-switched core network node, and

wherein the means for sending is configured to send a connectionless paging message to the radio access network in response to a page request received from the circuit-switched core network node for the mobile station.

3. The packet-switched core network node according to claim 1, wherein the connection-oriented paging message requires less information than the connectionless paging message.

4. The packet-switched core network node according to claim 1, wherein the connection-oriented message is transmitted over a dedicated, circuit-switched connection and the connectionless message is transmitted over a packet-switched connection.

5. The packet-switched core network node according to claim 1, wherein the packet-switched core network node is a serving GPRS support node (SGSN) and the circuit-switched core network node is a mobile switching center (MSC), the page request from the MSC is sent over a Gs interface to the SGSN, and the connection-oriented and connectionless paging messages are formatted in accordance with a radio access network application part (RANAP) protocol.

6. The packet-switched core network node according to claim 1, wherein the connection-oriented and connectionless RANAP paging messages are generated by the SGSN so that the radio network controller does not need to perform one or more paging coordination functions when either the connection-oriented or connectionless RANAP paging messages is received.

7. The packet-switched core network node according to claim 1, wherein the connection-oriented RANAP paging message is generated by the SGSN so that the radio network controller does not need to perform one or more paging coordination functions that would otherwise need to be performed if the connection-oriented paging message were connectionless.

8. A serving GPRS support node (SGSN) for use in a 3GPP-compliant mobile communications system that includes a mobile switching center (MSC) coupled to the SGSN over a Gs interface, wherein the SGSN is configured to receive a page request for a mobile station from the MSC over the Gs interface, the SGSN characterized in electronic circuitry configured to perform the following tasks:

determine whether the mobile station is in a packet mobility management (PMM)-idle state or a PMM-connected state, and

conduct connection-oriented paging over a radio access network application part (RANAP) protocol for the mobile station in response to the page request when the mobile station is determined to be in the PMM-connected state.

9. The SGSN according to claim 8, wherein the electronic circuitry is further configured to conduct connectionless paging over the RANAP protocol for the mobile

station in response to the page request when the mobile station is determined to be in the PMM-idle state.

10. The SGSN according to claim 8, wherein the electronic circuitry is further configured to send a connection-oriented RANAP paging message from the SGSN to a radio network controller when the mobile station is in the PMM-connected state and to send a connectionless RANAP paging message from the SGSN to a radio network controller when the mobile station is in the PMM-idle state.

11. The SGSN according to claim 10, wherein the connection-oriented RANAP paging message includes fewer information elements than the connectionless RANAP paging message.

12. A method in a packet-switched core network node for facilitating paging of a mobile radio station, after receiving a page request for the mobile station from a circuit-switched core network node the method c h a r a c t e r i z e d b y:

determining that the mobile station is in a connected state where an existing signaling connection is established for the mobile station between a radio network controller in a radio access network and the packet-switched core network node, and

in response to the received page request, sending a connection-oriented paging message over the existing signaling connection to the radio network controller.

13. The method according to claim 12, further comprising:

in response to the connection-oriented paging message, the radio network controller sending the paging message to the mobile station over an existing radio access network signaling connection established between the radio network controller and the mobile station.

14. The method according to claim 12, further comprising:

determining that the mobile station is in an idle state where there is no existing signaling connection established for the idle mobile station between a radio network controller in the radio access network and the packet-switched core network node;

in response to a page request received from the circuit-switched core network node for the idle mobile radio, sending a connectionless paging message to the radio access network.

15. The method according to claim 14, wherein the connection-oriented paging message requires less information than the connectionless paging message.

16. The method according to claim 14, wherein the connection-oriented type message is transmitted over a dedicated, circuit-switched connection and the connectionless message is transmitted over a packet-switched connection.

17. The method according to claim 14, wherein the radio network controller, upon receiving the connection-oriented or connectionless paging message, does not search to determine whether there is an existing signaling connection for the mobile station.

18. The method according to claim 14, wherein the packet-switched core network node is a serving GPRS support node (SGSN) and the circuit-switched core network node is a mobile switching center (MSC), the page request from the MSC is sent over a Gs interface to the SGSN, and the first and second types of paging messages are formatted in accordance with a radio access network application part (RANAP) protocol.

19. The method according to claim 12, wherein the radio network controller does not need to perform one or more paging coordination functions that would otherwise need to be performed if the connection-oriented paging message were connectionless.

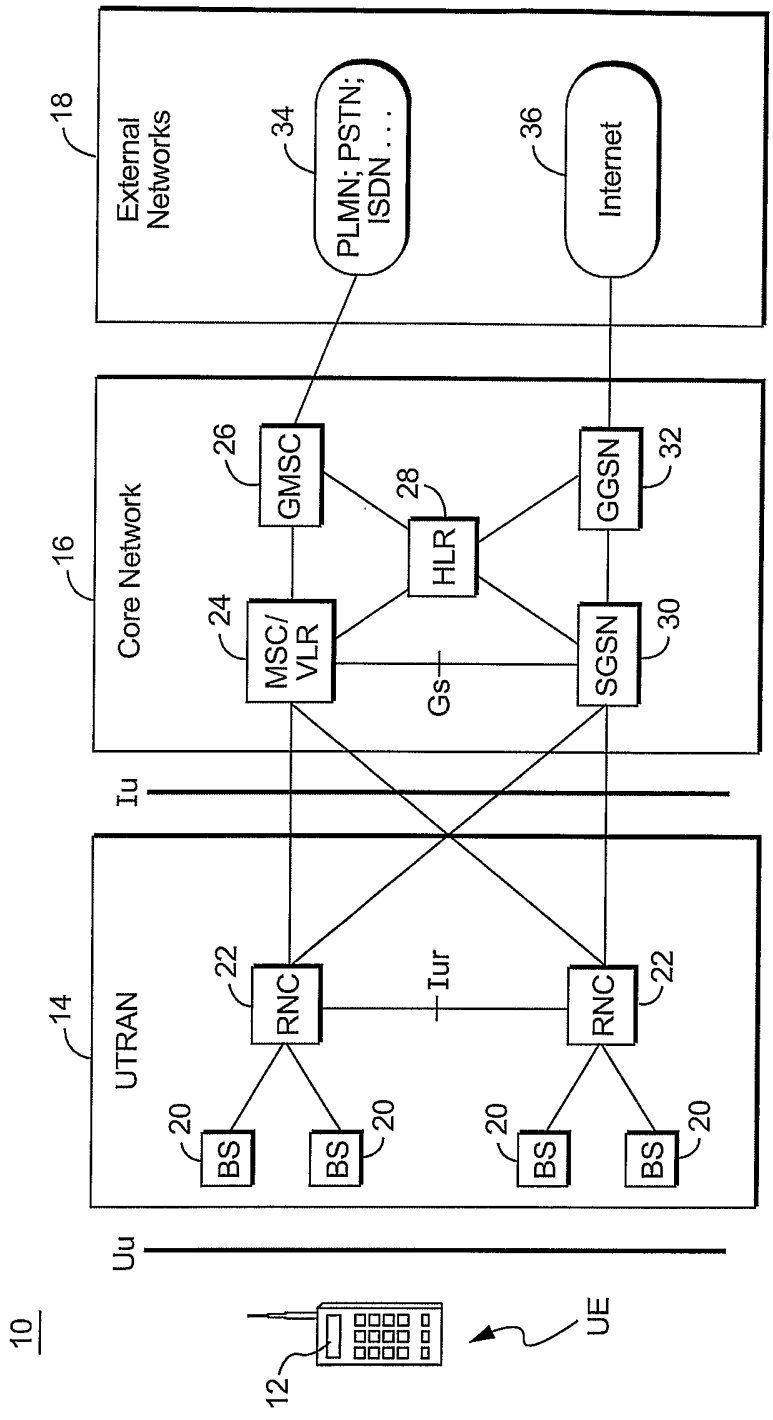
10
UE
12
Uu
UTRAN
14
BS
20
RNC
22
Iur
Iu
Core Network
16
MSC/
VLR
24
GMSC
26
HLR
28
SGSN
30
GGSN
32
Gs
External
Networks
18
PLMN; PSTN;
ISDN . . .
34
Internet
36

Fig. 1

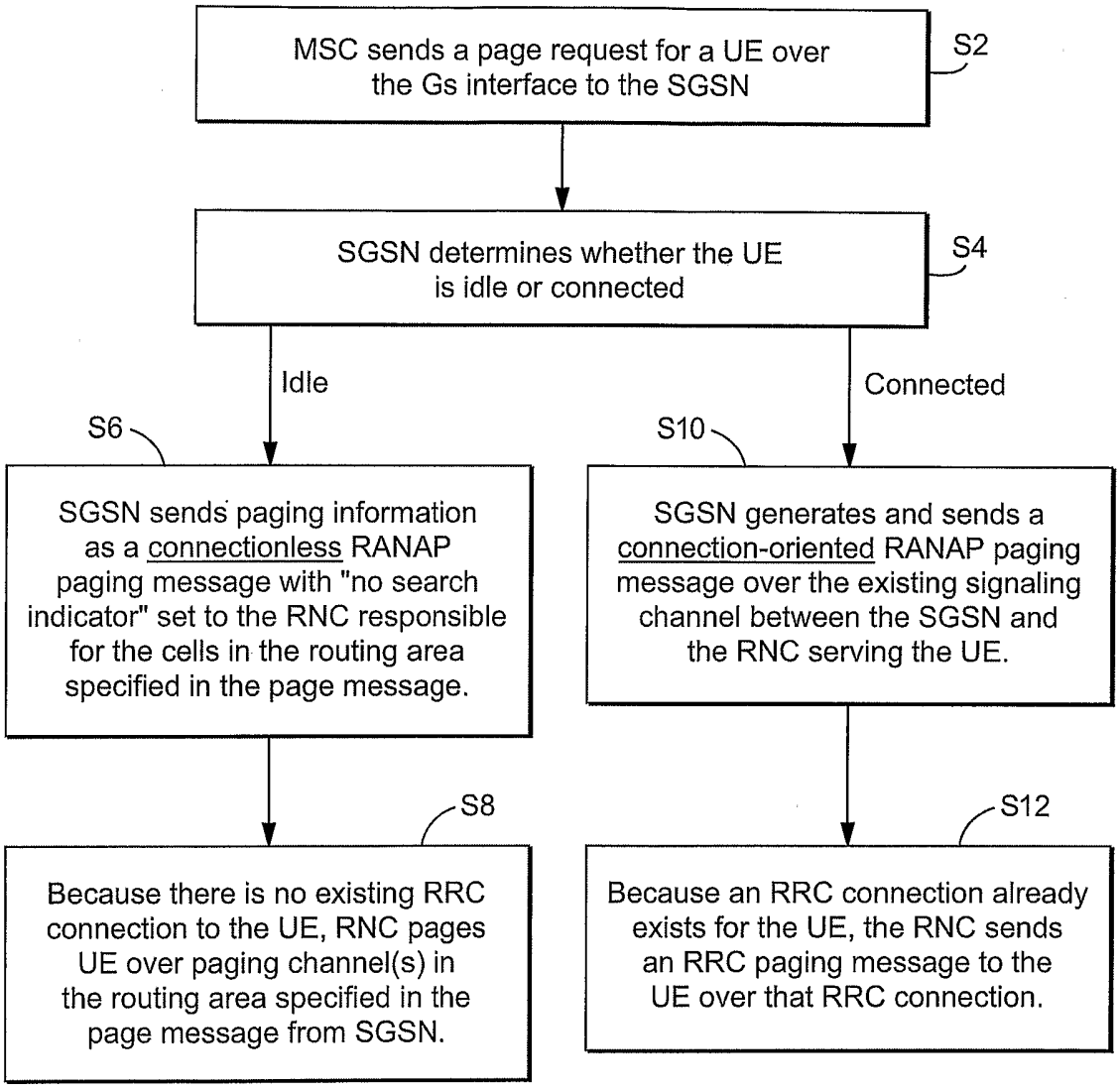
MSC sends a page request for a UE over the Gs interface to the SGSN
S2
SGSN determines whether the UE is idle or connected
S4
Idle
Connected
S6
S10
SGSN sends paging information as a connectionless RANAP paging message with "no search indicator" set to the RNC responsible for the cells in the routing area specified in the page message.
SGSN generates and sends a connection-oriented RANAP paging message over the existing signaling channel between the SGSN and the RNC serving the UE.
S8
S12
Because there is no existing RRC connection to the UE, RNC pages UE over paging channel(s) in the routing area specified in the page message from SGSN.
Because an RRC connection already exists for the UE, the RNC sends an RRC paging message to the UE over that RRC connection.

Fig. 2

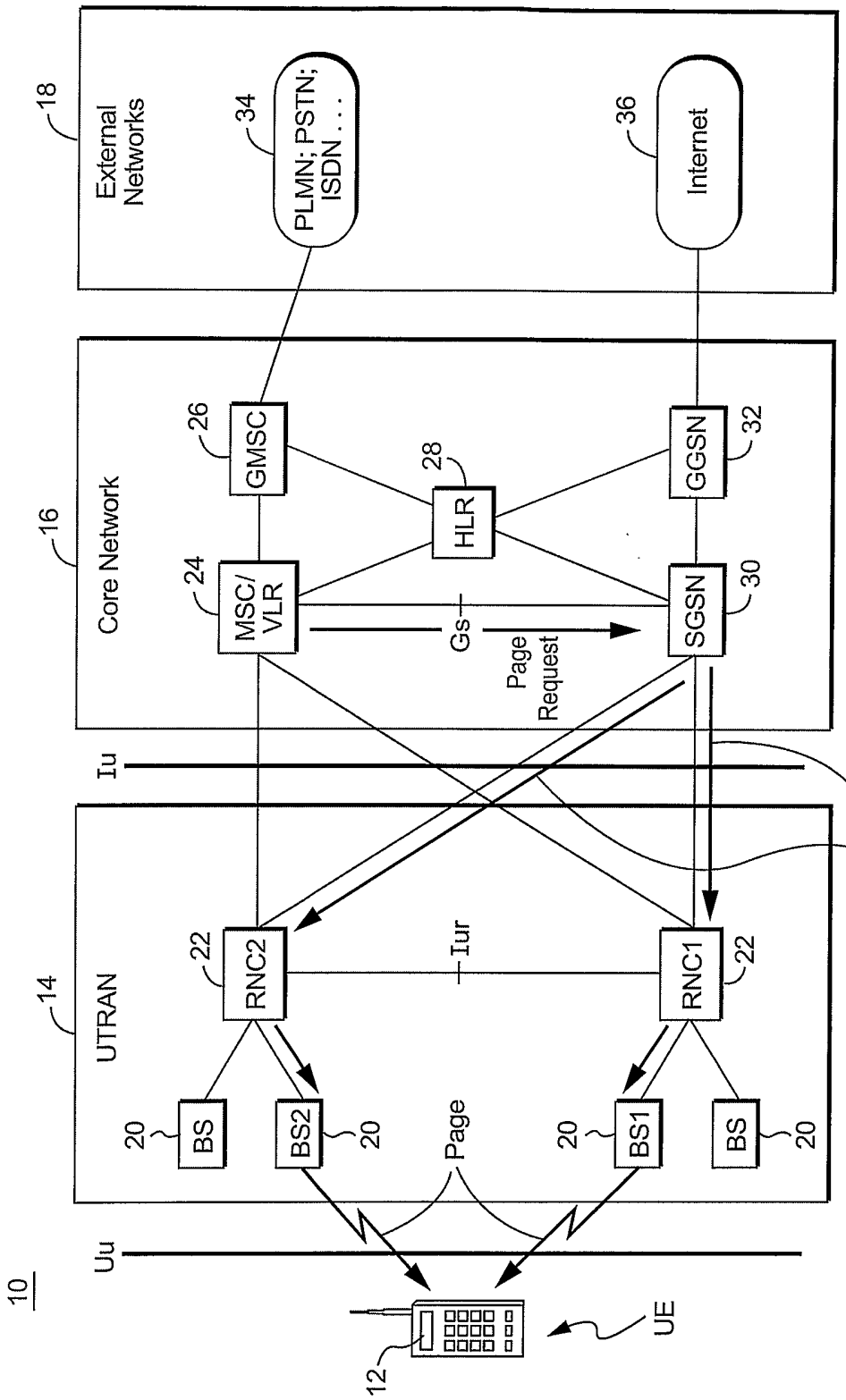
10
18
External Networks
34
PLMN; PSTN; ISDN . . .
36
Internet
16
Core Network
26
GMSC
28
HLR
32
GGSN
24
MSC/ VLR
Gs
Page Request
SGSN
30
Iu
14
UTRAN
22
RNC2
Iur
RNC1
22
Connectionless Page Message
20
BS
BS2
20
Page
20
BS1
BS
20
Uu
12
UE

Fig. 3

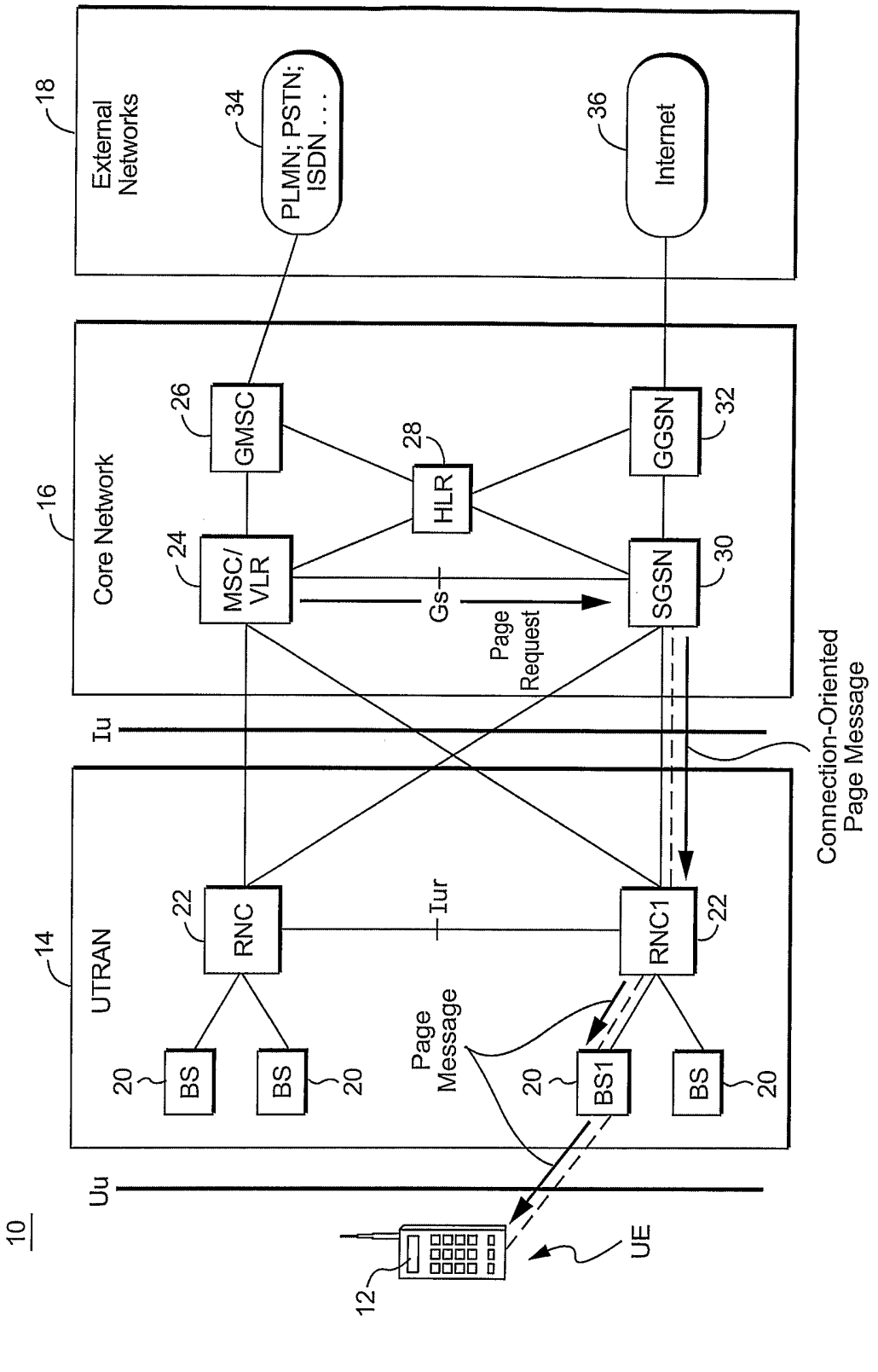
10
18
External Networks
34
PLMN; PSTN; ISDN . . .
36
Internet
16
Core Network
26
GMSC
28
HLR
32
GGSN
24
MSC/ VLR
Gs
Page Request
SGSN
30
Iu
Connection-Oriented Page Message
14
UTRAN
22
RNC
Iur
RNC1
22
Page Message
20
BS
20
BS
20
BS1
20
BS
20
Uu
12
UE
Existing Signaling Connection

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 2004/001913

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/20
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 20020150084 A1 (SANG-HEON LEE ET AL), 17 October 2002 (17.10.2002), see whole document ---	1-19
A	EP 1318686 A1 (NOKIA CORPORATION), 11 June 2003 (11.06.2003), see whole document ---	1-19

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 March 2005	17 -03- 2005
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Rune Bengtsson/MN Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

30/01/2005

International application No.
PCT/SE 2004/001913

US	20020150084	A1	17/10/2002	KR	2002015983	A	02/03/2002
EP	1318686	A1	11/06/2003	GB	0129386	D	00/00/0000
				US	20030123428	A	03/07/2003