



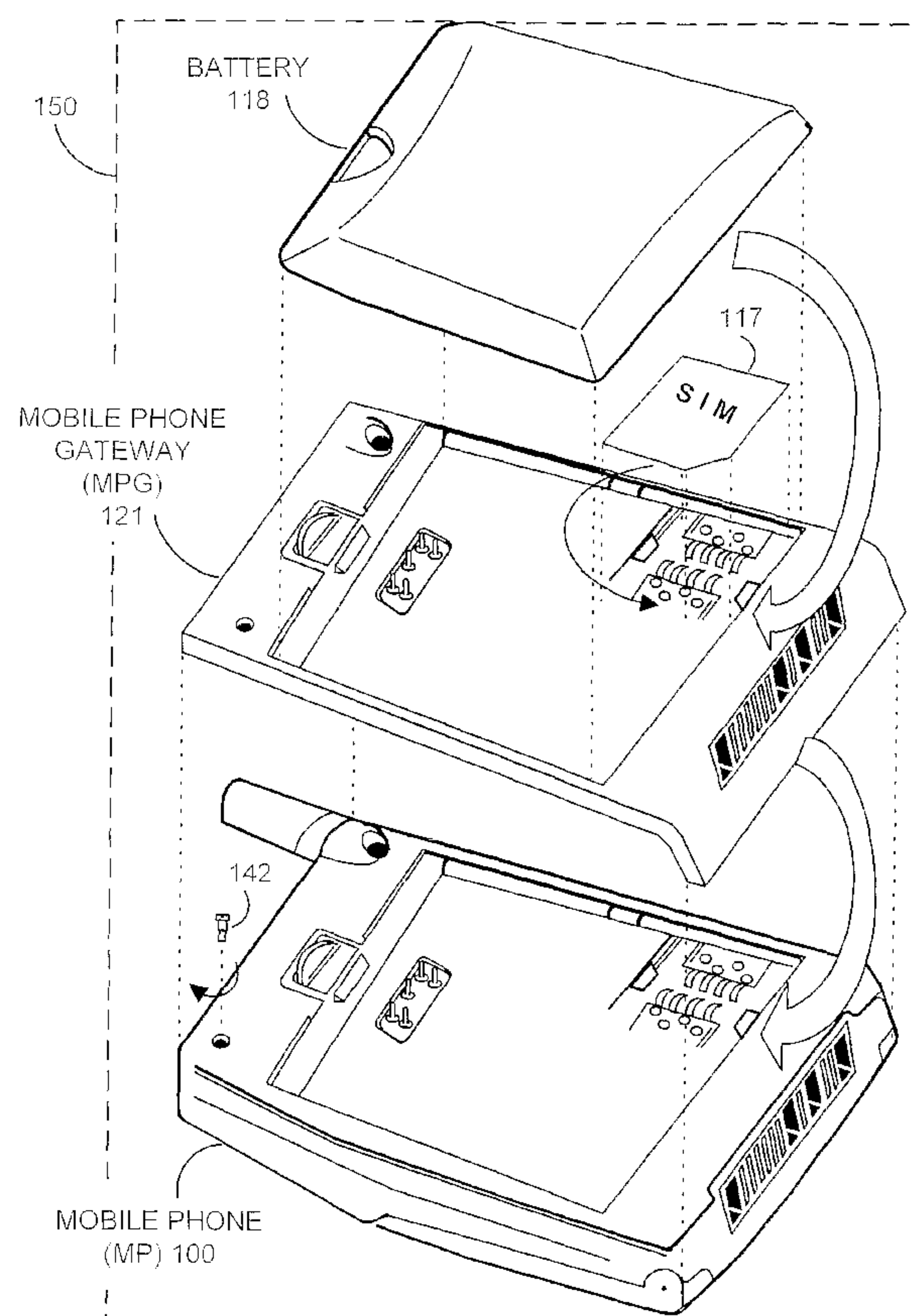
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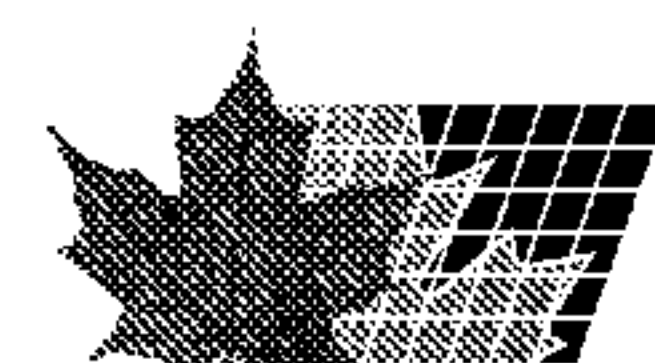
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(54) Titre : DISPOSITIF DE PASSERELLE DE TELEPHONE MOBILE, SYSTEME DE COMMUNICATION ET SYSTEME DE COMMANDE DE PASSERELLE
(54) Title: MOBILE TELEPHONE GATEWAY APPARATUS, COMMUNICATION SYSTEM, AND GATEWAY OPERATING SYSTEM



(57) Abrégé/Abstract:

A mobile telephone gateway and call routing device (MPG) (121) disclosed by the present invention is physically coupled with mobile phone (100) which is operative in accordance with first protocol, for adding communication capabilities through at least



(57) Abrégé(suite)/Abstract(continued):

second communication network, possibly using a second protocol. A mobile communication system (150) is disclosed, comprising MPG (121) placed in-between mobile phone (100) and its battery (118) and Subscriber Identification Module (SIM) card (117). MPG (121) connects to the SIM interface of mobile phone (100), using which it controls call management. It connects to the data/signaling interface of mobile phone (100), using which it communicates with it, while communicating with the second network using another communication means. It connects to the Terminal Adapter/Terminal Equipment (TA/TE) interface of mobile phone (100), thereby enabling communication with wireless data terminals. In the preferred embodiment, the present invention adds Bluetooth (T.M.) cordless telephony and private wireless networking capabilities to a standard mobile phone.

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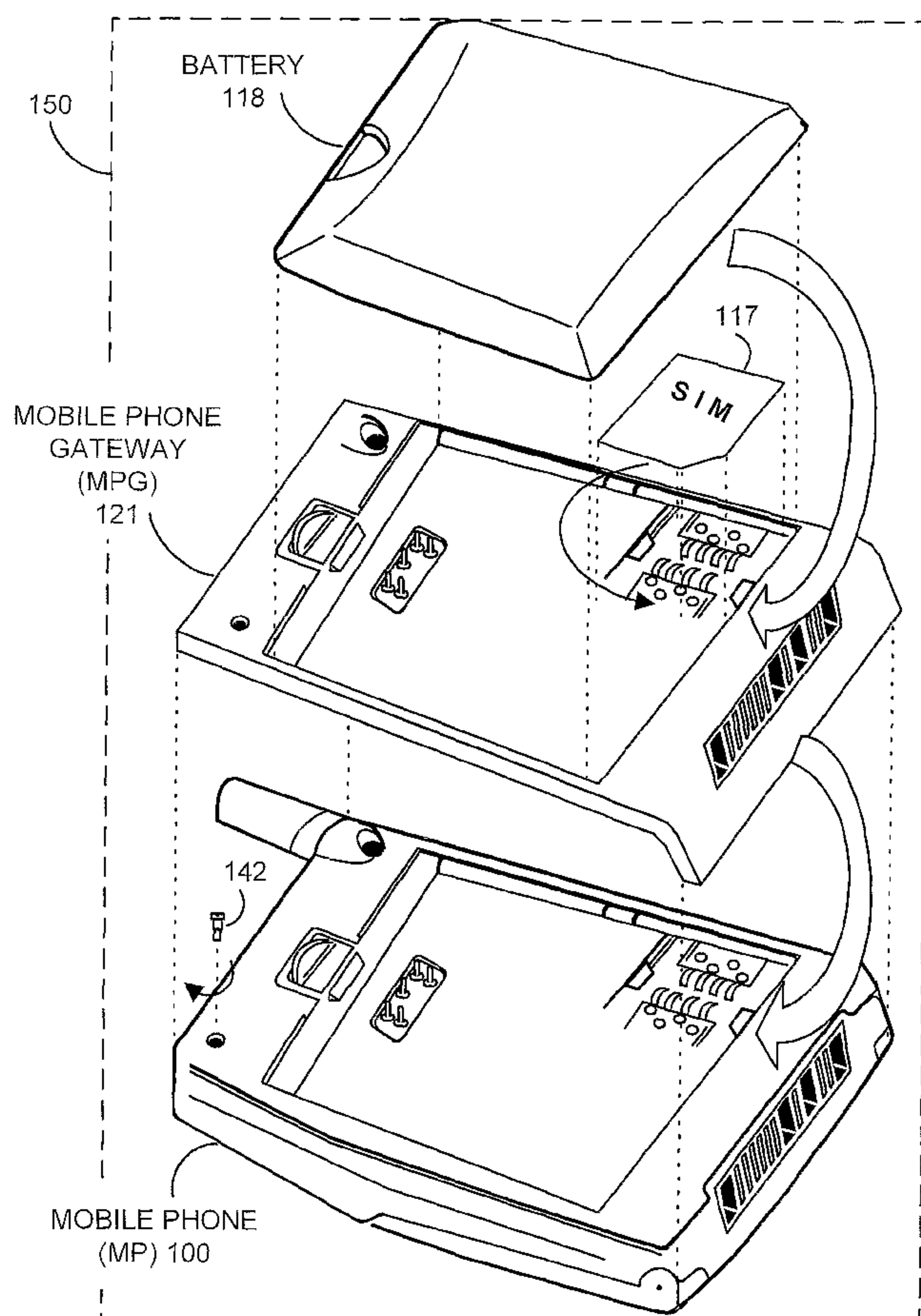
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(54) Title: MOBILE TELEPHONE GATEWAY APPARATUS, COMMUNICATION SYSTEM, AND GATEWAY OPERATING SYSTEM



(57) Abstract: A mobile telephone gateway and call routing device (MPG) (121) disclosed by the present invention is physically coupled with mobile phone (100) which is operative in accordance with first protocol, for adding communication capabilities through at least second communication network, possibly using a second protocol. A mobile communication system (150) is disclosed, comprising MPG (121) placed in-between mobile phone (100) and its battery (118) and Subscriber Identification Module (SIM) card (117). MPG (121) connects to the SIM interface of mobile phone (100), using which it controls call management. It connects to the data/signaling interface of mobile phone (100), using which it communicates with it, while communicating with the second network using another communication means. It connects to the Terminal Adapter/Terminal Equipment (TA/TE) interface of mobile phone (100), thereby enabling communication with wireless data terminals. In the preferred embodiment, the present invention adds Bluetooth (T.M.) cordless telephony and private wireless networking capabilities to a standard mobile phone.

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MOBILE TELEPHONE GATEWAY APPARATUS, COMMUNICATION SYSTEM, AND GATEWAY OPERATING SYSTEM

TECHNICAL FIELD

The present invention relates to mobile telephones operative on first communication
5 network. More particularly, the present invention relates to a gateway device and method
that enable communication between a mobile phone and a second communication network.

BACKGROUND ART

Wireless communication networks in general, and cellular networks in particular, defer
10 in various issues, including the frequency band they use, the communication protocol they
apply, and to some extent, the types of services they support. Examples of frequency bands
currently in use for cellular communication are the 800 – 900 MHz and 1800 – 1900 MHz
frequency bands in the United State, and the 800 – 900 MHz in Europe. Examples of
communication protocols currently in use are the second generation GSM (Global System
15 for Mobile communications) and CDMA (Code Division Multiple Access) standards and
the third generation UMTS (Universal Mobile Telecommunications System, also known as
W-CDMA) and CDMA2000 standards. Examples of types of services are the standard
circuit-switched voice call services, the packet-switched services, short message services
(SMS), and Internet-based services based on the Internet Protocol (IP) and the Wireless
20 Application Protocol (WAP). An example of a short-range wireless communication
standard is the Bluetooth/IEEE 802.15 protocol, operating on an Industry, Scientific, and
Medicine (ISM) frequency band such as the 2.4 – 2.483 GHz.

The vast majority of MPs sold today are either single-band or dual-band devices
registered for service with a certain service provider, where service accessibility is enabled
25 by a Subscriber Identification Module (SIM) card placed within the mobile phone. Triple-
band MPs are also becoming available, with two cellular communication bands, and a third
personal wireless communication band such as a Bluetooth (T.M.)-based network.

When a person purchases a mobile phone, usually she also becomes a subscriber of a
certain service provider. Once a person becomes a subscriber of a cellular network, she is
30 bound to use her mobile phone only within the network to which it has been designed for
and to which she has subscribed to.

Several methods and apparatuses have been devised for enabling MPs for communication through a different network, some use satellite networks, some use standard landline networks, and some use private wireless networks, for establishing a communication link with the cellular network service provider.

5 A different approach for accessing a second network is to incorporate a gateway within the communication path established between the MP and a terminal of the other network. In one configuration, the gateway is incorporated in-between the first and second networks. In another configuration, the gateway is incorporated in-between a data terminal and the MP, where the MP serves as the entry point for the data terminal to the network. In yet
10 another configuration, the gateway is incorporated within the MP itself and is used as an access point for data terminals to the network. Also, multiple gateways may be incorporated within the same communication path. In these configurations, a link has to be established between the MP and the first network.

In yet another configuration, the MP, data terminals, and the gateway are
15 communicating through a short-range network, and the gateway enables accessing a plurality of networks, including cellular networks, the PSTN, and a local area network. In this configuration, the MP cannot communicate with the cellular network unless a gateway is within range or unless it is equipped with means for communicating on both the short range and the cellular networks. Therefore, the gateway is not transparent to the MP, since
20 the design of the MP has to conform to the network and protocol of the gateway device.

In another aspect of the prior art, methods and apparatuses have been developed for adding service accessibility to MPs by extending the SIM card module to encompass multiple SIM cards. This has been done in two major ways: by adding another built-in SIM card reader and SIM card socket within the MP, and by coupling an accessory device with
25 multiple SIM card sockets and a processor for controlling them. These extensions to service accessibility, however, handle only the accessibility phase of the communication process, while the communication with the network is handled by the MP. Therefore, this solution is suitable for accessing networks within the frequency bands and in accordance with the communication protocols supported by the MP.

30 Therefore, there is a need for an apparatus and method transparent to the MP, for adding communication capabilities through a second network to a standard MP, such that a communication path established between the MP and the second network does not comprise a communication link between the MP and the first network.

DISCLOSURE OF INVENTION

A mobile phone gateway and call routing device (MPG) 121 is physically coupled to a MP.

Many models of MPs come with a removable SIM card. According to a first aspect of the present invention, MPG 121 plugs into the SIM interface of the MP for the purpose of embellishing the call control (GSM SIM service no. 28), authentication, ciphering, event handling, proactive commands (GSM SIM service no. 29), and user interface services (GSM SIM service no. 27) originally provided by the MP's SIM card. The MP's SIM card is plugged to the MPG for the purpose of relaying requests, events and responses in-between the MP and its original SIM card wherever appropriate.

Some models of MPs provide access to their data/signaling (D/S) subsystem by external devices. Typically, such MPs are equipped with a jack for the radio frequency (r.f.) signal. An external antenna may then be connected to this jack and used instead of the MP's internal antenna. This feature is typical to certain models such as the R380e, R520m, R600, T20e, T29s, and T39m models manufactured by Ericsson Ltd. Other models of MPs provide access to the baseband-form of the signal. Yet other models provide access to the digital-form of the signal. According to a further aspect of the present invention, an MPG physically connects to the D/S subsystem such that it electrically communicates with the MP, and communication between the MP and a network has to pass through the MPG. This enables processing and redirecting communication through a different network, possibly incorporating protocol conversion for mediating between the MP's protocol and the second network protocol, and a gateway application for mediating between the application layer of the MP and a terminal of the second network.

Most MPs feature a Terminal Adapter/Terminal Equipment (TA/TE) interface means as a network access point to accessory devices. According to a further aspect of the present invention, an MPG plugs into the TA/TE interface means of the MP such that it can serve as a network interface to wireless data terminals. Here, a communication path comprises first path between a wireless device and the MP passing through the TA/TE interface, and second path between the MP and the second network passing through the D/S interface, both established between the MP and the MPG.

Typically, a battery is coupled to MPs through a power/recharge connector. According to a further aspect of the present invention, MPG plugs on one hand to the battery and on

the other hand to the power/recharge connector of the MP, such that it draws power from the battery while relaying power/recharging in-between the battery and the MP.

Typically, MPs are equipped with latching means for securing them to an external accessory device such as a hands-free cradle. According to a further aspect of the present invention, MPG features a mating latching means and is structured such that it can be
5 secured to the MP after removing the MP's battery and SIM card. MPG features the same latching means on its back side, such that the battery and the SIM card can be secured to it, as well as accessory devices designed for use with the particular MP.

According to an embodiment of the present invention, the first network and protocol is
10 GSM and the second network and protocol is Bluetooth.

According to an embodiment of the present invention, the first network and protocol is CDMA and the second network and protocol is Bluetooth.

According to an embodiment of the present invention, the first network and protocol is UMTS and the second network and protocol is Bluetooth.

15 According to an embodiment of the present invention, the first network and protocol is CDMA2000 and the second network and protocol is Bluetooth.

According to an embodiment of the present invention, the first network and protocol is GSM and the second network and protocol is UMTS.

According to an embodiment of the present invention, a WAP gateway application is
20 incorporated by MPG for accessing the Internet through a private wireless network.

According to an embodiment of the present invention, an i-Mode gateway application is incorporated by MPG for accessing messaging services of the second network.

According to an embodiment of the present invention, a Bluetooth Cordless Telephony Profile (CTP) is incorporated by MPG as a gateway application for communicating
25 through a Public Switched Telephone Network (PSTN).

According to an embodiment of the present invention, a Bluetooth Intercom Services Profile (ISC) is incorporated by MPG as a gateway application for a point-to-point communication with another Bluetooth-compatible, wireless device.

According to an embodiment of the present invention, other Bluetooth extension
30 profiles are incorporated by the MPG as gateway applications.

In the preferred mode of the present invention, an MPG is disclosed for use with a MP operating on a GSM, CDMA, UMTS, or CDMA200 network, adding communication

capabilities through a private wireless network operating on an Industrial, Scientific, and Medicine (ISM) frequency band such as the 2.4-2.483 GHz band, using the Bluetooth protocol. In this preferred mode, MPG communicates with the MP through an r.f. interface established through an r.f. socket of the MP. In addition, MPG, the communication system, and the gateway operating system support multi-calls/sessions, where some of the calls/sessions are made over the first network, while the others are made over the second network.

BRIEF DESCRIPTION OF THE DRAWINGS

10 These and other advantages and features of the present invention will become better understood upon consideration of the following detailed description of the invention when considered in connection with the accompanying drawings, in which like reference numerals designate like parts throughout the figures thereof, and wherein:

Fig. 1 illustrates an exemplary MP.

15 Fig. 2 illustrates an MPG designed to mate with the exemplary MP of Fig. 1.

Fig. 3 illustrates a communication system comprising the exemplary MP and MPG.

Fig. 4 shows a generalized communication system comprising a MP and an MPG.

Fig. 5 shows a block structure of an MPG configured for r.f.-form data/signaling (D/S) interface with the MP.

20 Fig. 6 shows a block structure of an MPG configured for baseband-form D/S interface with the MP.

Fig. 7 shows a block structure of an MPG configured for digital-form D/S interface with the MP.

25 Fig. 8 shows a path-switching logic of an MPG configured for r.f.-form D/S interface with the MP.

Fig. 9 shows a path-switching logic of an MPG configured for baseband-form D/S interface with the MP.

Fig. 10 shows a path-switching logic of an MPG configured for digital-form D/S interface with the MP.

30 Fig. 11 is an interaction diagram illustrating mobile-originated call initiation for a GSM SIM - compatible MP, where the call is routed through the first network.

Fig. 12 is an interaction diagram illustrating mobile-terminated call initiation for a GSM SIM - compatible MP, where the call is issued by the first network.

Fig. 13 is an interaction diagram illustrating mobile-originated call initiation for a GSM SIM - compatible MP where the call is routed through the second network, and where the second network is a Bluetooth network.

Fig. 14 is an interaction diagram illustrating mobile-terminated call initiation for a
5 GSM SIM - compatible MP, where the call is issued by the second network, and where the second network is a Bluetooth network.

Fig. 15 schematically illustrates the processing of a voice call by an MP and a base station of a conventional cellular network.

Fig. 16 – 17 schematically illustrate protocol conversion of a voice call by MPG, done
10 in accordance with the processing illustrated in Fig. 15.

Fig. 18 – 19 schematically illustrate the encapsulation (tunneling) method of processing a voice call by an intermediate network or gateway.

Fig. 20 – 21 schematically illustrate protocol conversion of a voice call by MPG, done
in accordance with the encapsulation method illustrated in Fig. 18 – 19.

Fig. 22 – 25 are schematics showing various communication paths that may be
15 established by MPG in accordance with the present invention.

Fig. 26 is a state transition graph of MPG.

Fig. 27 shows key control modules, protocol stack layers and associated interface
elements of MPG.

20

MODES FOR CARRYING OUT THE INVENTION

Note: For convenience, a table of parts and modules is appended in pages 33 – 39.

The following description relates to an exemplary MP that is operating in a GSM network. It is however noted, that the present invention is not restricted to the form, type,
25 arrangement of components, or any other features specific to the exemplary MP other than those specified as pre-requisites in the previous sections or reflected in the claims.

In the following description, the terms “connector” and “socket” are often used to relate to physical interface means. From the point of view of the present invention, however, there is no significant difference between these terms other than convenience and
30 simplicity of the verbal description.

In the above and the following description, wherever a reference is made to MPG without a numeral indication, it should be construed as relating to MPG 121 as specified in the description hereinafter and in the drawings.

Fig. 1 shows an exemplary MP 100 based on the T29 model manufactured by Ericsson Ltd. This phone comprises: earpiece 101; display 103; keypad 104; microphone 105; antenna 106; and SIM card 117. MP 100 also features a set of connectors and sockets, including: external antenna socket 107; power/recharge connector 110; SIM card socket 113; and accessory socket 114 typically used for connecting to an accessory device such as a hands-free set, a TA/TE-compatible device, or a recharging unit. Accessory socket 114 further comprises a plurality of connecting members or contacts as well as engagement recesses 115. In addition, MP 100 further comprises: belt-clip engagement recess 116; battery clip locker 108; and SIM card locker 111.

Fig. 2 shows an embodiment of an MPG 121 designed for use with the exemplary MP 100. In the front side, MPG 100 is formed such that it fits into the niches of the SIM card and battery of MP 100 and plugs into the MP's connectors, sockets, lockers and engagement recesses. In the rear-bottom side, MPG 121 is formed to reflect the structure, connectors, sockets, lockers and engagement recesses, and their arrangement, such that the MP's SIM card 117, battery 118, and accessory devices designed for use with it, can be coupled with it through MPG 121.

Specifically, on the front side, MPG 121 comprises: r.f. connector 122; power/recharge socket 126; SIM card connector 128; and accessory device connector 129. These connectors will plug into the relevant connectors of MP 100 shown in Fig. 1. A locking/unlocking mechanism comprising an unlocking button 123, a locking recess 124, and a latching screw 142 (shown in Fig. 3), will be used to secure MPG 121 to MP 100.

On the rear-bottom side, MPG 121 comprises: external r.f socket 131; power/recharge connector 134; SIM card socket 137; and accessory device socket 138. Also, battery clip locker 132, SIM card lockers 135, and belt-clip engagement recess 141 will be used to secure SIM card 117, battery 118, and any accessory device, to MPG 121.

Fig. 3 shows an embodiment of a communication system 150 comprising the exemplary MP 100 and MPG 121. After removing battery 118 and SIM card 117 from MP 100, screw 142 is screwed into engagement recess 116. Then, MPG 121 is physically attached to MP 100, secured to latching screw 116 using engagement recess 141, and

engaged with it through the connectors and sockets described earlier. SIM card 117 and battery 118 are then connected and secured to it. Once MPG 121 has been assembled with MP 100, communication system 150 can be used to invoke and accept calls as will be illustrated in the following.

5 **Fig. 4** shows a generalized communication system 150 comprising: MP 100; MPG 121; SIM card 117; battery 118; a collection of interfaces between MP 100 and MPG 121, established through a collection of mating interface means; an interface between MPG 121 and SIM card 117, and an interface between MPG 121 and battery 118, established through mating interface means.

10 SIM Interface 201 is established between MPG 121 and MP 100 for the purpose of taking over SIM card functionality. SIM Interface 207 is established between MPG 121 and the MP's original SIM Card 117. Together, these two interfaces provide the basis for wrapping SIM functionality by MPG 121.

15 Data/Signaling (D/S) interface 202 is established between MPG 121 and MP 100 to enforce communication between MP 100 and any network to pass through MPG 121, thus enabling processing and redirecting communication through a different network. Connector 232 enables engaging MPG 121 with another accessory D/S device in the same manner it would when engaged directly with MP 100.

20 Clock interface 203 is used to obtain the system clock of the MP. This reduces design complexity of MPG 121 and improves synchronization with the MP 100. Typically, MPs provide clock lines as part of their SIM card socket 113 as well as of their accessory device socket 114. Either one or both of these clock lines may be used by MPG 121. Clock lines are relayed by MPG 121 for use by SIM Card 117 and/or accessory devices. This is depicted by abstract connector 233.

25 Remote Sense/Indication interface 204 is used by accessory devices to signal MP 100 whenever they are plugged to it. When MP 100 is signaled through this interface, it routes communication with the network to pass through D/S interface 202. MPG 121 also features Remote Sense interface means 234 in the same form as Remote Sense interface means 214 of MP 100, so that D/S communication with the network can be further delegated by MPG
30 121 through another accessory device. Typically, Remote Sense interface means 214 is formed as part of accessory device socket 114 of MP 100.

Power/Recharge interface 205 is used in conjunction with Power interface 208 for powering MP 100 and MPG 121 by battery 118, and for recharging battery 118. In the

embodiment depicted in Fig. 2, connector 225 is realized by socket 126, whereas connector 235 is realized by connector 134. Power/recharge socket 126 and connector 134 are physically coupled to enable powering MP 100 from battery 118, as well as powering MPG 121 internally. In addition, MPG 121 relays external power sources plugged through accessory device socket 138 to pass through MP 100, which then recharges battery 118 through connector 110.

Mobile phones come with various types, forms, and arrangements of an accessory device socket. Such differences, however, have no effect on the present invention other than those related to the external design of an MPG for a particular model of MP and the relay of unused contacts in-between the MP's socket 114 and the MPG's socket 138.

TA/TE Interface 206 enables communication between MP 100 and wireless data terminals (DTs) through MPG 121, in which case MPG 121 interconnects MP 100 with wireless DTs complying with the TA/TE protocol of MP 100. A communication session may then be established between a wireless DT and either the first or second network, wherein when established with the second network, MPG 121 serves also as a gateway between MP 100 and the second network. Interface means 236 is formed and arranged in the same manner as interface means 216 of MP 100, such that wired DTs can be plugged to MPG 121 and interact through it with MP 100. Typically, mobile phones offer a TA/TE interface as part of their accessory device socket.

Internally, MPG 121 comprises components for interfacing with a MP, interfacing with the communication networks, and for processing. These components may be broadly classified into four subsystems: data/signaling (D/S) communication subsystem, TA/TE interface subsystem, SIM logic subsystem, and processing and control subsystem.

Fig. 5 is a block structure of an MPG configured for use with a MP having an r.f.-form D/S interface. Consequently, the D/S communication subsystem of MPG comprises: connector 263, further comprising an r.f. connector realizing abstract D/S interface means 222; first transceiver 260 and first analog-to-digital and digital-to-analog conversion (ADC/DAC) logic 259, both configured for use in accordance with the first protocol (the protocol of the MP); second transceiver 257 and second ADC/DAC logic 256, both configured for use in accordance with the second protocol (the protocol of the network facilitated by the MPG); antenna circuitry 258 configured for use in at least the second network; socket 264, further comprising an r.f. socket realizing abstract D/S interface

means 232; and path-switch logic 262 controlled by microcontroller (MCU) 250 and used for routing a communication path to pass in various ways. A detailed description of the switching states is provided in Fig. 8, in its description, and in the claims.

The TA/TE interface subsystem comprises: TA/TE modem 269; TA/TE connector 226; TA/TE socket 236; and TA/TE switch 270 controlled by MCU 250. When TA/TE connector 226 is switched to TA/TE socket 236, MPG 121 relays communication between the MP and a DT plugged to the TA/TE socket 236. When TA/TE connector 226 is switched to TA/TE modem 269, MPG serves as an access point to wireless DTs for accessing the second network.

The SIM logic subsystem comprises: SIM card logic 253 implementing SIM functionality for the second network; SIM card connector 221 with which MPG connects to SIM card socket 211 of MP 100; SIM card socket 231 into which SIM card 117 is connected; SIM card reader 255 used for accessing SIM card 117 by MPG; and SIM switch 254 controlled by MCU 250. When SIM card connector 221 is switched to SIM card socket 231, MPG is effectively bypassed, and the MP communicates directly with SIM card 117. When, however, SIM card connector 221 is switched to MCU 250 and SIM card reader 255 is switched to SIM card socket 231, MPG effectively engages into the SIM communication path of the MP, and thus, is able to process SIM requests and events. In particular, call control events are intercepted and processed by MPG to decide through which network a call should be routed, and hence, which SIM card logic to use. Other features of this design include; embellishing the user interface of the MP with menus, menu items, menu selection events handling, and audiovisual effects issued by MPG so as to enable controlling MPG behavior by the user; and access to the authentication and ciphering keys produced by SIM card 117.

The processing and control subsystem comprises: microcontroller (MCU) 250 used for controlling and managing activities in MPG; digital signal processor (DSP) 251; and a memory module (MEM) 252. Note, however, that some or all of these components, as well as components of the other subsystems, may be implemented within a single Application Specific Integrated Chip (ASIC), or in multiple chips.

As in conventional designs of integrated circuits for wireless devices, a bus 280 is used in conjunction with Traffic Controller 290 for the communication between system components. Control line 281 is used for controlling path-switch logic 262, control line 282 is used for controlling TA/TE switch logic 270, and control line 283 is used for

controlling SIM switch logic 254. Data line 284 is used for communication between MCU 250 and SIM card 117 through SIM card socket 231, whereas data line 285 is used for communication between MCU 250 and MP 100 through SIM card connector 221. Data line 286 is used for communication between MCU 250 and SIM card logic 253.

5 **Fig. 6** is a block structure of an MPG configured for use with a MP having a baseband-form D/S interface. In this configuration, D/S connector 267 and socket 268 are designed for baseband signaling, signaling on the D/S interface 202 is done by DAC/ADC logic 259, and antenna circuitry 265 is configured for use on the second network. Path-switch logic 266 is properly designed for this configuration as further explored in Fig. 9. All other
10 components in this configuration are identical to those depicted in Fig. 5.

Fig. 7 is a block structure of an MPG configured for use with a MP having a digital-form D/S interface. In this configuration, D/S connector 275 and socket 276 are designed for digital signaling, signaling on the D/S interface 202 is handled by bus adapter logic 273, and antenna circuitry 265 is configured for use on the second network.. Bus adapter
15 273 mediates between the interface bus of the MP and the internal bus 280 of MPG. Path-switch logic 274 is properly designed for this configuration as further explored in Fig. 10. All other components in this configuration are identical to those depicted in Fig. 5.

 MPG implements a state machine comprising the following states: OFF – wherein only features related to handling menu events issued through SIM interface 201 are active;
20 RELAY – wherein MPG waits for the end of a communication session established between MP 100 and the first network; ACTIVE – wherein MPG routes and processes packets exchanged between MP 100 and stations and DTs of the second network; SLEEP – wherein MPG listens to the paging channel of the second network less frequently; and SUSPEND – wherein MPG waits for channels to become free. A more comprehensive
25 description of the state machine is provided in Fig. 26 and the related description.

 In addition, MPG defines first network-context, wherein MPG is set such that MP 100 can communicate with the first network; and second network-context, wherein MPG is set such that MP 100 communicates with the second network through MPG.

 In an MPG not configured to communicate or relay communication with the first
30 network, switching to first network-context comprises: properly setting the path-switch (266, 274): breaking communication links with the second network; and powering down unnecessary hardware elements. From this point, MPG relays SIM requests issued by MP

100 to SIM card 117. Events and requests issued by the MP on SIM interface 201 indicate when the communication session ends. Accordingly, switching to second network-context comprises: powering up hardware elements required for operation as a gateway and call routing device; properly setting the path-switch; and establishing a control communication
5 link with the second network. From this point, MPG intercepts and processes SIM requests issued by MP 100 through SIM interface 201.

Path-switch logics (262, 266, 274) control the communication path established between MP 100, MPG 121, and first and second networks. A path-switch logic comprises switching means and interface means, wherein the interface means comprises D/S interface
10 means (222, 232), and remote sense/indication interface means (224, 234). The switching means is best described using a state table specifying: the source ("From"), the target ("To"), whether an external D/S interface means is engaged to MPG, the current network-context, the input component to the D/S subsystem, the output component from the D/S subsystem, the state of MPG, and a switching map between input/output lines to which the
15 path-switch is connected.

In the following descriptions of Fig. 8 – 10, we shall relate to an electromechanical remote sense/indication interface. In an embodiment of the present invention wherein MP 100 is equipped with only mechanical remote sense/indication interface means, when MPG 121 is coupled with MP 100, communication paths established between MP 100 and any
20 network are constantly routed through MPG 121, implying that MPG has to be equipped with means for communicating with or relaying communication to the first network.

We shall also assume that if a communication means is coupled with MPG through the second D/S and remote sense/indication interface means (264, 268, 276), then it is operative in accordance with both first and second protocols and networks. The more
25 restricted form wherein a coupled communication means is operative only on the first network requires minor modifications to be made to the state table of the path-switch logic.

Fig. 8 schematically illustrates an MPG with path-switch 262 configured for an r.f.-form D/S interface with the MP. The following description relates to transceivers (257, 260) having a duplexer, such as transceivers compliant with CDMA protocol. For time-
30 division protocols such as GSM, a two-way switch replaces the duplexer such that at any time, either the receiver or the transmitter is connected to the input/output line.

In this configuration, connector 263 using which MPG communicates with MP 100 comprises: r.f. connector 311; remote indication pin 323; external power pin 322 pin; and common ground pin 321. Socket 264 using which MPG communicates through an external communication means comprises: r.f. socket 312; remote sense contact 327; external power 326 and common ground 325 contacts.

The input/output lines to/from path-switch 262 are: r.f. signaling line 331; remote indication line 332; r.f. signaling line 337; remote sense line 333; line 334 to duplexer 305 of transceiver 260; line 338 to duplexer 310 of transceiver 257; and line 336 to antenna circuitry 258. In addition, line 281 is used for controlling switch state, and line 335 connects the receivers 304, and 308 such that when in ACTIVE state, MPG can still listen to paging request on the first network while processing communication sessions established between MP 100 and the second network.

Table 1 explores the possible states of path-switch 262.

From	To	Ext. Ant.	Network Context	In	Out	MPG 121	Switch Line		
							331	332	338
N/A		Any	First	263	264	OFF	337	333	336
N/A		No	First	263	264	READY	336	+V	336
N/A		Yes	First	264	263	READY	337	333	337
MP	NET	No	First	263	258	RELAY	336	+V	336
MP	NET	Yes	First	263	264	RELAY	337	333	337
NET	MP	No	First	264	263	RELAY	336	+V	336
NET	MP	Yes	First	264	263	RELAY	337	333	337
MPG	MP	Any	First	N/A	N/A	N/A			
MPG	NET	Any	First	N/A	N/A	N/A			
MPG	MP	No	Second	303	263	ACTIVE	334	+V	336
MPG	MP	Yes	Second	303	263	ACTIVE	334	+V	337
MP	NET	No	Second	263	304	ACTIVE	334	+V	336
MP	NET	Yes	Second	263	304	ACTIVE	334	+V	337
MPG	NET	No	Second	309	258	ACTIVE	334	+V	336
MPG	NET	Yes	Second	309	264	ACTIVE	334	+V	337
NET	MPG	No	Second	258	308	ACTIVE	334	+V	336
NET	MPG	Yes	Second	264	308	ACTIVE	334	+V	337

Table 1

wherein: N/A is an abbreviation for Not Applicable; MP relates to MP 100; MPG relates to MPG 121; NET is an abbreviation for either first or second network, depending on the network context; and the symbol +V indicates positive signal or power.

Referring to Table 1, when in OFF state, r.f. line 331 is switched to r.f. line 337, and no
 5 remote indication signal is issued by MPG. When in READY state and no external r.f. accessory device is connected, antenna 258 serves MP 100 for listening to first network while serving MPG for listening to second network. This feature enables instant switching from first to second network-context, and is useful in case MP 100 re-registers with the network whenever remote indication interface 204 changes state. When in READY state
 10 and an external r.f. accessory device is connected, this external device serves both MP 100 and MPG for communicating with the first and the second networks, respectively. When in ACTIVE state, r.f. line 331 is switched to line 334 and through it to receiver 304 and transmitter 303, while receiver 308 and transmitter 309 are switched to antenna 258 if no external r.f. accessory device is connected, or to r.f. socket 312 otherwise. When in this
 15 state, remote indication line 332 is turned on.

Fig. 9 schematically illustrates an MPG 121 with path-switch 266 configured for a baseband-form D/S interface to the MP.

In this configuration, connector 267 using which MPG communicates with MP 100 comprises: baseband input 341 and output 342 pins; remote indication pin 323; external
 20 power pin 322; and common ground pin 321. Socket 268 using which MPG communicates through an external communication means comprises: baseband input 344 and output 343 contacts; remote sense contact 327; external power 326 and common ground 325 contacts.

The input/output lines to/from path-switch 266 are: baseband input 346 and output 345 lines; remote indication line 332; baseband input 348 and output 347 lines; remote sense
 25 line 333; power line 349; baseband input 350 and output 351 lines; and power line 352.

Table 2 explores the possible states of path-switch 266.

Referring to Table 2, when in OFF or RELAY state, baseband lines 345 and 346 are switched to baseband lines 348 and 347, respectively, and remote indication line 332 is switched to remote sense line 333, thus MPG is effectively bypassed. The difference
 30 between OFF or RELAY states and READY state is that when in READY state, transceiver 257 of the second network is powered on so that MPG can communicate with the second network. When in ACTIVE state and no external ADC/DAC is connected through socket 268, baseband lines 345, 346 are switched to baseband lines 350, 351,

respectively, remote indication line 332 is turned on, and transceiver 257 is powered on, thus generating a path between MP 100 and the second network through MPG. If, however, an external ADC/DAC is connected through socket 268, transceiver 257 is powered down and communication with the second network passes through socket 268.

From	To	Ext. RF	Network Context	In	Out	MPG 121	Switch Line			
							345	346	332	352
N/A		Any	First	267	268	OFF	348	347	333	0
N/A		No	First	268	267	READY	348	347	333	+V
N/A		Yes	First	268	267	READY	348	347	333	+V
MP	NET	No	First	N/A	N/A	RELAY	348	347	333	0
MP	NET	Yes	First	267	268	RELAY	348	347	333	0
NET	MP	No	First	N/A	N/A	RELAY	348	347	333	0
NET	MP	Yes	First	268	267	RELAY	348	347	333	0
MPG	MP	Any	First	N/A	N/A	N/A				
MPG	NET	Any	First	N/A	N/A	N/A				
MPG	MP	No	Second	350	267	ACTIVE	350	351	+V	+V
MPG	MP	Yes	Second	350	267	ACTIVE	350	351	+V	+V
MP	NET	No	Second	267	351	ACTIVE	350	351	+V	+V
MP	NET	Yes	Second	267	351	ACTIVE	350	351	+V	+V
MPG	NET	No	Second	257	265	ACTIVE	350	351	+V	+V
MPG	NET	Yes	Second	257	268	ACTIVE	350	351	+V	0
NET	MPG	No	Second	265	257	ACTIVE	350	351	+V	+V
NET	MPG	Yes	Second	268	257	ACTIVE	350	351	+V	0

Table 2

Fig. 10 schematically illustrates an MPG 121 with path-switch 274 configured for a digital-form D/S interface with the MP.

In this configuration, connector 275 using which MPG communicates with MP 100 comprises: bus connector 361 formed to obtain mechanical, structural, and electrical compatibility with the digital bus of MP 100; remote indication pin 323; external power pin 322; and common ground pin 321. Socket 276 using which MPG communicates with accessory devices comprises: bus socket 362 conforming to the same specifications as the

bus socket of MP 100; remote sense contact 327; external power 326 and common ground 325 contacts.

The input/output lines to/from path-switch 274 are: bus 363; remote indication line 332; bus 364; remote sense line 333; power line 349; bus 365; and power line 352.

5 Table 3 explores the possible states of path-switch 274.

From	To	Ext. ADC/DAC	Network Context	In	Out	MPG 121	Switch Line		
							363	332	352
N/A		Any	First	275	276	OFF	364	333	0
N/A		No	First	275	276	READY	364	333	+V
N/A		Yes	First	276	275	READY	364	333	+V
MP	NET	No	First	N/A	N/A	RELAY	364	333	0
MP	NET	Yes	First	275	276	RELAY	364	333	0
NET	MP	No	First	N/A	N/A	RELAY	364	333	0
NET	MP	Yes	First	276	275	RELAY	364	333	0
MPG	MP	Any	First	N/A	N/A	N/A			
MPG	NET	Any	First	N/A	N/A	N/A			
MPG	MP	No	Second	273	275	ACTIVE	365	+V	+V
MPG	MP	Yes	Second	273	275	ACTIVE	365	+V	+V
MP	NET	No	Second	275	273	ACTIVE	365	+V	+V
MP	NET	Yes	Second	275	273	ACTIVE	365	+V	+V
MPG	NET	No	Second	257	265	ACTIVE	365	+V	+V
MPG	NET	Yes	Second	257	276	ACTIVE	365	+V	0
NET	MPG	No	Second	265	257	ACTIVE	365	+V	+V
NET	MPG	Yes	Second	276	257	ACTIVE	365	+V	0

Table 3

Referring to Table 3, when in OFF or RELAY state, bus 363 is switched to bus 364, and remote indication line 332 is switched to remote sense line 333, thus MPG is effectively bypassed. The difference between OFF or RELAY states and READY state is that when in READY state, transceiver 257 of the second network is powered on so that MPG can communicate with the second network. When in ACTIVE state and no external digital processing device is connected through socket 276, bus 363 is switched to bus 365.

remote indication line 332 is turned on, and transceiver 257 is powered on, thus generating a path between MP 100 and the second network through MPG 121. If, however, an external digital processing device is connected through socket 276, transceiver 257 is powered down and communication with the second network passes through socket 276.

5 Once the issue of path switching has been resolved, we may turn to the issue of controlling and managing the call setup phase. Two major key functions carried out during a call setup phase are authentication and ciphering. Authentication prevents unauthorized equipment from connecting to the network. A MP will not even register with the network unless a SIM card is plugged into it and authentication has succeeded. Ciphering prevents
10 unauthorized equipment from encrypting data exchanged between the MP and the network. In third generation protocols like UMTS, ciphering is extended to the control data portion of packets, thereby preventing routing of calls through unauthorized networks. Consequently, for a successful communication through the second network, MPG has to take over SIM responsibilities.

15 The following description relates to call initiation phase wherein the MP supports call control services (GSM SIM service no. 28) on its SIM interface. This, however, should not be regarded as a limitation of the present invention to the particular type of devices and protocols, but rather as a demonstration as to how the present invention may be applied in cases where the mobile phone handles call control in cooperation with its SIM card.

20 Furthermore, the same principles and methods are applicable to the initiation of any communication session established between the MP and the network, such as short message services (SMS) and multimedia message services (MMS).

A MP supporting call control services delegates call initiation control to the SIM card. Also, when the MP receives a call, it interacts with the SIM card for authentication,
25 approval, and initiation notification. Being placed in-between the MP and its SIM card, MPG is able to intercept these interactions and alter their processing such that when appropriate, communication will be passing through the second network. Figures 11-14 are interaction diagrams describing the four major scenarios of a call initiation phase in an embodiment of the present invention where the first network is GSM and the second
30 network is Bluetooth. In all these diagrams, unless specified otherwise, it is assumed that MPG is in READY state.

Fig. 11 is an interaction diagram of a mobile-originated call initiation phase, wherein the call is routed through the first network. This scenario begins with a CALL CONTROL request issued by MP 100 through SIM interface 201. This message is intercepted by MPG and examined based on user preferences, MPG's setup, and availability of a communication link with the second network. Assuming MPG has concluded that the call should be routed through the first network, it switches to the first network-context.

While processing requests, events, and responses, MPG may send a WAIT message to MP 100. This technique is used in all call initiation scenarios in order to avoid timeout failure as a result of processing delay introduced by MPG.

At this point, MP 100 conducts a call initiation phase with base station (BS) 401 of the first network. This process comprises: control channel request and assignment; authentication; ciphering mode setting; passing call request data; traffic channel assignment; and alert and connect messages. Once MP 100 has acknowledged connection, it sends a CALL CONNECTED event to its SIM card. When MPG intercepts this event, it enters a RELAY state, wherein it waits for a CALL COMPLETED event to be issued by MP 100 through SIM interface 201.

Fig. 12 is an interaction diagram of a mobile-terminated call initiation phase, wherein the call is issued by the first network. This scenario begins with a PAGING REQUEST message issued by BS 401. According to GSM protocol, after assigning a control channel, the MP is requested to authenticate itself. An AUTHENTICATE request is then issued by MP 100 through SIM interface 201. MPG intercepts this request, but since no prior authentication request was issued by it to MP 100 through either the D/S interface 202 or the TA/TE interface 206, it delegates the request to the MP's SIM card 117. After authenticating and receiving the call request, MP 100 issues a MT CALL event through SIM interface 201 to get approval of the call. MPG intercepts this event and, after delegating it to SIM card 117, switches to the first network-context. Once call initiation has completed successfully, MP 100 sends a CALL CONNECTED event through SIM interface 201. At this point, MPG enters the RELAY state, wherein it waits for a CALL COMPLETED event to be issued on SIM interface 201.

Fig. 13 is an interaction diagram of a mobile-originated call initiation phase, wherein the call is routed through the second network. This scenario begins as in Fig. 11 with a CALL CONTROL request issued by MP 100 through SIM interface 201. This time,

however, MPG concludes the call should be routed through the second network. It then establishes a communication path between MP 100 and BS 402 of the second network. This communication path comprises two communication links, the first link established in sections 405, 406 between MPG 121 and BS 402 and named as the MPG-Network link, whereas the second link established in sections 407, 408 between MPG 121 and MP 100 and named as the MP-MPG link.

To exit the SLEEP mode, MPG sends an ACCESS REQUEST to BS 402, which, according to Bluetooth protocol, is responded with an UNPARK message, and then with authentication and ciphering mode setup process. Following this, BS 402 sends a POLL request that is responded with a REGISTER CALL message, indicating that MPG wishes to issue a call. Then, MPG switches to the second network-context.

Next, MPG begins establishing the MP-MPG link by emulating a BS of the first network. This comprises: control channel assignment; authentication; and ciphering mode setting. In the scenario depicted in Fig. 13, authentication is handled by the MP's SIM card 117, and ciphering mode is turned off. This is the simplest scenario. Other scenarios are also possible, wherein authentication is handled by MPG's own SIM card logic 253 and ciphering mode is turned on. In either scenario, MPG stores the authentication and ciphering keys for use during communication on the MP-MPG link.

A SETUP message is then transmitted by MP 100 on the MP-MPG link, and after converted to the format of the second protocol, transmitted by MPG 121 to BS 402, which in response, dials the number, sends back a CALL IN PROGRESS message, and allocates a Synchronous COmmunication (SCO) channel.

In response, MPG completes the establishment of the MP-MPG link by allocating traffic channels and notifying MP 100. At this point, a communication path between MP 100 and BS 402 has been established, and MP 100 and MPG wait for completion of the call initiation process. When connection has been acknowledged by MP 100 and after passing this message to BS 402, MPG enters the ACTIVE state, wherein it receives, processes, and transmits packets in-between MP 100 and BS 402.

Fig. 14 is an interaction diagram of a mobile-terminated call initiation phase, wherein the call is issued by the second network. This scenario begins with a SETUP message sent by BS 402 to MPG 121, triggering the establishment of a MPG-Network link as specified in section 409. When receiving a SETUP message, MPG authenticates with BS 402 using SIM card logic 253. Once ciphering mode setting and traffic link establishment completes,

MPG switches to the second network-context. Then it establishes the MP-MPG link through the D/S interface 202 by emulating a BS of the first network, and passing the call request data to MP 100 through the MP-MPG link. Since MPG intercepts interaction of MP 100 with SIM card 117, when receiving a MT CALL event through SIM interface 201, it approves it. The standard procedure of call confirmation, alerting, and connecting is then carried out in-between MP 100 and MPG 121 in conjunction with the same process being carried out in-between MPG 121 and BS 402. Once the call has been acknowledged, MPG enters the ACTIVE state.

During call initiation where the call is routed through the second network and MPG is configured for an r.f. D/S interface, MPG instructs MP 100 to reduce transmission power to the minimum required, in the same manner this is done when communicating on the first network.

Fig. 15 show key functions in the processing of a voice call in standard cellular networks such as GSM and CDMA. The relation to voice calls should be regarded as demonstrative rather than restrictive, since similar description can be made to non-voice calls, with most of the key functions and procedure of processing identical.

In the following descriptions, the term “channel” relates to a combination of allocation of time frames, packet segments, and frequency bands. For instance, in GSM, once a call has been established, all data and control channels are multiplexed on the same frequency band of each side, where control channels are multiplexed in two major forms: time frames specifically allocated for control channels, and ordinary time frames wherein the transmitted packet carries an indication bit signaling its content relates to a control channel. In contrast, in Bluetooth, each packet may carry control channels data on its header. Other, more complex allocations of time frames, packet segments, and frequency bands may be defined and applied as well.

Referring to Fig. 15, on the transmitter side, this process comprises: analog-to-PCM coding 501; voice coding 502, which compresses the digitized voice; digital encoding 503, comprising error correction/detection channel coding, data ciphering, message ciphering (in UMTS), channels multiplexing, and packets interleaving; digital modulation 504, which transforms the coded digital data according to the modulation scheme of the protocol; DAC 505, which produces a baseband representation of the signal; analog modulation 506, which maps the baseband representation into the allocated frequency band, and transmission 507, which transmits the signal.

Processing on the receiver side comprises: receiving of a signal 511; analog demodulation 512; ADC 513; digital de-modulation 514; digital decoding 515; voice decoding 516; and PCM-to-analog conversion 517.

Fig. 16 – 17 show an embodiment of the present invention for the processing of a voice call in accordance with the processing shown in Fig. 15.

Referring to Fig. 16, MPG 121 electrically connects through D/S interface 202 with MP 100 for receiving packets, and wirelessly connects on the second network to BS 402 for transmitting packets.

CONF 576 is a configuration-dependent processing block that processes packets received on the D/S interface in accordance with the first protocol, with internal processing sub-blocks depended on the specific configuration of MPG. For an MPG configured for r.f.-form D/S interface with MP 100, CONF 576 comprises: receiving a packet 304; analog demodulation 512; and ADC 302. For an MPG configured for baseband-form D/S interface, CONF 576 comprises ADC 302. For an MPG configured for digital-form D/S interface, CONF 576 comprises processing by bus adapter 273 to obtain electrical and logical compatibility with internal bus 280. In either one of these configurations, the output of CONF 576 is a digital packet complying with the first protocol.

After being processed by CONF 576, processing proceeds in accordance with first protocol and comprises: digital de-modulation 514; and digital decoding 515. At this stage, signaling channels have been separated from data channels. The content of the signaling channels is then passed for processing by session control 550, whereas data is transcoded (560) in accordance with the coding scheme of the second protocol. Session Control 550 produces messages in accordance with the second protocol, based on: signaling messages received from MP 100; signaling messages received earlier from BS 402; MPG state; MP 100 state; and the state of the communication session. These signaling messages and transcoded data from transcoding 560 are then pre-processed for transmission on the second network, wherein pre-processing is in accordance with the second protocol and comprises: digital encoding 523; digital modulation 524; DAC 307; analog modulation 526; and transmission 309.

Referring to Fig. 17, MPG 121 wirelessly connects on the second network to BS 402 for receiving packets, and electrically connects with MP 100 on the D/S interface for transmitting packets.

When a packet arrives through the second network, it is processed by MPG, wherein processing is in accordance with the second protocol and comprises: receiving a packet 308; analog de-modulation 532, ADC 306, digital de-modulation 534, and digital decoding 535. At this stage, signaling channels have been separated from data channels. The content
5 of the signaling channels is then passed for processing by session control 550, whereas data is transcoded (560) in accordance with the coding scheme of the first protocol. Session Control 550 produces messages in accordance with the first protocol, based on: signaling messages received from BS 402; signaling messages received earlier from MP 100; MPG state; MP 100 state; and the state of the communication session. These signaling
10 messages and transcoded data from transcoding 560 are then pre-processed for transmission on the D/S interface 202, wherein pre-processing is in accordance with the first protocol and comprises: digital encoding 503; digital modulation 504; and CONF 586.

CONF 586 is a configuration-dependent processing block that prepares packets for transmission on the D/S interface in accordance with the first protocol, with internal
15 processing sub-blocks depended on the specific configuration of MPG. For an MPG configured for r.f.-form D/S interface with MP 100, CONF 586 comprises: DAC 301; analog modulation 506, and transmission 303. For an MPG configured for baseband-form D/S interface, CONF 586 comprises DAC 301. For an MPG configured for digital-form D/S interface, CONF 586 comprises processing by bus adapter 273 to obtain electrical and
20 logical compatibility with internal bus 280. In either one of these configurations, the input to CONF 586 is a digital packet complying with the first protocol.

In the embodiments explored in Fig. 16 – 17, MPG functions as a payload gateway and as a signaling gateway. There is, however, another method called “encapsulation” or “tunneling”, wherein the gateway processes only the signaling portion of the
25 communication session while leaving the processing of the payload portion to the terminals. The MPG-Network link in this method can be described as a pair of links: the carrier link which is the actual communication link between MPG 121 and BS 402, and the payload link which is an application-layer link between the application in MP 100 and the application in BS 402. The payload link is carried within the payload segments of packets
30 of the carrier link, and is not transcoded by MPG, thereby reducing processing power requirements and device price and complexity. Therefore, this method is particularly useful for a gateway device coupled to a MP and powered by the same battery.

In particular, this method can be found useful for voice calls where the first network is a cellular network like GSM, CDMA, or UMTS, and the second network is Bluetooth. This is because Bluetooth uses an up-to 64 KB/sec PCM coding of audio signal, requiring full time activity of ADC/DAC 256 and RF 257, as well as substantial processing effort.

5 Instead, an extension to the Cordless Telephone Profile can be defined and used in conjunction with MPG, such that the voice signal is efficiently encoded and compressed according to the coding scheme of the cellular network, thereby reducing transmission/reception activity on the second network while keeping voice quality as good as in the first network. For instance, using an 160 bits packet size of an SCO link between

10 MPG 121 and BS 402 without additional encoding (there is no need since payload bits are already encoded by the MP), and where the first network is CDMA, requires only 4 cycles of 0.625 milliseconds (ms) transmission/reception time on the MPG-Network link in every 20 ms, compared with 16 cycles required for a standard Bluetooth audio link. This is because a standard CDMA packet is 576 bits on the uplink and 384 bits on the downlink,

15 and thus can be packed into four packets of 160 bits.

Note that for the purpose of properly ciphering and de-ciphering the payload content transmitted to BS 402, MPG 121 first has to pass to it the ciphering key. This can be done by transmitting the de-ciphering key to BS 402 during the setup or the beginning of the communication session. Preferably, the de-ciphering key is ciphered by the ciphering key

20 resulting from the authentication process carried out between MPG 121 and BS 402.

Fig. 18 – 19 show key functions in the processing of a voice call by BS 402 of the second network that is also equipped with processing means for processing data of the first protocol in accordance with the “encapsulation” method.

Fig. 18 shows the processing of packets of a voice call by BS 402, wherein: packets are

25 received through the second network in accordance with the second protocol, but with payload in accordance with the first protocol; processing is done in two phases. In the first phase, processing is in accordance with the second protocol and comprises: receiving a packet 531; analog de-modulation 532; ADC 533; unpacking 571, wherein unpacking comprises de-multiplexing carrier link signaling channels from carrier link data channels.

30 Carrier link signaling channels are then further processed, wherein processing is in accordance with the first protocol and comprises: message de-modulation 572; and message decoding 573, wherein message decoding comprises message channel decoding, and message de-ciphering (in UMTS). The output is passed to session control 580 for

further processing. Session control 580 processes messages in accordance with the second protocol, based on: signaling messages received from the transmitting terminal; the state of BS 402; and the state of the communication session.

Carrier link data channels are passed for second stage processing, wherein processing
5 is in accordance with first protocol and comprises: digital de-modulation 514; digital decoding 515; voice decoding 516; and PCM-to-analog conversion 517.

Fig. 19 shows the processing of packets of a voice call by BS 402, wherein: packets are transmitted through the second network in accordance with the second protocol, but with payload in accordance with the first protocol; and processing is done in two phases. In the
10 first phase, processing is in accordance with the first protocol and comprises: analog-to-PCM conversion 501; voice encoding 502; digital encoding 503; and digital modulation 504. The output is passed to packing 583 for further processing.

Messages are produced by session control 580 in accordance with the second protocol, based on: signaling messages received earlier from the receiving terminal; the state of the
15 BS 402; and the state of the communication path. Messages produced by session control 580 are processed in accordance with the second protocol, wherein processing comprises: message encoding 581, wherein message encoding comprises message channel encoding, and message ciphering (in UMTS); and message modulation 582. The output is passed to packing 583 for further processing.

20 The processing in the second phase is in accordance with the second protocol and comprises: packing 583 data and signaling streams into transmission buffers, wherein packing comprises multiplexing signaling stream into the carrier link signaling channels and data stream into the carrier link data channels, and digital encoding; DAC 584; analog modulation 526; and transmission 527.

25 **Fig. 20 – 21** show an embodiment of the present invention for the processing of a voice call in accordance with the encapsulation method shown in Fig. 18 – 19.

Referring to Fig. 20, MPG 121 electrically connects through D/S interface 202 with MP 100 for receiving packets, and wirelessly connects on the second network to BS 402 for transmitting packets.

30 CONF 576 is a configuration-dependent processing block as described earlier, whose output is a digital-representation of a packet received on the MP-MPG link.

After being processed by CONF 576, processing proceeds in accordance with the first protocol and comprises channels de-multiplexing 591, wherein signaling channels are de-multiplexed from data channels. Signaling channels content is then further processed, wherein further processing comprises: message de-modulation 592 wherein the process of
5 digital de-modulation for the signaling channels is completed; and message decoding 593, after which the messages sent by MP 100 are ready for processing by session control 590.

Session control 590 produces messages in accordance with the second protocol, based on: signaling messages received from MP 100; signaling messages received earlier from BS 402; MPG 121 state; MP 100 state; and the state of the communication session. These
10 messages are then processed in accordance with the second protocol, wherein processing comprises: message encoding 581; and message modulation 582. The output of message modulation 582 and the data stream of channels de-multiplexing 591 are passed for further processing, wherein further processing is in accordance with the second protocol and comprises: packing 583; DAC 307; analog modulation 526; and transmission 309.

15 **Referring to Fig. 21**, MPG 121 wirelessly connects on the second network with BS 402 for receiving packets, and electrically connects with MP (100) on the D/S interface for transmitting packets.

When a packet arrives on the second network, it is processed by MPG, wherein processing is in accordance with the second protocol and comprises: receiving a packet
20 308; analog de-modulation 532; ADC 306; and unpacking 571, wherein unpacking 571 comprises de-multiplexing carrier link signaling channels from carrier link data channels.

Carrier link signaling channels are then further processed, wherein processing is in accordance with the first protocol and comprises: message de-modulation 572; and message decoding 573, wherein message decoding comprises message channel decoding,
25 and message de-ciphering (in UMTS). The output of message decoding 573 is passed to session control 590 for further processing.

Session control 590 processes messages in accordance with the second protocol, based on: signaling messages received from MP 100; signaling messages received earlier from BS 402; the state of MPG; the state MP 100; the state of the communication session. These
30 signaling messages are then pre-processed in accordance with the first protocol, wherein processing comprises: message encoding 595; and message modulation 596. The output of message modulation 596 and the data stream output of channels unpacking 571 are passed for further processing, wherein further processing is in accordance with the first protocol

and comprises: channel multiplexing 597; and CONF 586. CONF 586 is a configuration-dependent processing block as described earlier, whose input is a digital-representation of a packet to be transmitted on the MP-MPG link.

Fig. 22 – 25 schematically illustrate communication links and communication paths that may be established in conjunction with MPG. In these figures, PLMN 600 is the first network, Protocol A is the first protocol, NETB 601 is the second network, Protocol B is the second protocol, ST 603 is a base station (BS) or a mobile station (MS) of the second network, and DT 604 is a wireless data terminal of the second network.

Fig. 22 illustrates a communication path 612, established between MP 100 and ST 603, comprising: an MP-MPG link 610 following Protocol A; and a MPG-Network link 611 following Protocol B.

Fig. 23 illustrates a communication path 615, established between MP 100 and ST 603, comprising: an MP-MPG link 610 following Protocol A; a carrier link 613 following protocol B; and a payload link 614 overlaid on the payload portion of carrier link 613, with content following protocol A' which is the application-layer part of protocol A.

Fig. 24 illustrates a communication path 618, established between MP 100 and DT 604, comprising: a TA/TE link 616 between MP 100 and MPG 121 and following a TA/TE protocol supported by them; and a MPG-network link 617 following Protocol B.

Fig. 25 illustrates a communication path 620, established between DT 604 and ST 603, comprising: communication path 618 established between DT 604 and MP 100 as depicted in Fig. 24; and communication path 612 established between MP 100 and ST 603 as depicted in Fig. 22 or 23.

Fig. 26 is a state transition graph of MPG 121. Initially, MPG is in OFF state, wherein only features related to handling menu events issued through SIM interface 201 are active. This provides the user with an interface for powering on MPG from the MP's user interface. When powered on, MPG switches to the ON state, wherein no connection is yet established between MPG and the second network. This may be a transition state between the OFF state and the CONNECT state wherein MPG tries to establish a connection. It may, however, be a static state in case MPG is not expected to automatically connect to the second network.

When in CONNECT state, MPG tries establishing a control link with the second network. If succeeded, it switches to the READY state, wherein it is able to handle

incoming and outgoing calls routed through the second network. After a pre-specified idle time, MPG may enter the SLEEP state, wherein it monitors the paging channel of the second network less frequently.

When a call is being routed through the first network while MPG is in READY state, it
5 enters the RELAY state, wherein it waits for completion of the call.

When a call is routed through the second network, MPG enters the ACTIVE state, wherein it processes packets exchanged between MP 100 and stations and data terminals of the second network.

MPG may reside in RELAY or ACTIVE state while simultaneously residing in one of
10 the states: CALL WAIT, CALL HOLD, REASSIGN CHANNELS, SUSPEND, ROAM-IN, or ROAM-OUT.

While in RELAY state, MPG monitors the paging channel of the second network, using SIM proactive commands such as beeping to signal the user whenever a paging request is recorded, and enters the CALL WAIT state.

15 While in ACTIVE state, an MPG configured for r.f. D/S interface and equipped with an antenna circuitry operative on both the first and the second networks, listens to the paging channel of the first network. When receiving a paging request, MPG inserts a CALL WAIT message into the message transmission buffer on the MP-MPG link, and enters the CALL WAIT state. While in CALL WAIT state, MPG monitors SIM interface
20 201 for keypad events signaling call-switching requests issued by the user.

When receiving a call-switching event, MPG first lets a CALL HOLD message to be sent to the network of the current call, and then enters the CALL HOLD state. If there is another call on the other network, MPG switches to the network-context of the network of the call and activates it. Otherwise, it waits for a CALL RESUME keypad event, upon
25 which it returns to either RELAY or ACTIVE state in accordance with the communication network of the call resumed.

States REASSIGN CHANNELS, SUSPEND, ROAM-IN, and ROAM-OUT are applicable only for an MPG with r.f.-form configuration of the D/S interface and with an antenna circuitry operative on both the first and second networks.

30 When routing a call through the second network, MPG arbitrarily assigns traffic channels to the MP-MPG link. When switching to a call routed through the first network, the network might assign different channels to the call. In communication protocols like GSM, the MP expects the two calls to be assigned the same traffic channels. Therefore,

when such a case occurs, MPG enters the REASSIGN CHANNELS, wherein it changes the traffic channels assigned to the MP-MPG link to be the same as the channels assigned to the call on the first network. This situation may occur during the initiation of the call but also during the call itself.

5 In some situations, MPG might not be able to reassign channels to the call on the first network, in which case the communication session of this call enters the SUSPEND state until channels become available, e.g., due to termination of a call.

When the first and second networks support roaming a call from one network to the other, MPG supports also the ROAM-IN and ROAM-OUT states.

10 Roaming-in occurs when the following conditions are met: a call is being routed through the first network; MPG enters the communication range of the second network; and preferences setting of MPG indicate that the call should be handed to the second network. When entering this state, MPG sends a message to the second network, requesting to hand the call to it from the first network. The second network is responsible
15 for managing the handing process with the first network. When ready, it sends an acknowledgment message to MPG, which in response switches to the ACTIVE state. The switching process comprises: terminating the communication session with the first network; switching to the second network-context; and establishing a communication path between MP 100 and the second network.

20 Roaming-out occurs when the following conditions are met: a call is being routed through the second network; MPG goes out of range of the second network; and preferences setting of MPG indicate that the call should be handed to the first network. Either MPG or the second network may initiate a roam-out process. When entering this state, MPG sends a message to the second network, requesting to hand the call to the first
25 network. The second network is responsible for managing the handing process with the first network. When ready, it sends an acknowledgment message to MPG, which in response switches to the RELAY state. The switching process comprises: terminating the communication session with the second network; switching to first network-context; and establishing a communication path between MP 100 and the first network.

30 An adaptive scheduling method may be required in order to resolve synchronization issues involved in case of two protocols with substantial transmission/reception timing differences, and channel reassignment issues in embodiments where multiple sessions may be established with more than one network. Such a scheduling method is characterized in

that: received packets are stored in memory and scheduled for processing; processing times are scheduled in-between receiving times and due transmission times; re-scheduling time is computed and the rescheduling process is scheduled for re-aligning processing by said mobile phone gateway with said receiving times and said due transmission times, such that minimal dropouts and delays occur as a result of processing by said mobile phone gateway.

Fig. 27 shows key control modules of MPG 121 together with key protocol stack layers, and with interface elements associated with them. As indicated earlier, these modules and elements may be implemented as an ASIC or using multiples chips.

Management and control module 700 controls the operation of MPG.

Modules 710, 720, and 730 are control modules which at least some of their components are active at all time even when MPG is in OFF state.

Path Control Logic 710 encompasses: SIM Path Control 711 which controls SIM switch 254; TA/TE Path Control 712 which controls TA/TE switch 270; and Data/Signaling Path Control 713 which controls D/S path switch (262, 266, 274).

Service and Call Control module 720 comprises: Communication Sessions Manager 721 initiates and manages a plurality of communication sessions established between MP 100 and the secondary network through MPG; Network-Context Control 722 is responsible for switching between network-contexts; and User Interface module 723 which provides user interface services, using the user interface of MP 100 through either SIM interface (201), D/S interface (202), or TA/TE interface (206).

SIM Wrapping Logic 730 encompasses all SIM functionalities, including: accessing MPG's own SIM card logic 253 which may be implemented as a software module, a built-in SIM card, or a removable SIM card; SIM wrapper Control Logic 731 which directs SIM requests and responses to the appropriate SIM card; SIM wrapper File System 732 which builds upon the file systems of SIM card 117 and SIM card Logic 253 to provide a unified SIM file system to MP 100 and to MPG 121; SIM interface 201; and SIM Interface 207.

Gateway protocol stack 740 is a logical arrangement of functionalities implemented by MPG that are related to the implementation and realization of gateway applications and protocol conversion. Interaction between the control modules (700, 710, 720) and elements of the gateway protocol stack (740) takes place through the Gateway Application Layer (750). whereas communication between MPG and MP 100, and between MPG and the secondary network is handled by elements of the protocol stack.

Gateway Application Layer 750 encompasses gateway applications that may be embedded within MPG. In an embodiment of the present invention, Gateway Application Layer includes: Bluetooth profiles such as Cordless Telephone Profile, Intercom Services Profile, and Dial-Up Networking Profile; Bluetooth applications built on top of the Bluetooth profiles; Internet access by a WAP gateway application; advanced messaging serviced by i-Mode gateway application; and circuit-switched/packet-switched server which handles communication sessions wherein either the MP-MPG link or the MPG-Network link is a circuit-switched link, whereas the other link is a packet-switched link. Other gateway applications may also be embedded as part of this layer.

Gateway Layer Services 760 handle session control (550, 590), Quality of Service management, communication links and paths management, and scheduling.

Protocol Conversion Layer 770 handles conversion and transcoding of packets exchanged on the MP-MPG link and the MPG-Network link.

Management Layer 780 comprises third-layer entities required for interacting on the MP-MPG and MPG-Network links. These entities are used by modules of the gateway application layer, gateway layer services, and protocol conversion layer, for accessing the MP-MPG and MPG-Network links. For instance, in an embodiment wherein the first protocol is GSM, this layer comprises Communication Management (CM) entities, Mobile Management (MM) entities, and Radio Resource (RR) entities, using which communication through the MP-MPG link is carried out.

Data/Signaling Interface Layer 790 encompasses the logics of the data link and the physical layers of the protocol stack, using which MPG communicates with MP 100 through the D/S interface and through the TA/TE interface, and with the second network through the second communication means.

In the area of telecommunication, the terms “multi-call” and “multi-session” are used to describe a service of the network and a capability of the mobile phone to have more than one call/session open at the same time. In theory, the multiple calls/sessions may run concurrently. However, as of the time of issuing this description, only the non-concurrent stage is supported by mobile networks and phones, wherein only one call is active at any time, while the others are put into hold, and sessions are handled in a timesharing manner.

In the context of the present invention, the terms “multi-call” and “multi-session” may be extended to relate to a situation of having one or more calls/sessions open with each one

of the first and second networks. This requires MPG 121 to be able to monitor the control and paging channels of the first network while in ACTIVE state.

From the description of the three MPG configurations and their related path-switches disclosed earlier, it is evident that only the r.f.-form configuration has been designed to support this capability. This is because filtering of network frequency bands is done by the transceivers (RF 257 and RF 260). Therefore, communication with the first network can run through MPG 121, merely requiring switching it to the multi-band antenna circuitry. Furthermore, because of the nature of the r.f. medium, MPG 121 can still listen to the paging channel of the first network while processing packets of the second network.

For the baseband-form and digital-form configurations, in addition to a multi-band antenna circuitry, the following modifications should be done in order to support multi-call/session: modifying the path-switch design and state-table; adding a transceiver for the first network, and in the case of the digital-form configuration, also a ADC/DAC, using them for processing incoming/outgoing signal to conform with the specifications of the first network on one hand, and with the form of communication with the MP on the other hand. These modifications are, however, straightforward, and once made, eliminate much of the difference between the three configurations from the point of view of the other elements of the present invention.

A further improvement relates to running simultaneous communication sessions on both first and second networks. This requires several modifications to be made to the design of MPG, including: adding session de-multiplexing module to the processing chain of the incoming signal on the D/S interface, just before processing by MPG or redirecting to the appropriate communication means with the network; adding session multiplexing module to the processing chain of the outgoing signal on the D/S interface, in between the processing modules and the signaling modules; when communicating through MPG's own network communication means (e.g., the multiband antenna circuitry), all communication means for the first and second network have to be powered on to the extent that receiving/transmitting packets on both networks can be performed simultaneously, in the r.f.-form configuration of MPG, a mixer has to be added to the transmission path for mixing the output of the transmitters of the two networks; in the baseband-form and digital-form configurations of MPG, when communicating through an accessory device (e.g., an external ADC/DAC), multiplexer and de-multiplexer modules should be added to the processing chains of outgoing and incoming signals, respectively. Also, modifications

to the processing and scheduling modules, and to the call control and session management modules of MPG may be required in order to facilitate this improvement. These modifications, are however straightforward, as most of them are already implied by the ability to serve multiple sessions running through a single network.

5 Up to this point, the description has concentrated on the extension of the communication capabilities of MP 100 to a single network and protocol designated as the second network and second protocol. The extension to multiple networks and protocols can be obtained by making certain modifications to the design of MPG, the key ones include: adding multi-network communication means (e.g., a multi-band transceiver) for
10 communicating through all extension networks; adding protocols implementation of the set of protocols of all extension networks; modifying the call initiation process and properties to consider all networks; providing means for attaching multiple SIM cards, SIM card logics. or SIM implementations; if more than one network communication means (e.g., multiple transceivers) are configured, modifying the power management method and the
15 path-switch logic accordingly.

Another relaxation to the description so far relates to the assumption that SIM card 117 is the original SIM card of MP 100. In fact, any SIM card is suitable for use in conjunction with the present invention, provided it conforms to the interface requirements and connection specifications. Furthermore, extension of the present invention to multiple SIM
20 cards can be achieved with the following key modifications to the design of MPG: adding multiple SIM card sockets and interfaces; modifying the SIM Wrapping Logic such that it is able to handle multiple SIM implementations; and modifying the call initiation methods to relate to multiple service providers.

The above description of the present invention has been provided for the purpose of
25 illustrating and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments as are suited
30 to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

PARTS AND MODULES TABLE

Abbreviations:

ADC/DAC – Analog-to-Digital Converter / Digital-to-Analog Converter

BS – Base Station

5 D/S – Data/Signaling

DT – (Wireless) Data Terminal (of the second network)

DUP – Duplexer

GOS – Gateway Operating System for MPG 121

MCS – Mobile Communication System 150

10 MP – Mobile Phone 100

MPG – Mobile Phone Gateway 121

MPG/GOS – A hardware/software logic implementation of a process/module

ST – A station of the second network (e.g., base station, mobile station)

TA/TE – Terminal Adapter/Terminal Equipment

15 Transceiver – RF

Note: In the fourth column, articles are differentiated from remarks by an underline.

Num	Device/ System	Assembly	<u>Article</u> / Remark	Fig.
100	MP			1, 3, 4 22–25
101	MP	Earpiece		1
103	MP	Display		1
104	MP	Keypad		1
105	MP	Microphone		1
106	MP	Antenna		1
107	MP	Ant. Socket		1
108	MP	Battery Latching		1
110	MP	Power Connector		1
111	MP	SIM Latching		1
113	MP	SIM Socket		1
114	MP	Accessory Device Socket		1
115	MP	Accessory Device Socket	<u>Engagement Recesses</u>	1
116	MP	Belt-Clip Engagement Recess		1
117	MP	SIM Card		1
118	MP	Battery		1
121	MPG			2, 3, 4 22–25

Num	Device/ System	Assembly	Article / Remark	Fig.
122	MPG	r.f. Connector		2
123	MPG	Unlock Button		2
124	MPG	Locking Recess		2
126	MPG	Power Socket		2
128	MPG	SIM card connector		2
129	MPG	Accessory Device Connector		2
131	MPG	r.f. Socket		2
132	MPG	Battery Clip		2
134	MPG	Power Connector		2
135	MPG	SIM Card Lockers		2
137	MPG	SIM Card Socket		2
138	MPG	Accessory Device Socket		2
140	MPG	Housing	For Exemplary MPG	2
141	MPG	Belt-Clip Engagement Recess		2
142	MPG	Engagement Screw		3
150	MCS 150			3, 4
201	MCS 150	SIM Interface		4
202	MCS 150	Data/Signaling (D/S) Interface		4
203	MCS 150	Clock Interface		4
204	MCS 150	Remote Sense/Indication Interface		4
205	MCS 150	Power/Recharge Interface		4
206	MCS 150	TA/TE Interface		4
207	MCS 150	SIM Card Interface		4
208	MCS 150	Battery Power/Recharge Interface		4
211	MP	SIM Interface Means		4
212	MP	D/S Interface Means		4
213	MP	Clock Interface Means		4
214	MP	Remote Sense/Indication Interface Means		4
215	MP	Power/Recharge Interface Means		4
216	MP	TA/TE Interface Means		4
221	MPG	SIM Interface Means	To MP	4
222	MPG	D/S Interface Means	To MP	4
223	MPG	Clock Interface Means	In	4
224	MPG	Remote Sense/Indication Interface Means	To MP	4
225	MPG	Power/Recharge Interface Means	To MP	4
226	MPG	TA/TE Interface Means	To MP	4
231	MPG	SIM Card Interface Means	To SIM Card 117	4
232	MPG	D/S Interface Means	To Accessory Device	4
233	MPG	Clock Interface Means	Out	4
234	MPG	Remote Sense/Indication Interface Means	To Accessory Device	4
235	MPG	Power/Recharge Interface Means	To Battery 118	4

Num	Device/ System	Assembly	Article / Remark	Fig.
236	MPG	TA/TE Interface Means	To Accessory Device	4
250	MPG	Microcontroller Logic		5,6,7
251	MPG	Digital Signal Processing Logic		5,6,7
252	MPG	Memory		5,6,7
253	MPG	SIM Card Logic		5,6,7
254	MPG	SIM Switch Logic		5,6,7
255	MPG	SIM Card Reader		5,6,7
256	MPG	ADC/DAC Logic – Second Network		5,6,7
257	MPG	Transceiver – Second Network		5,6,7
258	MPG	Antenna – First and Second Networks		5,8
259	MPG	ADC/DAC – First Network		5
260	MPG	Transceiver – First Network		5
262	MPG	Path Switch – r.f.-form configuration		5,8
263	MPG	Connector – r.f.-form configuration	Communication with MP	5,8
264	MPG	Socket – r.f.-form configuration	Communication through external device	5,8
265	MPG	Antenna – Second Network		6,7,9,10
266	MPG	Path Switch – baseband-form configuration		6,9
267	MPG	Connector – baseband-form configuration	Communication with MP	6,9
268	MPG	Socket – baseband-form configuration	Communication through external device	6,9
269	MPG	TA/TE Modem		5,6,7
270	MPG	TA/TE Switch		5,6,7
273	MPG	Bus Adapter		7,10
274	MPG	Path Switch – digital-form configuration		7,10
275	MPG	Connector – digital-form configuration	Communication with MP	7,10
276	MPG	Socket – digital-form configuration	Communication through external device	7,10
280	MPG	Internal Bus		5,6,7
281	MPG	Control Line	MCU 250 –to– Path Switch	5 – 10
282	MPG	Control Line	MCU 250 –to– TA/TE Switch	5,6,7
283	MPG	Control Line	MCU 250 –to– SIM Switch	5,6,7
284	MPG	SIM Data Line	MCU 250 – SIM Card 117	5,6,7
285	MPG	SIM Data Line	MCU 250 – MP 100	5,6,7
286	MPG	SIM Data Line	MCU 250 – SIM Card Logic 253	5,6,7
290	MPG	Traffic Controller		5,6,7
301	MPG	ADC/DAC 259	<u>DAC</u>	8,9
302	MPG	ADC/DAC 259	<u>ADC</u>	8,9

Num	Device/ System	Assembly	Article / Remark	Fig.
303	MPG	RF 260	<u>Transmitter</u>	8
304	MPG	RF 260	<u>Receiver</u>	8
305	MPG	RF 260	<u>Duplexer</u>	8
306	MPG	ADC/DAC 256	<u>ADC</u>	8,9
307	MPG	ADC/DAC 256	<u>DAC</u>	8,9
308	MPG	RF (RF) 257	<u>Receiver</u>	8
309	MPG	RF 257	<u>Transmitter</u>	8
310	MPG	RF 257	<u>Duplexer</u>	8
311	MPG	Connector 263	<u>Coax cable connector</u>	8
312	MPG	Socket 264	<u>Coax cable socket</u>	8
321	MPG	Connector 263/267/275	<u>Common Ground contact</u>	8,9,10
322	MPG	Connector 263/267/275	<u>Power contact</u>	8,9,10
323	MPG	Connector 263/267/275	<u>Remote Indication contact</u>	8,9,10
325	MPG	Socket 264	<u>Common Ground contact</u>	8,9,10
326	MPG	Socket 264	<u>Power Contact</u>	8,9,10
327	MPG	Socket 264	<u>Remote Sense Contact</u>	8,9,10
331	MPG	Path Switch 262	<u>Coax Line to Connector 311</u>	8
332	MPG	Path Switch 262	<u>Remote Indication Line to MP</u>	8,9,10
333	MPG	Path Switch 262	<u>Remote Sense Line from Accessory Device</u>	8,9,10
334	MPG	Path Switch 262	<u>Signal Line to DUP 305</u>	8
335	MPG	Path Switch 262	<u>Receivers' Bridge Line</u>	8
336	MPG	Path Switch 262	<u>Line to Antenna</u>	8
337	MPG	Path Switch 262	<u>Coax Line to Socket 312</u>	8
338	MPG	Path Switch 262	<u>Signal Line to DUP 310</u>	8
341	MPG	Connector 267	<u>Baseband Input contact</u>	9
342	MPG	Connector 267	<u>Baseband Output contact</u>	9
343	MPG	Socket 268	<u>Baseband Output contact</u>	9
344	MPG	Socket 268	<u>Baseband Input contact</u>	9
345	MPG	Path Switch 266	<u>Baseband Line Out to connector 267</u>	9
346	MPG	Path Switch 266	<u>Baseband Line In from connector 267</u>	9
347	MPG	Path Switch 266	<u>Baseband Line Out to socket 268</u>	9
348	MPG	Path Switch 266	<u>Baseband Line In from socket 268</u>	9
349	MPG	Path Switch 266	<u>Power In</u>	9,10

Num	Device/ System	Assembly	Article / Remark	Fig.
350	MPG	Path Switch 266	<u>Baseband Line In from DAC 301</u>	9
351	MPG	Path Switch 266	<u>Baseband Line Out to ADC 302</u>	9
352	MPG	Path Switch 266	<u>Power Out to RF 257</u>	9,10
361	MPG	Connector 275	<u>Bus Connector</u>	10
362	MPG	Socket 276	<u>Bus Socket</u>	10
363	MPG	Path Switch 274	<u>Bus I/O to connector 275</u>	10
364	MPG	Path Switch 274	<u>Bus I/O to socket 276</u>	10
365	MPG	Path Switch	<u>Bus I/O to Bus Adapter 273</u>	10
401	BS	Base Station – First Network		11,12,15 22 – 25
402	BS	Base Station – Second Network		13,14, 18, 19
405	GOS	MPG-Network Link Establishing – Phase 1	Mobile – Initiated Call	13
406	GOS	MPG-Network Link Establishing – Phase 2	Mobile – Initiated Call	13
407	GOS	MP-MPG Link Establishing – Phase 1	Mobile – Initiated Call	13
408	GOS	MP-MPG Link Establishing – Phase 2	Mobile – Initiated Call	13
409	GOS	MP-Network Link Establishing	Mobile – Terminated Call	14
410	GOS	MP-MPG Link Establishing	Mobile – Terminated Call	14
501	MP	ADC-to-PCM conversion	First Protocol	15,19
502	MP	Voice Coding	First Protocol	15, 19
503	MP/MPG	Digital Encoding	First Protocol	15,17,19
504	MP/MPG	Digital Modulation	First Protocol	15,17,19
505	MP	DAC	First Protocol	15
506	MP	Analog Modulation	First Protocol	15
507	MP	Transmitting	First Protocol	15
511	MP	Receiving	First Protocol	15
512	MP	Analog Demodulation	First Protocol	15
513	MP	ADC	First Protocol	15
514	MP/MPG	Digital Demodulation	First Protocol	15,16,18
515	MP/MPG	Digital Decoding	First Protocol	15,16,18
516	MP	Voice Decoding	First Protocol	15,18
517	MP	DAC from PCM	First Protocol	15,18
523	MPG/GOS	Digital Encoding	Second Protocol	16
524	MPG/GOS	Digital Modulation	Second Protocol	16
526	MPG/GOS	Analog Modulation	Second Protocol	16,20
527	BS 402	Transmitting	Second Protocol	19
531	BS 402	Receiving	Second Protocol	18

Num	Device/ System	Assembly	<u>Article</u> / Remark	Fig.
532	MPG/ BS 402	Analog Demodulation	Second Protocol	18,21
533	BS 402	ADC	Second Protocol	18
534	MPG/GOS	Digital Demodulation	Second Protocol	17
535	MPG/GOS	Digital Decoding	Second Protocol	17
550	MPG/GOS	Session Control		16,17
560	MPG/GOS	Transcoding		16,17
571	MPG/GOS BS 402	Encapsulation Method	<u>Unpacking – Second Protocol Packets</u>	18,21
572	MPG/GOS BS 402	Encapsulation Method	<u>Message Demodulation</u>	18,21
573	MPG/GOS BS 402	Encapsulation Method	<u>Message Decoding</u>	18,21
576	MPG/GOS	Configuration-Specific Processing Block	MP-to-MPG	16,20
580	BS 402	Encapsulation Method	<u>Session Control</u>	18,19
581	BS 402	Encapsulation Method	<u>Message Encoding</u>	19,20
582	MPG/GOS BS 402	Encapsulation Method	<u>Message Modulation</u>	19,20
583	MPG/GOS BS 402	Encapsulation Method	<u>Packing – Second Protocol Packets</u>	19,20
584	BS 402	DAC		19
586	MPG/GOS	Configuration-Specific Processing Block	MPG-to-MP	17,21
590	MPG/GOS	Encapsulation Method	<u>Session Control</u>	20,21
591	MPG/GOS	Encapsulation Method	<u>Channel Demultiplexing – First Protocol</u>	20
592	MPG/GOS	Encapsulation Method	<u>Message Demodulation – First Protocol</u>	20
593	MPG/GOS	Encapsulation Method	<u>Message Decoding – First Protocol</u>	20
595	MPG/GOS	Encapsulation Method	<u>Message Encoding – First Protocol</u>	21
596	MPG/GOS	Encapsulation Method	<u>Message Modulation – First Protocol</u>	21
597	MPG/GOS	Encapsulation Method	<u>Channel Multiplexing – First Protocol</u>	21
600	PLMN		First Network	22 – 25
601	NETB		Second Network	22 – 25
602	DTE-DCE		TA/TE network	24,25
603	ST		Second Network	22 – 25
604	DT		Second Network	24,25
610	MCS	MP – MPG Link		22,23,25
611	MCS	MPG – Network Link		22

Num	Device/ System	Assembly	Article / Remark	Fig.
612	MCS	MP – ST Communication Path		22,25
613	MCS	Encapsulation Method	<u>Carrier Link</u>	23
614	MCS	Encapsulation Method	<u>Payload Link</u>	23
615	MCS	Encapsulation Method	<u>MP – ST Communication Path</u>	23
616	MCS	TA/TE Link		24,25
617	MCS	MPG – DT Link		24,25
618	MCS	MP – DT Communication Path		24,25
620	MCS	DT – ST Communication Path		25
700	MPG/GOS	Management and Control Module		27
710	MPG/GOS	Path Control Logic		27
711	MPG/GOS	Path Control Logic	<u>SIM Path Control</u>	27
712	MPG/GOS	Path Control Logic	<u>TA/TE Path Control</u>	27
713	MPG/GOS	Path Control Logic	<u>D/S Path Control</u>	27
720	MPG/GOS	Service and Call Control		27
721	MPG/GOS	Service and Call Control	<u>Communication Session Manager</u>	27
722	MPG/GOS	Service and Call Control	<u>Network – Context Control</u>	27
723	MPG/GOS	Service and Call Control	<u>User Interface</u>	27
730	MPG/GOS	SIM Wrapping Logic		27
731	MPG/GOS	SIM Wrapping Logic	<u>SIM Wrapper Control Logic</u>	27
732	MPG/GOS	SIM Wrapping Logic	<u>SIM Wrapper File System</u>	27
733	MPG/GOS	SIM Wrapping Logic	<u>SIM Request/Response Handler</u>	27
740	MPG/GOS	Gateway Application Layer		27
750	MPG/GOS	Gateway Layer Services		27
760	MPG/GOS	Protocol Conversion Layer		27
770	MPG/GOS	Management Layer		27
780	MPG/GOS	D/S Interface Layer		27

CLAIMS

1. A mobile phone gateway apparatus (121) for providing wireless communication capabilities through at least second communication network in accordance with second communication protocol, to a mobile phone operative on at least first communication network in accordance with first communication protocol, said mobile phone gateway comprising:

control and processing subsystem; Subscriber Identification Module (SIM) logic subsystem; data/signaling communication subsystem; Terminal Adapter/Terminal Equipment (TA/TE) subsystem; power subsystem; and a housing (140);

said control and processing subsystem performs control, management, and processing activities, and comprises: microcontroller logic (250); digital signal processing logic (251); memory (252); internal bus (280); and traffic controller (290) for controlling communication between components of said processing subsystem and said internal bus;

said SIM logic subsystem provides a unified SIM services to said mobile phone and to said mobile phone gateway, based on SIM services provided by the mobile phone SIM card (117) and SIM services provided by said mobile phone gateway, said SIM logic subsystem comprises: SIM card reader logic (255); SIM card logic (253); SIM card connector (221); SIM card socket (231); and SIM switch (254);

said data/signaling communication subsystem provides communication means with said mobile phone and with said second network, and comprises: first communication means operative on at least said first network in accordance with said first protocol, wherein communication on said first network is done by means of physical connection and electrical communication; second communication means operative on at least said second network in accordance with said second protocol, wherein communication on said second network is done by means of wireless radio frequency (r.f.) signaling; wireless communication interface means; first communication interface means; second communication interface means; communication path switching means (262, 266, 274);

said TA/TE subsystem interconnects wireless data terminals of said second network with said mobile phone;

said power subsystem provides means for connecting said mobile phone and said mobile phone gateway to common power sources;

said mobile phone gateway controls communication sessions initiation and management by wrapping SIM functionality, and processes, converts, and routes data and

signaling packets of said communication sessions in-between said first communication interface means and any one of said wireless communication interface means or said second communication interface means.

2. The mobile phone gateway of claim 1, wherein said second communication means
5 comprises:

analog-to-digital and digital-to-analog conversion (ADC/DAC) logic (256), and second transceiver logic (257), all operative in accordance with at least said second network and at least said second protocol.

3. The mobile phone gateway of claim 2, wherein said SIM switch (254) operative by
10 instruction from said control and processing subsystem to switch between:

first state, wherein said SIM card connector (221) is connected to said SIM card socket (231); and second state, wherein said SIM card connector is connected to said microcontroller logic (250), said SIM card socket is connected to said SIM card reader (255), and said SIM card reader is connected to said microcontroller logic.

15 4. The mobile phone gateway of claim 3, wherein:

said housing (140) is formed such that said mobile phone gateway can be physically integrated with a mobile phone of a particular make and model after removing the battery (118) and the mobile phone SIM card (117), said housing comprises:

first latching means for securing said mobile phone gateway to said mobile phone;
20 second latching means for securing said mobile phone SIM card to said SIM card socket;
third latching means for securing said battery of said mobile phone to said mobile phone gateway; fourth latching means for securing said mobile phone gateway to accessory devices designed for use with said mobile phone.

5. The mobile phone gateway of claim 4, wherein said power subsystem comprises:

25 power/recharge socket (225), mating to power/recharge connector (215) of said mobile phone; power/recharge connector (235), mating to power/recharge socket of the battery of said mobile phone, and means for relaying power/recharge between said power/recharge connector and said power/recharge socket.

6. The mobile phone gateway of claim 5, wherein said first communication interface
30 means comprises: first data/signaling interface means (222) complementary to a mating data/signaling interface means (212) of said mobile phone; remote indication interface

means (224) complementary to a mating remote sense interface means (214) of said mobile phone.

7. The mobile phone gateway of claim 6, wherein said second communication interface means comprises: second data/signaling interface means (232) complementary to a mating data/signaling interface means of accessory devices formed for use with said mobile phone; remote sense interface means (234) complementary to a mating remote indication interface means of accessory devices formed for use with said mobile phone.

8. The mobile phone gateway of claim 7, wherein said TA/TE subsystem comprises:

first TA/TE interface means (226) mating to a TA/TE interface means (216) of said mobile phone, second TA/TE interface means (236) mating to a TA/TE interface means of accessory devices formed for use with said mobile phone, TA/TE switch (270), and TA/TE modem (269);

said TA/TE switch operative by instruction from said control and processing subsystem to switch between: first TA/TE state, wherein said first TA/TE interface means is connected to said second TA/TE interface means; and second TA/TE state, wherein said first TA/TE interface means is connected to said TA/TE modem;

said mobile phone gateway controls communication sessions initiation and management by wrapping SIM functionality, and converts, processes, and routes data and signaling packets of said communication sessions in-between said first TA/TE interface means and said wireless communication interface means.

9. The mobile phone gateway of claim 8, wherein said wireless communication interface means comprises an antenna circuitry (258) operative on at least said first network in accordance with said first protocol, and on said second network in accordance with said second protocol.

10. The mobile phone gateway of claim 9, wherein:

said communication path switching means operative by instruction from said control and processing subsystem to switch between:

first switching state, wherein said first communication interface means is connected to said second communication interface means and said second communication means is powered off;

second switching state, wherein said first communication interface means is connected to said first communication means, and said second communication means is connected to said second communication interface means;

third switching state, wherein said first communication interface means is connected to
5 said first communication means, and said second communication means is connected to said wireless communication interface means;

fourth switching state, wherein said first communication interface means is connected to said second communication interface means, and said second communication means is connected to said wireless communication interface means;

10 fifth switching state, wherein said first communication interface means and said second communication interface means are connected to said wireless communication interface means;

sixth switching state, wherein said first communication interface means and said second communication means are connected to said second communication interface
15 means;

said communication path switching means further characterized in that:

when in any one of said second, said third, or said fifth switching state, the signal on said remote indication interface means is positive;

said communication path switching means switches from said third to said second
20 switching state when signal on said remote sense interface means is positive, and from said second to said third switching state when signal on said remote sense interface means is negative;

said communication path switching means switches from said fifth to said sixth
switching state when signal on said remote sense interface means is positive, and from said
25 sixth to said fifth switching state when signal on said remote sense interface means is negative.

11. The mobile phone gateway of claim 10, wherein:

said first data/signaling interface means (222) comprises radio frequency (r.f.)
connector; said second data/signaling interface means (232) comprises r.f. socket; and said
30 first communication means comprises ADC/DAC logic (259), and first transceiver logic (260). all operative in accordance with said first network and said first protocol.

12. The mobile phone gateway of claim 11, wherein:

when said communication path switching means is in said second switching state, the receiver part of said first transceiver connects to said second communication interface means, and when said communication path switching means is in said third switching state, said receiver part connects to said wireless communication interface means.

5 13. The mobile phone gateway of claim 8, wherein said wireless communication interface means comprises an antenna circuitry (265) operative on at least said second network in accordance with said second protocol.

14. The mobile phone gateway of claim 13, wherein:

10 said communication path switching means operative by instruction from said control and processing subsystem to switch between:

first switching state, wherein said first communication interface means is connected to said second communication interface means, and said second communication means is powered off;

15 second switching state, wherein said first communication interface means is connected to said second communication interface means, and said second communication means is powered on;

third switching state, wherein said first communication interface means is connected to said first communication means, and said second communication means is powered on;

20 fourth switching state, wherein said first communication interface means is connected to said first communication means, and said second communication means is powered off;

said communication path switching means further characterized in that:

when in any one of said second, said third, or said fourth switching state, the signal on said remote indication interface means is positive;

25 said communication path switching means switches from said second to said first switching state when signal on said remote sense interface means is positive, and from said first to said second switching state when signal on said remote sense interface means is negative;

30 said communication path switching means switches from said third to said fourth switching state when signal on said remote sense interface means is positive, and from said fourth to said third switching state when signal on said remote sense interface means is negative..

15. The mobile phone gateway of claim 14, wherein:

said first data/signaling interface means (222) comprises r.f. connector; said second data/signaling interface means (232) comprises r.f. socket; and said first communication means comprises first ADC/DAC logic (259), and first transceiver logic (260), all operative in accordance with at least said first network and at least said first protocol.

5 16. The mobile phone gateway of claim 14, wherein:

said first data/signaling interface means (222) comprises first baseband connector for baseband communication; said second data/signaling interface means (232) comprises second baseband socket for baseband communication; and said first communication means comprises first ADC/DAC logic (259), operative in accordance with said first network and
10 said first protocol.

17. The mobile phone gateway of claim 14, wherein:

said first data/signaling interface means (222) comprises first digital bus connector for digital communication; said second data/signaling interface means (232) comprises second digital bus connector for digital communication; and said first communication means
15 comprises bus adapter (273), coupled to said first digital bus connector through said communication path switching means, and to said internal bus (280) of said mobile phone gateway, to obtain physical, electrical, and logical compatibility between said internal bus and said first data/signaling interface means.

18. A communication system (150) for providing communication capabilities through a
20 plurality of communication networks using a plurality of communication protocols, said communication system comprising:

a mobile phone (100) operative in accordance with at least first network and first protocol, said mobile phone comprising a mobile phone body, a mobile phone Subscriber Identification Module (SIM) card (117), SIM interface means (211) for communicating
25 with said mobile phone SIM card, and data/signaling interface means (212) for communicating with said first network through a physically attached external device;

the mobile phone gateway (121) of claim 1, said mobile phone gateway formed and designed to be coupled and operate with said mobile phone;

a collection of interfaces between said mobile phone and said mobile phone gateway,
30 comprising: first SIM interface (201) established through said SIM interface means of said mobile phone and the first SIM interface means of said mobile phone gateway, and data/signaling communication interface (202) established through said data/signaling

interface means of said mobile phone and the data/signaling interface means of said mobile phone gateway;

second SIM interface (207) established through the second SIM interface means of said mobile phone gateway and SIM interface means of said mobile phone SIM card;

5 an arrangement of said mobile phone and said mobile phone gateway, characterized in that: mating interface means of said mobile phone, said mobile phone gateway, and said mobile phone SIM card plug into each other, communication between said mobile phone and said mobile phone SIM card passes through and controlled by said mobile phone gateway, and communication between said mobile phone and said second network passes
10 through and processed by said mobile phone gateway;

a plurality of communication paths for communicating data and signaling between said mobile phone and terminals of said second network through said mobile phone gateway.

19. The communication system of claim 18, wherein:

said data/signaling interface is an r.f. interface established through a physical
15 connection and characterized in that signaling is performed by means of radio frequency signaling on the frequency bands of said first network.

20. The communication system of claim 18, wherein:

said data/signaling interface is a baseband interface established through a physical connection and characterized in that signaling is performed by means of baseband
20 frequency signaling on the baseband frequency bands of said first network.

21. The communication system of claim 18, wherein:

said data/signaling interface is a digital interface established through a physical connection and characterized in that signaling is performed by means of digital signaling in accordance with digital signaling specifications of said mobile phone.

25 22. The communication system of claim 18, wherein:

said collection of interfaces further comprises a clock interface (203), established through a clock interface means (213) of said mobile phone and an external clock interface means (223) of said mobile phone gateway

23. The communication system of claim 18, wherein:

30 said collection of interfaces further comprises a remote sense/indication interface (204) established through a remote sense interface means (214) of said mobile phone and remote indication interface means (224) of said mobile phone gateway, said remote

sense/indication interface characterized in that: said mobile phone gateway turns on signaling on said remote sense/indication interface when communication between said mobile phone and a communication network has to pass through it; said mobile phone disables its own network communication means and directs communication with the communication network through said data/signaling interface means whenever the signal on said remote sense/indication interface is positive.

24. The communication system of claim 18, wherein said collection of communication paths comprises a communication path (612), said communication path comprising:

first link (610), established between said mobile phone and said mobile phone gateway through said data/signaling interface; second link (611), established between said mobile phone gateway and first terminal (603) of said second network, said second link operative in accordance with said second protocol.

25. The communication system of claim 18, wherein said collection of communication paths comprises a communication path (615), said communication path comprising:

first link (610), established between said mobile phone and said mobile phone gateway through said data/signaling interface; carrier link (613), said carrier link is a network-level communication link established between said mobile phone gateway and first terminal (603) of said second network and operative in accordance with said second protocol; and payload link (614) for exchanging data between said mobile phone and said first terminal, said payload link is an application-level link occupying the payload segments of packets of said carrier link, with content in accordance with said first protocol.

26. The communication system of claim 18, wherein:

said collection of interfaces further comprises a Terminal Adapter/Terminal Equipment (TA/TE) interface (206), established through a TA/TE interface means (216) of said mobile phone and a TA/TE interface means (226) of said mobile phone gateway, said TA/TE interface operative in accordance with the TA/TE communication protocol supported by said mobile phone.

27. The communication system of claim 26, wherein said collection of communication paths comprises a communication path (618, 620), said communication path comprising:

first link (616), established between said mobile phone and said mobile phone gateway through said TA/TE interface; second link (617), established between said mobile phone

gateway and second terminal (604) of said second network, said second link operative in accordance with said second protocol.

28. The communication system of claim 27, wherein said communication path further comprising:

5 third link (610), established between said mobile phone and said mobile phone gateway through said data/signaling interface; fourth link (611), established between said mobile phone gateway and first terminal (603) of said second network, said second link operative in accordance with said second protocol.

29. The communication system of claim 28, wherein said communication path further
10 comprising:

third link (610), established between said mobile phone and said mobile phone gateway through said data/signaling interface; carrier link (613), said carrier link is a network-level communication link established between said mobile phone gateway and first terminal (603) of said second network and operative in accordance with said second protocol; and
15 payload link (614) for exchanging data between said mobile phone and said first terminal, said payload link is an application-level link occupying the payload segments of packets of said carrier link, with content in accordance with said first protocol.

30. The communication system of claim 18, wherein said arrangement of said mobile phone and said mobile phone gateway is obtained by an assembly method, said assembly
20 method comprising the steps of:

detaching the battery and said mobile phone SIM card from said mobile phone; attaching the front side of said mobile phone gateway to the back side of said mobile phone, such that mating interface means and latching means plug into each other; attaching said mobile phone SIM card to the rear side of said mobile phone gateway, such that
25 mating interface means and latching means plug into each other; and attaching said battery to the rear side of said mobile phone gateway such that mating interface and latching means plug into each other.

31. A gateway operating system for the mobile phone gateway of the communication system of claim 26, wherein the mobile phone supports at least menu selection Subscriber
30 Identification Module (SIM) services, call control SIM services, and proactive SIM services, said gateway operating system initiates, manages, and terminates a plurality of communication sessions between the mobile phone and at least the second network, and

applies gateway applications, protocol conversion processing, and inter-networking services to said communication sessions, said gateway operating system comprises:

path control logic (710), comprising control means for switching SIM card path, data/signaling path, and Terminal Adapter/Terminal Equipment (TA/TE) communication path in accordance with the state of said mobile phone gateway and with the required service;

session control module (721) for managing and controlling a communication session and for processing session control messages;

Network-context control (722) for setting said mobile phone gateway such that said mobile phone communicates with any one of said first network or said second network;

user interface services (723) for providing means for interacting with said mobile phone and means for interacting with the user through the user interface of said mobile phone;

SIM wrapper control logic (731) for controlling interaction through the first SIM interface (201) and through the second SIM interface (207);

SIM wrapper file system (732) that builds upon the file system of the mobile phone SIM card and upon the file system of the SIM card logic (253) of said mobile phone gateway, to provide a unified SIM file system to be accessed by said mobile phone and by said gateway operating system;

SIM wrapping method for interacting as a SIM server with said mobile phone through said first SIM interface (201), and as a SIM client with said mobile phone SIM card through said second SIM interface (207);

call control services for handling the initiation and termination phases of mobile-originated and mobile-terminated calls;

TA/TE communication services for providing communication capabilities between said mobile phone and wireless data terminals, said TA/TE communication services comprising means for communicating with said mobile phone through said TA/TE interface in accordance with a TA/TE communication protocol;

inter-network services for providing inter-network call-wait and call-hold services;

gateway applications for conducting interaction between said mobile phone and said second network in accordance with the specifications of said gateway applications;

adaptive scheduling method for adaptively scheduling packets reception, processing and transmission between said mobile phone and said second network;

protocol conversion methods for conversion of data/signaling packets between the first protocol applied to the communication link between said mobile phone and said mobile phone gateway, and said second protocol applied to the communication link between said mobile phone gateway and said second network;

5 state machine implementation which implements state space definition and state transition specifications.

32. The gateway operating system of claim 31, wherein said SIM wrapping method comprises the steps of:

trapping events and requests issued by said mobile phone through said first SIM
10 interface (201); determining if an event or a request should be processed by said gateway operating system, or by said mobile phone SIM card, or by both of them in sequence; delegating events, requests, and responses in-between said mobile phone gateway and said mobile phone SIM card; delegating events, requests, and responses in-between said mobile phone and either said mobile phone gateway or said mobile phone SIM card;
15 synchronizing said SIM wrapper file system with the file system of said mobile phone SIM card and the file system of said SIM card logic of said mobile phone gateway.

33. The gateway operating system of claim 32, wherein said user interface services comprises:

menus, menu items, and menu selection handling methods for managing and
20 controlling said mobile phone gateway; keypad events handling methods; timer events handling methods; audiovisual stimuli sent to said mobile phone; and user interface services for use by said gateway applications.

34. The gateway operating system of claim 33, wherein said user interface services characterized in that:

25 interaction is performed through any one of the first SIM interface (201), the data/signaling interface (202), or the TA/TE interface (206);

interaction performed through said first SIM interface are provided by means of SIM services supported by said mobile phone;

and said menus and said menu items are integrated with the original menus and menu
30 items of said mobile phone as implemented by said mobile phone SIM card.

35. The gateway operating system of claim 34, wherein said state machine comprises:

OFF state, characterized in that: all but user interface means related to the activation of said mobile phone gateway are turned off; all but menu event handling through said first SIM interface are delegated to said mobile phone SIM card; said first data/signaling interface means is switched to said second data/signaling interface means; the first TA/TE interface means (226) is switched to the second TA/TE interface means (236);

READY state, characterized in that: paging requests may be sent to and received from said second network; no communication session is established between said mobile phone and any network;

RELAY state, characterized in that: said mobile phone conducts a communication session with said first network; said mobile phone gateway waits for CALL DISCONNECTED event to be issued through said first SIM interface; while waiting, said mobile phone gateway listens to the control and paging channels of said second network; when trapping a CALL DISCONNECTED event, said mobile phone gateway returns to READY state;

ACTIVE state, characterized in that: a communication session is conducted between said mobile phone and said second network through said mobile phone gateway; said mobile phone gateway applies a protocol conversion method to said communication session.

36. The gateway operating system of claim 35, wherein said call-control services comprises a method for mobile-originated call control, said method for mobile-originated call control comprising the steps of:

receiving a call initiation request from said mobile phone through said first SIM interface; determining the network through which the call should be routed; and applying network-dependent processing, such that:

if the call should be routed through said first network, said network-dependent processing steps comprising: delegating processing of said call initiation request to said mobile phone SIM card; returning response to said mobile phone; switching to first network-context; and switching state to said RELAY state;

if the call should be routed through said second network, said network-dependent processing steps comprising: establishing a communication path between said mobile phone and said second network; switching to second network-context; transpassing call setup information in-between said mobile phone and said second network; determining the

gateway application which will be handling the call; switching state to said ACTIVE state; and passing control to said gateway application.

37. The gateway operating system of claim 36, wherein said call control services further comprising a first method for mobile-terminated call control, said first method for
5 mobile-terminated call control comprising the steps of:

receiving an event through said first SIM interface indicating a mobile-terminated call is being established between said mobile phone and said first network; delegating events, requests, and responses in-between said first SIM interface and said second SIM interface; switching to said first network-context; and once a communication session has been
10 established, switching state to said RELAY state.

38. The gateway operating system of claim 37, wherein said call control services further comprising a second method for mobile-terminated call control. said second method for mobile-terminated call control comprising the steps of:

receiving a paging request through said second network; establishing a communication
15 link between said mobile phone and said mobile phone gateway; switching to second network-context; sending a paging request to said mobile phone; establishing a communication link between said mobile phone gateway and said second network; transpassing call setup information in-between said mobile phone and said second network; determining the gateway application that will be handling the call; switching state
20 to said ACTIVE state; passing control to said gateway application.

39. The gateway operating system of claim 38, wherein the step of establishing a communication path between said mobile phone and said second network further comprising the steps of:

establishing a MP-MPG link between said mobile phone and said mobile phone
25 gateway in accordance with said first protocol; establishing a MPG-Network link between said mobile phone gateway and said second network in accordance with said second protocol.

40. The gateway operating system of claim 39, wherein the step of establishing any one of a MP-MPG link or a MPG-Network link comprises the steps of:

30 allocating uplink and downlink communication channels; authenticating; setting ciphering mode; and negotiating appropriate transmission power level.

41. The gateway operating system of claim 40, wherein:

when authenticating with said second network, said SIM card logic of said mobile phone gateway is used; when authenticating with said mobile phone, said mobile phone SIM card is used; authentication and ciphering keys produced during call initiation phase are stored to be used during call initiation and call processing phases.

5 42. The gateway operating system of claim 41, wherein said protocol conversion methods comprises first conversion method, said first conversion method comprising:

first processing thread, characterized in that: packets received through said MP-MPG link are interpreted using ciphering keys produced during call initiation phase and in accordance with said first protocol, obtaining first control data and first payload data; said
10 first payload data is transcoded into the data format of said second protocol; said first control data is processed by said first processing thread; control messages produced by said first processing thread are multiplexed with transcoded payload data, resulting packets to be transmitted through said MP-Network link;

second processing thread, characterized in that: packets received through said MPG-
15 Network link are interpreted using ciphering keys produced during call initiation phase and in accordance with said second protocol, obtaining second control data and second payload data; said second payload data is transcoded into the data format of said first protocol; said second control data is processed by said second processing thread; control messages produced by said second processing thread are multiplexed with transcoded payload data,
20 resulting packets to be transmitted through said MP-MPG link.

43. The gateway operating system of claim 42, wherein said protocol conversion methods further comprises second conversion method, said second conversion method comprising:

processing initiation phase wherein the ciphering keys using which said mobile phone
25 encodes payload data are communicated to the peer terminal of said second network;

first processing thread characterized in that: packets received through said MP-MPG link are de-multiplexed into first control segments and first payload segments in accordance with said first protocol; said first control segments are interpreted using control data ciphering key produced during call initiation phase, and then processed by said first
30 processing thread; said first payload segments are encapsulated within second protocol packets payload segments; control messages produced by said first processing thread are

multiplexed into second protocol packets control segments to be transmitted through said MPG-Network link;

second processing thread characterized in that: packets received through said MPG-Network link are de-multiplexed into second control segments and second payload
5 segments of said second protocol; said second control segments are interpreted using control data ciphering key produced during call initiation phase, and then processed by said second processing thread; said second payload segments are encapsulated within first protocol packets payload segments; control messages produced by said second processing thread are multiplexed into first protocol packets control segments to be transmitted
10 through said MP-MPG link.

44. The gateway operating system of claim 43, wherein said adaptive scheduling method is characterized in that:

received packets are stored in memory and scheduled for processing; processing times are scheduled in-between receiving times and due transmission times; re-scheduling time is
15 computed and scheduled for re-aligning processing by said mobile phone gateway with said receiving times and said due transmission times, such that minimal dropouts and delays occur as a result of processing by said mobile phone gateway.

45. The gateway operating system of claim 44, wherein said state machine further comprising:

20 CALL WAIT state, characterized in that: said mobile phone is conducting a communication session with any one of said first network or said second network; a paging request has been received from a network, wherein the network is not the one with which said communication session is conducted; said gateway operating system has notified said mobile phone about said paging request;

25 CALL HOLD state, characterized in that:

at least one communication session was initiated and not yet ended; the user put at least one communication session into hold.

46. The gateway operating system of claim 45, wherein said inter-network services comprises first call-wait service, characterized in that:

30 said gateway operating system is in said RELAY state; a paging request is received through said second network; a CALL WAIT message is sent to said second network; a

CALL WAIT notification is issued to the user using said user interface services; said gateway operating system enters said CALL WAIT state.

47. The gateway operating system of claim 46, wherein said inter-network services further comprising first call-hold service, characterized in that:

5 said mobile phone gateway is in said ACTIVE state; a CALL HOLD keypad event is received through said first SIM interface; a CALL HOLD message is sent to said second network; said gateway operating system enters said CALL HOLD state.

48. The gateway operating system of claim 47, wherein said inter-network services further comprising first inter-network call-resume service, characterized in that:

10 first communication session with said first network is currently active; second communication session with said second network was put into hold; a CALL RESUME keypad event is received through said first SIM interface; said gateway operating system waits until said first communication session is put into hold; said gateway operating system requests said second network to resume said second communication session; said gateway
15 operating system switches to said second network-context, resumes said second communication session, and enters said ACTIVE state.

49. The gateway operating system of claim 48, wherein said inter-network services further comprising second inter-network call-resume service, characterized in that:

20 second communication session with said second network is currently active; first communication session with said first network was put into hold; a CALL RESUME message is received through said MP-MPG link; said gateway operating system sends CALL HOLD message to said second network; said gateway operating system sends a message to said mobile phone through said MP-MPG link of said second communication session, indicating the CALL RESUME message should be sent again; said gateway
25 operating system switches to said second network-context and enters said RELAY state.

50. The gateway operating system of claim 49, wherein said switching to first network-context comprises the steps of:

30 turning off signal on said remote indication interface; breaking communication links with said second network; and powering down hardware elements of said mobile phone gateway other than those required for monitoring powering-up user-interface events.

51. The gateway operating system of claim 50, wherein said switching to second network-context comprises the steps of:

powering up hardware elements of said mobile phone gateway required for operation as a gateway and call routing device; establishing a control communication link with said second network; switching said data/signaling interface to said first communication means; and turning on signaling on said remote indication interface.

5 52. The gateway operating system of claim 51, wherein the step of establishing a communication path further comprising the steps of:

switching the first TA/TE interface means of said mobile phone gateway to the TA/TE modem of said mobile phone gateway; establishing second MP-MPG link between said mobile phone and said mobile phone gateway through said TA/TE interface and in
10 accordance with a TA/TE protocol; establishing a MPG-Network link between said mobile phone gateway and second terminal on said second network.

53. The gateway operating system of claim 49, wherein:

when not in OFF state, said remote indication interface means is constantly turned on.

54. The gateway operating system of claim 53, wherein said switching to first network-
15 context comprises switching said data/signaling interface to pass through the wireless communication interface means of said mobile phone gateway.

55. The gateway operating system of claim 54, wherein said switching to second network-context comprises switching said data/signaling interface to pass through the first communication means of said mobile phone gateway.

20 56. The gateway operating system of claim 55, wherein the step of establishing a communication path further comprising the steps of:

establishing second MP-MPG link between said mobile phone and said mobile phone gateway through said TA/TE interface and in accordance with a TA/TE protocol; and establishing a MPG-Network link between said mobile phone gateway and second terminal
25 on said second network.

57. The gateway operating system of claim 55, wherein said inter-network services further comprising second call-wait service, characterized in that:

said gateway operating system is in said ACTIVE state; a paging request is received through said first communication means; a CALL WAIT message is sent to said mobile
30 phone through said MP-MPG link of the active communication session; said gateway operating system enters said CALL WAIT state.

58. The gateway operating system of claim 56, wherein said state machine further comprising:

ROAM-IN state, characterized in that: a communication session is conducted between said mobile phone and said first network; a ROAM-IN request was sent to said second network; said gateway operating system waits for acknowledgment message;

ROAM-OUT state, characterized in that: a communication session is conducted between said mobile phone and said second network; a ROAM-OUT request was sent to said second network; said gateway operating system waits for acknowledgment message.

59. The gateway operating system of claim 58, wherein said first and said second networks support roaming from said first to said second network. said inter-network services further comprising roam-in service, characterized in that:

said gateway operating system is in said RELAY state; said mobile phone gateway enters the communication range of said second network; preferences setting indicate said communication session should continue on said second network; said gateway operating system sends a ROAM-IN message to said second network; when acknowledged, said gateway operating system switches to said second network-context. establishes a communication path between said mobile phone and said second network. and enters said ACTIVE state.

60. The gateway operating system of claim 58, wherein said first and said second network support roaming from said second to said first network, said inter-network services further comprising roam-out service, characterized in that:

said gateway operating system is in said ACTIVE state; said gateway operating system concludes it is going out of communication range with said second network; preferences setting indicate said communication session should continue on said first network; said gateway operating system sends a ROAM-OUT message through said MPG-Network link of the active communication session; when acknowledged, said gateway operating system breaks the communication path between said mobile phone and said second network, switches to said first network-context, and enters said RELAY state.

61. The mobile phone gateway of any one of claims 12, 15, 16, or 17, or the communication system of any one of claims 18, 19, 20, 21, 24, 25, 28, 29, or 30. or the gateway operating system of any one of claims 51, 52, 55, 56, 57, 59, or 60, wherein:

said first network is a GSM network; said first protocol is the GSM protocol; said second network is a UMTS network; said second protocol is the UMTS protocol.

62. The mobile phone gateway of any one of claims 12, 15, 16, or 17, or the communication system of any one of claims 18, 19, 20, 21, 24, 25, 28, 29, or 30, or the gateway operating system of any one of claims 51, 52, 55, 56, 57, 59, or 60, wherein:

said first network is a GSM network; said first protocol is the GSM protocol; said second network operates in an unlicensed industry, scientific, and Medical (ISM) radio frequency (r.f.) band; said second protocol is the Bluetooth protocol.

63. The mobile phone gateway of any one of claims 12, 15, 16, or 17, or the communication system of any one of claims 18, 19, 20, 21, 24, 25, 28, 29, or 30, or the gateway operating system of any one of claims 51, 52, 55, 56, 57, 59, or 60, wherein:

said first network is a CDMA network; said first protocol is the CDMA protocol; said second network operates in an unlicensed ISM r.f. band; said second protocol is the Bluetooth protocol.

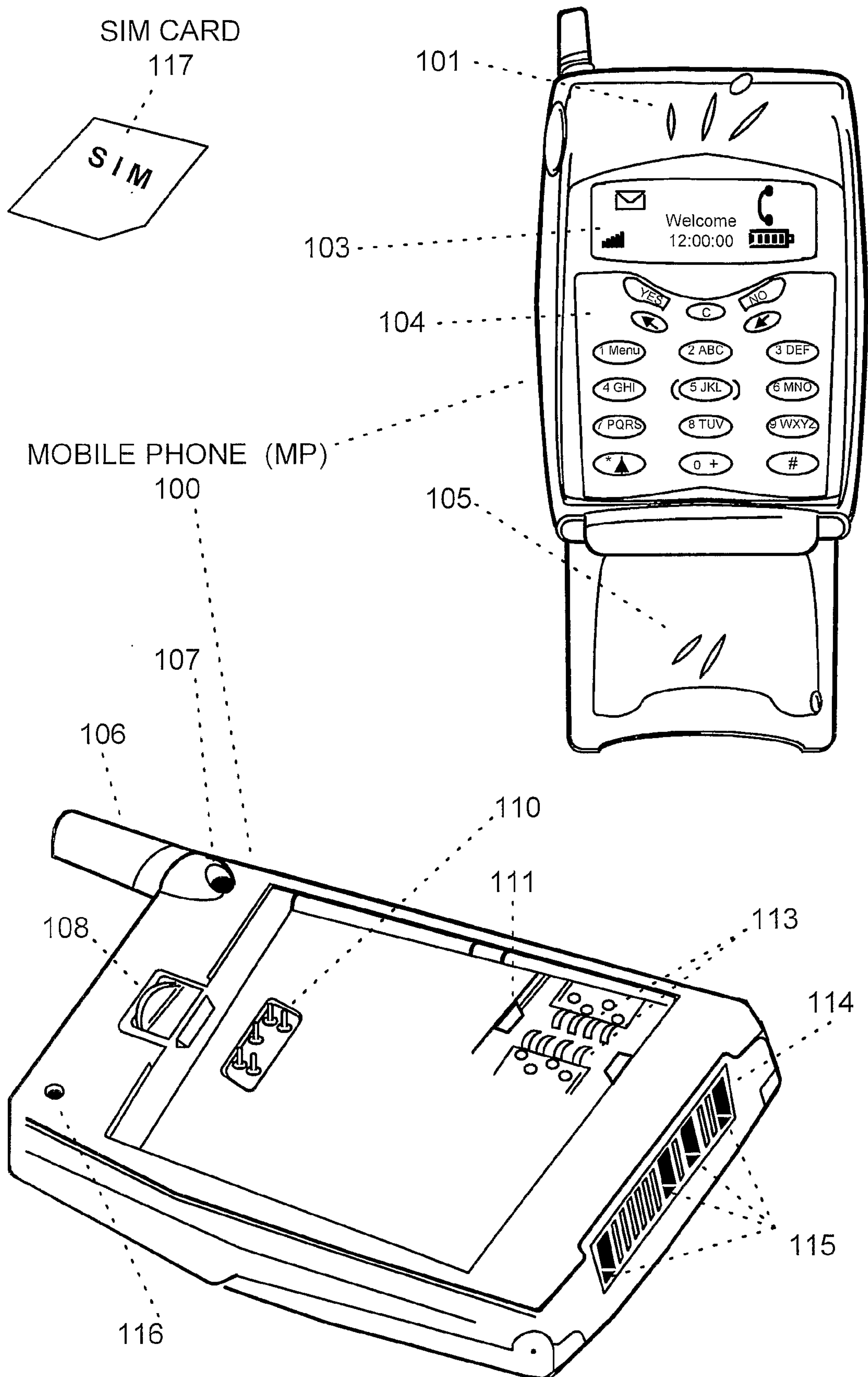
64. The mobile phone gateway of any one of claims 12, 15, 16, or 17, or the communication system of any one of claims 18, 19, 20, 21, 24, 25, 28, 29, or 30, or the gateway operating system of any one of claims 51, 52, 55, 56, 57, 59, or 60, wherein:

said first network is a UMTS network; said first protocol is the UMTS protocol; said second network operates in an unlicensed ISM r.f. band; said second protocol is the Bluetooth protocol.

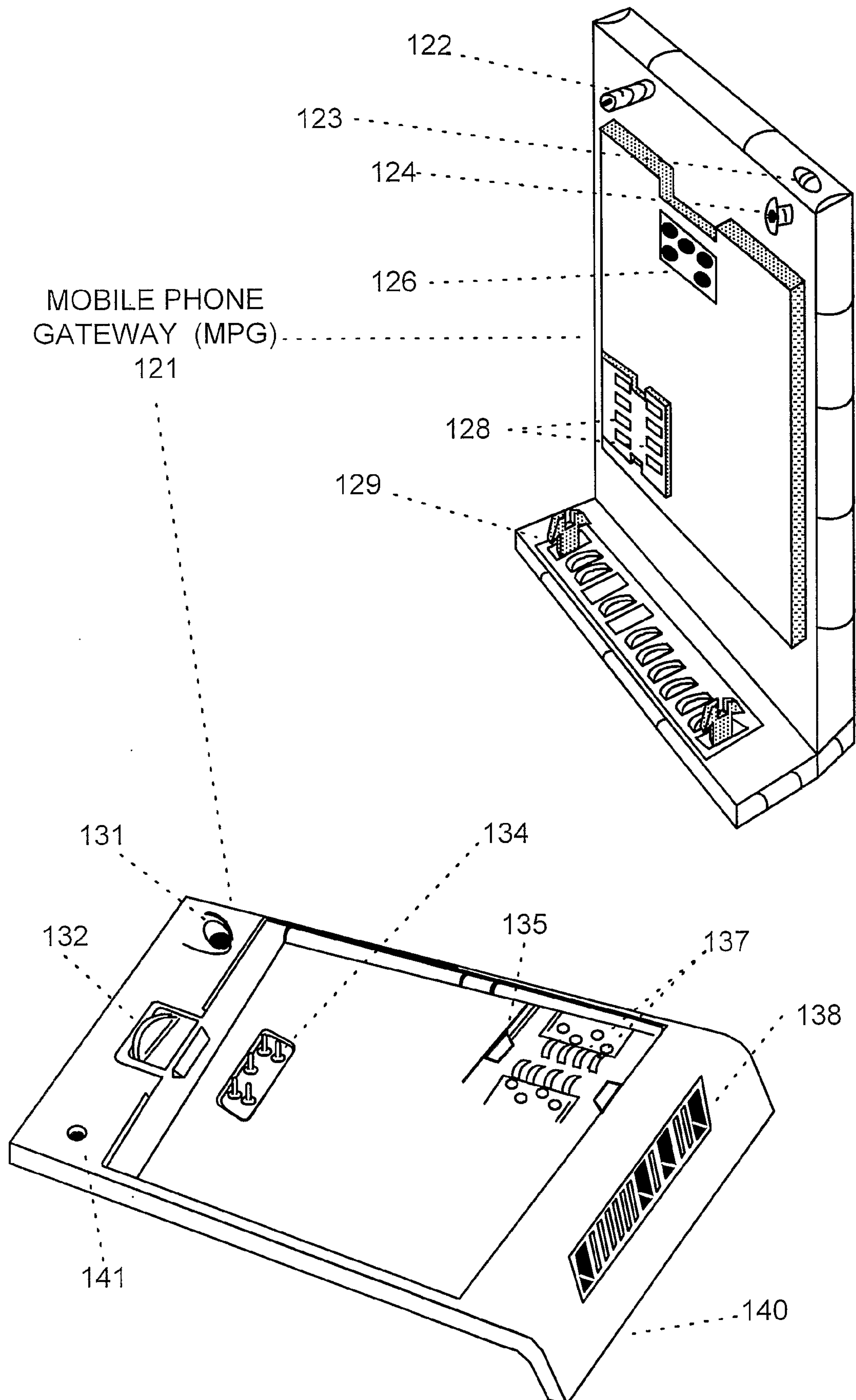
65. The mobile phone gateway of any one of claims 12, 15, 16, or 17, or the communication system of any one of claims 18, 19, 20, 21, 24, 25, 28, 29, or 30, or the gateway operating system of any one of claims 51, 52, 55, 56, 57, 59, or 60, wherein:

said first network is a CDMA2000 network; said first protocol is the CDMA2000 protocol; said second network operates in an unlicensed ISM r.f. band; said second protocol is the Bluetooth protocol.

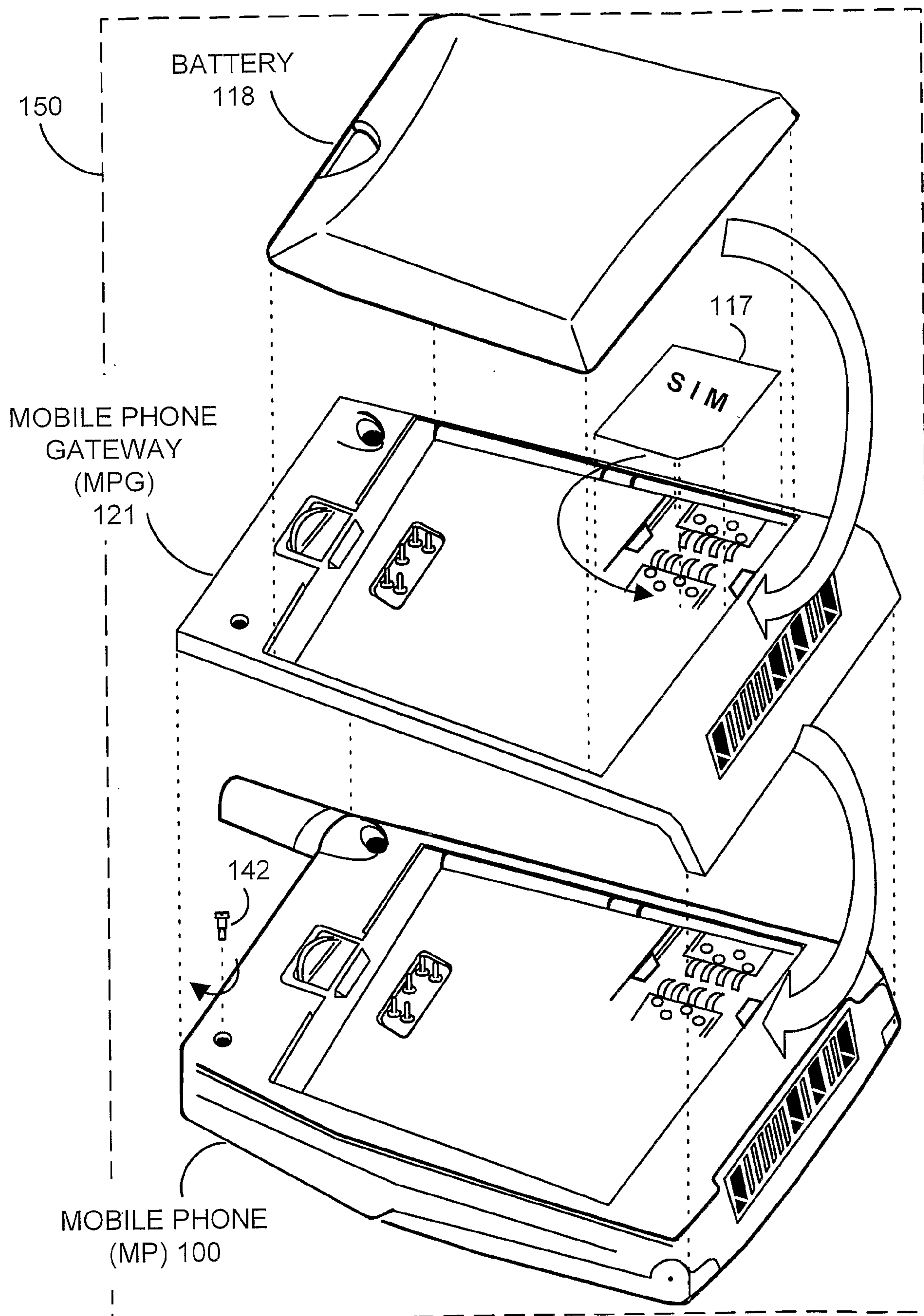
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**Fig. 1 (Prior Art)**

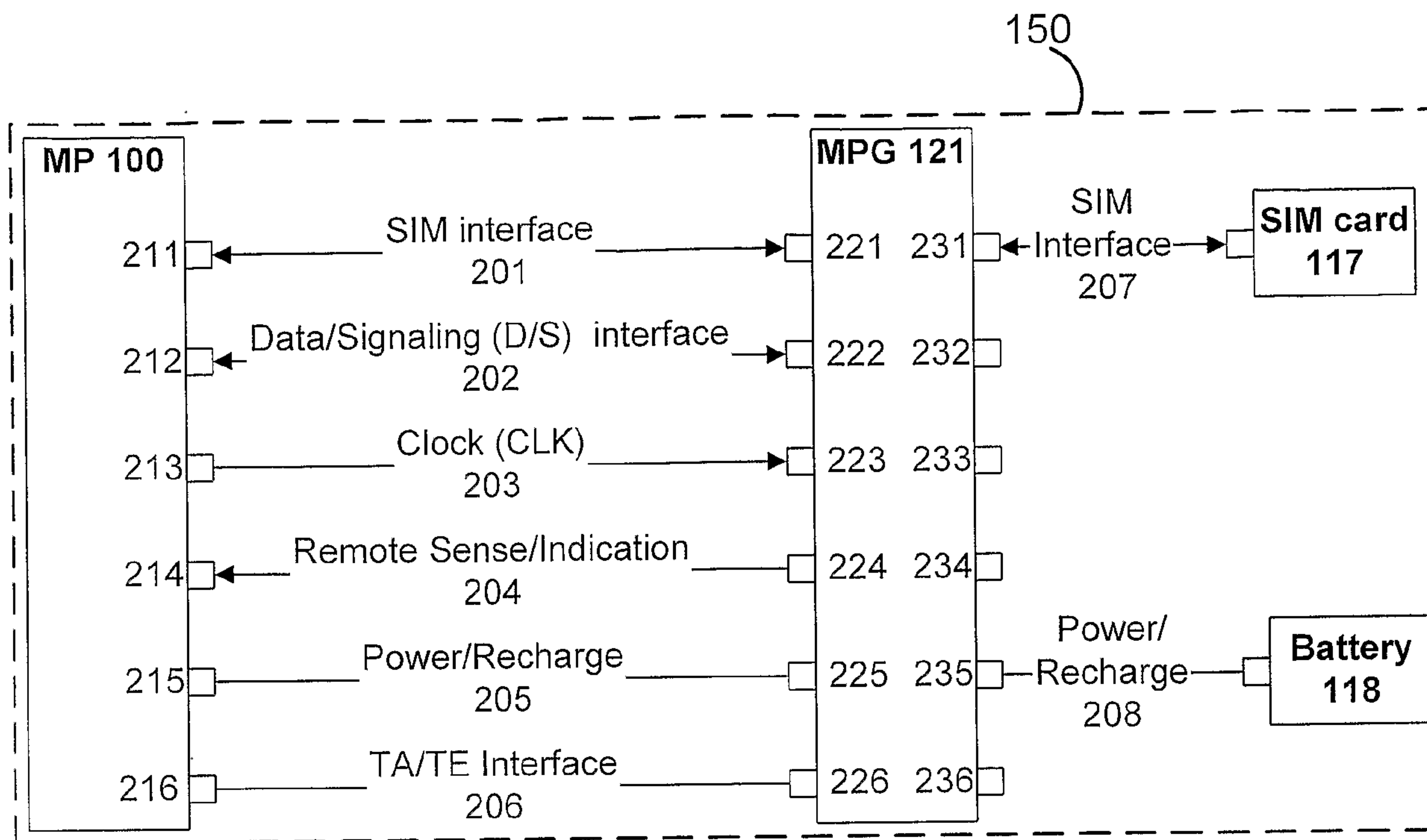
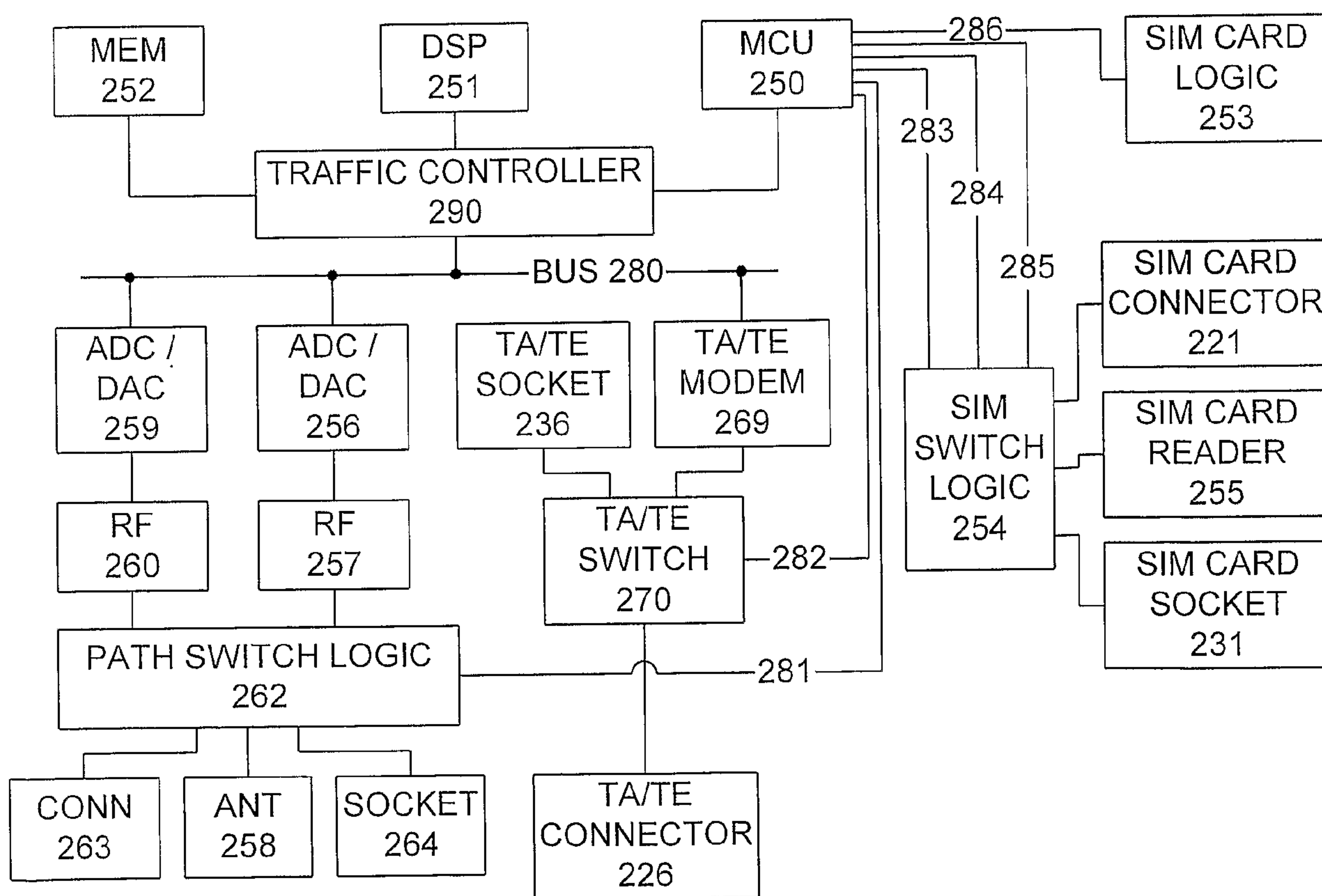
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**Fig. 2**

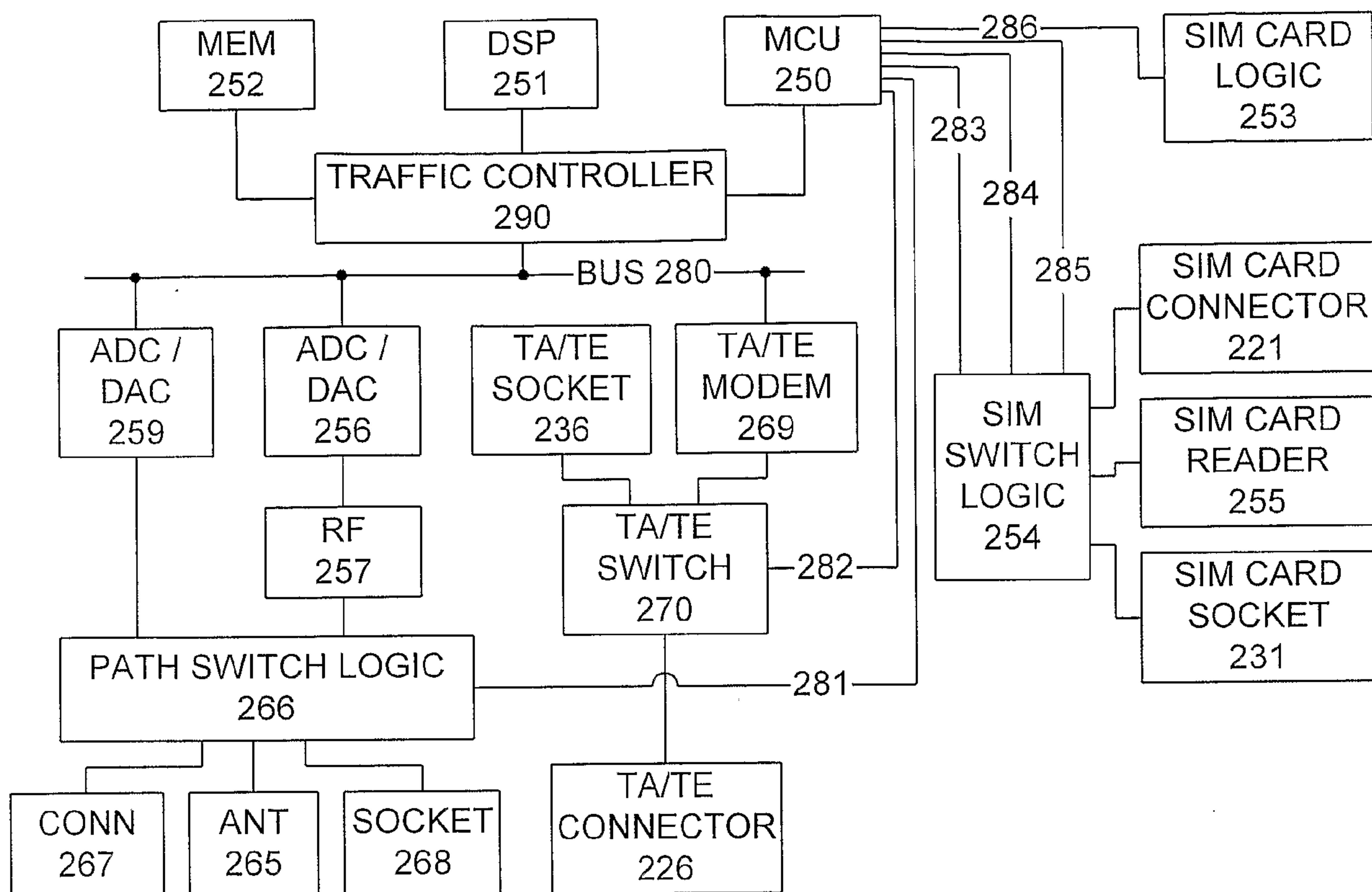
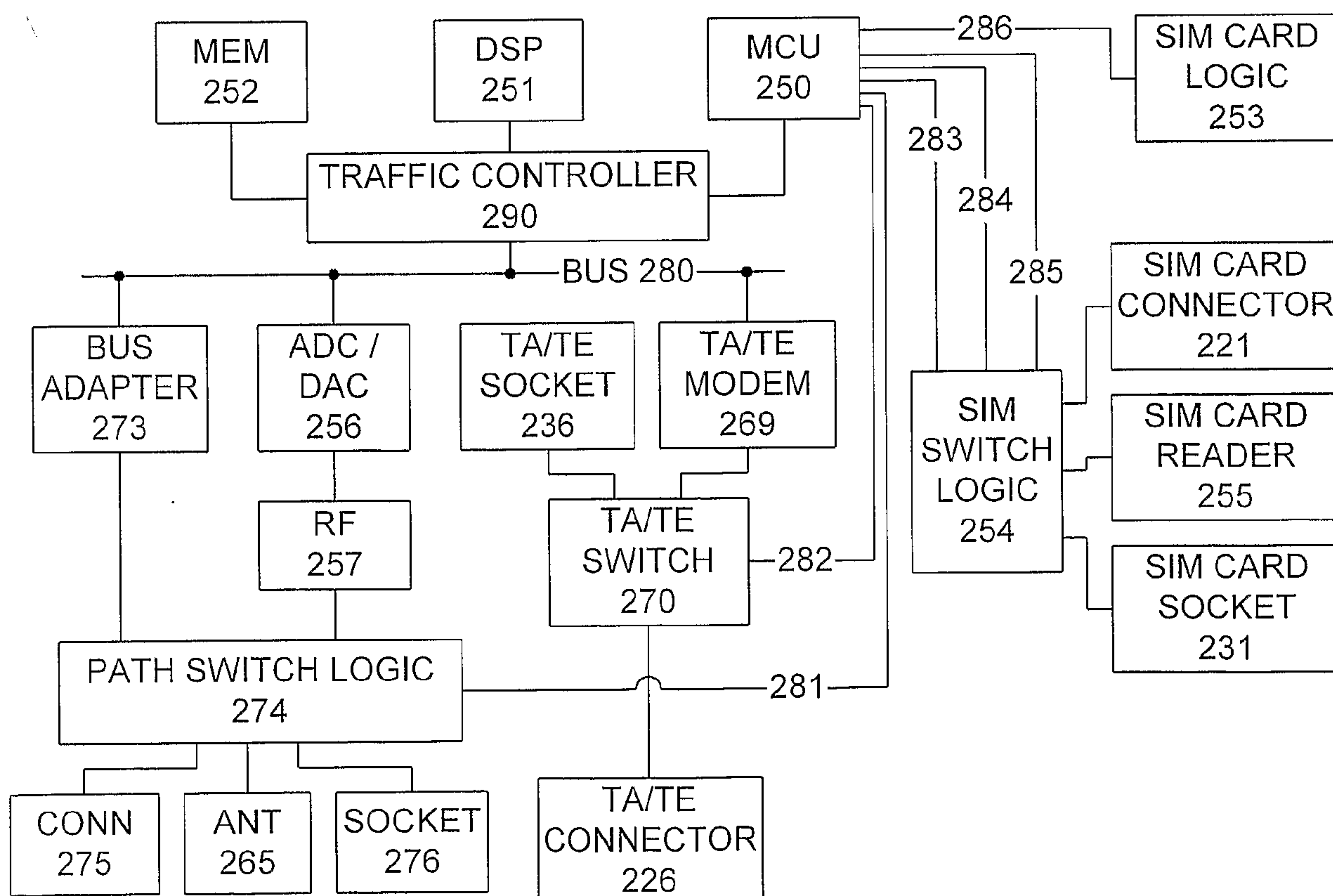
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**Fig. 3**

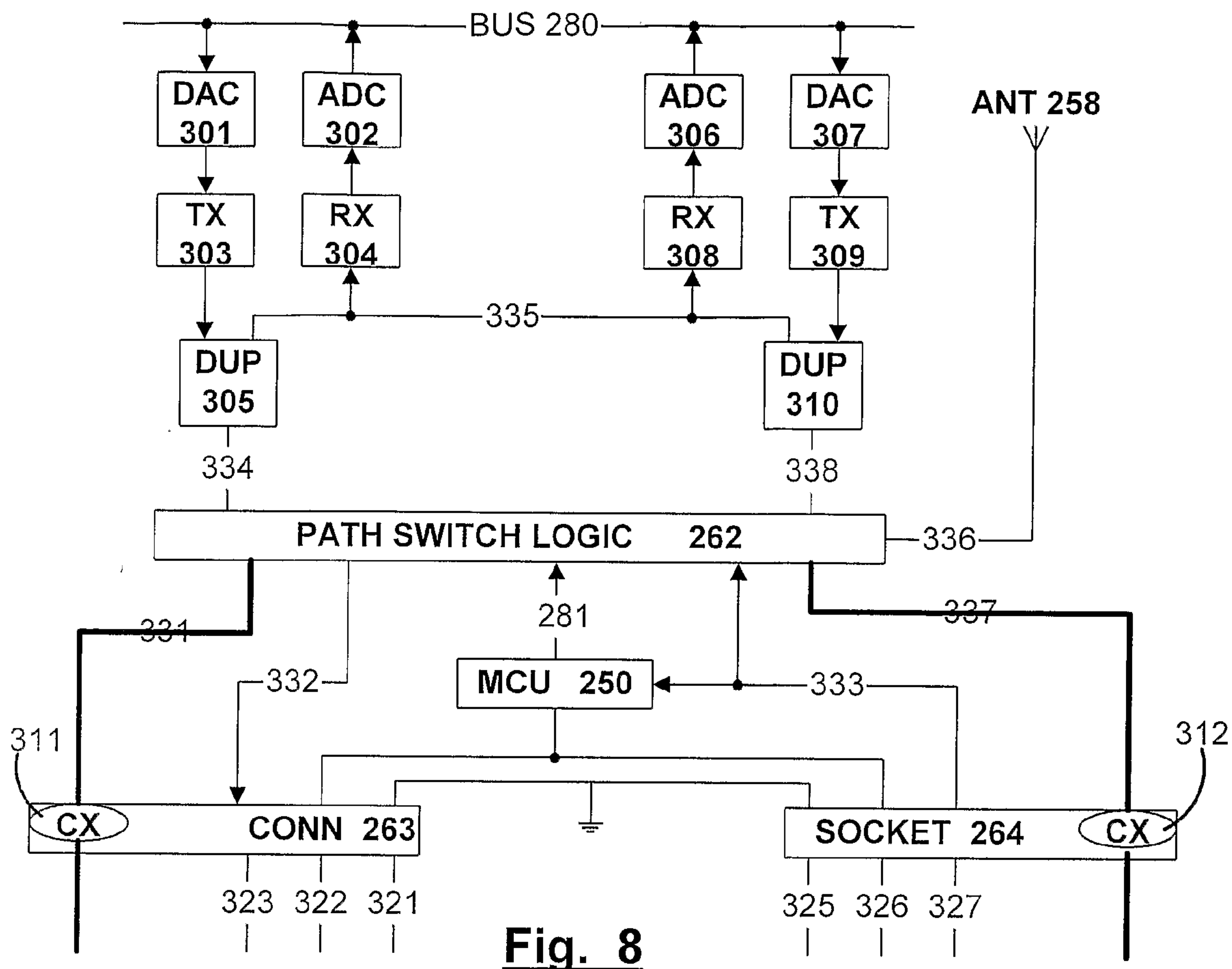
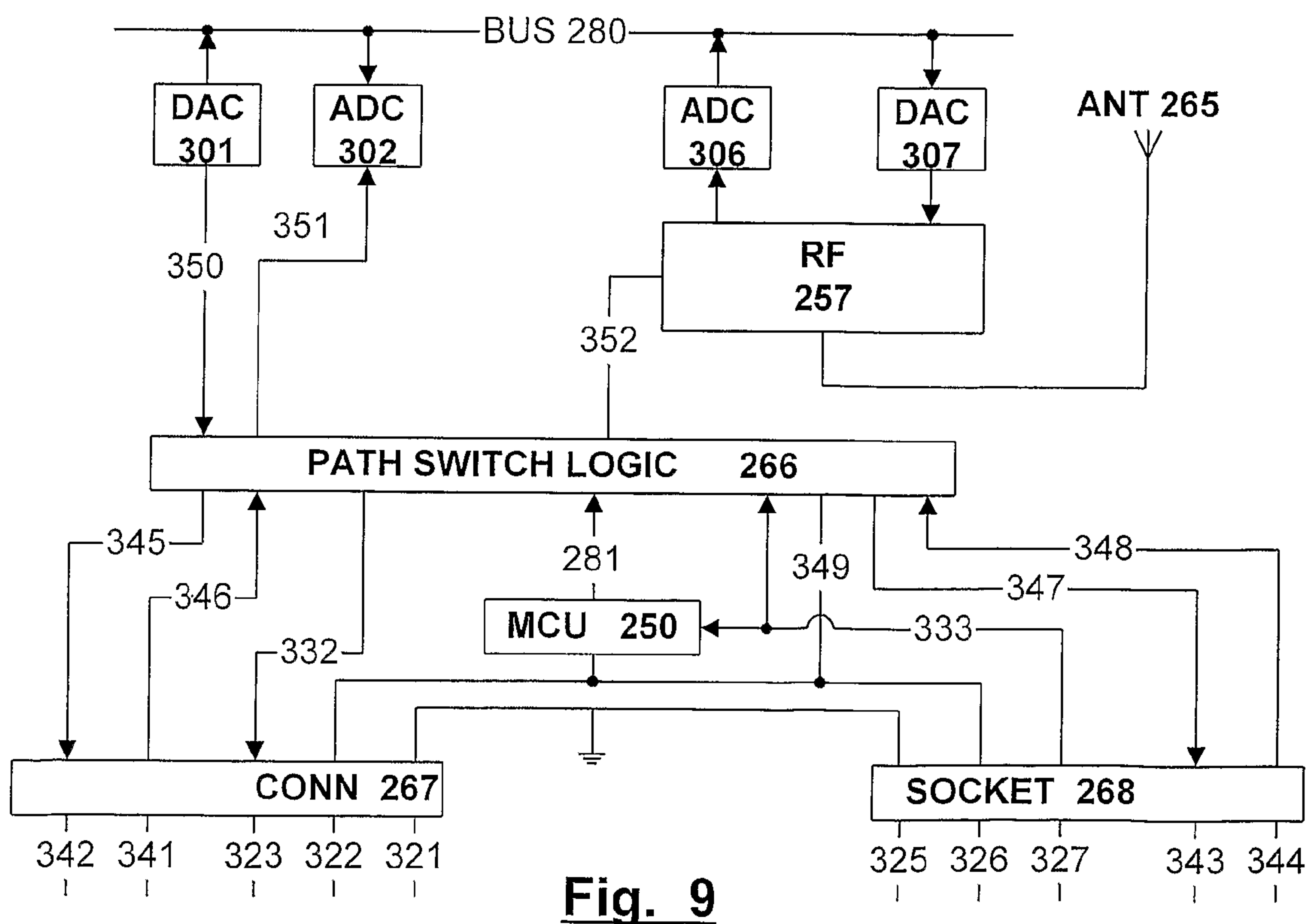
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**Fig. 4****Fig. 5**

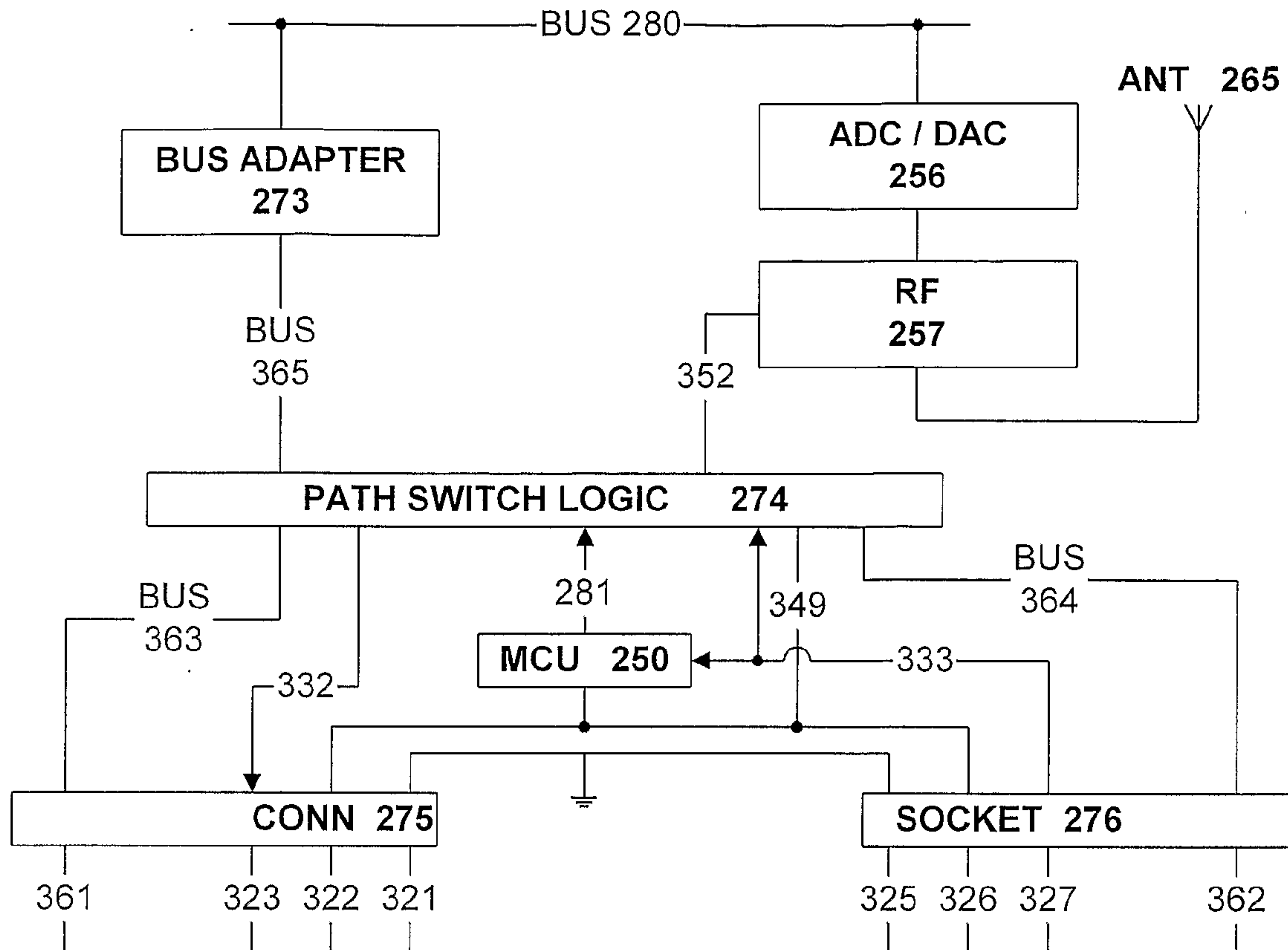
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**Fig. 6****Fig. 7**

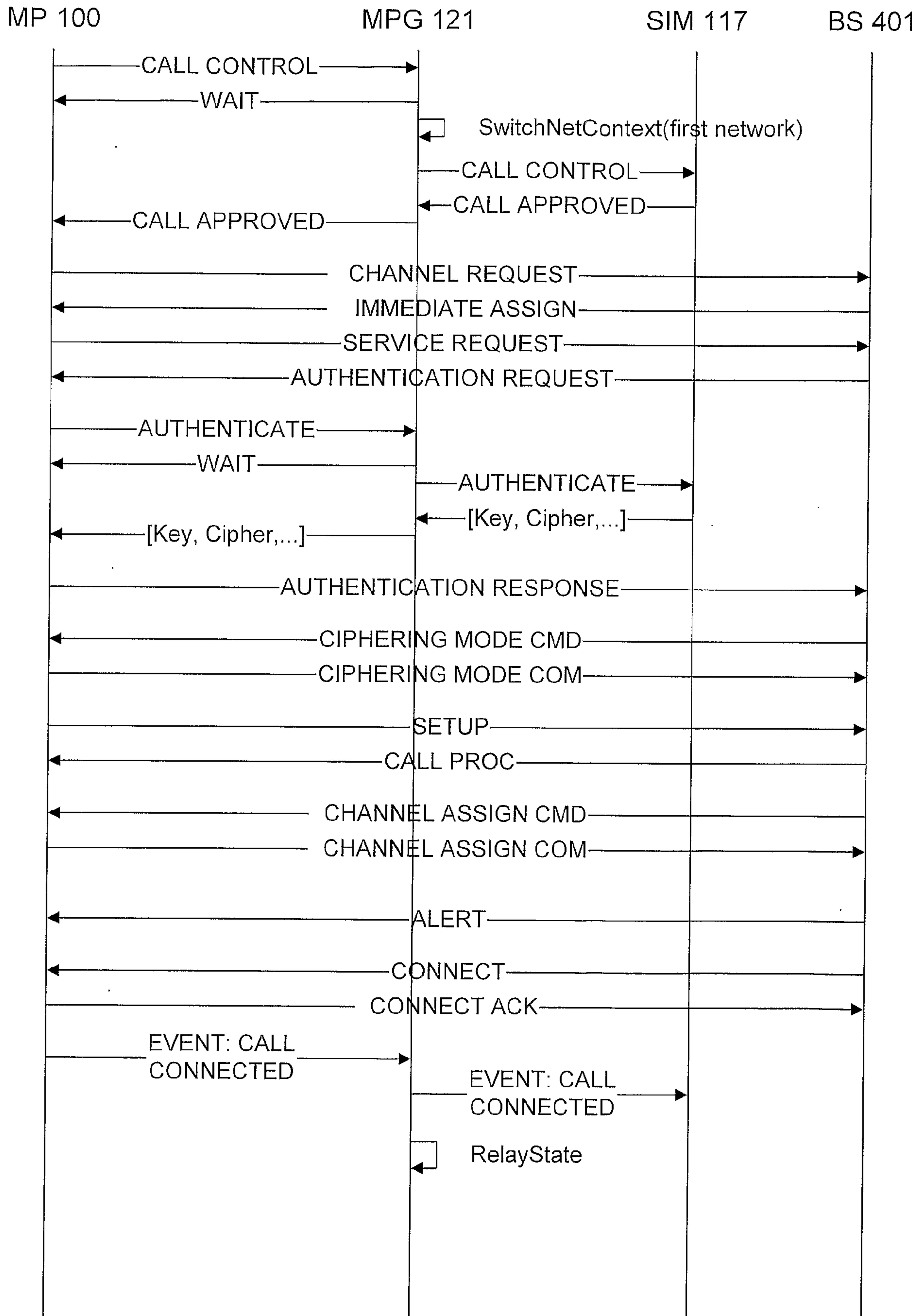
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**Fig. 8****Fig. 9**

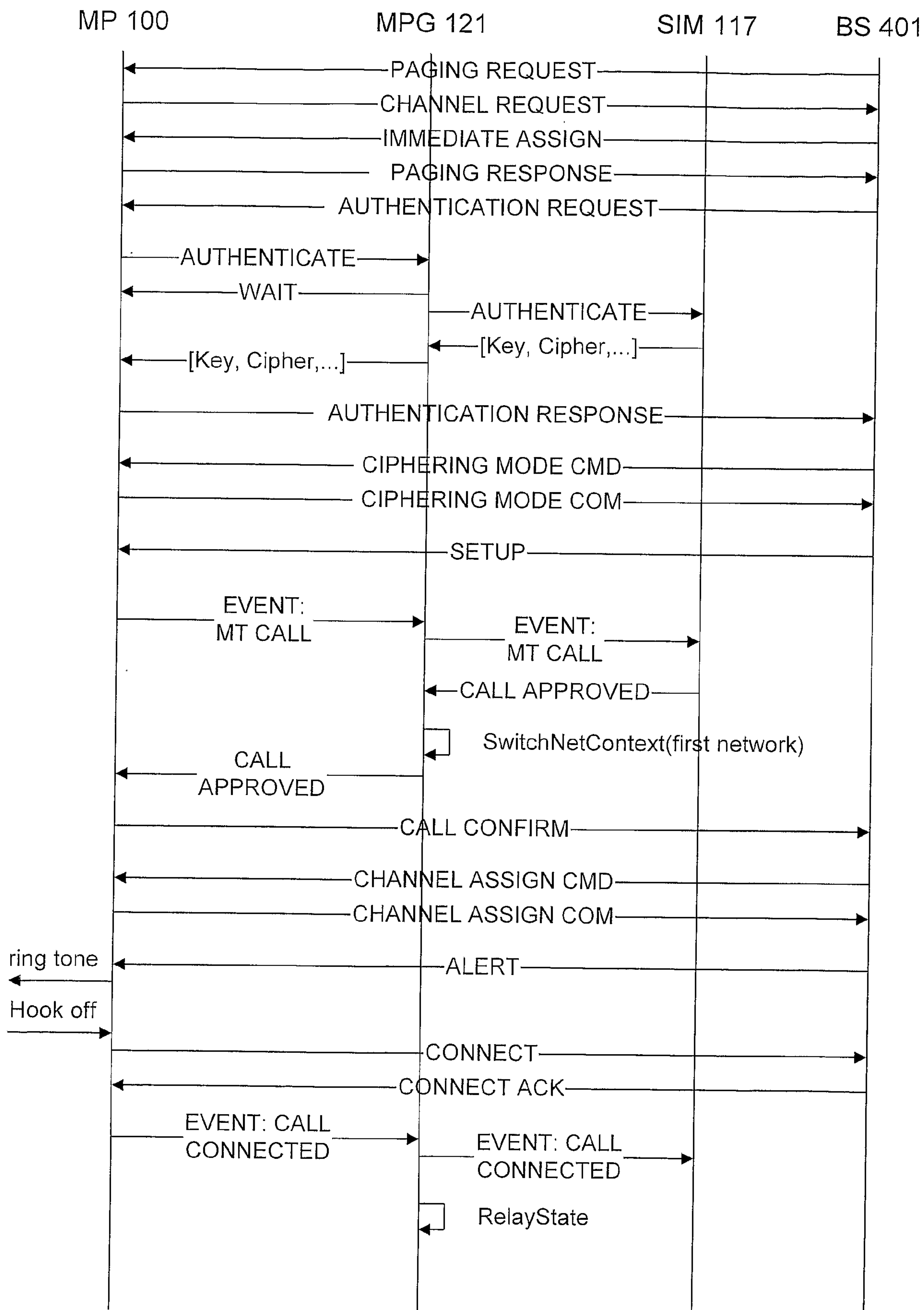
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**Fig. 10**

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**Fig. 11**

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**Fig. 12**

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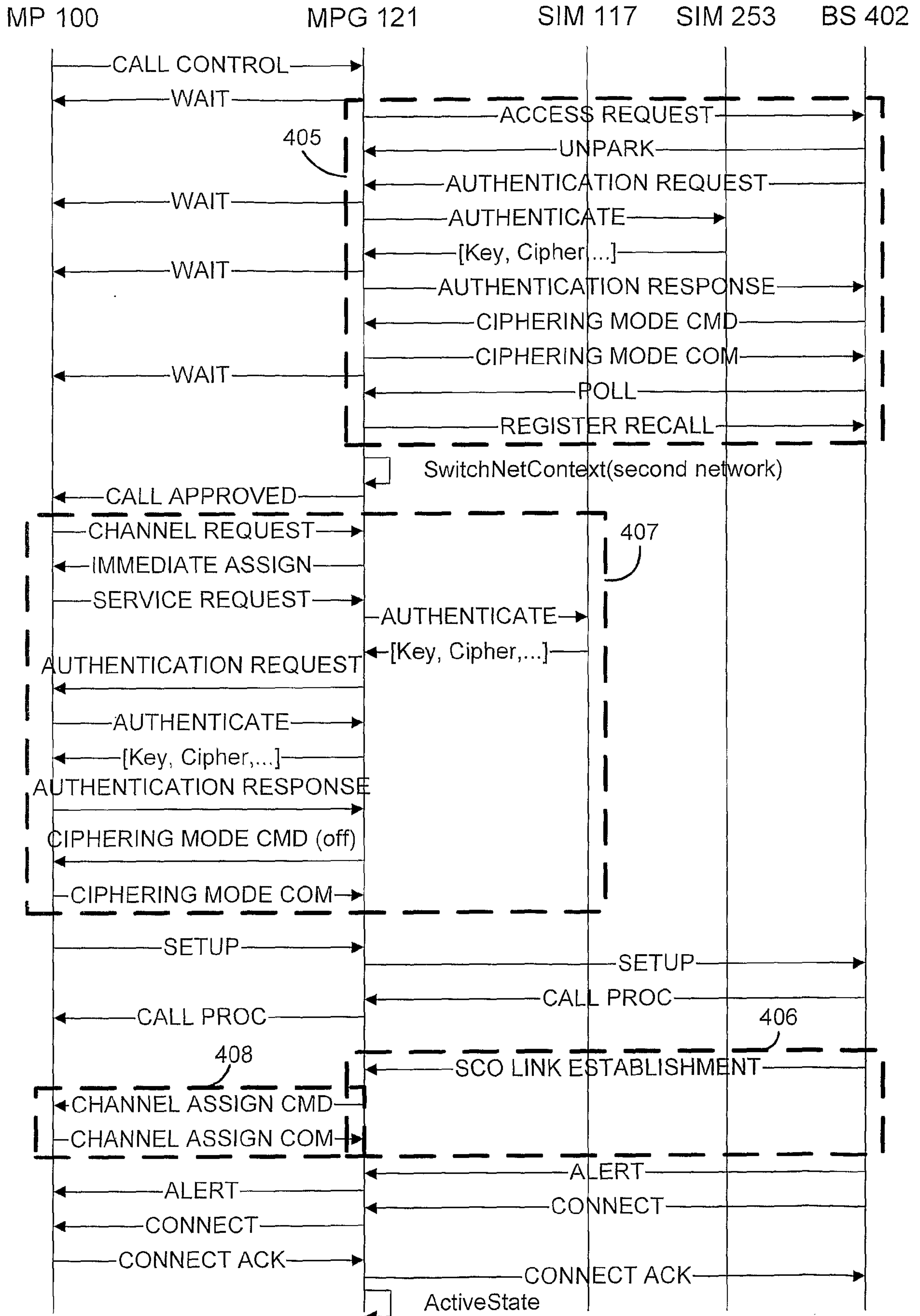
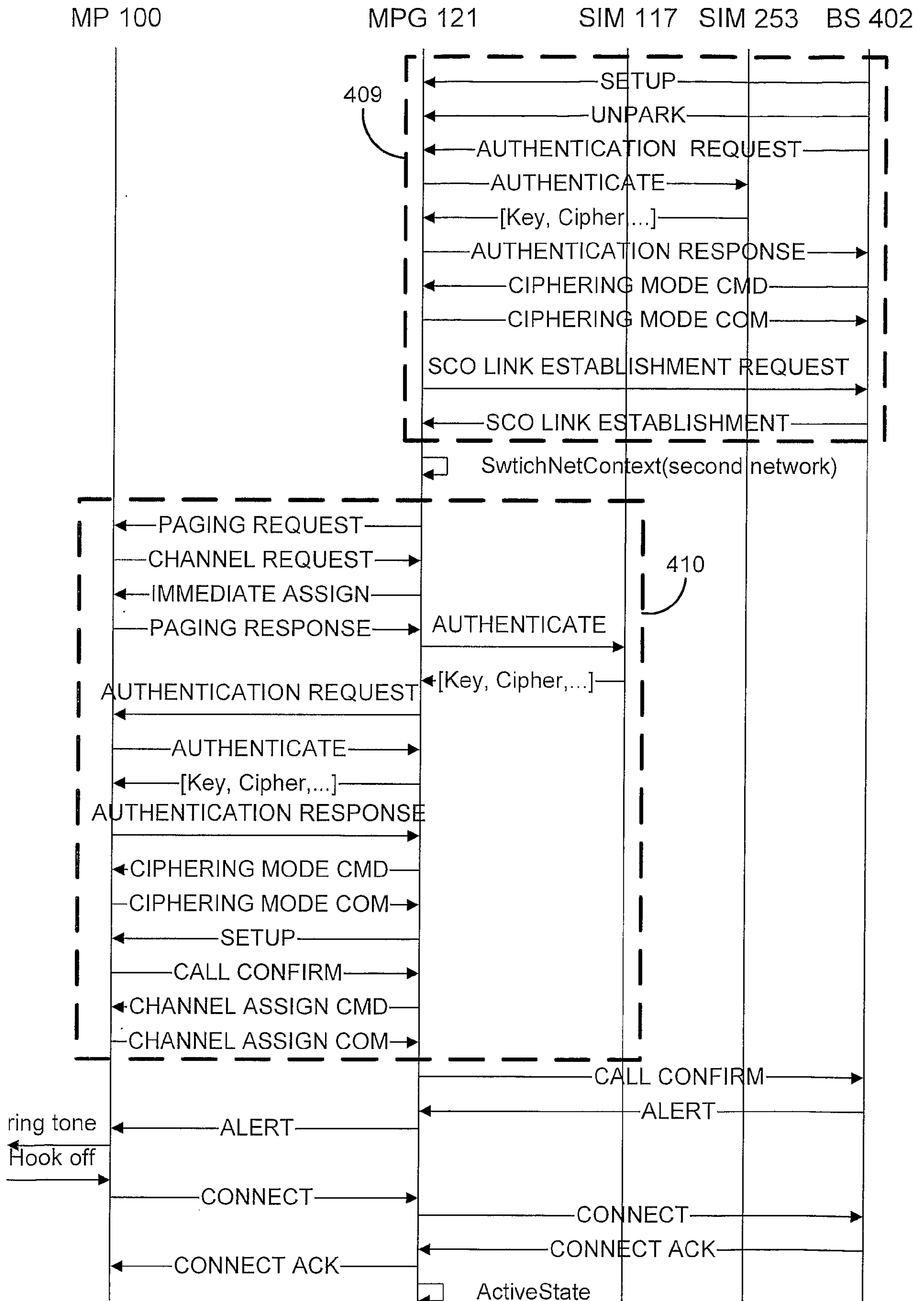
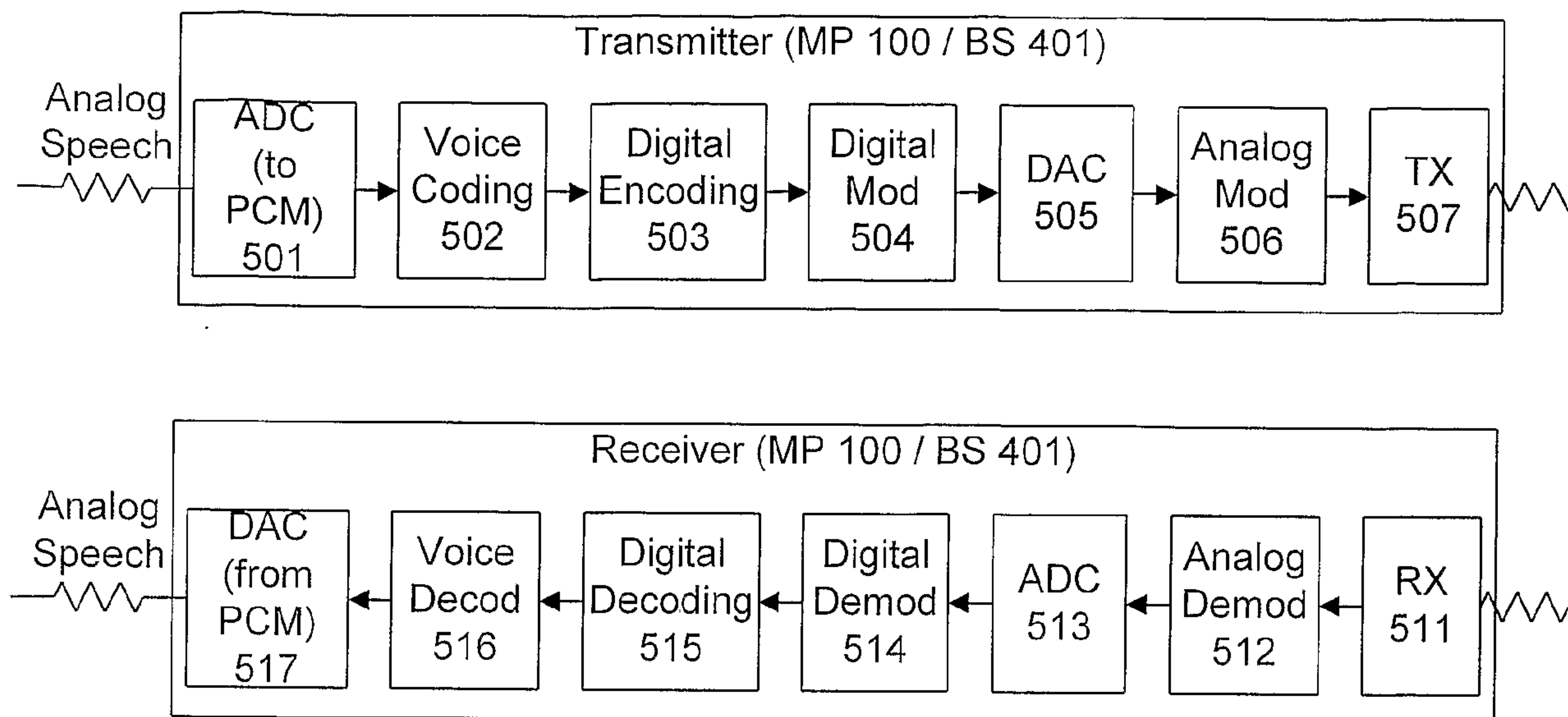
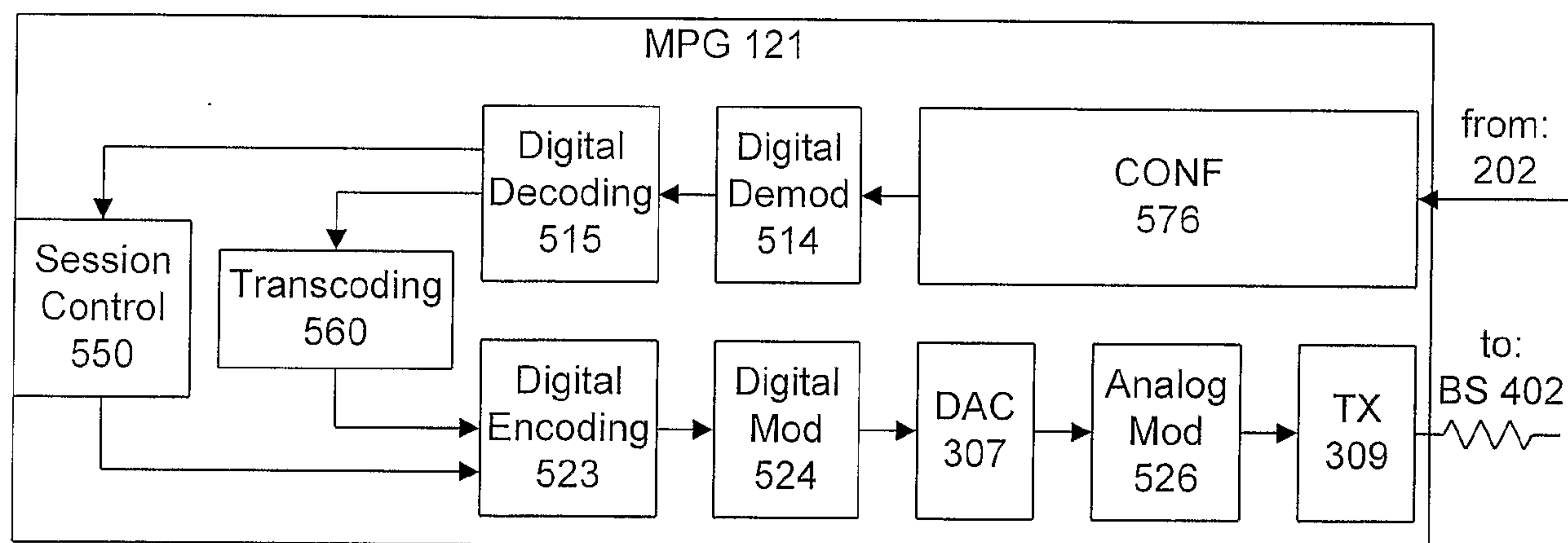
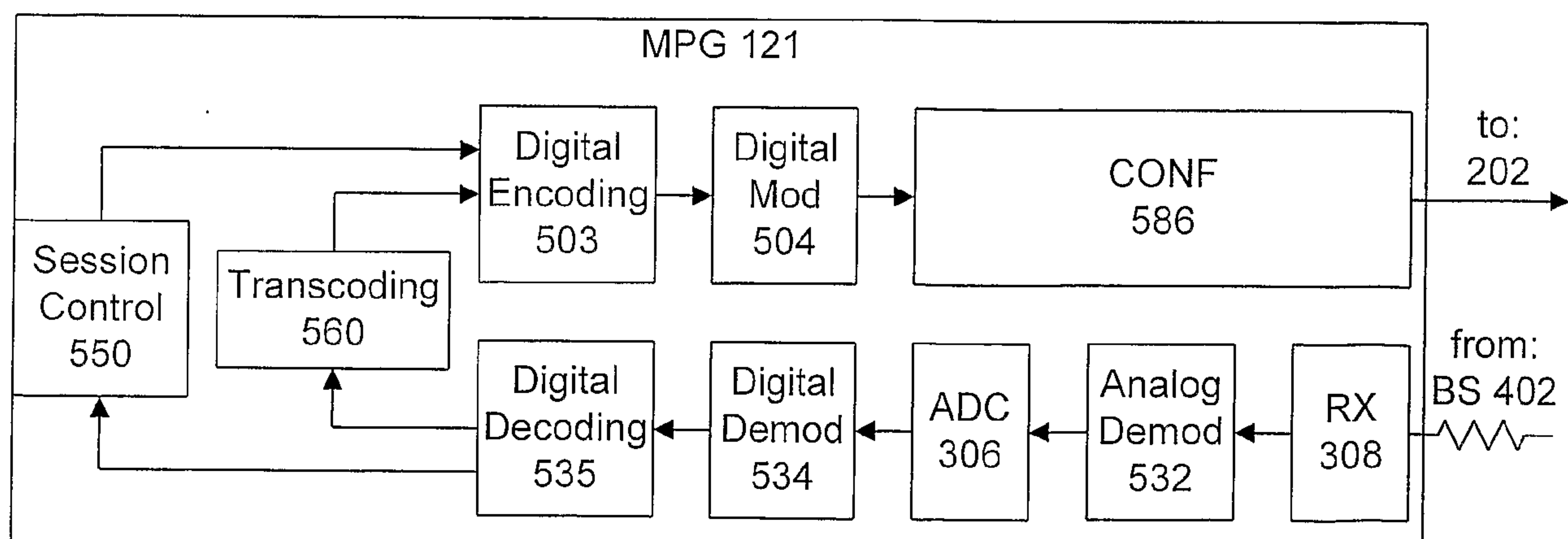


Fig. 13

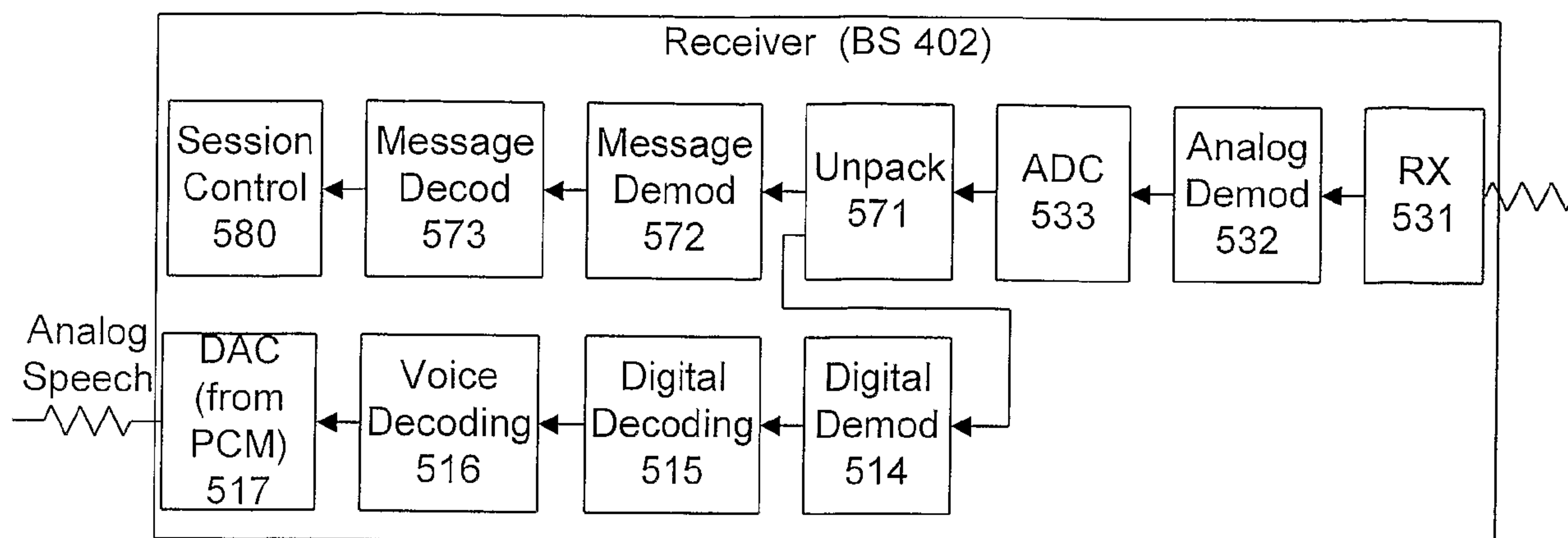
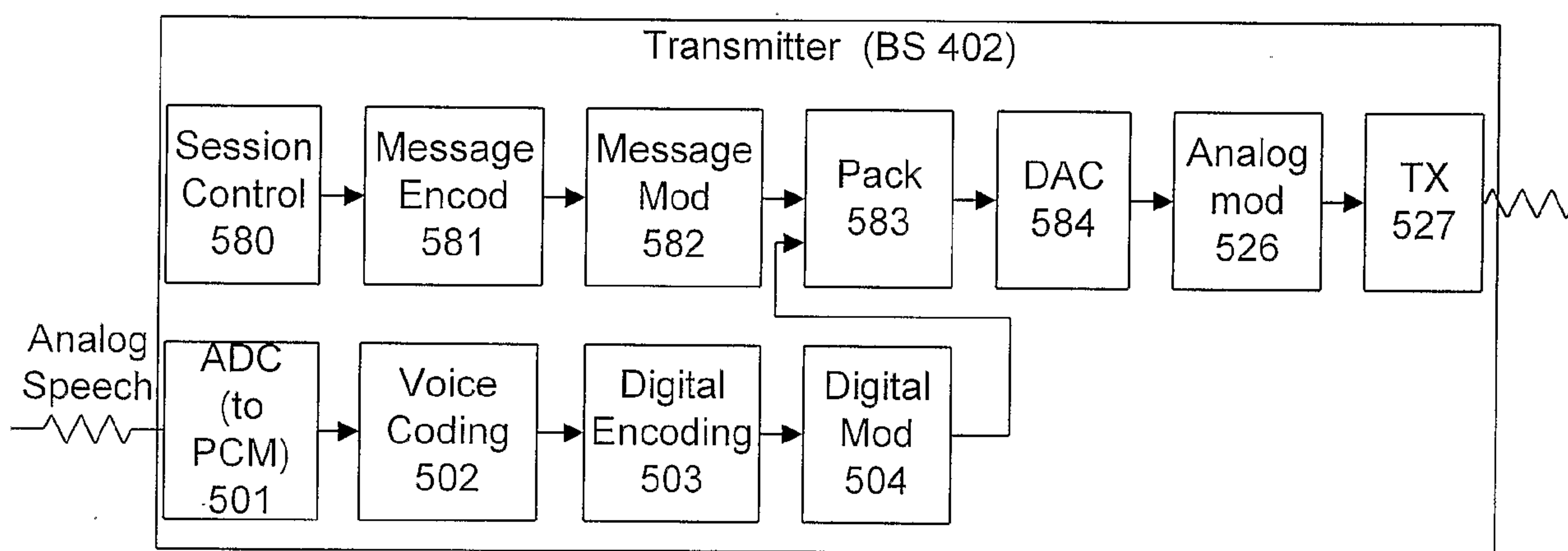
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**Fig. 14**

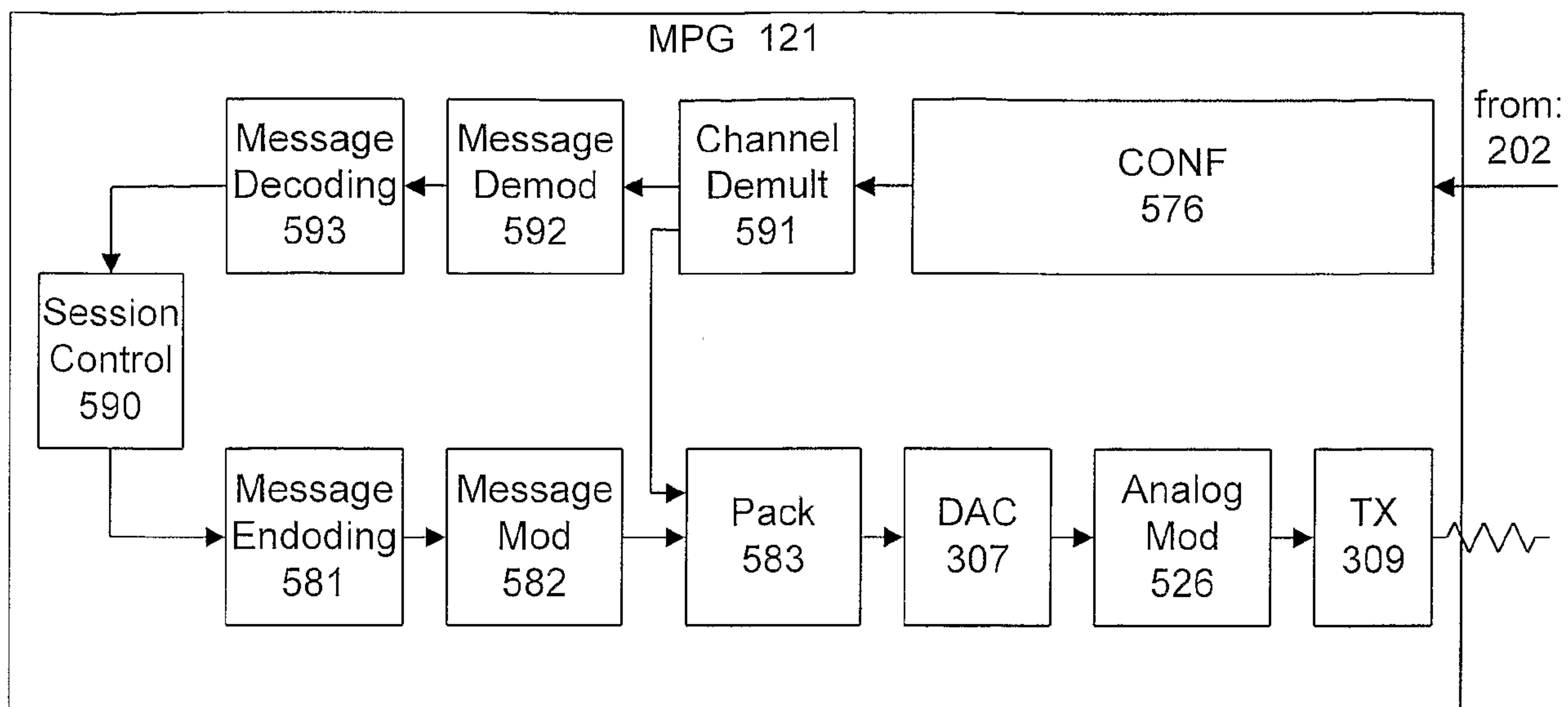
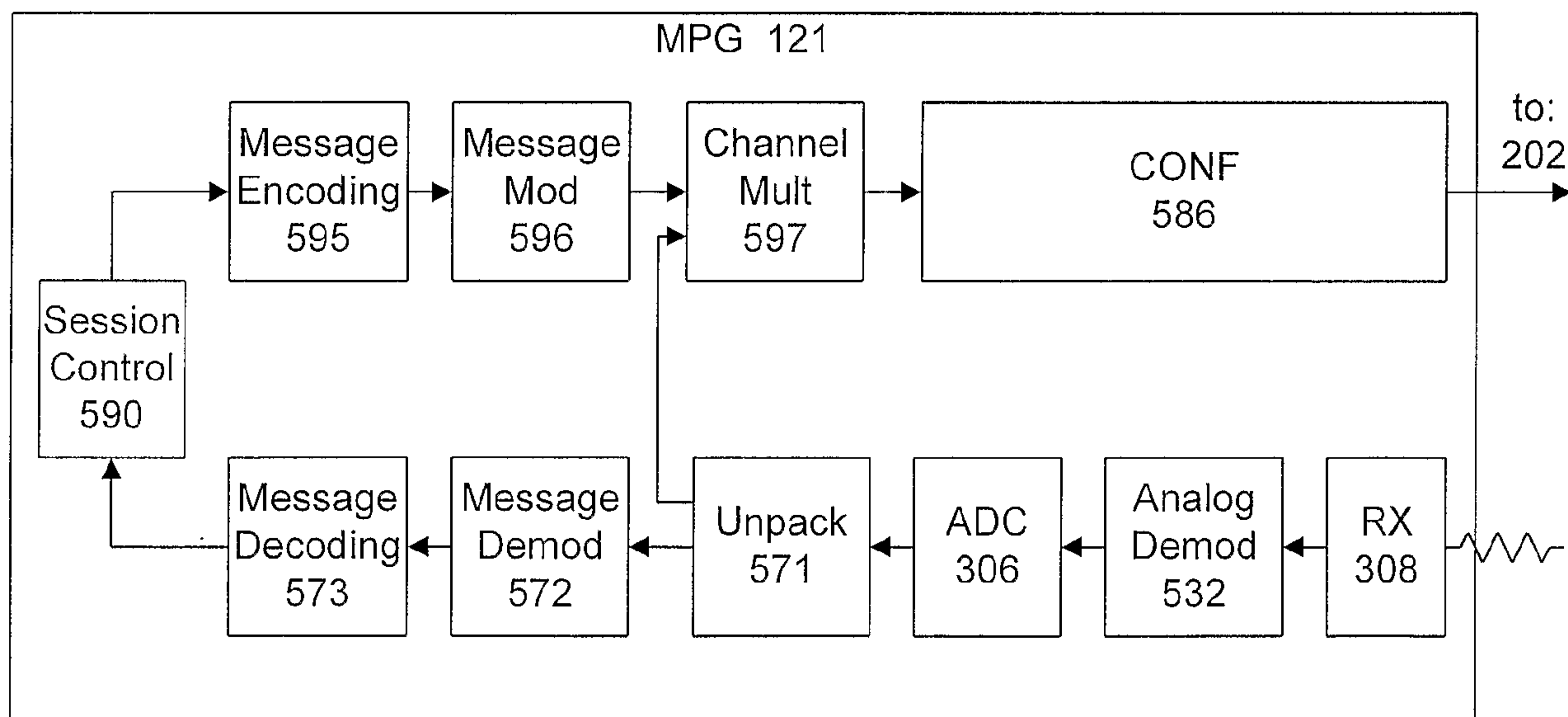
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**Fig. 15 (Prior Art)****Fig. 16****Fig. 17**

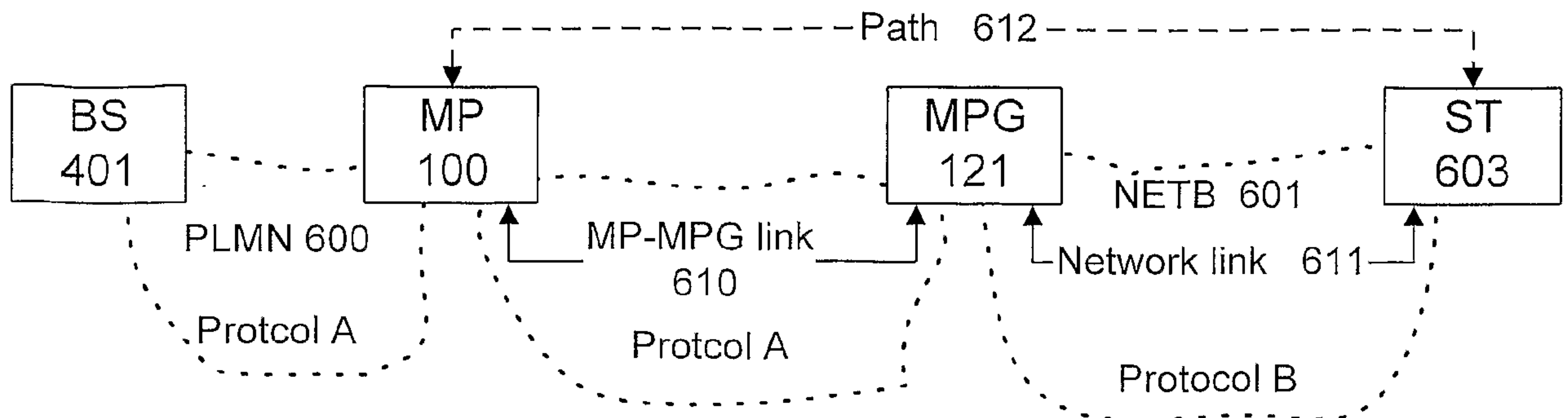
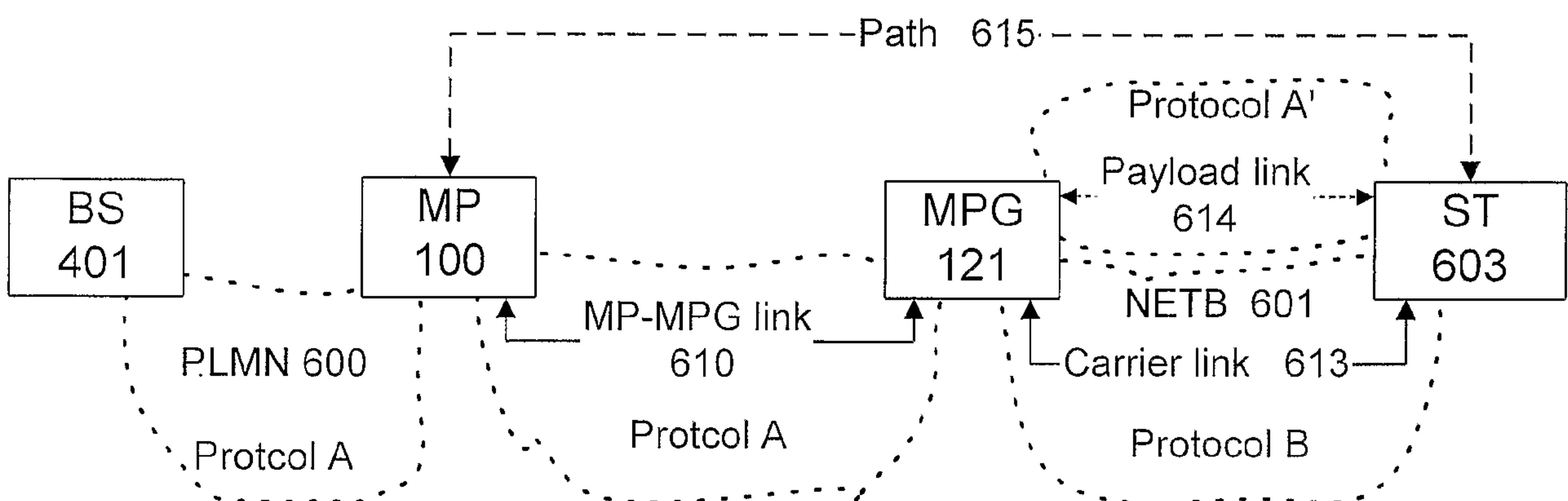
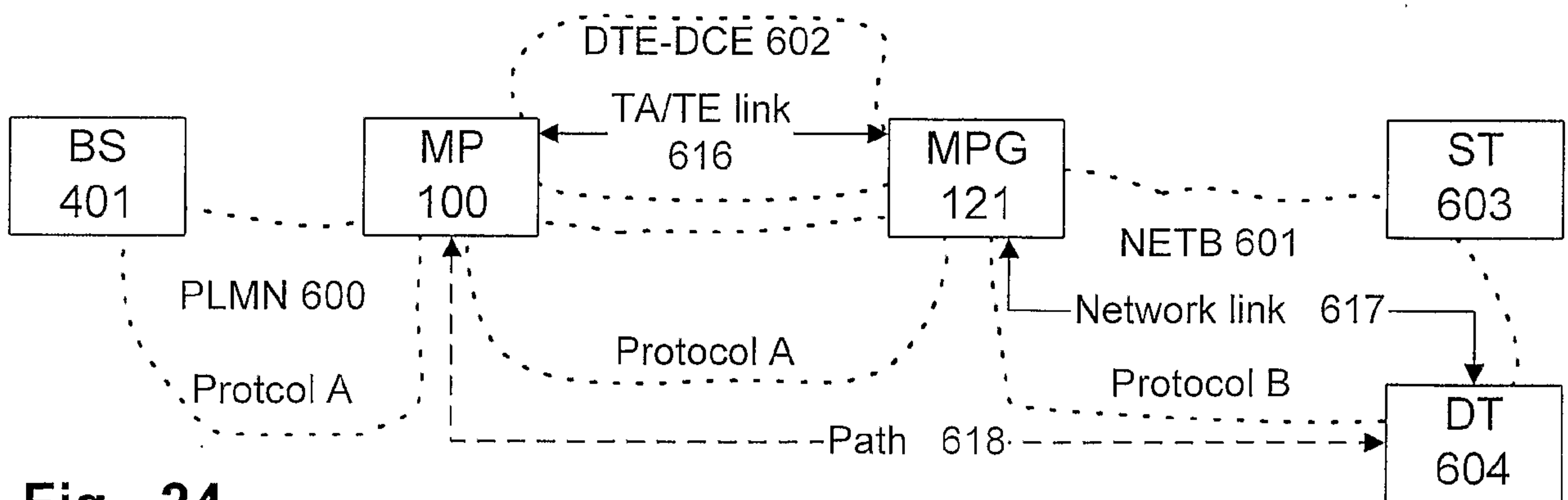
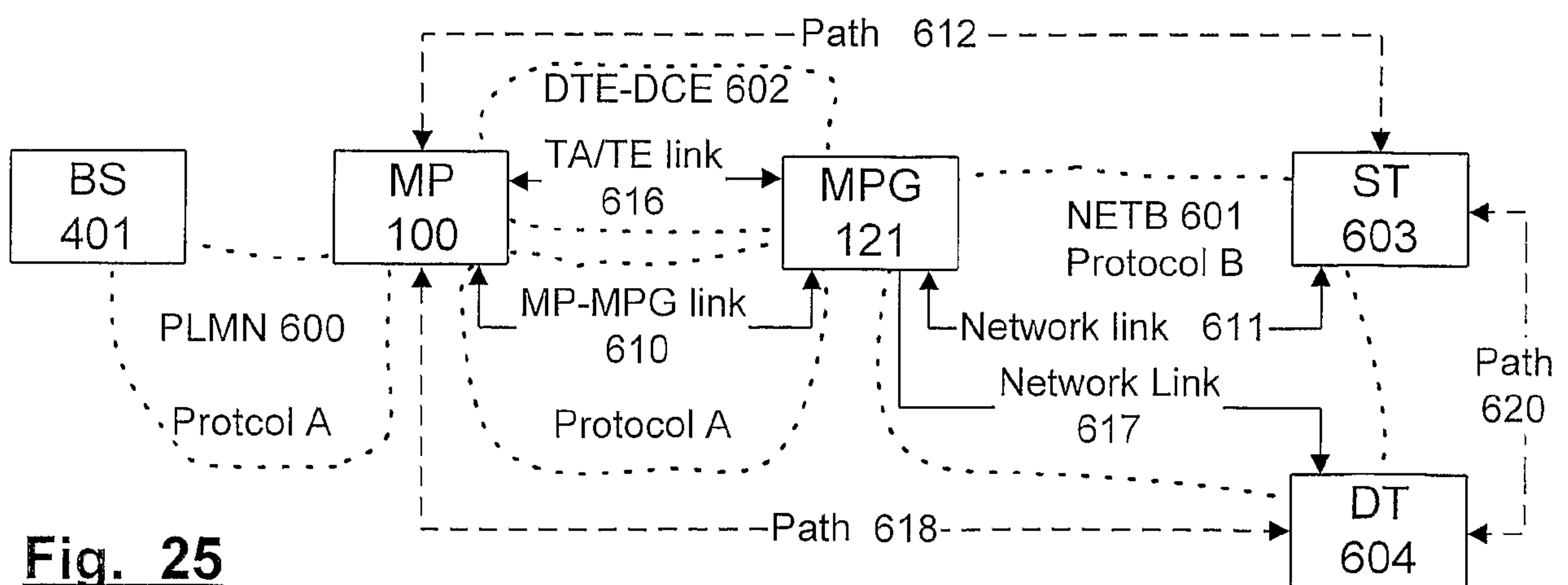
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**Fig. 18 (Prior Art)****Fig. 19 (Prior Art)**

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Fig. 20Fig. 21

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**Fig. 22****Fig. 23****Fig. 24****Fig. 25**

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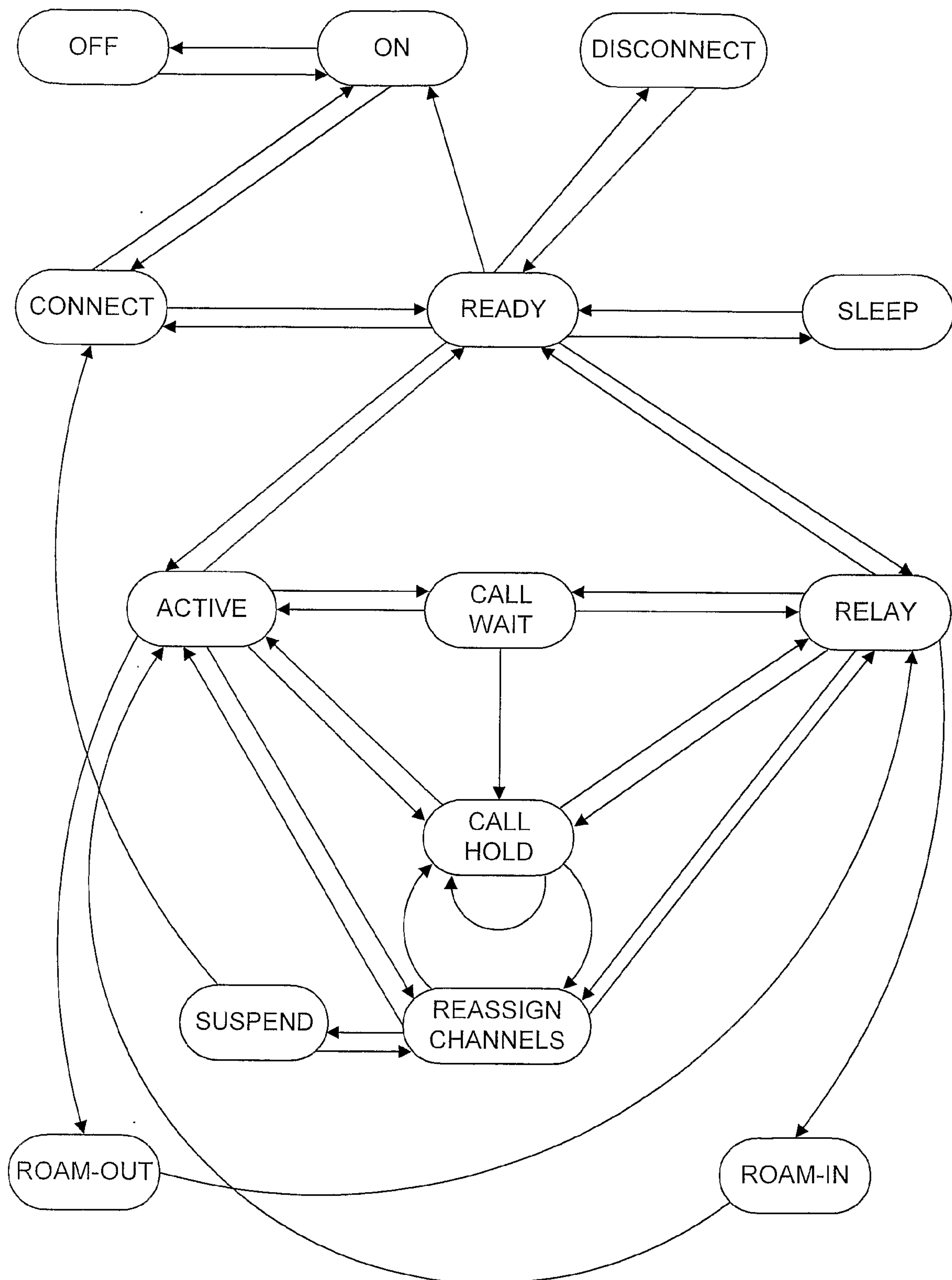


Fig. 26

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