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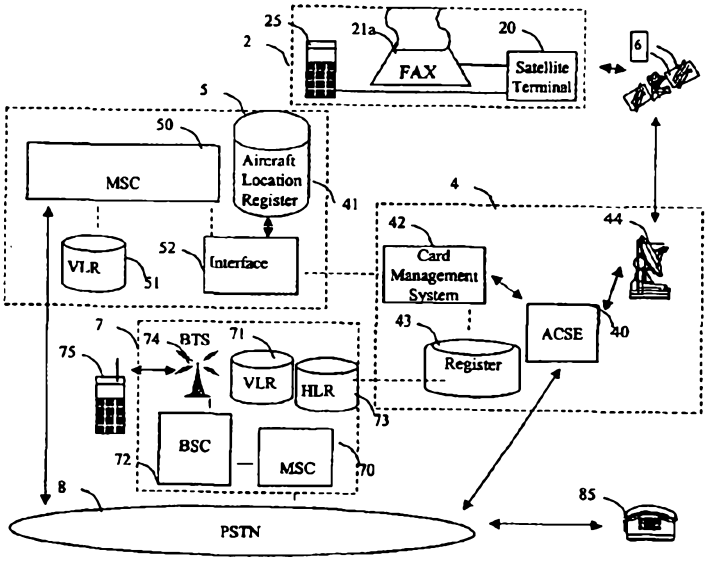
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(54) Title: MOBILE CELLULAR RADIO SYSTEM



(57) Abstract: An interface (52) is provided between a satellite telephone system (4) and a cellular telephone system (5) for allowing calls to a user's cellular telephone to be diverted to a satellite telephone handset (25) when the user is unable to use his cellular telephone, for example when on board an aircraft (2) fitted with a satellite telephone system (20). The user inserts a card (which may be the SIM of his mobile phone, or a card compatible with existing satellite telephone equipment) into a suitable reader in the satellite telephone (20), which causes the satellite ground station's card verification system (42) to connect to a host cellular network (50). The host cellular network has an interface unit (520) which emulates the operation of a normal base station, so that the host cellular system (50) acts as if the mobile user's terminal is roaming on the host network, but is currently "busy". The interface (52) also resets the user's existing call diversion instructions so that when the host cellular system (5) receives a busy tone from the base station emulator (52), it routes calls to the directory number of the terminal (20). In order to allow the host network to retrieve the user's handset identity (IMSI), it makes use of a process by which data relating to a user having an identification code of a first type (the directory number) can be used to access a register in which identification codes of the first type are related to identification codes of the second type (the IMSI), and receiving from the register, in response to the signal, a code of the second type, so that location update information can then be transmitted to an associated switching system in respect of the identification code of the second type.

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MOBILE CELLULAR RADIO SYSTEM

This invention relates to mobile telephony, and in particular to systems for use on board vehicles.

There has been considerable activity in recent years in proposals to allow the use of mobile telephones in environments where conventional cellular telephony base stations cannot provide coverage, in particular on board ships and aircraft. These vehicles frequently travel beyond the range of land-based cellular base stations, which typically have a range of the order of 1 to 10km.

There are a number of special difficulties to be addressed if a standard cellular telephone is to be used in an aircraft. Firstly, many cellular base stations have antennas arranged for maximum gain in the horizontal plane, so an airborne cellular telephone may not be able to obtain a signal from any base station, even when flying over land served by a cellular base station network. If the range of the base stations does extend to the normal flying height of aircraft, frequency re-use patterns, which allow several base stations to use the same radio frequencies without interference, are designed on the assumption that a mobile unit served by one base station is not able to exchange radio signals with other base stations using the same frequency. This assumption ceases to be valid if a mobile unit is several thousand metres above the ground, since it may be in line-of-sight of a large number of base stations simultaneously. Moreover, although reliable handover of a mobile unit can be achieved from moving vehicles travelling at speeds of up to 200km/h, a typical passenger aircraft travels at speeds approaching 1000 km/h. Airlines also impose restrictions on the use of powerful radio signals on board, as a precaution against possible interference with the aircraft's electronic systems.

For truly global coverage, satellite telephones are available. However, these are expensive and much heavier than a cellular telephone. Both cellular telephones and satellite telephones also suffer from the screening effect of being inside a metal hulled vehicle. As with cellular telephones, the unrestricted use of a portable satellite telephone within an aircraft may be prohibited.

A user without his own satellite telephone may use special facilities provided on board, such as the service provided to several airlines by the applicant company under the Registered Trade Mark "Skyphone". This uses onboard terminals

connected, through a satellite link between the aircraft and a satellite ground station, to the telephone network. Another system, TFTS (terrestrial flight telephony system, marketed as "Jetphone"), operates in a similar manner, but uses a direct link between the aircraft and the ground station, without a satellite link. Similar systems are provided on board ships. However payment for these services is generally at the point of use (or prepaid), and may be in a foreign currency. Calls made to the user's cellular telephone will not be successful unless the calls can be diverted to the telephone number of the onboard user terminal (which will generally not be known to the caller), and any special facilities offered by the user's cellular network will in general be unavailable. A user with his own cellular telephone account which, through "roaming" agreements between network operators, can be used in many different countries, would therefore prefer to continue to use his cellular telephone subscription when travelling within or between these countries on board an aircraft or other vehicle.

Proposals have been made, for example EP0915577 (Rohde & Schwartz) for a facility which would allow cellular telephones to make outgoing calls by way of the aircraft's own onboard telephone system. This allows the aircraft's onboard systems to impose power control on the mobile units and ensure that their radio transmissions are kept within safe limits. However, the cellular telephone is not directly connected to the cellular network, so conventional cellular radio location update processes cannot be used to inform the user's home network of its current location and allow incoming calls to be routed to the telephone.

Proposals have also been made to allow a user to use his own cellular radio identity when using the satellite facility, instead of a special identity under the satellite system. This would allow billing to be made through the user's normal cellular radio account, and would also allow incoming calls made to his cellular telephone number to be received whilst travelling. To this end, systems have been developed which allow call diversions to be set up to allow calls made to the user's cellular number to be transferred to a destination node of the tracking radio system. The destination node may be an onboard handset temporarily allocated the user's cellular identity, or it may be an onboard base station capable of wireless connection to the user's own cellular telephone. Systems of this general kind have been disclosed in International Patent Applications WO99/12227 (Nokia), WO94/28684

(Nordictel) and WO98/26521 (Ericsson); European Patent Applications 0920147 (Alcatel) and 0915577 (Rohde & Schwartz), and United Kingdom Patent Application 2310973 (Motorola). An onboard base station can be integrated with other onboard systems, allowing local control of the base station's transmitter, and those of the mobile units with which it is co-operating, so as to keep their power within permitted limits.

In one proposed arrangement, the subject of the applicant's co-pending International patent application filed on the same date as the present application, with agent's reference A25823 and a priority date of 14th September 1999, and to be described in more detail later in this specification, a user may arrange for incoming calls to his cellular telephone number to be routed by way of the fixed part of a cellular telephone network as an interface with an onboard satellite telephone system. The interface unit is arranged to appear to the switching system as a typical radio base station control system, to which the mobile handset is currently working, although in fact no radio base stations are actually controlled by it. This interface unit may therefore be considered to be a "Virtual" Base Site Controller. The switching system itself requires no modification: it merely registers that the user is working to the "Virtual" Base Site Controller and stores the user details in its "Visitor Location Register" (VLR), in the same way as it would for a mobile unit working to any real base site controller to which it is connected. The interface unit also generates a call diversion instruction, which will appear to the switching system to have come from the mobile handset, by way of the "Virtual" Base Site Controller. This call diversion instruction is set up in the switching system such that if the "Virtual" Base Site Controller responds to a call request directed to the mobile unit with a "busy line" response (or some other specified condition), calls are to be diverted, through normal network interconnects, to a specified directory number, namely that of the satellite termination point to which the user is connected. The interface unit does not in fact monitor the real condition of the user terminal, (which is not operatively connected to the interface unit), but instead always returns the "line busy" signal to the switching system.

The interface unit includes a store to record any diversion settings existing for the telephone apparatus prior to the diversion to the second network being set up. This allows these settings to be retrieved when the user disconnects from the

first telecommunications system, so that they can be reinstated in the switching system of the second telecommunications system, or transferred to another telecommunications system, when the telephone apparatus makes contact with a real radio base station, thereby initiating a handover procedure from the "Virtual" Base Site Controller to the real one.

Should a second call attempt to the user's cellular telephone be made whilst a call is in progress to the onboard system, the switching system may be arranged to divert it to another predetermined number, such as the user's "voicemail", or automatic answering service, address.

If the user termination is in an aircraft or other vehicle connected to a ground station (by satellite or otherwise), it may move from the area covered by one satellite (or ground station) to that of another. In that case, the network address of the termination changes. To accommodate this, the interface may be provided with means to store the address of termination points in the first system, means to record changes to the said addresses transmitted to it from the first system, and means to modify the diversion instruction in the switching system when such a change takes place. Alternatively, the termination point may be arranged simply to repeat the set-up process, causing the mobile unit to be re-registered with the interface unit, (which will not be apparent to the switching system, as it will perceive the same "virtual" base site controller), and to transmit a new call divert instruction to the revised address of the termination point.

The telecommunications termination point may be provided with reading apparatus for reading an information carrier encoded with the user's identity. Such apparatus is commonly used for telephone terminals to which the public has access to allow calls to be charged to a user's credit card account, or an account with the service provider, or to deduct value from a stored value on the card.

In those cellular systems where the user identity is carried on a data carrier card transferable between telephone handsets, the reading apparatus may be arranged to read this carrier. In the "GSM" standard these cards are known as "Subscriber Identity Modules" or SIMs, and are either of standard credit card size (86mm x 54 mm) or rather smaller (14mm x 25mm), and may be transferred from one cellular telephone handset to another to allow the same telephone user account and directory number to be used with different handsets.

However, standard on-board satellite telephone card readers may not be compatible with GSM "SIMs", or complete telephones. To avoid the need to modify the user terminals, a user identity may be carried on a special carrier compatible with the existing card readers. This user identity may be the user's cellular radio network identity (IMSI), or some other identity from which it can be derived.

In practice, the user identity required by the network (known in the GSM standard as the IMSI) is unique to one carrier (the "SIM") and is not encoded on any other. This provision is primarily a fraud prevention measure, made to prevent the user identity being used to access a cellular network when the authorised user is actually elsewhere. However, the invention disclosed in the applicant's aforementioned International patent application requires access to a cellular network when the user is actually not directly connected to that network but is elsewhere. It is therefore necessary for the interface means ("Virtual" Base Site Controller) in that network to obtain the user identity.

According to a first aspect of the present invention, there is provided a mobile telecommunications system apparatus comprising

means for receiving data relating to a user having an identification code of a first type,

means for transmitting a signal to a register in which identification codes of the first type are related to identification codes of the second type,

means for receiving from the register, in response to the signal, a code of the second type, and

means for transmitting location update information to an associated switching system in respect of the identification code of the second type.

According to a second aspect, there is provided a method of operating a mobile telecommunications system comprising the steps of:

receiving data relating to a user having an identification code of a first type,

transmitting a signal to a register in which identification codes of the first type are related to identification codes of the second type,

receiving from the register, in response to the signal, a code of the second type, and

transmitting location update information to an associated switching system in respect of the identification code of the second type.

In the GSM standard it is possible to obtain an IMSI if the user's directory number (MSISDN) is known by interrogating the appropriate Home Location Register. To do this, a "request for routing information" signal is transmitted, using the MSISDN. The standard HLR responds to such a request with a signal which includes the IMSI corresponding to the MSISDN in the request. The present invention makes use of this facility to obtain the user identity of the originator, and then controls the location update process in respect of the user identity so obtained.

The present invention will become more fully understood from the following detailed description of preferred but non-limiting embodiments thereof, described in connection with the accompanying drawing(s), wherein:

Figure 1 is a schematic diagram showing the functional relationships between the systems which co-operate to form one embodiment of the invention

Figure 2 is a more detailed schematic diagram of the network termination and associated card reading equipment, which for illustrative purposes will be assumed to be on board an aircraft

Figure 3 is a schematic diagram showing the functional relationships between the components of the fixed part of the first telecommunications system which co-operate in the invention,

Figure 4 is a schematic diagram of the switching system, interface unit, and associated parts of the second telecommunications system;

Figure 5 is a flow chart showing the process by which a diversion is set up in the second network to a termination connected to the first network

Figure 6 is a flow chart showing the process by which a call coming in to the second network is connected to a telephone connected to the first network

Figure 7 is a flow chart showing the process by which the second network restores the original settings for a telephone when it disconnects from the first network.

Figure 8 illustrates the forwarding process implemented to a data message.

Figure 9 illustrates a conditional forwarding process for a data message.

Figure 10 is a flow chart showing a call diversion process, for use when the system has to be temporarily shut down.

The following embodiments illustrate the invention using a standard switched cellular network, using the terminology of the "GSM" standard for illustrative purposes. However, the invention is applicable to other cellular networks,

including packet networks, which are used to carry data over a distributed computer network such as the "Internet", carrying messages using formats such as the "Internet Protocol" (IP). Thus, unless the context clearly demands otherwise, any reference in this specification to switching includes the equivalent routing functions in a packet network of this kind.

Figure 1 shows the general arrangement of the various components which co-operate in this embodiment. Note that traffic links (which can carry speech, data, etc) are shown as full lines, signalling links used only for call set up are shown as broken lines.

The onboard part 2 (shown in more detail in Figure 2) comprises one or more handsets 25 connected to a termination point 20 of the satellite network. The termination point 20 is in communication with a ground station 4, shown in more detail in Figure 3. In this embodiment, the communication link is made through an earth-orbiting satellite 6.

The principal components of the ground station 4 relevant to this invention are an antenna 44 which communicates, by way of the satellite 6, with the onboard system 2, an Access Control and Signalling Equipment (ACSE) 40 which carries out call switching functions to allow calls to be placed through the public switched telephone network (PSTN) 8 to other telephones 85, and a Card Management System 42 which authorises the use of an individual terminals 25 according to user identities entered with respect to that terminal. There is also a register 43 of card identities, to provide a correspondence between the user identities used by the satellite terminal and the corresponding cellular telephone user identities, and to provide billing information.

The card management system 42 interacts with an interface unit 52 of a "host" cellular telephone network 5, shown in more detail in Figure 4. This network 5 is connected to the public switched telephone network (PSTN) 8 and to other cellular networks 7 through a switching centre 50. Associated with the interface unit 52 there is an "aircraft location register" 41 which monitors the terminals currently served by each individual satellite, and modifies the call diversion function when a terminal 20, for example on board an aircraft 2, moves from the coverage area of one satellite 6 (and its ground station 44) to another.

The cellular network 7 illustrates in simplified form the system architecture of a "GSM"-standard cellular radio system, and the terminology used in this standard. The network 7 has a switching system (MSC) 70 to allow connection of one or more base transceiver sites (BTS) 74, through one or more base site control systems 72, to the PSTN 8 and thus to other telephones 85. A mobile telephone 75 may establish radio contact with one of the base stations 74 in order to make and receive telephone calls. The network 7 also includes a "Visitor Location Register" 71, which maintains details of those cellular telephones 75 currently co-operating with the network 7. Mobile telephones according to the "GSM" standard are capable of co-operating with different networks ("roaming" between networks). To allow this to take place, when a mobile telephone 75 changes from one network to another, the network to which it has moved retrieves data from a "Home Location Register" 73 permanently associated with the handset 75. The network 7 in which the Home Location Register 73 associated with a given handset is to be found is identifiable from the handset's identity code. The Home Location Register also records the identity of the network 7 with which the mobile handset 75 is currently operating.

The "host" network 5 operates like a conventional cellular network, but is provided with an interface unit 52, which interacts with the mobile switching centre 50 as a base site controller would. This interface unit 52 may be in addition to one or more base site controllers (not shown). The interface unit does not interact with any base transceiver sites or mobile handsets, but obtains user details (in particular the identity of a mobile handset) from the card management system 42 to allow it to appear to the switching centre 50, and the HLR 73 in the user's home network, that it is in radio communication with a mobile handset 25. It can then control the call forwarding instructions stored in the host network's VLR 51, to cause incoming calls directed to that handset to be diverted, through the switching system 40 of the satellite network 4, to the satellite terminal 20.

Figures 2 and 3 illustrate an embodiment of the invention applied to a satellite telephone system such as that provided by the applicant company under the Registered Trade Mark "Skyphone". Figure 2 shows an embodiment of the mobile part. Figure 3 shows the ground station.

The onboard system 20 shown in Figure 2 comprises a plurality of user terminals 21, 21a (only one shown in detail), connected by a multiplex and radio

interface unit 28 to an antenna 29 which provides radio communication with a satellite 6. Each user terminal 21 has a card reading unit 23 into which an intending user can insert a card 24 or other data carrier providing user identification data. The data may give details of the user's credit card account, or a special account for the use of the onboard telephone service. The card reader 23 may be adapted to read the SIM (Subscriber Identity Module) of a GSM-standard cellular telephone. (It should be noted that one variant of the method according to the invention, in which the user enters his own details using a keypad of the terminal 25, does not make use of the card reading apparatus 23,24,26, although it may nevertheless be present for use by other customers of the satellite system).

Further user terminals 21a may be set aside for non-voice applications, for example an onboard facsimile machine.

The user handset 25 provides the usual keypad, microphone and earphone to allow the user to make telephone calls. The user handset 25 and the card reader 23 are both connected to a processor 26 which converts data read from the card 24, and keystrokes input from the handset 25, into data signals for transmission over the radio link 29. It also provides identification data indicative of which of the terminals 21 it is. A further processor 27 performs analogue/digital conversion of speech signals from the handset 25.

The digitised signals from each terminal 21 are multiplexed and modulated onto a radio carrier in a interface unit 28, and transmitted from the antenna 29.

The antenna 29 also receives signals which are demodulated and demultiplexed in the unit 28. Data signals are processed in the processor 26, whilst digitised speech is converted to analogue speech in the analogue/digital converter 27 and fed to the handset 25.

The interface unit 28 also includes a connection to the data bus 22 of the aircraft 2 giving access to aircraft parameters such as undercarriage deployment, "weight-on-wheels", time to destination, altitude, etc. When a predetermined condition indicative of the impending end of a flight is met, the interface unit 28 transmits a signal to the ground station to cause a deregistration signal to be transmitted to the card management system 42.

Because the onboard telephone system was originally designed for making outgoing calls, the handsets 25 provided in existing terminals 21 are not equipped

with a suitable call alerting device. The handsets 25 could be modified to provide a buzzer or light to alert the user to an incoming call. Alternatively, to avoid distracting other passengers on the aircraft, the telephone terminal 21 may be connected to an at-seat entertainment system 200, to provide an alert either through the earpieces 202 or on the screen 201.

The operation of this onboard system will now be described with reference to Figure 5. When the card reader 23 detects the presence of a card 24 (step 601) it generates a prompt to indicate to the user that he may wish to have calls diverted to the onboard system. If the user requires this service, he enters a code on the keypad of the handset 25 which causes a divert request to be generated (step 602). The details from the card 23 are then passed to the processor 26 which also provides the identity of the terminal 21 (step 603) and transmits the data to the interface unit 28.

Alternatively, these steps (602, 603) may be activated by the user without a card, by dialling an access code (divert request 602) followed by further keystrokes to identify the account to be used (terminal identity step 603). These keystrokes may include the user's MSISDN (which, as his own directory number would be known to him). To prevent misuse of the system by unauthorised personnel, a security code (Personal Identification Number: "PIN") may be added. This code may have been issued previously to the user, or the user may request such a code by making a call using the satellite system to his home network's customer service department and providing personal details to the operator to prove his identity.

The user may select for the identity of a terminal 21a other than his own at seat terminal 21 to be selected as the destination for incoming calls. For example, if his MSISDN code (or one of them) relates to a facsimile machine having cellular capability, he may request that incoming calls to that number be directed to an onboard facsimile machine 21a.

The data received by the interface unit 28 is then transmitted to the ground station 4 (step 604). The further steps (605-615) in the process are carried out by the co-operating networks 4, 5 and will be described later.

If the user decides that he no longer wishes to have his calls diverted to the terminal 21, he may cancel the diversion instruction by entering a special code on the keypad of the handset 25. Disconnect codes may also be generated in the interface unit 28 for all the termination points 21, either by the cabin crew or automatically in

response to a signal detected on the aircraft's data bus 22 which is indicative of the imminent end of the journey, such as undercarriage deployment, weight on wheels, low altitude, or time remaining to destination as determined by the aircraft's flight management system. The disconnect instruction is transmitted (step 801, Figure 7) by way of the switching system 40 in the ground station 4, to the interface unit 52 whose operation (steps 802 to 805) will be described later.

The Ground Station 4 shown in Figure 3 has a radio antenna system 44 for communicating with the terminal 20, through a satellite link 6 or otherwise. Signals are handled by an Access Control Signalling Equipment (ACSE) 40 which carries out switching functions to route calls to or from the public switched telephone network (PSTN) 8.

A card management system 42 comprises a data acquisition unit 47 which reads data transmitted from the card reader 24, and/or keyed in by the user, to identify the type of user, confirm the user's account details and arrange billing for any calls made, through a billing system 45 which raises invoices, or interacts with the systems of a credit card operator or bank.

In the existing onboard systems a user cannot receive calls, unless the caller knows the unique "AES" number of the handset 21, 21a. This is unlikely, as the number depends on the identity of the aircraft, the seat, and the serving satellite or base station.

The conventional ground station equipment just described is augmented in the present embodiment by an interface 46 with the host network 5, and through that to the Home Location Register 73 of each network 7 (Figure 1) whose subscribers are to be given access to the service. The interface 46 stores a concordance between the card identities and the card-holder's cellular radio telephone number (MSISDN: mobile systems integrated services data network number), on request from the data acquisition unit 47, which is arranged to recognise the card identities which require such translation. In a preferred embodiment the concordance is supplied to a register 43 in the ground station by the operator of user's home network 7, when the network operator provides the user with the card. The operator of the home network 7 also records the concordance in its own Home Location Register 73. This arrangement allows the existing card readers 23 to be used on board the aircraft, without modification. However, if the users' mobile

subscriber identities are supplied from the onboard system, for example by the user keying it in, the store 43 can be omitted. Billing information is also returned to the user's home network 7.

The operation of the ground station 4 will now be described with reference to Figure 5. The data acquisition unit 47 receives the card details from the reader 23 (see steps 601 to 604 already discussed) and if it identifies as those details as corresponding to a cellular user (step 605), it retrieves the cellular user identity from the store 43 containing this concordance, or from the HLR 73 of the user's home network, (step 606). (This step can be omitted if the user's mobile network identity is provided by the onboard apparatus 20).

The data transmission unit 46 then generates a signal for transmission of the cellular user identity, together with the identity of the terminal 21, to the cellular network 5 acting as host to the interface (step 607). This host network 5 will, in general, not be the same as the user's home network 7. The further steps (608 to 615) in this process will be described later, with reference to Figure 4.

If a cancellation signal is received from the aircraft in respect of a given terminal 21, (step 801, previously discussed) the data transmission unit 46 transmits a "cancellation" signal to the host network 5. As already discussed, the cancellation signal may be generated either for an individual handset 21, by its user dialling a special code, or for all handsets as the result signals received by the radio interface unit 28 over the aircraft's data bus 22 indicative of the imminent end of the flight.

An embodiment of the host network 5 of the invention is shown in Figure 4. Its operation will be discussed with reference to Figures 5, 6, and 7 In this network 5 an interface unit 52 is provided, which is arranged to appear to the switching system 50 as if it is a normal base station of the cellular radio system.

In order to do this, the interface unit 52 is provided with a data acquisition unit 54 which receives from the card management system 42 of the ground station 4 the identity of the cellular telephone it is to represent, and the AES identity of the onboard terminal 20 (step 608, Figure 5). Mobile telephones have three identification codes: the equipment identity (IMEI, which will not be discussed further here), the directory number (MSISDN) and the actual SIM identity (IMSI). In practice, for security reasons, the IMSI is not made generally known, and a user is normally identified by his MSISDN unless the SIM itself is used. If the SIM is used in the card

reader 23 the IMSI can be read directly from the data received by the data acquisition unit 54. However, if the user keys in his own identification data (step 603), or a concordance is provided by the card reader 23, the data acquisition unit will receive the MSISDN, and not the IMSI. (There may also be a PIN or other security code, which is checked by the data acquisition unit 54).

In the GSM standard it is possible to obtain an IMSI if the MSISDN is known by interrogating the appropriate Home Location Register 73. The present invention makes use of the same facility to obtain the user identity of the originator, and then controls the location update process in respect of the user identity so obtained. To do this, the interface unit 52 transmits a "request for routing information" signal, using the MSISDN (step 609). The standard HLR 73 responds to such a request with a signal which includes the IMSI corresponding to the MSISDN in the request (step 610). (The "request for routing information" signal was provided under the GSM standard as a means of obtaining routing information for data messages intended for a destination for which only the MSISDN number is known. However, it may be used for other purposes, such as that described above).

The telephone identity (IMSI), whether obtained directly from the card reader 23, or indirectly as just described, is passed to a network registration unit 55 which exchanges signals with the mobile switching centre 50 in the same way that a real cellular telephone would do. The mobile switching centre therefore informs the user's Home Location Register 73 that the mobile telephone is now registered with the network 5 (step 611). The Home Location Register 73 records that the mobile handset is now registered with host MSC 50 (step 612).

It should be noted that, although registered with the host MSC 50, the user's mobile handset is not operatively connected to the host MSC 50 - in fact the mobile handset may be switched off to allow the card 24 to be used. The user may be in an aircraft, anywhere in the world within the coverage area of the satellite network.

The user's details, including any diversion instructions, are sent by the Home Location Register 73 to the network's VLR 51 (step 613). A store 57 records a copy of the details of these diversion instructions (step 614).

Conventionally, any incoming calls for a mobile user are sent in the first instance to the user's home network 7, and the HLR 73 provides information to

identify the MSC 50 where the mobile handset can currently be found. Consequently, in the present arrangement, any incoming calls intended for the mobile user will now be directed to the network 5, as the mobile user is currently registered there.

The data acquisition unit 54 in the interface 52 now passes the directory number of the termination point 21 to a call diversion instruction unit 56, which generates a "divert on busy" instruction to the VLR 51 (step 615). This is a standard divert arrangement, and operates such that should the mobile unit appear to be engaged on another call when a call attempt is made to it, the call attempt is diverted to a specified directory number, in this case the termination point 21 or 21a, identified by its AES code. This diversion instruction replaces any previous instruction held in the VLR 51. Further settings may be made in the call diversion instruction unit 56, such as the identification of a termination point 21 to which a data message is to be sent when a call is diverted to another termination point 21a.

Of course, there is in fact no mobile telephone connected to the interface unit 52, and therefore it is unable to connect incoming calls to the mobile telephone in the conventional way, or to identify the current true operating condition (switched off, busy, ready for calls, etc) of the mobile handset. Instead, the system responds to a call attempt as will now be described with reference to Figure 6.

When a call attempt is made (step 701), the MSC 70 to which the call is initially routed (hereinafter referred to as the "home MSC") obtains from the HLR 73 the current location of the mobile telephone (step 702), and on receiving the identity of the host MSC 50 (step 703), directs the call there (step 703). The host MSC 50 in turn transmits the call attempt to the currently serving base station, which is in fact the interface unit 52 (step 704). If the disconnect procedure (to be described later with reference to Figure 7) has been carried out, the call will not be connected to the onboard system (step 705), and instead a signal is transmitted back to the home MSC 70. Otherwise, call attempts received by the interface unit 52 are handled by a call request handling unit 58, which automatically returns a "busy" signal to any such request (step 706). The MSC 50, on receiving the "busy" signal, retrieves the diversion information from the VLR 51 (step 708) allowing it to route the call through the PSTN 8 to the user terminal 21, 21a (step 710).

In the event that the destination terminal 21a is not the terminal 21 that originated the instruction, the call request handling unit 58 of the ground-based

interface unit 52 may be arranged such that whenever a message addressed to the user's MSISDN is diverted to the terminal 21a, the call request handling unit 58 also generates a data message (step 711) for transmission to the instructing terminal 21 by way of the MSC 50, PSTN 8, and satellite system 4, 6 (step 712) either during the call or after it ends. Such a message can be used for example to alert the user of the terminal 21 that a facsimile message addressed to him has been sent to the terminal 21a. As with the call alerting process described above, the message may be displayed using the in flight entertainment system 200.

If a second call attempt is made, the ACSE 40 may identify that the divert instruction will not work as it is currently handling a diverted call to that number. The default condition in such cases is to arrange for the second call to be diverted to the user's voicemail address (not shown) in his home network 7. The user may also be sent a data message to inform him of the new voicemail message. This message would normally be sent to the mobile unit, which appears to the MSC 50 to be co-operating with the interface unit 52, so the MSC 50 transmits the data message to the interface unit 52 (step 711). In order to inform the user of the new voice mail message, the interface unit 52 now regenerates the data message for forwarding to the user terminal 21 via the MSC 50, PSTN 8, and satellite system 4, 6 (step 712) either during the call or after it ends. However, data messages are not suitable for switching via the MSC 50 and PSTN 8, nor for handling by the on-board terminal 21 as it is only equipped for voice. Because the IMSI is recorded in the HLR 73 as being registered with the "Virtual" BSC, or interface unit, 52, any other data messages intended for the user will also be routed to the interface unit 52, and require forwarding to the user. As with the call alerting process described above, the message may be displayed using the in flight entertainment system 200.

To allow the use of the at seat display system 201 for data messages, not suitable for transmission over the PSTN and satellite system in their original form the interface unit 52 (Figure 4), 148 (Figure 12) is provided with a data handling processor 53 for receiving data messages received over a packet data system 9 by way of the MSC 50 and intended for users currently associated with the interface unit 52. These messages include SMS messages sent from other callers, and SMS messages generated by the MSC 50 itself to alert the user that a message has been

sent to the voice mail system. The format of such a message is shown in Figure 8, and the process of sending and receiving it is shown in Figure 9.

The original message 900 basically consists of a data payload 901 and an address 902, which is the IMSI of the destination mobile telephone (Figure 8a).

When the interface unit 53 receives such a data message (step 990) it retrieves from the data acquisition unit 54 the data network address of the at-seat entertainment terminal 201 corresponding to the user's cellular identity which was originally provided to the data acquisition unit 54 when the user carried out the registration procedure (step 991). The interface unit 53 next generates a data call to that address (step 992), in a form suitable for transmission by the MSC 50 (step 993) over the packet data network 9 to the aircraft, with an address header corresponding to the data network address of the user's at-seat terminal 201. This data call may be a short message to indicate that a message is awaiting delivery, and displaying on the screen 201 an invitation to the user to dial a special code on his handset 25 to accept the message (step 994), and any charge associated with it. This acceptance is transmitted back, by way of the MSC 50, 141 to the interface unit 53 (step 995). (These steps 992 – 995 may be omitted if it is not required for users to acknowledge acceptance before receiving a data message).

The interface unit 53 then replaces the address header (the IMSI) 902 in the original data message with a code 912 identifying the terminal 201 and encapsulates the message in a form suitable for transmission over the packet data network 9 to the aircraft (step (996), with an address header 910 to send it to the data network interface 28 serving the onboard entertainment system 200. It can thus be transmitted to the interface 28 over the packet data network 9 (step 997), effectively as a packet with an address header 910 and a payload made up of the at-seat terminal number 912 and true payload 901 (Figure 8b).

On receipt of the data message, the on board data interface 28 extracts the data message payload 901, 912, (Figure 8c) (step998) and identifies the individual at-seat terminal 201 identified by the address 912. It can then cause display of the data message payload 901 on the screen 201 of the appropriate terminal (step 999).

If password protection is required, for example to ensure that the user is present when the message is displayed, the payload 901, 912 can also include a password code 913, which causes the interface 28 to withhold the remainder of the

payload until a predetermined sequence of keystrokes has been entered by the user in the terminal 201.

As the termination is itself mobile, being on board an aircraft, call routing to that termination may require revision from time to time. For example, the "Inmarsat" satellite system comprises several geostationary satellites, which each provide cover for part of the earth's surface. These areas of coverage overlap to a large extent, but nevertheless on a long flight the aircraft may pass out of the area covered by one satellite into that served by another. This causes a small but significant change in the network address of any satellite terminal on board the aircraft. The aircraft location register 41 monitors the identity of all aircraft currently being handled by each ground station 4. When it an aircraft location is updated, the call diversion instruction unit 56 responds by transmitting a new call diversion instruction to the VLR 51 so that any further incoming call attempts are diverted to the new network address of the terminal. Note that the diversion store 57 is not updated. Note also that this does not affect calls already in progress: there is usually sufficient overlap in coverage areas that handover from one satellite or base station to another can be arranged to take place when no call is in progress.

Figure 10 shows a process for intercepting calls when the onboard system 2 is switched off at times when its operation could interfere with conventional land-based cellular systems or with electronic control systems of the vehicle, to enforce "quiet" periods on board, or to allow transfer of the satellite link from one satellite to another. The control to switch the system off may be performed manually or under the control of a sensor detecting interference from nearby radio base stations 74, or an operational condition of the vehicle, such as deployment of the aircraft undercarriage, low altitude, or "weight on wheels", communicated to the onboard system by means of the control data bus 22. When such a disconnection occurs (step 1501), a signal is generated in the onboard system 2 (step 1502) for transmission over the satellite link 6 to the ground station 4 (step 1503). This signal causes the satellite ground station to invoke a call failure mode for any call directed to the onboard system 2 of the specified vehicle (step 1504).

Any call now diverted by the MSC 50 to a number corresponding to a node on board the vehicle (step 1505) will then receive a "call failed" indication from the ground station (step 1506), without any signalling required over the satellite link 6.

Such failed calls will be re-routed according to the user's own diversion instructions, stored by the host MSC 70 for use when the user's handset is busy (step 1507). Generally, such instructions will be to divert the call to a voicemail system in the user's home network. In addition, the host MSC 70 will record the existence, and possibly the origin (Calling line identity – CLI) of any such call attempts (step 1508).

When the onboard system 2 is re-activated (step 1511) a further signal is transmitted by the onboard system (step 1512) for transmission over the satellite link 6 to the ground station 4 (step 1513). This signal causes the satellite ground station to revoke the call failure mode for calls directed to the onboard system 2 of the specified vehicle (step 1514). When a user 25 reconnects to the onboard system 2 (step 1515) the onboard system transmits a signal to the host MSC 50 (step 1516) which causes the host MSC to retrieve the call attempt record previously stored for that user (step 1518). If one or more such call attempts have been made, the MSC returns a message to the user 25 (step 1519), prompting the user to retrieve his messages from the voicemail system should he so wish.

Generally, the detection of the same IMSI from two sources causes an HLR to disconnect both callers as a fraud prevention measure. Since this system causes the generation of an IMSI from the interface unit 52, instead of directly from the mobile telephone to which that IMSI relates, the user's mobile telephone should be switched off to prevent the network detecting the IMSI in two places, which would disrupt the call routing processes in the HLR 73 and elsewhere.. If the user is on board an aircraft, he should not be using his mobile handset in the conventional manner, and so there should be no problem. However, if the user, having left the aircraft, switches on his telephone 75 before the host network 5 has reported a loss of the mobile unit from its own network, the mobile unit may be perceived by the HLR 73 as being registered with two networks at once. To avoid this possibility, a disconnection procedure is followed as described with reference to Figure 7.

As already discussed, to stop calls being diverted to the user termination point 21, and restore the original call diversion settings, a disconnection signal may be transmitted from the onboard system 28 to the host network's interface unit 52 (step 801). The disconnection signal may be activated by a special code entered by the user, or it may be generated automatically by data collected from the aircraft's data bus 22 indicative of the imminent end of the flight. Note that this disconnection

signal merely controls the interface 52 – it has no effect on calls in progress, which is routed from the host MSC 50 by way of the PSTN 8.

The disconnect instruction is received by the interface unit 52 (step 802) and causes the call diversion instruction unit 56 to retrieve the call diversion data stored in the store 57 (step 803) and generate a call diversion instruction restoring the original settings to the VLR 51 (step 804). This ensures no further calls are routed to the onboard terminal 21.

The interface unit 52 next causes the network registration unit 55 in the interface unit 5 to instruct the MSC 50 that the user is no longer connected to the network 5 (step 805). This allows the mobile unit to register with another network 7 in the normal way. Call attempts to the user number will continue to be routed by the Home HLR 73 to the MSC 50 with which the mobile unit was most recently registered, (i.e. the host MSC 50) but as that MSC cannot now find the mobile unit, any such incoming call will return a "not found" signal to the home MSC 70 which will divert the call according to any diversion instructions set up, or fail the call. Alternatively, the host MSC 50 may handle the diversion itself if the mobile unit is "not found", using the original diversion instructions now in the VLR 51, having been retrieved from the store 57 (step 804 above).

Having left the aircraft, the user may switch on his mobile telephone 75, which will register with the local network (e.g.7) and will retrieve the original divert information from the HLR 73 (note that in general the HLR 73 will not be in the same network), and will cause all data relating to the user to be deleted from the VLR 51 in the "host" network 5.

Throughout the specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that that prior art forms part of the common general knowledge in Australia.

THE CLAIMS DEFINING THE PRESENT INVENTION ARE AS FOLLOWS:

1. A method of registering to divert a telephone call to a telecommunications device on-board a vehicle, the method including:

first receiving at least first and second identification information, the first identification information being associated with a cellular device, the second identification information being associated with the telecommunications device;

sending a request to a home network of the cellular device for additional information associated with the cellular device;

second receiving the additional information from the home network;

associating modified divert on busy instructions with the cellular device that identify the telecommunications device as a divert on busy instruction; and

setting an indication of a status of the cellular device as busy regardless of an actual status of the cellular device.

2. The method as claimed in claim 1, further including:

third receiving a telephonic call intended for the cellular device;

diverting the telephonic call to the on-board telecommunications device consistent with the primary divert on busy instruction.

3. The method as claimed in claim 1 wherein the on-board telecommunications device includes a facsimile device.

4. The method as claimed in claim 1, wherein said associating includes inserting a telecommunications device identifier as a primary divert on busy instructions within any existing divert on busy instructions.

5. The method as claimed in claim 1, wherein said first receiving, said second receiving, said associating and said setting occur at a host network associated with the vehicle, the host network being different from the home network, and said method further includes advising the home network that the cellular device is roaming within the coverage of the host network.

6. A method of registering of divert incoming cellular telephone calls to an on-board telecommunications device, the method including:

sending, from a host network, a request to a home network of a cellular device for information associated with a cellular device;

receiving the information from the remote network;

registering the cellular device as roaming on the host network regardless of the actual location of the cellular device relative to the host network; and

updating, in response to said registering, primary divert-on-busy instruction of the cellular device as an on-board telecommunication device.

7. The method as claimed in claim 6, further including setting an indication of a status of the cellular device as busy regardless of an actual status of the cellular device.

8. The method as claimed in claim 6, further including advising the home network that the cellular device is roaming on the host network.

9. The method as claimed in claim 6, further including:

receiving a telephonic call placed to the cellular device; and

diverting the telephonic call to the on-board telecommunications device.

10. The method as claimed in claim 6, wherein the on-board telecommunications device includes a facsimile device.

11. A method of receiving a telephonic call placed to a cellular device at a telecommunications device on-bard a vehicle including:

receiving at least first and second identification information, the first identification information being associated with a cellular device, said second identification information being associated with the telecommunications device;

sending a request to a home network of the cellular device for additional information associated with the cellular device;

receiving the additional information from the home network;

associating modified divert on busy instructions with the cellular device that identifies the telecommunications device as a divert on busy option;

setting an indication of a status of the cellular device as busy regardless of an actual status of the cellular device;

receiving a call forwarded from the remote network, the call being placed to the cellular device;

accessing the modified divert on busy instructions for the cellular device; and

forwarding the call to the telecommunications device consistent with said accessing;

wherein the call terminates at the telecommunications device on-board the vehicle.

12. The method as claimed in claim 10, wherein the on-board telecommunications device includes a facsimile device.

13. The method as claimed in claim 10, further including advising the home network that the cellular device is roaming on a host network.

14. The method as claimed in claim 10, wherein said associating includes inserting a telecommunications device identifier as a primary divert on busy instruction within any existing divert on busy instructions.

15. The method as claimed in claim 10, said method further including routing, when said actual status of the cellular device is busy, the call consistent with the existing divert on busy instructions.

16. A mobile telecommunications system apparatus, substantially as herein described with reference to the accompanying drawings.

17. A method of operating a mobile telecommunications system, substantially as herein described.

18. A method of registering to divert a telephone call to a telecommunications device on-board a vehicle, substantially as herein described.

19. A method of registering to divert incoming cellular telephone calls to an on-board telecommunications device, substantially as herein described.

20. A method of receiving a telephonic call placed to a cellular device at a telecommunications device on-board a vehicle, substantially as herein described.

DATED this 27th day, of February 2004

STATOS GLOBAL LIMITED

By Their Patent Attorneys

DAVIES COLLISON CAVE

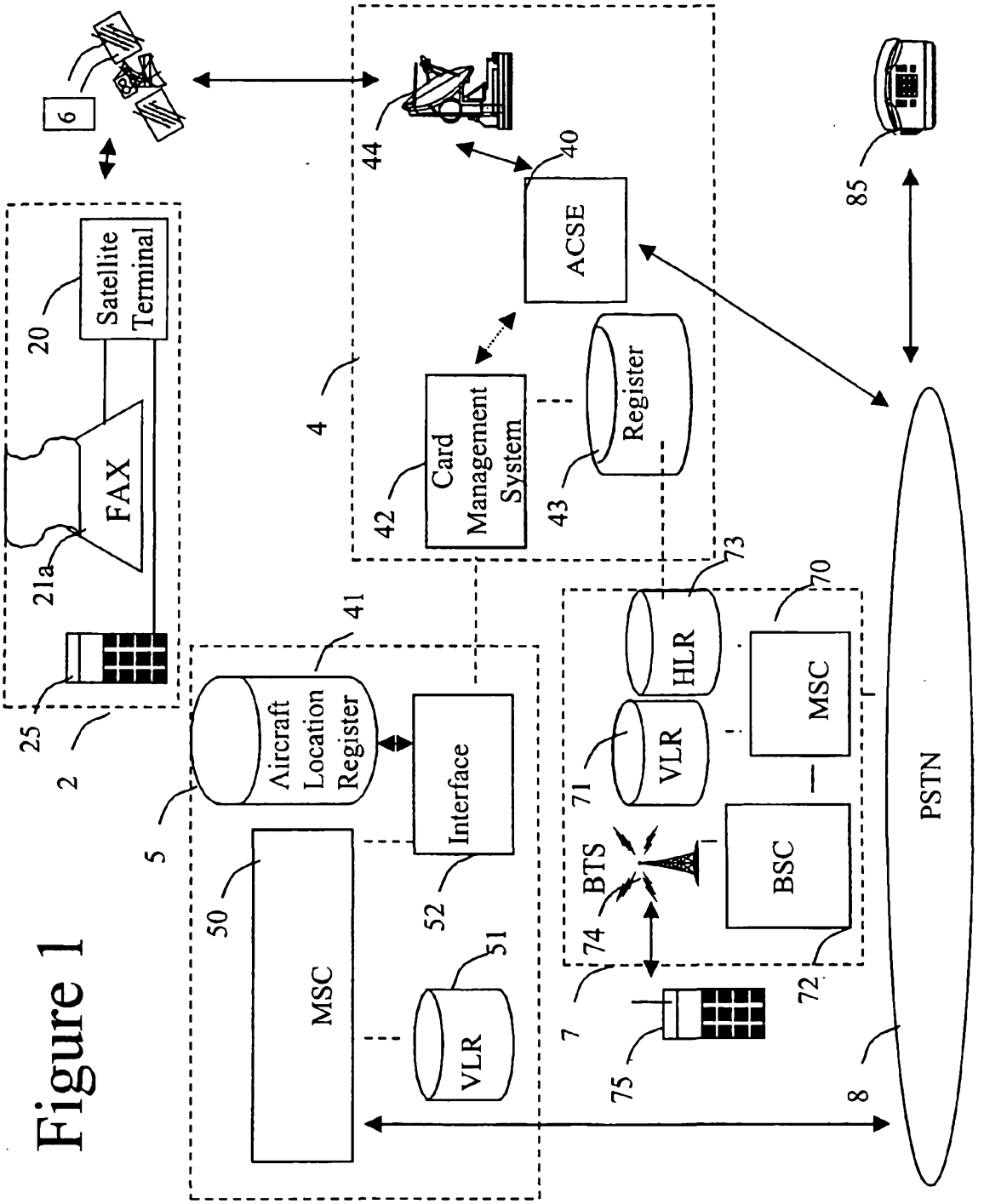

6
44
40
ACSE
85
Satellite Terminal
20
FAX
21a
25
2
4
Card Management System
42
Register
43
41
Aircraft Location Register
5
Interface
52
50
MSC
VLR
51
73
HLR
70
MSC
71
VLR
BTS
74
BSC
72
7
75
8
PSTN

Figure 1

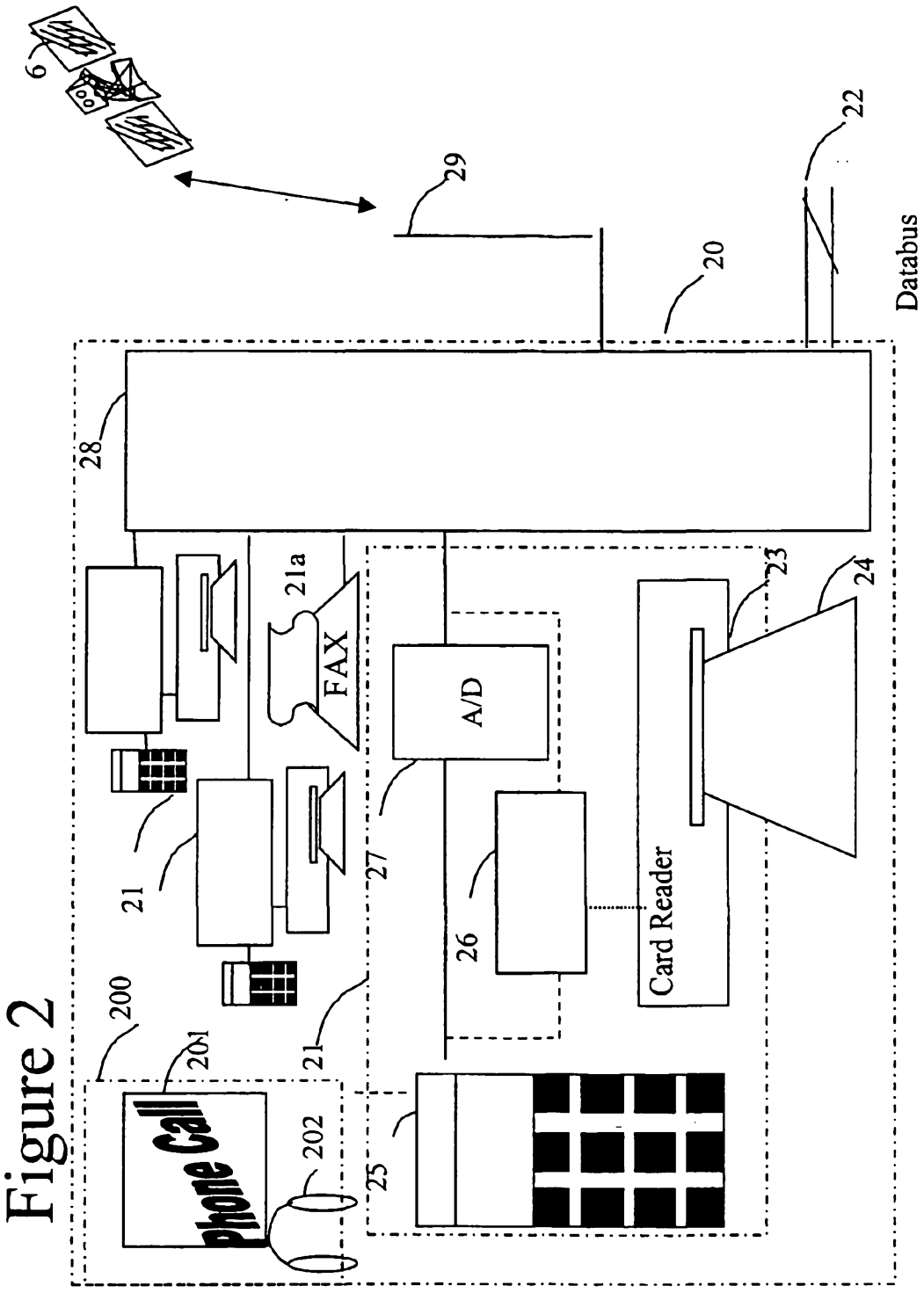

6
29
22
20
Databus
28
21a
FAX
A/D
23
24
21
27
26
Card Reader
200
201
21
Phone Call
202
25

Figure 2

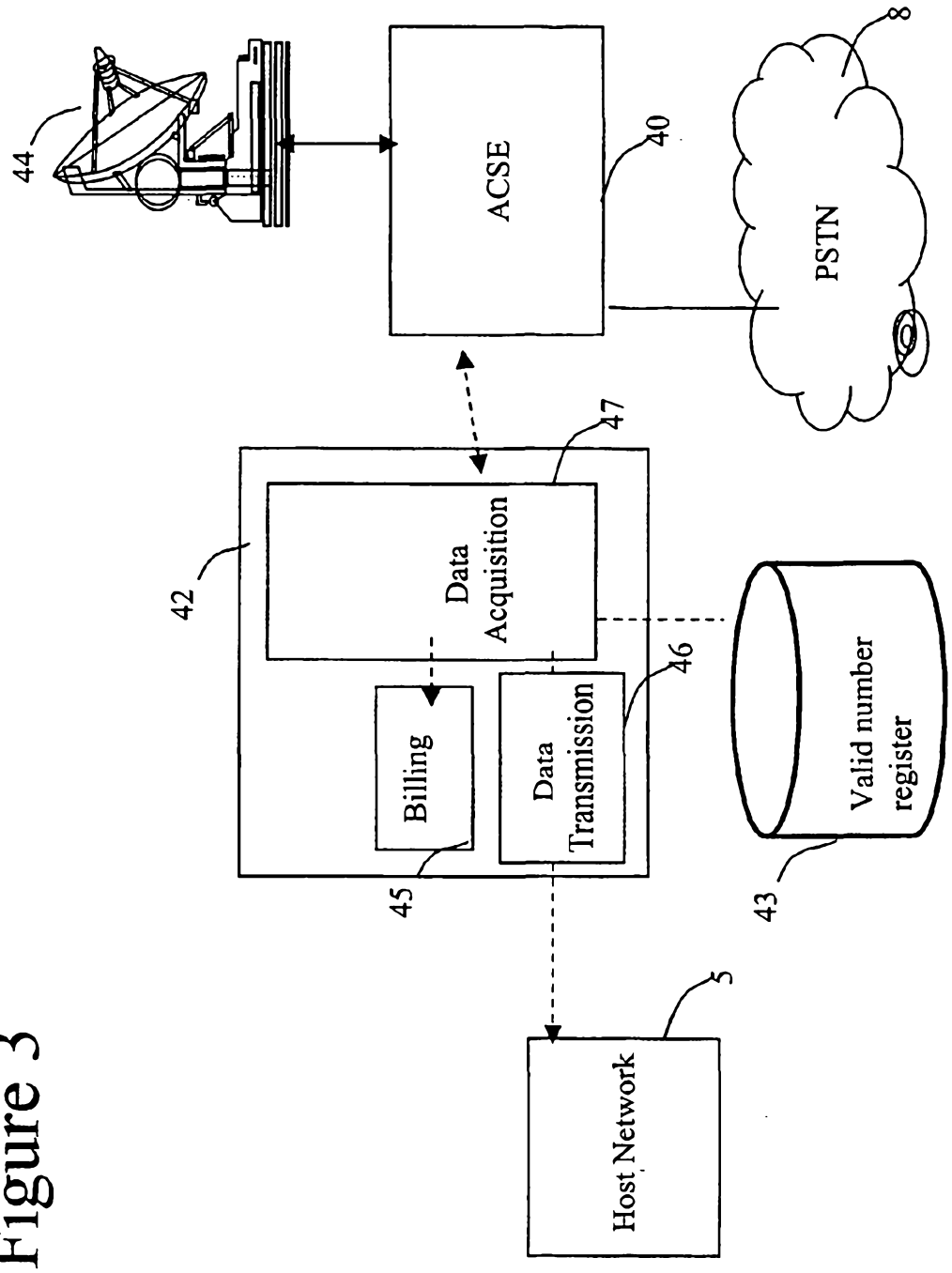

44
ACSE
40
PSTN
47
42
Data Acquisition
Billing
Data Transmission
46
45
Valid number register
43
Host Network
5

Figure 3

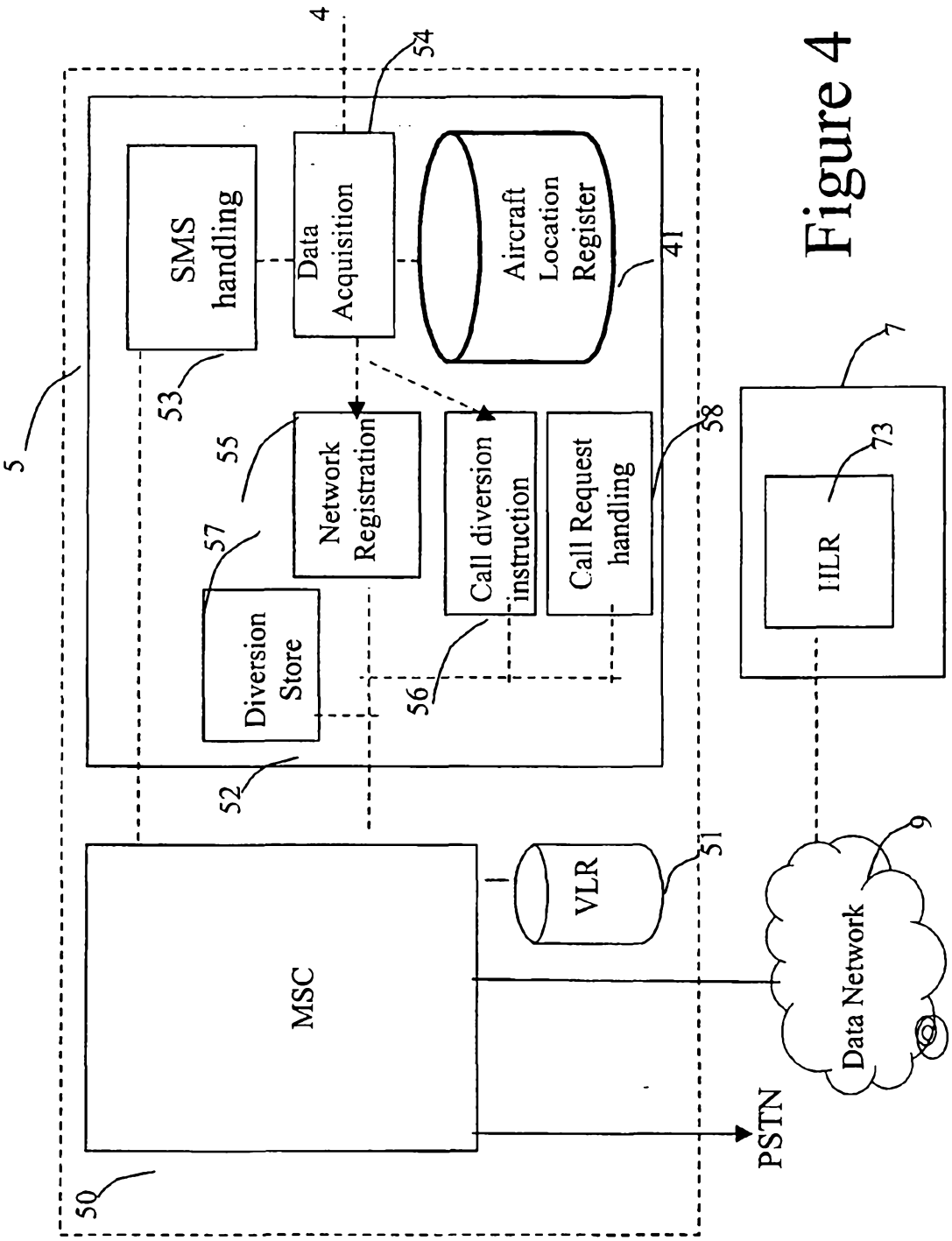

4
54
SMS handling
Data Acquisition
Aircraft Location Register
41
5
53
55
Network Registration
57
Call diversion instruction
Call Request handling
58
Diversion Store
56
52
7
73
IILR
MSC
VLR
51
9
Data Network
PSTN
50

Figure 4

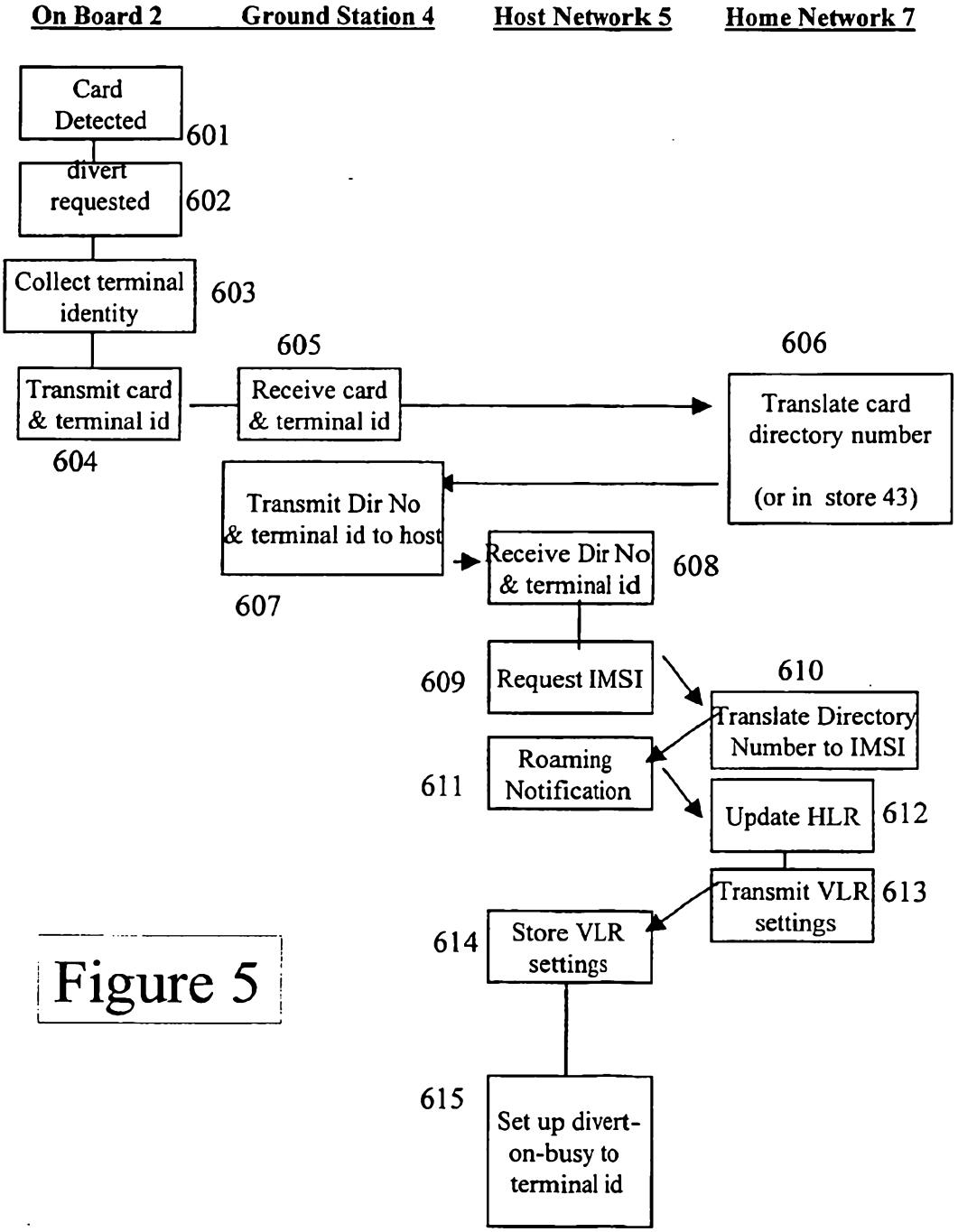

On Board 2
Ground Station 4
Host Network 5
Home Network 7
Card Detected
601
divert requested
602
Collect terminal identity
603
Transmit card & terminal id
604
605
Receive card & terminal id
606
Translate card directory number
(or in store 43)
Transmit Dir No & terminal id to host
607
Receive Dir No & terminal id
608
609
Request IMSI
610
Translate Directory Number to IMSI
611
Roaming Notification
Update HLR
612
Transmit VLR settings
613
614
Store VLR settings
615
Set up divert-on-busy to terminal id

Figure 5

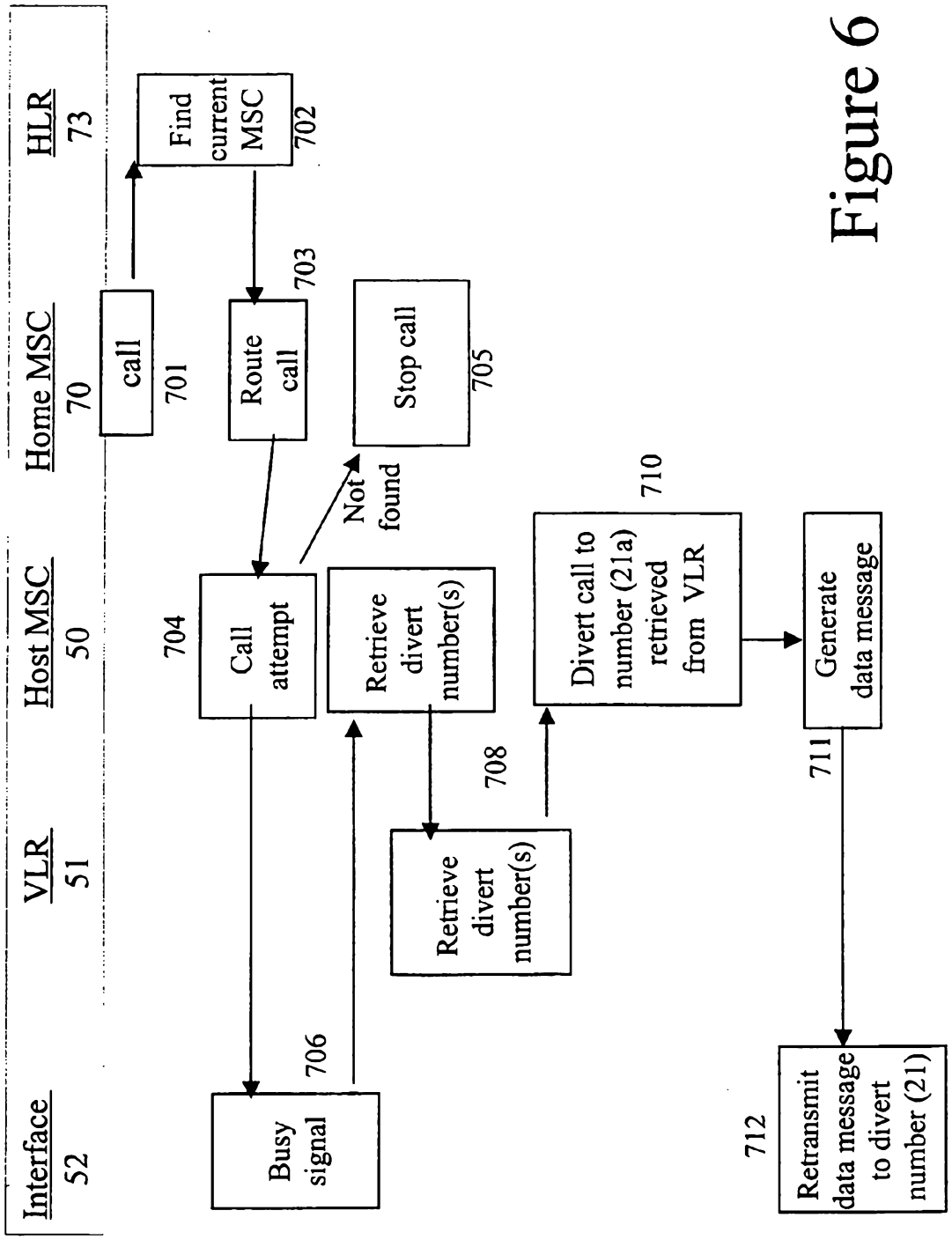

Interface 52
VLR 51
Host MSC 50
Home MSC 70
HLR 73
call 701
Find current MSC 702
Route call 703
Stop call 705
Not found
Call attempt 704
Retrieve divert number(s)
Busy signal 706
Retrieve divert number(s) 708
Divert call to number (21a) retrieved from VLR 710
Generate data message 711
Retransmit data message to divert number (21) 712

Figure 6

Figure 8

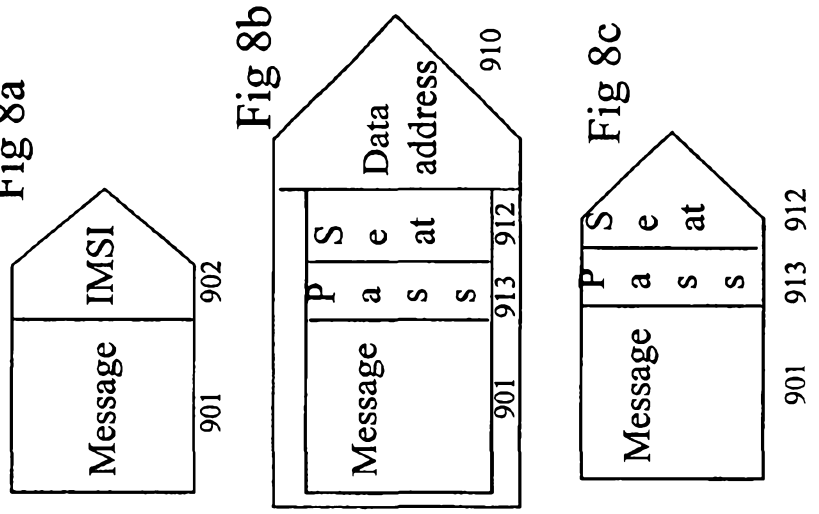
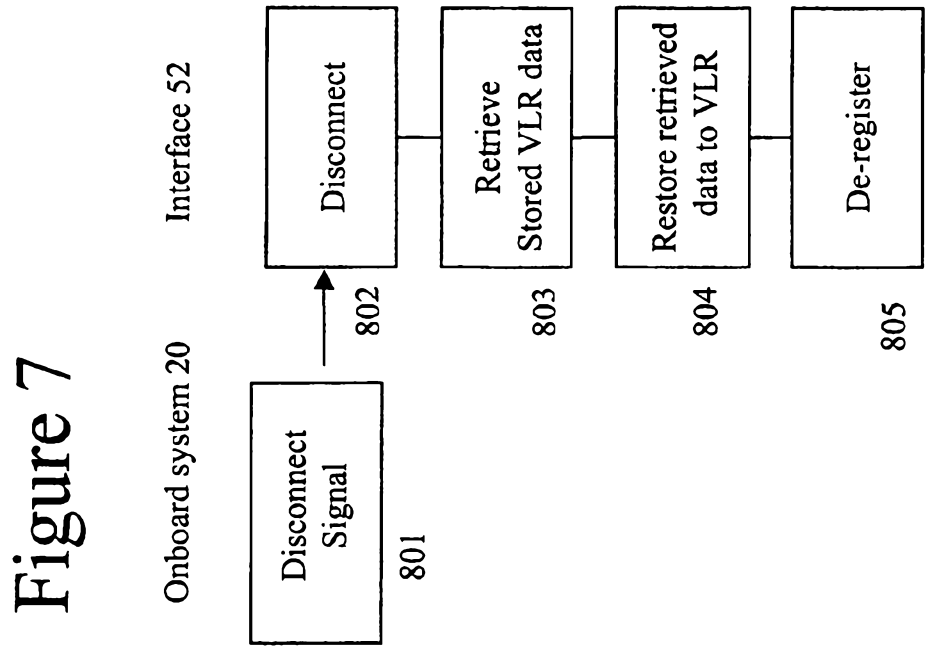


Figure 7



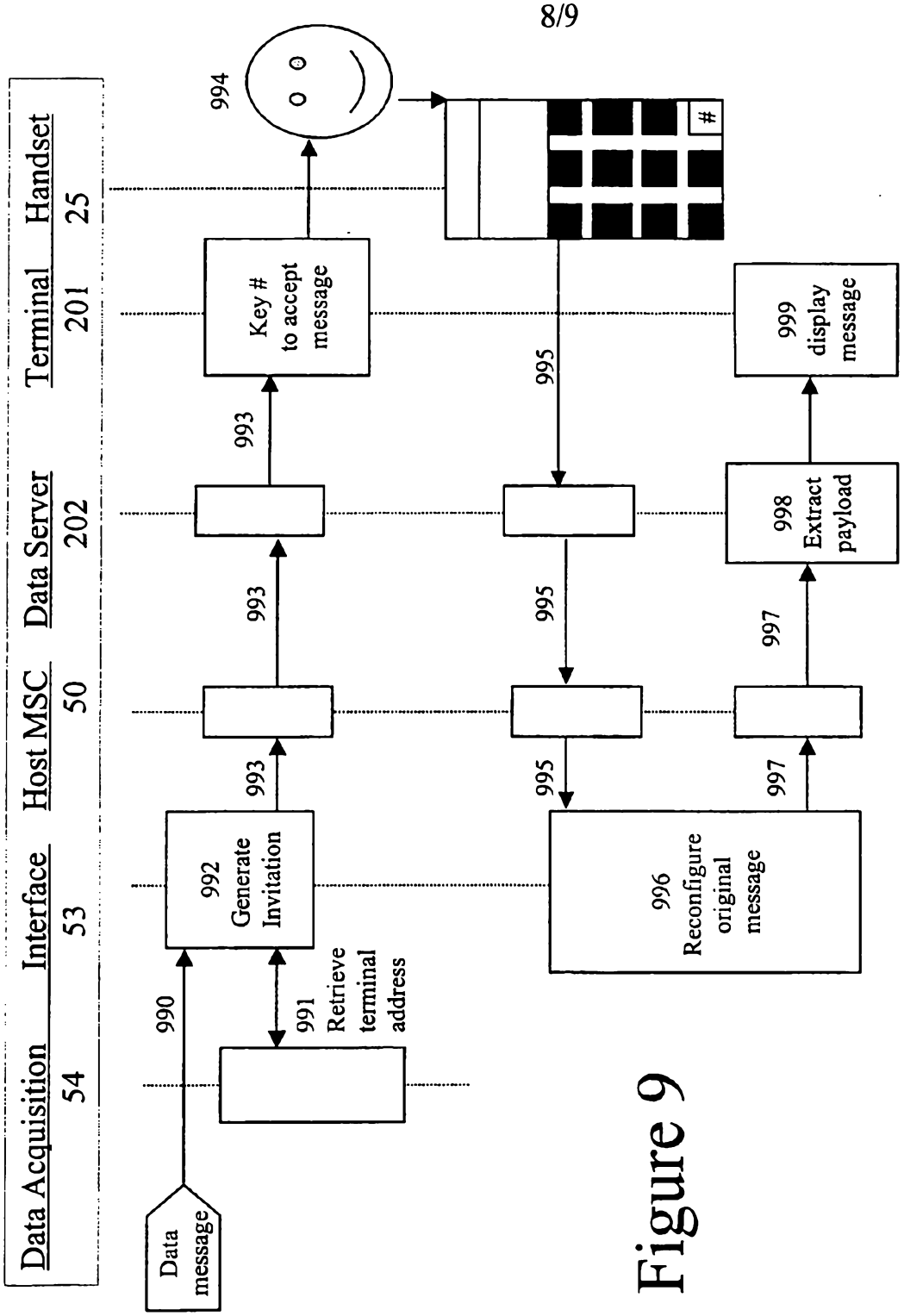
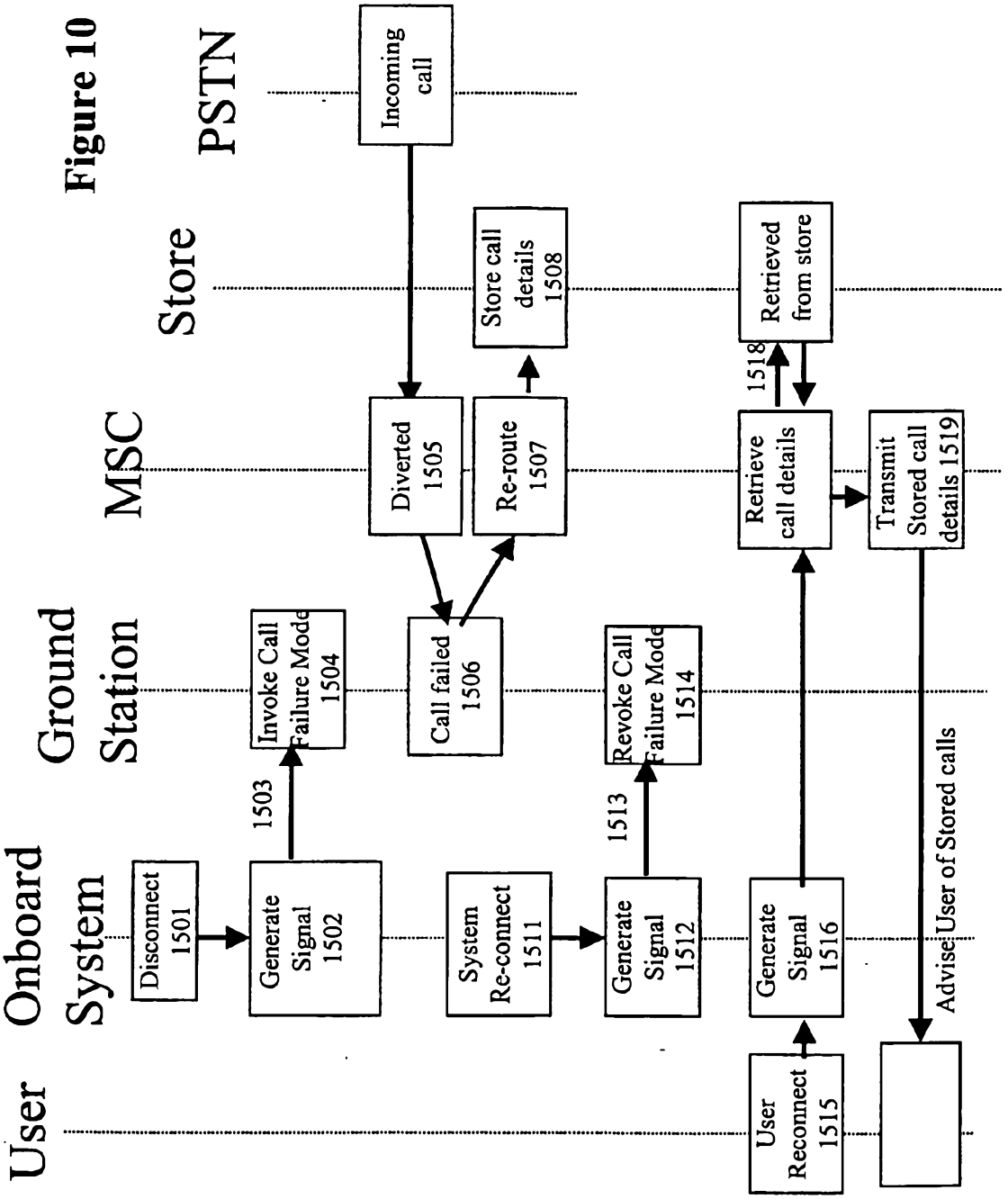

Data Acquisition 54
Interface 53
Host MSC 50
Data Server 202
Terminal Handset 201 25
Data message
990
991 Retrieve terminal address
992 Generate Invitation
993
Key # to accept message
994
995
996 Reconfigure original message
997
998 Extract payload
999 display message
#

Figure 9

Figure 10


User
Onboard System
Ground Station
MSC
Store
PSTN
Incoming call
Store call details 1508
Retrieved from store
1518
Diverted 1505
Re-route 1507
Retrieve call details
Transmit Stored call details 1519
Disconnect 1501
1503
Invoke Call Failure Mode 1504
Generate Signal 1502
Call failed 1506
System Re-connect 1511
1513
Revoke Call Failure Mode 1514
Generate Signal 1512
Generate Signal 1516
Advise User of Stored calls
User Reconnect 1515