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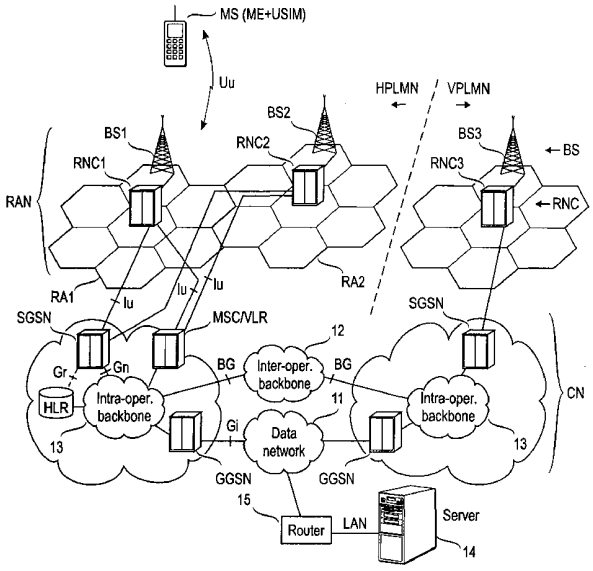
(54) **Title:** A METHOD FOR ESTABLISHING A CONNECTION BETWEEN A TERMINAL OF A FIRST TYPE AND A CORE NETWORK OF A SECOND TYPE IN A TELECOMMUNICATIONS NETWORK



(57) **Abstract:** A method for establishing a connection between a circuit-switched mobile station (MS) and a packet-switched switching element (MSC). A radio network controller (RNC) receives a first initiation signal (an attach request) from the mobile station (MS) via a circuit-switched connection. The RNC opens a signalling connection for the mobile station. While the signalling connection is active, the RNC receives a second initiation signal (call setup) and opens a real-time connection for the mobile station. Thus the packet-switched switching element (MSC) is able to switch a real-time connection to/from the circuit-switched mobile station (MS).

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A method for establishing a connection between a terminal of a first type and a core network of a second type in a telecommunications network.

Background of the invention

The invention relates to methods and equipment for supporting a dissimilar terminal in a network, such as a circuit-switched terminal in a packet network or vice versa.

Figure 1 is a block diagram of a telecommunications system showing the components which are essential for understanding the invention. A UMTS Mobile Station MS consists of Mobile Equipment ME and a USIM card (User and Services and Identity Module). There is a radio interface Uu between the MS and a Radio Access Network RAN which comprises Base Stations BS under control of Radio Network Controllers RNC. For circuit-switched services, the RNCs are connected to Mobile services Switching Centres MSC, and for packet-switched services, there is a connection to Serving GPRS Support Nodes SGSN (GPRS = General Packet Radio Service). The MSC and SGSN elements may include separate UMTS addition sections. Subscriber data related to the MS is stored permanently in a Home Location Register HLR and for circuit-switched operation, the data is transferred to the Visitor Location Register VLR of the MSC which currently serves the MS. For storing equipment-related data, the network comprises an Equipment Identity Register EIR. For entering and updating subscriber-specific data, there is an Operation and Maintenance O&M section having a Man-Machine Interface MMI. For creating and managing supplementary services, there is typically a dedicated Service Control Node SCN which can be seen as an evolved version of a Service Control Point (SCP) of Intelligent Networks.

Only the packet-switched section will be described in more detail, and it is assumed that this section will resemble a GPRS system. The GPRS infrastructure comprises support nodes such as a GPRS gateway support node (GGSN) and a GPRS serving support node (SGSN). The main functions of the GGSN nodes involve interaction with the external data network. The GGSN updates the location directory using routing information supplied by the SGSNs about an MS's path and routes the external data network protocol packet encapsulated over the GPRS backbone to the SGSN currently serving the MS. It also decapsulates and forwards external data network packets to the appropriate data network and handles the billing of data traffic.

The main functions of the SGSN are to detect new GPRS mobile stations in its service area, handle the process of registering the new MSs

along with the GPRS registers, send/receive data packets to/from the GPRS mobile station, and keep a record of the location of the mobile stations inside its service area. The subscription information is stored in a GPRS register (HLR) where the mapping between a mobile's identity (such as MS-ISDN or IMSI) and the PSPDN address is stored. The GPRS register acts as a database from which the SGSNs can ask whether a new MS in its area is allowed to join the GPRS network.

The GPRS gateway support nodes GGSN connect an operator's GPRS network to external systems, such as other operators' GPRS systems, data networks 11, such as an IP (Internet protocol) network (such as the Internet) or an X.25 network, and service centres. Fixed hosts 14 can be connected to a data network 11 e.g. by means of a local area network LAN and a router 15. A border gateway BG provides access to an inter-operator GPRS backbone network 12. The GGSN may also be connected directly to a private corporate network or a host. The GGSN includes GPRS subscribers' PDP (Packet Data Protocol) addresses and routing information, i.e. SGSN addresses. Routing information is used for tunnelling protocol data units PDU from the data network 11 to the current switching point of the MS, i.e. to the serving SGSN. The functionalities of the SGSN and GGSN can be connected to the same physical node.

The home location register HLR of the GSM network contains GPRS subscriber data and routing information and it maps the subscriber's IMSI into an SGSN address and one or more pairs of the PDP type and PDP address. The HLR also maps each PDP type and PDP address pair into a GGSN node. The SGSN has a Gr interface to the HLR (a direct signalling connection or via an internal backbone network 13). The HLR of a roaming MS and its serving SGSN may be located in different mobile communication networks.

The intra-operator backbone network 13, which interconnects an operator's SGSN and GGSN equipment can be implemented, for example, by means of a local network, such as an IP network. An operator's GPRS network can also be implemented without the intra-operator backbone network, for example by providing all features in one computer.

A problem with the network architecture as shown in Figure 1 is that a subscriber must have a UMTS handset in order to access UMTS services. A subscriber with a handset capable of only circuit-switched operation cannot

use the services provided by a UMTS network. As a result, the RNC-to-MSC interface(s) must support both circuit-switched and packet-switched operation.

Disclosure of the invention

An object of the invention is to provide a mechanism for solving the problems mentioned above. This object is achieved with a method and equipment which are characterized by what is disclosed in the attached independent claims. Preferred embodiments of the invention are disclosed in the attached dependent claims.

The invention is based on the idea that a radio network controller (RNC) operates towards a mobile station as a circuit-switched RNC does. In other words, the RNC (or another radio network node, such as a base station) emulates a packet-switched mobile station to the uplink network, and it emulates a circuit-switched network/telephone exchange to the mobile station.

The emulator function can be implemented by means of the following steps:

1. The radio network controller (RNC) receives a first initiation signal from the mobile station via a circuit-switched connection. In response to the first initiation signal, the RNC opens a first PDP context (such as a signalling PDP context) for the mobile station.

2. The RNC receives a second initiation signal and uses the first PDP context to open a second PDP context (such as a real-time PDP context).

As a result, the packet-switched switching element, such as an MSC, is able to support real-time connections to/from the circuit-switched mobile station. As used here, a 'circuit-switched mobile station' means a mobile station that uses only circuit-switched protocols. Similarly, a 'packet-switched switching element' means a switching element (such as an MSC or MSC server) that uses packet-switched protocols.

In response to the first initiation signal, the RNC requests the GGSN to open a first PDP context for the mobile station. The first initiation signal is preferably an attach request from the mobile station, and the first PDP context for the mobile station is preferably a signalling PDP context. This means that the signalling PDP context is maintained as long as the mobile station is attached to the network. A signalling PDP context is a context which is used to carry application signalling between the mobile station and network elements

outside the packet-switched network, ie beyond the Gi interface, transparently to the network.

The second initiation signal is preferably a request to establish a call (a voice, data, fax or video call) to/from the mobile station, and the second PDP context is a real-time context. A real-time context is a context which is used to carry real-time data, such as calls. This means that the real-time context is maintained only for the duration of an active call.

As an alternative, the first and the second initiation signals can be the same, ie the request for call setup. In other words, both PDP contexts are created only for the duration of an active call. Because the GGSN only has to maintain a context for mobile stations having an active call, this embodiment saves some memory in the GGSN. Call establishment is slower, however, because two contexts have to be created.

Thus, as soon as the RNC receives a call request, it automatically opens a real-time PDP context for the mobile station. The PDP context is opened to a GGSN node with a connection to a Call State Control Function (CSCF) or an MSC server. An MSC server is an MSC acting on top of an IP protocol stack (an MSC plus an interworking function, IWF), or in other words, an MSC which understands the IP protocol. Then a tunnel is established between the mobile station and the CSCF or the MSC server, based on an OSP PDP context or a special PDP context. The OSP (Octet Stream Protocol) PDP context is based on ETSI recommendations. The term "special PDP context", as used here, refers to a PDP context which is specially optimized for circuit-switched services). The circuit-switched data to/from the mobile station is carried via this tunnel. The special PDP context is used to carry GSM 04.08 or UMTS 24.008 mobile radio interface layer 3 signalling (call control and mobility management) from the RNC to the GGSN which forms an access point. The access point is such that from it a tunnel can be opened towards the IWF associated with the MSC. The mobile radio interface layer 3 signalling comprises, for example, call-related signalling (such as call setup, control and release) and mobility management-related signalling (such as location updating, attach and detach operations). The signalling messages are encapsulated into data packets.

After the signalling PDP context has been established and the call setup signalling has been carried to the IWF and MSC, a user data bearer can be allocated between the RNC and the MSC/IWF.

The signalling PDP context and the tunnel can be created in response to an MS-initiated attach procedure or a call setup from the mobile station. Establishing the tunnel in connection with an attach procedure is the preferred course of action because the tunnel can be used for mobile-terminated calls as well. Call establishment is faster and easier if the signalling PDP context has been opened beforehand. Some memory is wasted by maintaining the PDP context continuously (versus maintaining the PDP context only during a call) but the memory waste can be kept to a minimum by making use of the PDP context which is specially optimized for circuit-switched services, as stated above.

The invention can also be used in the reverse direction, that is, for establishing a connection between a packet-switched mobile station (or other terminal) and a circuit-switched exchange (or other switching element).

Brief description of the drawings

The invention will be described in more detail by means of preferred embodiments with reference to the appended drawing wherein:

Figure 1 is a block diagram illustrating one embodiment of the invention;

Figure 2 illustrates tunnelling and protocol stacks according to a preferred embodiment of the invention;

Figure 3 is a signalling diagram illustrating a procedure for opening a signalling PDP context in response to a mobile station's attach procedure;

Figure 4 is a signalling diagram illustrating a procedure for opening a real-time PDP context in response to a mobile-originated call request; and

Figure 5 is a signalling diagram illustrating a procedure for opening a real-time PDP context in response to a mobile-terminated call request.

Detailed description of the invention

Figure 2 illustrates tunnelling and protocol stacks according to a preferred embodiment of the invention. The top half of Figure 2 shows some of the elements of the telecommunication system shown in Figure 1, and the bottom half shows the protocol stacks used in the corresponding elements in the top half of the Figure. The embodiment of the invention shown in Figure 2 makes use of a tunnel 21 between the RNC and the MSC (or any other element which routes circuit-switched connections in the network). The tunnel 21 is built using GTP (GPRS Tunnelling Protocol) between the RNC and the

GGSN and UDP (User Datagram Protocol) between the GGSN and the MSC. The tunnel 21 conveys IP (Internet protocol) packets between the RNC and the MSC.

Figure 3 is a signalling diagram illustrating a procedure for opening a signalling PDP context in response to a mobile station's attach procedure in a system as shown in figures 1 and 2. In step 3-2, a mobile station MS initiates an attach procedure by sending the radio network controller RNC an ATTACH REQUEST message. In step 3-4, the RNC detects the attach message and forms a pre-configured PDP (packet data protocol) context. The pre-configured PDP context comprises a field called APN (access point name). This field can be set to '0408', for example. (The value is a mere example, but a value of '0408' suitably indicates that the mobile station uses a GSM protocol defined in ETSI recommendation GSM 04.08 to access the network.) At this stage, the RNC is able to relay the ATTACH REQUEST message to the MSC. Let us assume that the RNC forms an OSP-type (Octet Stream Protocol) PDP context with an APN value of '0408'. In step 3-6, the RNC sends the SGSN a PDP CONTEXT ACTIVATION request with an APN value of '0408' and a PDP type of 'OSP'. In step 3-8, the SGSN relays these parameters to the GGSN in a CREATE PDP CONTEXT REQUEST message. In step 3-10, the GGSN recognizes the APN value of '0408', set by the RNC. Based on this APN value, the GGSN knows that future messages originating from this PDP context are to be tunnelled to the Mobile services Switching Centre MSC whose address has been configured in advance. In step 3-12, the GGSN requests the MSC to open a tunnel, and in step 3-14, the MSC acknowledges. In steps 3-16 and 3-18, the GGSN and the SGSN respond to the messages sent in steps 3-8 and 3-6, respectively. Now the RNC knows that a PDP context has been established and a tunnel has been created to the MSC. In step 3-22, the RNC relays the mobile station's ATTACH request to the MSC via the tunnel, and in step 3-24, the MSC responds by sending an ATTACH RESPONSE to the mobile station MS.

Figure 4 is a signalling diagram illustrating a procedure for opening a real-time PDP context in response to a mobile-originated call request. In step 4-2, the mobile station MS initiates call establishment by sending a SETUP message which the RNC relays to the MSC in step 4-4. In step 4-6, the MSC responds to the SETUP message by sending a CONNECT message which the RNC relays to the mobile station MS in step 4-8. In step 4-10, the RNC detects

the CONNECT message from the MSC and, on the basis of it, opens a PDP context for the connection such that the QoS (quality of service) parameters of the PDP context are suitable for conveying speech. (We assume that the call setup relates to a voice call.) The PDP CONTEXT ACTIVATION request is sent to the SGSN in step 4-12, and in step 4-14, the SGSN relays the request to the GGSN. The activation request message's parameters comprise a QoS TFT, or Quality of Service Traffic Flow Template. (A traffic flow template indicates which traffic flow relates to which PDP context. In this case, incoming packets to the mobile station in question should be associated with the PDP context being created now. The QoS preferably indicates a data rate of 64 kilobits per second which corresponds to the data rate of one circuit-switched speech channel.)

In step 4-16, the GGSN opens the requested PDP context and forms a logical connection to the MSC/CSCF. The result of this step is essentially that between the GGSN and the MSC/CSCF, there is now a logical connection able to support the required quality of service. At the MSC/CSCF (or a media gateway connected to it, not shown separately) this logical connection is adapted to PCM/TSL (Pulse-Coded Modulation/Transport Stream Layer) for circuit-switched operations. Alternatively, the MSC/CSCF adapts call control signalling messages to a protocol understood by terminals and call control nodes for packet-switched operations. Examples of such protocols are H.323 and SIP (Session Initiation Protocol). Then, the MSC/CSCF forms a suitable media stream, such as PCM-coded 64 kilobits per second.

In steps 4-18 and 4-20, a response to the PDP Context Activation request is returned to the RNC. In step 4-22, the established PDP context can be used to convey speech packets to the MSC (or to a transcoder (not shown separately) connected to or co-located with the MSC), which is shown as a speech path 4-22 over the MS-to-MSC tunnel.

Figure 5 is a signalling diagram illustrating a procedure for opening a real-time PDP context in response to a mobile-terminated call request. Figure 5 is almost similar to Figure 4. Only the steps and messages relating to call establishment, namely messages 5-2 through 5-8, are reversed. The remaining steps and messages correspond to similarly numbered steps and messages in Figure 4.

The invention has been described by way of example in connection with a UMTS system. On the basis of the above description, it is easy for one

skilled in the art to apply the invention also to other mobile and wired systems. For instance, the invention can be used for establishing a connection between a packet-switched terminal and a circuit-switched switching element. Alternatively, the terminal and switching element may use different circuit-switched or packet-switched protocols. Yet further, the invention is not limited to a radio network but can be used in wired networks comprising an access network and a core network. Accordingly, the invention and its embodiments are not restricted to the above examples, but they can be modified within the scope of the claims.

Claims

1. A method for establishing a connection between a terminal (MS) of a first type and a core network node (MSC) of a second type in a telecommunications network (HPLMN, VPLMN) comprising an access network and a core network, the telecommunications network supporting a data protocol of the second type;

wherein at least one of the types comprises support of a packet-switched protocol and the remaining type comprises support of a different packet-switched protocol or a circuit-switched protocol;

c h a r a c t e r i z e d by the steps of:

receiving, at the access network node (RNC), a first initiation signal from the terminal (MS), and in response to the first initiation signal, opening a first connection for the terminal (MS); and

while the first connection is active, receiving, at the access network node (RNC), a second initiation signal, and in response to the second initiation signal, opening a second connection for the terminal;

whereby the core network node (MSC) of the second type is able to switch a real-time connection to/from the terminal (MS) of the first type.

2. A method for establishing a connection between a terminal (MS) of a first type and a core network node (MSC) of a second type in a telecommunications network (HPLMN, VPLMN) comprising an access network and a core network, the telecommunications network supporting a data protocol of the second type;

wherein at least one of the types comprises support of a packet-switched protocol and the remaining type comprises support of a different packet-switched protocol or a circuit-switched protocol;

c h a r a c t e r i z e d by the steps of:

receiving, at the access network node (RNC), a first initiation signal from the terminal (MS), and in response to the first initiation signal, opening a first connection for the terminal (MS);

using the first connection to open a second connection for the terminal;

whereby the core network node (MSC) of the second type is able to switch a real-time connection to/from the terminal (MS) of the first type.

3. A method according to claim 1 or 2, characterized in that the access network is a radio network.

4. A method according to claim 3, characterized in that the core network node is a mobile services switching centre.

5. A method according to any one the preceding claims, characterized in that the first initiation signal is an attach request from the terminal.

6. A method according to any one the preceding claims, characterized in that the second initiation signal is a request to establish a call to/from the terminal.

7. A method according to any one the preceding claims, characterized in that each of the first and second connections are or comprise a packet data context.

8. A method according to claim 7, characterized in that the first connection is a signalling context and the second connection is a real-time context.

9. A method according to any one the preceding claims, characterized in that the first type is circuit-switched and the second type is packet-switched.

10. A method according to any one the preceding claims, characterized in that the first type is packet-switched and the second type is circuit-switched.

11. A method according to any one the preceding claims, characterized in that the first type and second type are different packet-switched protocols.

12. An access network node (RNC) for supporting a connection between a terminal (MS) of a first type and a core network node (MSC) of a second type in a telecommunications network (HPLMN, VPLMN) comprising an access network and a core network, the telecommunications network supporting a data protocol of the second type;

wherein at least one of the types comprises support of a packet-switched protocol and the remaining type comprises support of a different packet-switched protocol or a circuit-switched protocol;

characterized by an emulator logic for emulating a network of the first type toward the terminal (MS) and for emulating a terminal of the second type toward the core network node (MSC).

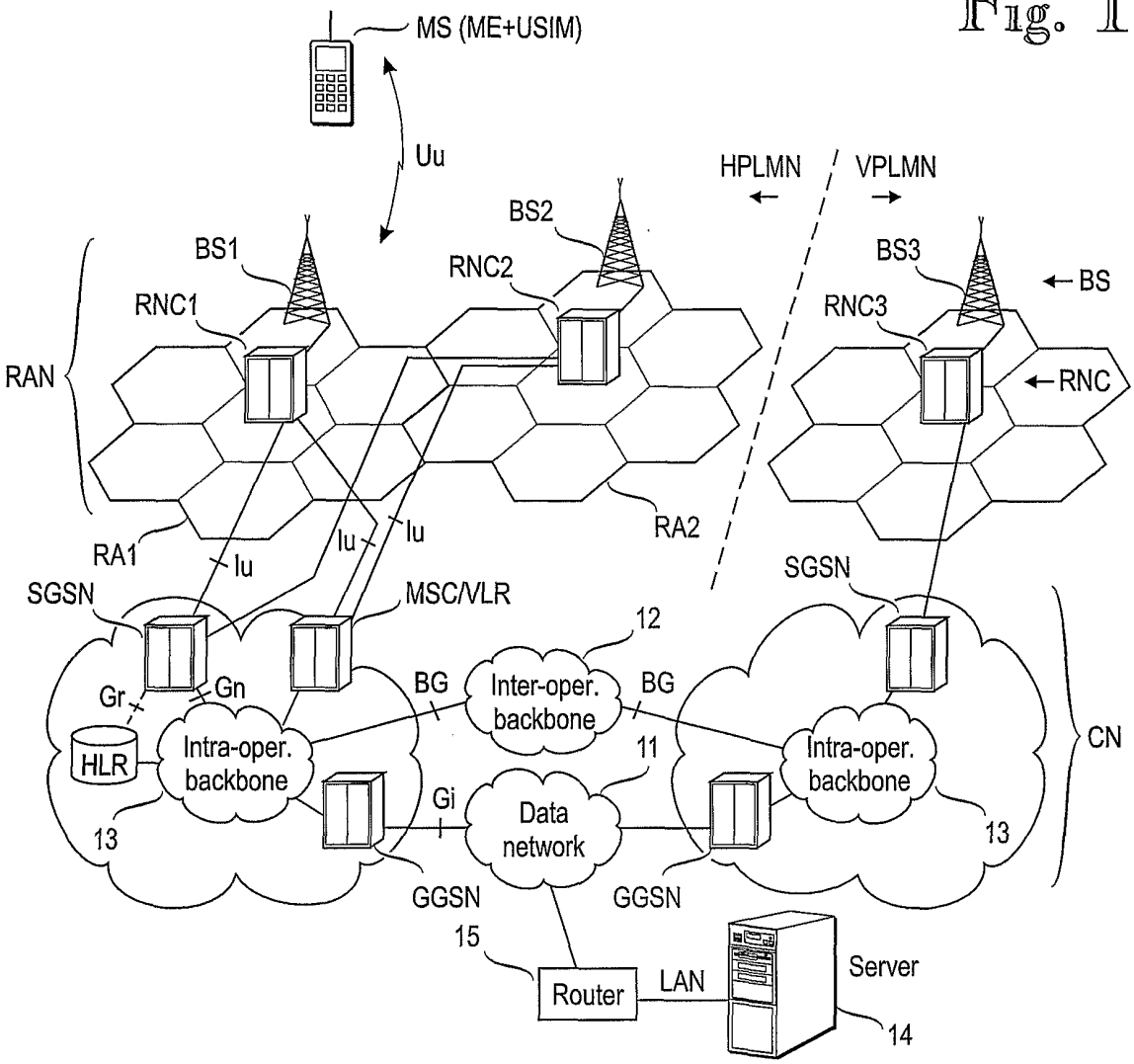
13. An access network node (RNC) according to claim 13, characterized in that the emulator logic comprises a connection establishment logic for:

establishing a signalling connection for a terminal (MS) in response to a first initiation signal from the terminal via a connection of the first type; and for:

using the first connection to open a real-time connection for the terminal.

14. An access network node (RNC) according to claim 12 or 13, characterized in that it is a radio network controller.

Fig. 1


MS (ME+USIM)
Uu
HPLMN
VPLMN
BS1
BS2
BS3
BS
RNC1
RNC2
RNC3
RNC
RAN
RA1
RA2
Iu
Iu
Iu
SGSN
MSC/VLR
SGSN
12
Gr
Gn
BG
Inter-oper. backbone
BG
HLR
Intra-oper. backbone
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CN
13
Gi
Data network
13
GGSN
GGSN
15
Router
LAN
Server
14

Fig. 2

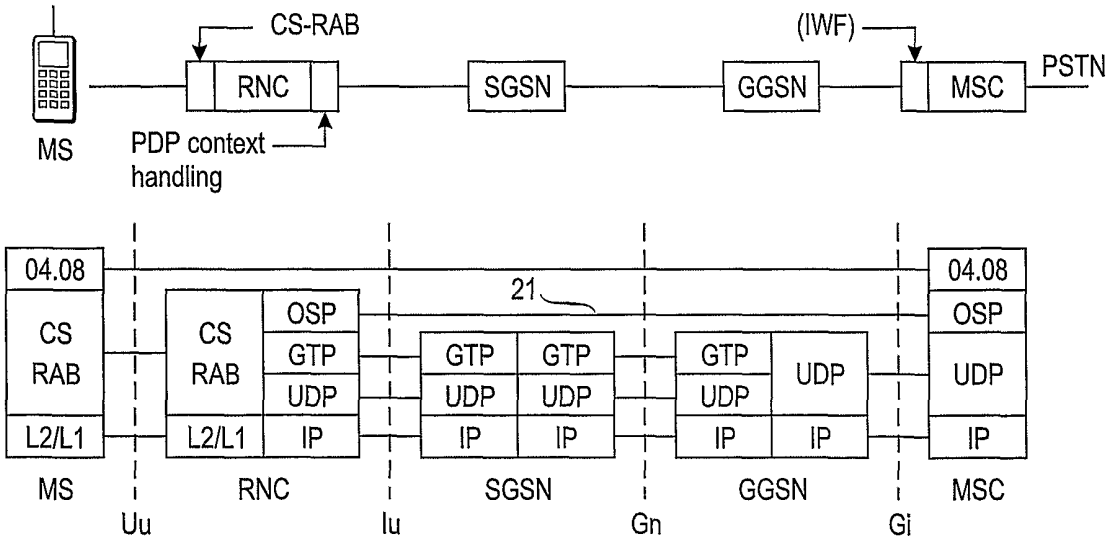

CS-RAB
(IWF)
RNC
SGSN
GGSN
MSC
PSTN
MS
PDP context handling
04.08
CS RAB
L2/L1
CS RAB
OSP
GTP
UDP
L2/L1
IP
21
GTP
GTP
UDP
UDP
IP
IP
GTP
UDP
UDP
IP
IP
UDP
04.08
OSP
UDP
IP
MS
RNC
SGSN
GGSN
MSC
Uu
Iu
Gn
Gi

Fig. 3

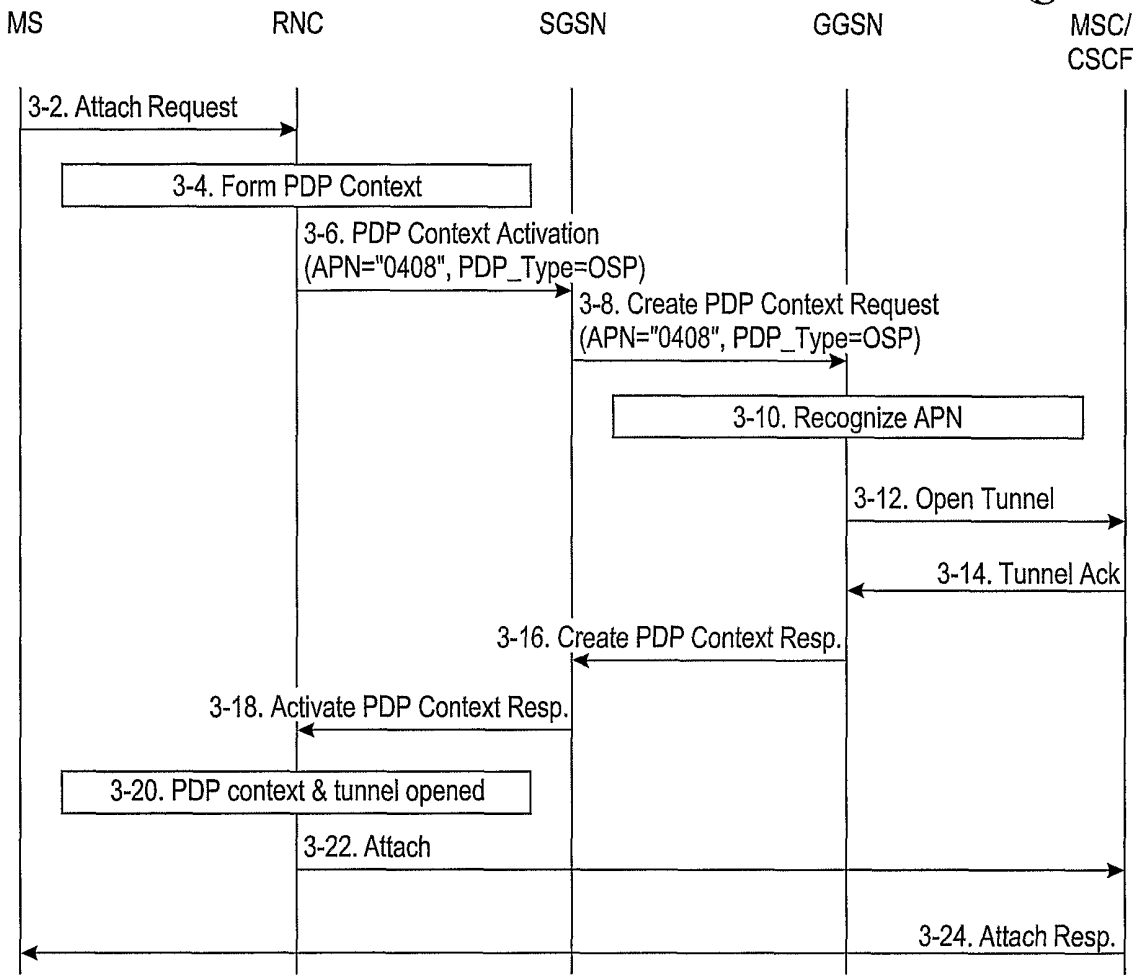

MS
RNC
SGSN
GGSN
MSC/
CSCF
3-2. Attach Request
3-4. Form PDP Context
3-6. PDP Context Activation
(APN="0408", PDP_Type=OSP)
3-8. Create PDP Context Request
(APN="0408", PDP_Type=OSP)
3-10. Recognize APN
3-12. Open Tunnel
3-14. Tunnel Ack
3-16. Create PDP Context Resp.
3-18. Activate PDP Context Resp.
3-20. PDP context & tunnel opened
3-22. Attach
3-24. Attach Resp.

Fig. 4

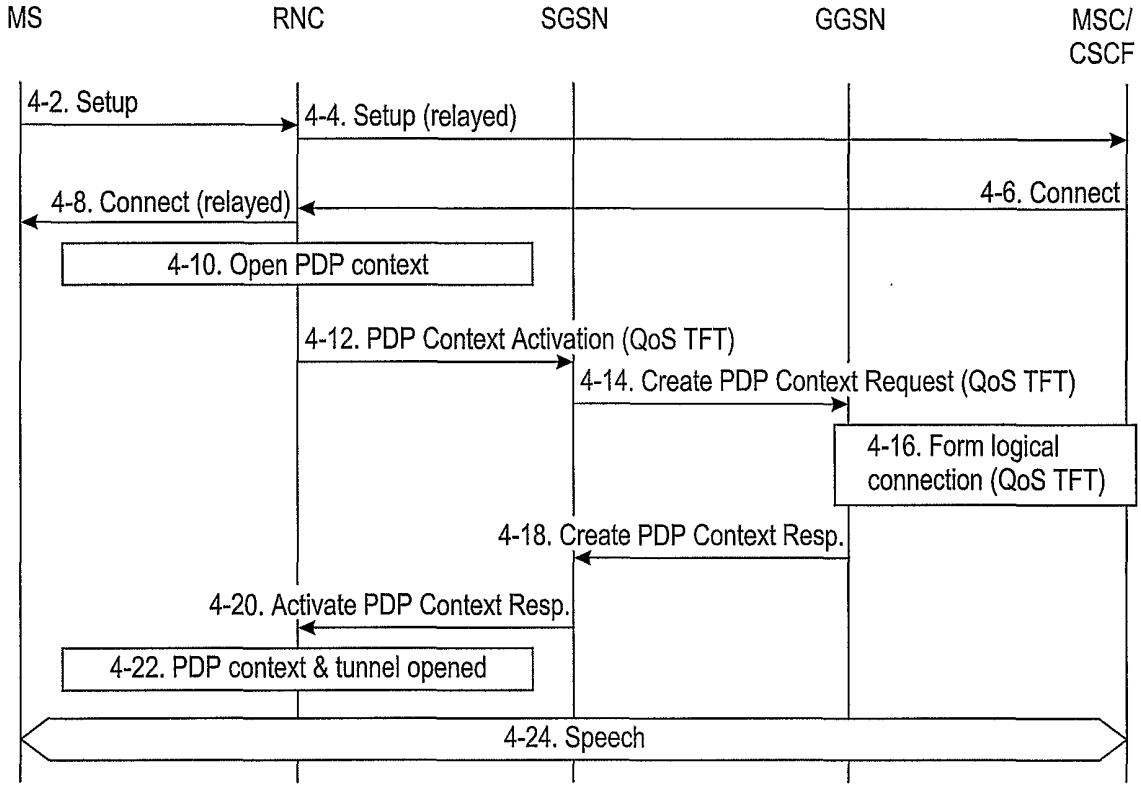
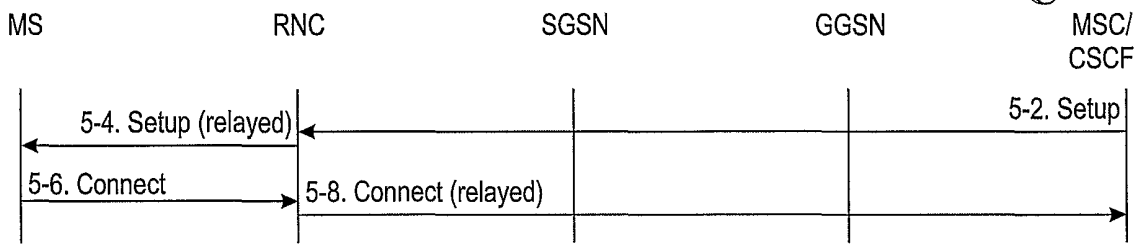


Fig. 5



Continue at step 4-10 in Figure 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 01/00620

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/38, H04Q 7/36
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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 0001186 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 6 January 2000 (06.01.00), page 1, line 23 - page 2, line 13; page 4, line 28 - page 5, line 7, abstract ---	1-14
X	US 5729534 A (HARI JOKINEN ET AL), 17 March 1998 (17.03.98), column 1, line 55 - column 2, line 32, claims 1,2,12,13, abstract ---	1-14
A	US 5528664 A (ARUNAS G. SLEKYS ET AL), 18 June 1996 (18.06.96), column 2, line 14 - line 57, abstract ---	1-14

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"&" 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 October 2001	09 -10- 2001
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 Mattias Arvidsson/MP Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 01/00620

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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P,X	WO 0041425 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 13 July 2000 (13.07.00), page 1, column 11 - page 1, line 27; page 6, column 25 - page 7, column 29, abstract -- --------	1-14

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Information on patent family members

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