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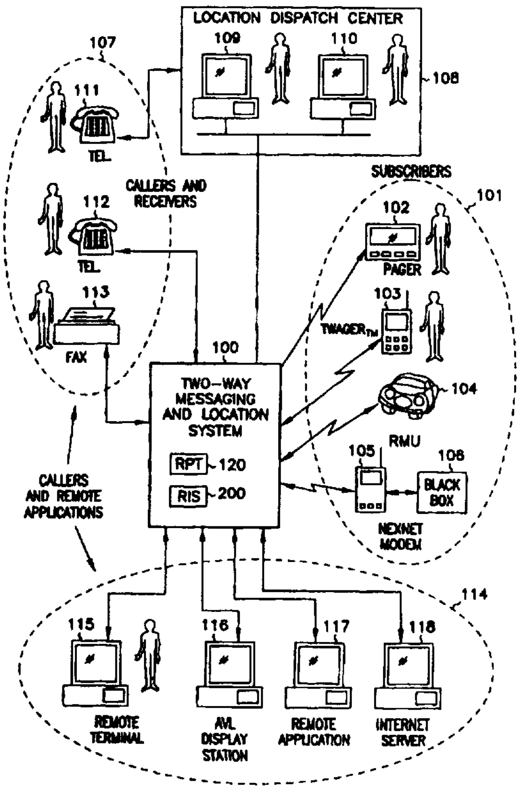
(57) Abstract

A global message server capable of sending and receiving a wide variety of message types to a wide variety of message receivers is described. The system allows the use of two-way paging devices to communicate with other two-way message devices located anywhere in the world. The messages destined for another two-way pager are sent through the Internet as an inexpensive and fast communications medium. The system also includes a two-way messaging and location system which receives a wide variety of information formats from a variety of input devices, stores and forwards the information to a wide variety of other receiving devices. Input devices and output devices include two-way pagers, remote mobile units, wireless modems, fax machine, Internet e-mail, interactive voice response telephone connections, operator assisted input systems and personal computer inputs. The two-way messaging and location system also includes the optional ability to locate the global position of two-way pagers, remote mobile units and wireless modems.



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GLOBAL TWO-WAY PAGING USING THE INTERNET

Field of the Invention

The present invention relates to two-way communication systems and in particular to a global two-way paging system, method and apparatus for sending and receiving paging messages via the Internet.

Background of the Invention

Two-way paging devices are small, typically handheld devices which allow sending and receiving alphanumeric paging messages within a certain geographical area. These paging devices are limited in range and are typically only registered for use within a limited geographic region. There is a need in the art for a two-way paging device which allows global paging in an inexpensive manner. There is a further need in the art for paging roaming and automatic registration when a roaming two-way pager enters a new location. There is a further need in the art for a messaging system which interfaces a wide variety of information input and output mediums. There is a further need in the art for the sending and receiving of a wide variety of information formats through wireless two-way paging devices.

Summary of the Invention

The present invention solves the aforementioned shortcomings in the art and other problems which will be understood by those skilled in the art upon reading and understanding the following specification. The present invention is directed to a global message server capable of sending and receiving a wide variety of message types to a wide variety of message receivers. In particular, the present invention allows the use of two-way paging devices to communicate with other two-way message devices located anywhere in the world. The message destined for another two-way pager are sent through the Internet as an inexpensive and fast communications medium.

In another embodiment, the present invention includes a two-way messaging and location system which receives a wide variety of information formats from a variety of input devices, stores and forwards the information to a wide variety of other receiving devices. Input devices and output devices include two way pagers, remote mobile units, wireless modems, fax machine, Internet e-mail, interactive voice response telephone connections, operator assisted input systems and personal computer inputs. The two-way messaging and location system also includes the optional ability to locate the global position of two-way pagers, remote mobile units and wireless modems.

Description of the Drawings

In the drawings, where like numerals describe like components throughout the several views,

Figure 1 is a general block diagram of the two-way messaging and location system and the related interface components; and

Figure 2 is a block diagram of the remote interface server of the two-way messaging and location system of Figure 1;

Figure 3 s a diagram showing a two-way paging communication path;

Figure 4 is an overview of the infrastructure of two-way frequency-hopped spread spectrum two-way paging system;

Figures 5, 5a and 5b describe the synchronization and message format of the outgoing (downlink) paging signals from the base stations; and

Figure 6 describes the format of the frequency-hopped spread spectrum signal transmitted (uplink) by the remote mobile units.

Detailed Description of the Preferred Embodiment

In the following detailed description of the preferred embodiment, reference is made to the accompanying drawings which form a part hereof, and in which is shown by way of illustration specific preferred embodiments in which the inventions may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that structural, logical and electrical changes may be made without departing from the spirit and scope of the present inventions. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present inventions is defined only by the appended claims.

System Overview

A two-way messaging and location system is shown in Figure 1 in block diagram form. The two-way messaging and location system 100 includes the ability to receive, store, and forward messages of a wide variety and type to and from a wide variety of callers, receivers, subscribers, and remote applications. The subscribers 101 are connected to the two-way messaging and location system by wireless communication links as will be described more fully below. Types of subscribers include, but are not limited to, a standard receive-only paging device 102, a two-way pager (Twager™) 103, a remote mobile unit typically found in a vehicle or the like 104, or a wireless modem 105 typically connecting to another device 106. The other device, referred to in Figure 1 as a black box, can be a wide variety of information systems including, but not limited to, a personal computer, a personal information system, a personal communication device, a vending machine information gathering device, a remote monitoring device, and a wide variety of other information retrieval or transmitting devices.

The callers and receivers 107 can either communicate directly into the two-way messaging and location system 100 or use a local dispatch center 108 equipped either with automated message handling equipment 109 (such as interactive voice response equipment) or operator-assisted equipment 110. The caller may communicate directly from a telephone 111 to the local dispatch center 108 or communicate with a telephone 112 to the two-way messaging and location system 100 directly if the user equipment is so equipped. Other communication devices can communicate with and receive messages from a two-way messaging and location system such as a facsimile machine 113. Those skilled in the art will readily recognize that a wide variety of other types of equipment such as personal computers and the like can communicate as a caller or receiver 107 with the two-way messaging and location system 100 or the location dispatch center 108. Typically the callers and receivers 107 communicate either with the local center 108 or the two-way messaging and location system 100 by wired communication such as telephone lines and the like.

At the heart of the two-way messaging and location system is its ability to communicate information from callers and receivers and subscribers to remote applications 114. The remote applications 114 are typically connected to the two-way messaging and location system 100 to send and receive information using wired or wireless communication links. For example, a remote terminal 115 has the ability of communicating through the two-way messaging and location system to receive a wide variety of information from callers and receivers or subscribers. An automatic vehicle location (AVL) display station 116 has the ability to automatically locate any one of the wireless subscribers 101. A variety of automatic vehicle location (AVL) systems are applicable to the present system including U.S. Patent No. 5,583,517 entitled "Multipath Resistant Frequency Hop Spread Spectrum Mobile Location System" issued December 10, 1996, U.S. Patent No. 5,592,180 entitled "Direction-Finding and Mobile Location System for Trunked Mobile Radio Systems" issued January 7, 1997, U.S. Patent No. 5,596,330 entitled "Differential Ranging for a Frequency Hopped Spread Spectrum Remote Position Determination System" issued January 21, 1997, and U.S. Patent Application No. 08/630,419 entitled "Vehicle Monitor for Use with an Automatic Location and Two-Way Paging System" filed April 2, 1996, all of which are assigned to the same assignee of the present invention and are hereby incorporated by reference.

Other types of remote applications 117 of the present system include two-way messaging and location systems 100 at other geographic locations. For example, the system of Figure 1 may be a location two-way messaging and location system located in a city such as New York. Remote application 117 may be another two-way messaging and location system 100 located in another city such as Los Angeles. The two-way messaging and location systems 100 (one of which would be remote application 117) could be linked by a wide variety of communication links such as long distance telephone lines, dedicated leased lines, fiber optic, Internet connections and satellite communications.

The two-way messaging and location system 100 including the local callers and receivers 107, local dispatch center 108 and subscribers 101 being at one geographic location may communicate with another two-way messaging and location system 100 located in another geographic location through Internet server 118. The information received or sent through the system of Figure 1 through the two-way messaging and location system 100 may be sent in the form of information packets over the Internet through Internet server 118 to find its way to another two-way messaging and location system 100 at any number of geographical locations around the globe. The information may be addressed based on a variety of addressing techniques including proprietary addressing, designed only to be sent and received by two-way messaging and location systems 100. Those skilled in the art will readily recognize that a wide variety of addressing and protocols could be used to send and receive information over the two-way messaging and location system connected to the Internet server 118 without departing from the scope of the present invention.

The two-way messaging and location system 100 is a store-and-forward messaging switch where the message originating unit can optionally be located, as described above. The switch 100 handles communication between subscribers or machines who own end units such as the two-way pager 103. Callers, subscribers or applications can send messages to the end units and receive messages from the end units.

Application Layers

One of the basic concepts of the present invention is the separation between the network communication and the application layers. The application layers include, but are not limited to, two-way paging for communication with a two-way pager 103, a remote unit 104, or a remote wireless modem 105. This type of communication is typically a wireless communication. In the preferred embodiment of the present invention, the two-way paging is accomplished using a standard paging downlink signal using a communication format such as the POCSAG format, HERMES format, FLEX format, or the like. These downlink communication signals are found in almost all cities around the globe and are typically transmitted at high power from a variety of communication towers.

The paging uplink in the preferred embodiment of the present invention from a two-way pager 103 is a frequency hopped spread spectrum digital communication signal such as that described in U.S. Patent No. 5,335,246 entitled "Pager with Reverse Paging Facility" issued August 2, 1994, and U.S. Patent No. 5,430,759 entitled "Low-Power Frequency Hopped Spread Spectrum Acknowledgment Paging System" issued July 4, 1995, which are assigned to the same assignee of the present patent application and are hereby incorporated by reference. These types of spread spectrum uplink communication described in the aforementioned patents use an extremely low power signal and are operational only within a limited ranged from a communication tower. Thus, global communication with such a two-way pager 103 is not possible without the present invention. The two-way messaging and location system 100 extends the range of the two-way pager 103 by allowing the user to send and receive information from a wide variety of callers and receivers 107 on a global basis to other two-way messaging and location systems located anywhere in the world through the remote application 140 and in particular, through the Internet server 118.

Also included in the application layer of the two-way messaging and location system 100 is the conversion of message formats from the type used to communicate with subscribers 101 and callers and receivers 107 and the remote applications 114. For example, canned messages may be sent and received from a two-way pager 103 or a remote mobile unit 104 or a wireless modem 105. The canned messages are managed and converted by the logic engine of the two-way messaging and location system 100 to match and convert the canned messages and destination to a real message and destination. Also in the application layer, some messages can be sent according to the destination without the need to convert information at the two-way messaging and location system 100. This is in the case, for example, where a two-way pager 103 sends a message to a wireless modem 105 in which the message and destination address are local and match. In some cases the information contained in a message may be a proprietary, encoded, or some other data format usable only by the recipient of the information. In this fashion, the payload of the message will be maintained even though the addressing and packet configuration may change. Users and vendors of the two-way messaging and location system and the network shown in Figure 1 have the ability to write and build their own applications without the involvement of the system owner or operator.

The remote applications 114 interface the two-way messaging and location system 100 through a remote interface server 200. All remote applications send or receive messages to or from the remote information server system. The messages can be with or without location information since location (as described above in conjunction with the AVL display station 116) is an optional feature and not a requirement of the present invention.

To communicate with the wireless subscribers, a reverse paging terminal 120 (also known as a two-way paging terminal) is also part of the two-way messaging and location system. The reverse paging terminal, as briefly described above, allows for the sending of messages to subscribers using standard paging downlink frequencies and protocols and receives, in the preferred embodiment of the present invention, frequency hopped spread spectrum low-power communication signals from the two-way pager 103, remote mobile unit 104 or the wireless modem 105. Those skilled in the art will readily recognize that the uplink of a variety of communication standards and formats need not be strictly a frequency hopped spread spectrum communication technology.

Since the remote paging terminal 120 is located at the two-way messaging and location system center 100, there are two different types of messages in the application layer of the protocol. For two-way paging applications, the messages are managed and converted by the reverse paging terminal's logic engine to enable, for example, matching and converting from two-way pager canned messages and destination information to real messages and real destination information. For other applications, messages will be sent according to the destination without any involvement of the center in the data. As described above, this information is carried as the payload of the message and may be of any proprietary format.

Remote Interface Server

The remote interface server block diagram of Figure 2 shows the variety of message protocols used throughout the system to communicate through the various communication mediums shown in Figure 1. A two-way pager 103, remote mobile unit 104 or wireless modem 105 can communicate through the two-way messaging and location system 100 to any one of the many subscribers, callers, receivers or remote applications shown in Figure 1. In order to allow such robust communication networking, a variety of protocols and protocol conversions are required. For example, a message from a two-way pager 103 may be transmitted through the two-way messaging and location system 100 to be transmitted by Internet to an e-mail site on the World Wide Web. As shown in Figure 2, the two-way paging message would be received by the one of the several base stations 214 of the reverse paging terminal (in the case of a frequency hopping uplink) or by the RF (Radio Frequency) network receiver 213. The uplink from two-way pagers 103 would be by frequency hopped spread spectrum communication, in the preferred embodiment, if through one of the Base Stations 214. The received message is forwarded to the FEC (Front End Controller) 215, which is the central site for the Reverse Paging Terminal for receiving the frequency hopped communications uplink messages.

Messages from two-way pagers using other communications uplink protocols are forwarded to the RF director 211 connected to a system network 219 for the remote interface server 200 within the two-way messaging and location system 100. If the message was directed to another two-way pager, the message would be forwarded to a downlink transmission system (Paging Terminal) 210 on the RF network 212 to send the reply message to a two-way pager 103 by a standard paging channel.

If the message from the two-way pager was directed to another location, the protocol would need to be changed to send the information out to, for example, the Internet 206, a remote application or the like. If the destination address is an Internet address, the message is routed to Internet server 207 where it is placed on the Internet 206. The protocol for placing the information on the Internet may be one of the several types of protocols shown in Figure 6, such as Internet e-mail two-way paging message through SMTP (Simple Mail Transfer Protocol) 201, Internet web station two-way paging message through HTTP (HyperText Transfer Protocol) 202, to a remote terminal or dispatch entry and exit two-way messaging remote application 203 or to any other remote application such as an automatic vehicle location system protocol 204. Information may also be sent out TME (Telocator Message Entry) server 208 through the Internet or through a PSTN (Public Switched Telephone Network) 205. This information is then forwarded either to a remote terminal through a remote terminal protocol 203 or to any other remote application through another remote protocol 204. Thus, the following protocols are available as shown in Figure 2 and listed in Table 1.

Table 1

1. TME clients to TME server – TME over TCP/IP on PSTN, Internet or any other digital net (WAN, MAN and LAN). The TME clients are "clients" of TME servers.
2. Internet client to Internet server – HTTP, SMTP and POP3 over TCP/IP to the Internet server in the central system.
3. RIS to LE (Logic Engine) – first phase cybase (client server) over Ethernet TCP/IP. Second phase WMapi over Ethernet TCP/IP.
4. RIS's to PG (Paging Terminal) – this connection gives the ability to the same clients and applications to send and receive messages to and from the two-way message and location system 100 and MPCS (or any one-way service) end units. The servers to the GL3000 protocol can be either TNPP (Telocator Network Paging Protocol) over RS232 218 or WMapi over Ethernet TCP/IP.

TME Client Applications

A remote terminal 115 can be applied as part of the two-way paging application. The remote terminal is an entry and exit device for alphanumeric messages for two-way paging messages (TWP MSG). The remote terminal (RT) can work with dialing (connect, send message and immediately disconnect for saving trunk lines) or on an open line (leased, Internet or any other digital net). The remote terminal will work with TME (Telocator Message Entry) on TCP/IP

(Transmission Control Protocol/Internet Protocol) , and can work through the PSTN (Public Switched Telephone Network) or through the Internet as an infrastructure.

The dispatch center 108 is viewed by the two-way messaging and location system 100 as a one-way remote terminal for two-way paging applications. The dispatch or message is an alphanumeric message from the calling center 107 through the local dispatch center 108 to the two-way messaging and location system 100.

Any remote application that will interact with the two-way messaging and location system 100 and any end unit such as subscribers 101 (such as remote mobile units 104 for fleet monitoring for anti-theft application or remote vehicle location), callers and receivers 107 or devices connected through the wireless modem 105 are all remote applications which can communicate with two-way paging protocol. These applications are supported by the TME client server processor 208 operating on the remote interface server 200 and its network 219. The TME server 208, in order to work effectively with the Internet as an infrastructure, should have a permanent dedicated leased line to an Internet service provider (ISP).

Internet Server Applications

The Internet server 207 of the remote interface service supports a number of different communication protocols to service the two-way messaging and location system. Two-way paging HTTP applications allow the two-way pagers and the other subscribers, callers and receivers to send and receive messages via the Internet. In this application, the Internet protocol HTTP is used to eliminate the need for developing an application for the remote terminal 115. The Internet server 207 will send using HTTP formats the two-way paging messages. Thus, these applications do not need any special programs to run at the remote stations such that the two-way messages are converted to HTTP protocol by Internet server 207.

E-mail is also a format that can be sent and received over the Internet by two-way pagers and other subscribers. E-mail is sent over the Internet in the SMTP (Simple Mail Transfer Protocol) and POP3 protocols. In this application, every end unit such as the units of the subscribers 101 will have an e-mail address that will be an extension of the Internet server e-mail address such that the Internet server 207 will collect all messages and send them to the message center 216. The address for an acknowledgment message for an e-mail received would be in the form of a field in the e-mail format. The Internet server would fetch this acknowledgment address from the e-mail message and will send it in the regular protocol the same as the TME server would over the Internet.

Network Addressing

The two-way messaging and location system 100 is a messaging switch center. Each address for a message has its own queue in the message server LE (Logic Engine) 216. Depending on the destination address of the message sent, a different type of messaging station or server is used which is responsible for the interaction with the devices of that specific type of address.

The DL (DownLink) queue 209 is for messages intended for the end units such as the subscriber units 101. The address is a PIN (personal identification number) which has a one-to-one correspondence with the POCSAG address of the paging receiver. A paging receiver is found in each of the subscriber units 101 since the subscriber units 101 receive information over the standard paging channels. The message type in a DL (DownLink) queue 209 is an alphanumeric or numeric message. The message is transmitted by a standard paging transmitter 210 using the RF Director 211 to send the wireless downlink paging messages.

The MB (Mail Box) queue is not for a device address but instead is a personal mailbox within the system that stores messages for persons and not for end devices. The person can call into the system from any device and ask to withdraw messages from the mailbox (MB) queue using a mailbox address and a password.

The system will send the message in the appropriate format according to the type of end device (text or voice) that is attempting to retrieve the mailbox messages.

The IVR queue is held at the IVR server 217 which is an interactive voice response unit. The end device destination is a telephone device and the address is an actual telephone number. The messages in this queue are typically, but not always, an acknowledgment that a message was sent.

A provider queue found on the TME server 208 stores messages from remote mobile units 104 and wireless modems 105 for forwarding to remote applications or remote providers. The message itself does not contain an address but the TME server 208 will identify that this message ID correlates with a provider ID. The remote applications read this queue with a queue ID and a password.

The TME server also contains a modem queue which holds messages destined for any remote application that has a modem on a PSTN (public switch telephone network) telephone number.

The Internet server 207 also contains an e-mail queue for saving messages destined for stations connected to the Internet. These are plain text messages with Internet e-mail addresses. A fax queue is also included on the TME server for the eventual destination of a fax machine. The address type is a telephone number.

Table 2 is a table showing the remote applications which read or receive messages from queues.

Table 2: Remote application reads or receives messages from queues

Remote devices & applications	MB queue	Provider queue	IVR queue	Modem queue	E-mail queue	Fax queue
Telephone unit	✔		✔			
Any remote application	✔	✔		✔		
Remote terminal	✔			✔		

Remote devices & applications	MB queue	Provider queue	IVR queue	Modem queue	E-mail queue	Fax queue
Internet browser with HTTP	✔					
Internet with SMTP e-mail					✔	
Fax machine						✔

TME System Operation

The TME server 208 of the remote information server is able to distinguish between many different types of messages and route them to the appropriate locations. In order to route the messages to the appropriate locations, the system uses a domain field and an address structure in order to distinguish the proper locations. In some cases, the domain may be in another geographic location and hence the messages from a two-way pager 103 in one geographic location may be intended for a two-way pager in a wholly different geographic location, such as from New York to Tokyo.

The remote information server operates with many subscribers simultaneously. For example, the remote interface server may allow multiple users to log in with a password and to send and receive mailbox messages through any number of subscriber units, callers, receivers or remote applications. Depending upon the type of message that is sent or received, a PIN number, mailbox identification number or queue identification number would be required to access the various information. In reading a large number of messages, filtering conditions can be applied to read certain messages and distinguish from other types of messages. Since the applications can receive both text and binary messages, the messages typically contain a string length identifier in a specific field. In some cases, messages are quite small (such as in the case of acknowledgment messages from two-way pagers 103) of medium length (such as packets received from the wireless modem 105) or in extended length (such as facsimile information received or sent from facsimile caller or receiver 113).

Other Applications

From the nature of the switch 100, the nature of the two-way pagers 103 is greatly enhanced. In the present invention, the two-way server essentially becomes a remote control for wireless information retrieval. The remote interface server 200, at the heart of the Two Way Messaging and Location System (switch) 100, becomes a robot application for information retrieval and information filtering. The subscribers 101 can program the RIS 200 either through the two-way paging devices 103, 104, 105, or through remote applications or PC's to retrieve information from Information Retrieval Service Providers such as stock quotations, weather information, sports information, etc. Once programmed, the two-way pagers 103 or the other subscriber end units 101 can receive filtered information of, for example, particular stock quotes or particular baseball game scores. In this fashion, a two-way pager subscriber 101 may program the RIS 200 to continuously monitor the stock market for a particular portfolio. Those skilled in the art will readily recognize a wide variety of applications for the present invention for information filtering and retrieval without departing from the scope of the present invention.

Other applications programmable into the RIS 200 would be the remote control of physical activities such as control of alarm systems in vehicles or homes through the Internet and through the wireless subscriber devices 101. For example, while traveling in Tokyo, a subscriber could be updated periodically as the temperature of her home during the winter, or the number of telephone calls received. The subscriber could remotely control operations remotely by switching on devices in the home of business while communicating with a wireless two-way pager via the Internet while on vacation in Europe. These types of remote control operations or information filtering and retrieval operations are programmable into the RIS 200 and invoked using canned messages from the two-way pagers103, 104, 105.

Operational Summary

From the foregoing description, a two-way paging device may quickly and inexpensively send and receive messages through a variety of communications media around the world. In particular, two-way messaging information from a two-way pager 103 or another type of subscriber 101 can be sent via the Internet 206 to any other type of two-way messaging and location system 100 in any other geographic location around the world. The messages can be sent to Internet mailboxes for remote applications or to other two-way pagers around the world.

Pager Roaming

In order to effectively address two-way pagers that may roam out of their registered geographic area, two-way pager registration is effected when the pager enters a new geographic location serviced by a different two-way messaging and location system 100. Each geographic location does not need the complete and robust two-way messaging and location system and all its related facilities as shown in Figure 1. Subsets of the functionality and connectivity of the two-way messaging and location system 100 may be effected depending upon the type of location in which the two-way pager may find itself. When a two-way pager roams out of its local area into a new geographic location served by a different two-way messaging and location system 100, it automatically registers its new location with the local system 100.

A database is held in the two-way messaging and location system 100 of a specific geographic location in which each of the subscribers 101 have registered their equipment, such as a two-way pager 103, a remote mobile unit 104 or a wireless modem 105. This registration information is held on the TME server

208 within the remote interface server 200. The local database only includes addresses for the subscriber units within that geographic area which are registered to operate there. When a subscriber unit 101 ventures to a new geographic location served by a different two-way messaging and location system 100, the device will register its new location and the new location of the two-way messaging and location system will inform the home base two-way messaging and location system that the two-way pager is now within its geographic location. Databases within the two locations will update one another as to the new location of the two-way pager such that messages for that particular device are forwarded to the correct two-way messaging and location systems serving that particular pager when it is roaming.

This is an advantage over nationwide paging systems since conventional paging systems must transmit the message to the intended recipient at all paging terminals and all paging transmitters all over the country since the systems are unaware of the current location of the pager. With the present invention, the two-way paging unit can register its location with the local service provider, the local service provider can then provide for forwarding of all messages for that two-way pager from the home two-way messaging and location system 100. This, of course, saves precious bandwidth in the geographic locations around the country. The subscriber unit 101, such as a two-way pager 103, will not attempt re-registration in the new zone until it identifies itself as being in a different geographic location. The geographic location can be programmed into the synchronization code word (described below) which is transmitted within each geographic location to all of the two-way pagers and other subscriber units to synchronize the frequency hopping spread spectrum signal. The two-way pager will recognize from the synchronization signal that it is no longer within its home geographic area. At that time it will initiate a message to the remote paging terminal 120 to alert the RPT 120 that the pager has changed geographic areas and wishes to now register in the new roaming area.

System Overview

Figure 3 is a drawing depicting the two-way paging system of the present invention. In the preferred embodiment of the present invention, the caller 300 calls a paging terminal 301 equipped with a two way paging system to contact a two-way pager 103 as shown in Figure 3. Paging terminal 301 receives the caller's message and queues the message with other messages to be transmitted by paging transmitter 302. The power of the transmission of paging transmitter 302 is approximately 200 Watts which is the same or similar to one-way paging systems but the radio paging signal contains additional information to support the acknowledgment paging system in the geographic market served. The two-way pager 103 receives the paging command and can respond back to the paging transmitter site using radio frequency transmissions through a reverse paging terminal 304 to return a message to caller 300.

In responding to the caller 300, a single response may be returned to the caller via an automatic dialing system with prerecorded voice messaging. In the alternative, choices among alternate responses could be made and the choice returned to the caller 300 once again through an automated dialing and prerecorded voice messaging system. In yet another alternative, the two way pager may be equipped with a keypad to allow free format messaging via a keypad such as that on a computer terminal in miniature pocket form. In this fashion, the two way pager system allows direct pager to pager communication through the central paging terminal. For more details on pager to paper messaging, see U.S. Patent Application No. 08/528,246 entitled "Two Way Pager Having Prerecorded Uplink Messages and Pager to Pager Messaging" filed September 14, 1995, which is assigned to the same assignee of the present invention and is hereby incorporated by reference.

The two way paging system is implemented in such a fashion as to take advantage of the existing infrastructure of an operational paging network. The additional hardware and computing power required to modify the paging terminal and paging transmitter is easily installed and implemented with very little impact on the existing system. In addition, the present invention allows the operation of two-way pagers through the Internet to extend the range of the two way operation.

Reverse Message Format

The reverse signal (uplink) sent from the two-way pager 103 to the base station 304 is a spread-spectrum, frequency-hopped transmission using differential bi-phase shift keying (DBPSK) modulation on the frequency-hopped carrier to transmit digital information. The transmission of information from two way pagers 103, the remote mobile units 104 or the wireless modems 105 on the frequency hopped carrier may also be done using Frequency Shift Keying (FSK) modulation. The frequency hops are relatively slow, the frequencies transmitted are very narrow and the transmission power is extremely small. The maximum peak output power of transmission from two-way pager 103 is limited to less than one Watt to allow use of the 902-928 MHz band in the United States without the need for licensing the paging transmitters as allowed by FCC regulations defined in 47 C.F.R. §15.247, which is hereby incorporated by reference. Those skilled in the art will readily recognize that other frequency bands and transmissions power levels may be employed depending upon FCC licensing requirements or other frequency licensing requirements of other nationalities.

The use of an accurate crystal to control each frequency of transmission is required. For example, high accuracy crystals to transmit the narrow bandwidth frequencies used for the frequency hopped transmissions are available with an accuracy of three parts per million. At 900 MHz, a 3 ppm drift would place a single frequency somewhere within a 2.7 kHz band. To tolerate frequency drift due to aging and temperature, each individual frequency of the frequency hopped signal is allocated to a 7.5 kHz band or channel, even though the actual frequency is on the order of a 200 Hz wide skirt within this 7.5 kHz allocated bandwidth. Those skilled in the art will readily recognize that by using alternate components, the frequency channels (individual frequency of the frequency hopped signals) of 7.5

kHz allocated bandwidth may be wider or more narrow depending upon the overall allocated bandwidth for the system. For example, 1 kHz or less bands may alternatively be allocated per channel.

Tests on this invention have shown that by using the combination of unique fast Fourier Transform algorithms of the present invention, as described below, to locate and retrieve the frequency hops and by using a combination of unique confidence algorithms with a plurality of error correction codes, the receiving reverse paging terminal 304 is able to pull the response information from a very low power signal from a distance of up to 45 kilometers (28 miles) in a flat terrain. In a rather noisy urban environment, a range of 24 kilometers (15 miles) is the norm.

As shown in Table 3, the acknowledgment message format consists of a preamble and the message body spanning a total of 53 frequency hops. Those skilled in the art will readily recognize that longer messages may be transmitted using the preferred embodiment of the present invention, and the messages format described here is illustrative but not limiting. Much longer message hops to transfer more digital data is also implemented but not described here. Of course, those skilled in the art will readily recognize that shorter messages than those described below are equally possible for the preferred embodiments of the present invention. The message length and number of transmission hops are a matter of design choice.

The message preamble consists only of alternating ones and zeros to get the attention of the base unit receiver to begin pulling the message out of the noise. The preamble consists of 165 bits transmitted across 5 hops, that is, transmitted using DBPSK (Differential Bi-Phase Shift Keying) on five different frequencies selected from the frequency list with the specific frequencies selected based on the PN (Pseudo-random Noise) Code list stored within the two-way pager. The sequence location within the PN code that the reverse pager will begin to follow is based on the synchronized time of day. Within a single hop (a single carrier frequency), the carrier phase is alternated 33 times to encode the predefined one-zero pattern.

The message body follows the preamble and consists of three groups of data. Each group consists of 30 actual data bits so that the entire message is, in the preferred embodiment of the present invention, 90 total data bits (although other bit length messages may be chosen). The actual data encoded within these 90 bits is described above and may be in any convenient coded format. Those skilled in the art will readily recognize that a wide variety of message formats and encoding of the data bits may be used without departing from the spirit and scope of the present invention. The encoding described here, however, has been proven effective in retrieving the data bits buried in background noise with a high degree of accuracy and a low actual error rate.

TABLE 3: Remote Mobile Unit Message Format

```
Preamble is 165 bits (33 bits x 5 hops)
Message is 48*33 transmitted bits
(Message is 90 bits actual data)

[ ] = One Frequency Hop

|preamble | Message Body Spread Over 48 Hops |
```

Outer Message Coding

Each of the three groups of message data (30 bits each) are BCH encoded using a standard 30,63 BCH code and with a single parity bit added to form a 64-bit word. This encoding decreases the error rate from 10^{-2} to 10^{-5}. This encoding, documented and understood by those skilled in the art, can correct up to 6 errors or detect up to 13 errors. Detection of corruption of a data word that cannot be reconstructed will cause the base to request a second transmission of the reverse message.

Inner Coding and Interleaving

The inner coding of the message will protect the integrity of the message with an error rate as high as 25%. Each block of 64 bits of data (corresponding to a groups of 30 bits and earlier encoded by a standard 30,63 BCH code) is split into two sub-blocks of 32 bits (sub-blocks A and B of Table 4), and a reference bit is added to each sub-block to assist the differential encoding to provide a reference bit to the DBPSK decoder. The 33 bit sub-blocks are transmitted over one frequency hop each and are replicated 8 times so that the 64-bit block traverses 16 frequency hops. In transmission, the 33 bit sub-blocks are interleaved to further reduce loss of data, as shown in Table 5, where sub-blocks A and B of Table 4 correspond to the first group of 30 bits, sub-blocks C and D, correspond to the second group of 30 bits, etc. The total message is 53 hops where each hop is 180 msec in length making the duration of a single message 9.54 seconds.

TABLE 4: Interleaving Format for Sub-block

A = 1 reference bit and 32 data bits = 33 bits
B = 1 reference bit and 32 data bits = 33 bits

□ = One Frequency Hop

A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B

TABLE 5: Inner Coding and Interleaving of Sub-blocks

A = first 33 bits of 1st block
B = second 33 bits of 1st block
C = first 33 bits of 2nd block
D = second 33 bits of 2nd block
E = first 33 bits of 3rd block
F = second 33 bits of 3rd block

□ = One Frequency Hop

preamble	A	B	A	..B	A	B	C	D	C	...	D	C	D	E	F	..E	F	E	F

Those skilled in the art will readily recognize that a wide variety of data interleaving may be utilized to effect better error tolerance and may be substituted for the interleaving described here. Such alternate substitute interleaving means are CIRC (Cross Interleaved Reed Solomon Code) used in CD (Compact Disc) recording media operating either at the block level or at the bit level.

Single Hop Format

The acknowledgment signals are transmitted by the reverse pagers 114 in a 1.5 MHz band selected from within the 902-928 MHz spectrum. The 1.5 MHz band is divided into 7.5 kHz channels to provide 200 channels available in which the frequency hops can occur. Thus, each frequency hop is a channel 7.5 kHz wide in which a carrier frequency is transmitted. For example, channel one will have a frequency F1 at 902.00375 MHz +/- 3.75 kHz, channel two will have its center carrier frequency at 902.01025 MHz +/- 3.75 kHz, etc.

Each transmit frequency of each hop will thus be centered at the approximate mid-point of the assigned channel band; however, due to inaccuracies in the reverse pager circuits and reference crystals, the actual transmit frequencies will vary between units. If high quality crystals are used to accurately produce the required frequencies, very little drift off the center frequency will result. In the preferred embodiment of the present invention, low cost crystals are purposely employed to keep the per-unit manufacturing costs down. This will allow for a lower-cost product sold to the user which will increase market penetration. Thus, reference crystals are preferred which have a frequency accuracy of 3 ppm such that at 900 MHz, the statistical drift would be approximately 2700 Hz. The crystals center frequency within its nominal accuracy also drifts due to aging and temperature variations, but this drift is slow compared to the transmission times so the drift during a single transmission due to these latter variants is unimportant.

A single frequency hop is shown in Table 6. The 15 millisecond guard time preceding each hop is primarily a settling time for the oscillator circuits of the reverse pagers to allow the internal oscillator circuit to lock onto the new frequency between hops. Each hop is transmitted at a single frequency in which the phase of the carrier is either at 0 degrees phase or 180 degrees phase in reference to the phase of the reference bit immediately following the quiet or guard time. Thus the first bit is a phase reference bit followed by 32 data bits exhibiting either zero phase shift or 180 degree phase shift to encode the data bits as DBPSK (Differential Bi-Phase Shift Keying). In an alternative implementation, each frequency hop may be modulated using Frequency Shift Keying (FSK) in which two frequencies are used to transmit data bits. One hop frequency may indicate a logical one while a second hop frequency may indicate a logical zero. The frequency shift is minor and the frequency differential is contained within a single hop channel.

Each bit of DBPSK or FSK is a transmission of 5 milliseconds of the hop carrier frequency either in phase with the reference bit transmission or 180 degrees out of phase.

TABLE 6: Single Frequency Hop Format

```
Guard time (quiet) = 15 ms
Single Bit = 5 ms of carrier DBPSK / FSK
33 Bits plus guard time = 180 ms
```

15ms Guard Time	5ms Ref Bit	5ms 1st Bit	5ms 2nd Bit	5ms 3rd Bit	- - -	5ms 31st Bit	5ms 32nd Bit

Frequency Hopping Sequence

All of the reverse pagers in the market serviced by the reverse paging terminal use the same pseudo random noise code to determine the frequency hops. The pseudo random noise code is a digital code which is repeating after approximately 1,000 unique codes. In the preferred embodiment of the present invention, the pseudo random noise code is stored in memory of each of the pagers. Those skilled in the art will readily recognize, however, that a linear feedback shift register could be used to generate the pseudo random noise code on a real-time basis instead of using a look-up table which is presently in the preferred embodiment.

The PN (pseudo-random noise) code list is stored in memory and maps to a frequency list. In the preferred embodiment of the present invention, the PN code list has 1,000 entries which repeat as a sequence. The control means of the reverse paging units continuously maintain a count of the proper location within this list for the exact time of day. As described below, the time of day for all pagers in the market served by the base terminal are periodically synchronized to ensure acknowledgment messages are synchronized to transmit the hop frequency at the proper time and to synchronize the location within the PN code list that each pager will use to transmit.

The 1,000 member PN code list maps to a 200 member frequency list. In order to allow a large number of reverse pagers to simultaneously operate in the same geographic market, the pagers are divided into groups and the groups are assigned different sequence segment locations in the same 1,000 member PN list. Thus a pager from group one will begin transmitting a hop at a frequency determined from a first location with the PN code, while a pager from group two may begin transmitting a hop at a frequency determined from a second location in the PN code. The pagers from group one and group two will complete their respective reverse messages in 53 hops. Preferably, the sequence of the PN code used to determine the frequencies of the 53 hops for the pager of the first group will not overlap the sequence of the PN code used to determine the frequencies of the 53 hops for the pager of the second group. More preferable, the frequencies chosen based on the non-overlapping segments of the PN code list are orthogonal such that the same frequency is never used by two pagers belonging to different groups.

In the preferred implementation, the 1,000 member PN code list is divided into 160 hopping sequences. The remote paging units are divided into 40 groups with the members of each group synchronized to track the same location in the PN code list. The microcontroller of each pager, regardless of its group membership, continuously runs through the repeating PN code sequence to stay in synchronization with the base unit and all other pagers. Each group of pagers is further divided into four subgroups such that the pagers within each subgroup are assigned one sequence within the PN code list. Although the 53 hop sequence needed for each reverse transmission may overlap the 53 hop sequence used by a pager in another subgroup, the transmission sequences of a pager of one group is chosen to not overlap the 53 hop sequence used by a pager in another group.

Base Station Design

Referring to Figure 4, the two-way paging system consists of a central station transmitting via multiple transmit towers 302a, 302b, 302c located throughout the geographic market served. In the preferred embodiment of the present invention, the paging system consists of a single central station and several base stations located throughout the region as shown in Figure 4. The outbound communication shown in Figure 4 will be performed via the existing paging system infrastructure. In operation, an outgoing page will consist of a call placed to the central station 400 or a local dispatch center 108. An operator at the central station 400 will type the message on a management computer work station or the call may be automatically handled by automatic answering machines. The message will be sent via local terminal 401 to the paging terminal 402 through an asynchronous communication line, through the VSAT hub 403 and then be transmitted simultaneously through antennas 302am 302b, 302c.

The inbound leg, that is, the uplink paging signal from the two-way pagers, will be received by one of the plurality of base stations 304a, 304b, 304c shown in Figure 4. The received message will be down converted, demodulated and error corrected. The messages are then transferred to a central computer within the two-way (reverse) paging terminal 120 with the time of arrival, the pager ID and the destination through the VSAT lines. The central station can then transfer the messages to a central management computer via RS 232 port (for return of the acknowledgment to the caller), to the Internet as an e-mail message, to a fax machine as a destination, or to one of the many other destinations described above.

Base Station to Pager Synchronization

Standard paging messages sent from the base stations BS_1, BS_2 and BS_3 to the plurality of two-way paging communications devices 103, 104, 105, are, in the preferred embodiment, sent as digital data encoded in the POCSAG paging standard. In addition to sending paging messages to the two way devices, these POCSAG messages may be used to synchronize the frequency hopping transmitters, interrogate the two-way paging communications devices 103, 104, 105, to activate the two-way paging communications device to allow the base stations to begin the location process or to alert the two way paging devices of the geographic location they are now in. Typically the paging channel has a center frequency of 143.160

MHz, with an NRZ FSK data rate of 512 bps or 1200 bps. Other bit rates such as 2400 baud (bps) are also feasible.

Figures 5a and 5b (viewed together as Figure 5) describe the POCSAG paging communications protocol as modified for use by the preferred embodiments of the present invention. In the top line of Figure 5a, a greatly compressed time line of digital data transmitted according to the POCSAG protocol is shown. Batches of messages are transmitted in groups as shown in the details in the subsequent lines below the top line of Figure 5a. In the second line of Figure 5a, a 1.0625 second interval (for 512 baud) is shown in which 544 bits are transmitted as a single batch. The batch is preceded by a synchronization code word SC as shown in the first line of Figure 5b. This synchronization code word is used to get the attention of two-way paging communications devices 114 in the geographic locale serviced by the paging terminal.

The synchronization code word within each batch is followed by eight frames of digital data. Each frame is divided into two portions, an address portion and a message portion. The address code word of the message of frame two of Figure 5a is shown in line two of Figure 5b while the message code word of the second half of frame two is shown in line three of Figure 5b. The address code word is preceded by a digital zero followed by 18 address bits, two function bits and 10 check bits. The address code word is followed by an even parity bit. The message code word portion of the frame is preceded by a digital one followed by 20 message bits which are followed by 10 check bits and a single even parity bit. Thus each frame is comprised of 64 bits divided into two 32 bit sections.

Synchronization of the base stations 304a, 304b, 304c, and the two-way paging communications devices 103 is necessary to ensure that the units 103 are transmitting at the same time that the base stations 304a, 304b, 304c, are listening. Synchronization is also necessary to coordinate the division of the large number of two-way paging communications devices 304 into groups so that members of one group use different frequency hopping patterns from members of other groups. Synchronization of the two-way pager communication devices 114 is accomplished by inserting a special frame into the POCSAG data which is used to synchronize the units.

Synchronization between the two-way paging base stations 304a, 304b, 304c and the two-way pager communication devices 103 is important on two levels. Synchronization of the two-way paging communications devices 103 within groups of two-way paging communications devices determine where along the pseudo random noise code the frequency hops are to be followed. For example, within a single group of two-way paging communications devices, all of the two-way paging communications devices within that group will be synchronized to begin transmitting at the same location in the pseudo random noise code list for any acknowledgment which may be required. Synchronization information is sent from the two-way paging terminal periodically to the addresses of each of the two-way paging communications devices within each group to remind the two-way pager communication devices 103 where along the pseudo random noise code they should be tracking. This also enables the dynamic changing of a two-way pager communication devices group membership such that if one group is experiencing a large number of collisions due to simultaneous transmissions, the two-way paging terminal 120 may re-allocate some of the two-way pager communication devices within that group to new groups to minimize collisions.

Another form of synchronization is required to synchronize the two-way pager communication devices to the exact times for transmitting frequencies from within any of the hops. This fine synchronization information is transmitted as part of the POCSAG codes. For more information, see U.S. Patent Application No. 08/398,372 entitled "Synchronization System for a Shared Channel Communication System" filed March 3, 1995, which is assigned to the same assignee of the present invention and is hereby incorporated by reference.

Referring once again to Figure 5a and 5b, eight frames of information are transmitted in each burst using the POCSAG format. Two-way pager communication devices 103, 104, 105 may be assigned to a specific frame within the transmission so that the two-way pager communication devices, once recognizing the synchronization code word, can scan a specific frame for that two-way pager's address. Once the address is found, the two-way pager can determine any group changes that may be required to re-allocate that two-way pager to a different group. In addition, the POCSAG format is used to transmit a fine time synchronization code. The fine synchronization code is a transmission of a time pulse at an exact time synchronized to a GPS (Global Positioning System) clock, or some other highly accurate time source, to synchronize all the two-way pager communication devices 103, 104, 105 for time of transmission.

For example, periodically during the day the two-way paging terminal 120 will send a synchronization code within the POCSAG code word to the paging terminal which is transmitted at a very precise time. In order to ensure that a precise time pulse is sent, the two-way paging terminal 120 receives accurate time information using a GPS antenna to receive accurate time of day information. The time used to send the synchronization pulse is when the day clock reaches exactly some multiple of 0.9 seconds in the preferred embodiment. In this synchronization information, 20 bits of information are transmitted to give the accurate time of day information.

In each of the two-way pager communication devices 103, 104, 105, the microprocessor compares this accurate time pulse which will indicate the exact time of day and compare it to its own day clock. The clock within each microprocessor is accurate down to a few milliseconds, but the time at which the synchronization pulse occurs should have a resolution much finer than that such as down to 0.1 milliseconds for time of day. In this fashion, each of the microprocessors in each of the remote two-way paging devices can periodically realign its day clock to know within a millisecond the exact time. Each microprocessor does not actually realign its clock but changes a clock offset within memory so that it understands how far off its own internal clock is and can make the adjustment when using that clock to determine when to start transmitting information using the eight frequency hopped spread spectrum signal.

The synchronization pulse is only transmitted every few minutes. However, the resolution of the start of the message indicating the synchronization pulse is very accurate, it being transmitted at 0.090000 seconds GPS time after a fixed time of day, such as 12:00 GMT. This GPS time is accurate to at least within 100 nanoseconds.

Uplink Transmission Format

An overview of the transmission format of the two-way pager is shown in Figure 6. The actual transmission of information from the two-way pager communication devices 103, 104, 105 is done using Differential Bi-Phase Shift Keying (DBPSK) modulation on a frequency hopped carrier of less than one watt. The transmission of information from the two-way pager communication devices 114 on the frequency hopped carrier may also be done using Frequency Shift Keying (FSK) modulation. Typically a single transmission consists of 53 hops or 53 changed frequencies selected from a list of narrow band frequencies. The frequency selection is based on a pseudo-random noise code list pointing to the frequency selection list. The synchronization information tells the two-way pager 103 where along the pseudo random noise code it should be synchronized for transmission of its message and the fine synchronization information tells exactly the time of day so that the two-way pager 103 knows exactly when to start transmitting the specific frequency so that the two-way paging terminal 120 is looking for that frequency at the same time.

In operation, 200 frequencies are used by the two-way pager 103 and the base stations and internally stored in a list numbered F1 through F200. For a specific message, 53 frequencies will be used to transmit the entire message. These 53 frequencies are selected based on a 1,000 member pseudo-random noise code.

The use of the accurate synchronization signal periodically broadcast via the outbound paging signal enables the two-way pager communication devices to use lower accuracy components thus reducing the manufacturing cost of two-way pager communication devices. For example, high accuracy crystals to track the time of day within the microprocessor are available with an accuracy of three parts per million. Thus, a time drift of approximately three micro seconds per second or 180 microseconds in a minute is the known drift. There are also time inaccuracies which are introduced due to the time of transmission (variable path length) from the source from the two-way paging terminal when the synchronization information is sent. By employing crystals which are cheaper and have an accuracy of the order 50 parts per million, the amount of time-of-day drift normally wouldn't be tolerable. However, by using the synchronization information transmitted on a regular basis from the two-way paging terminal, the microprocessor can continually correct its own internal day clock so that accurate time of day measurements are always maintained. The microprocessor estimates the momentary inaccuracy of the crystal by tracking the drift across several synchronization transmissions and dynamically adjusts for the frequency drift of the crystal and the offset using internal offset registers for accurate time of day information.

Counters are employed within each microprocessor of the two-way paging units to compensate for the offset of the frequency based on the synchronization time information. There are generally two major factors which affect the drift in a crystal: temperature and acceleration. Most of the drift is due to temperature, and the remaining drift components are negligible. The frequency drift in a crystal due to temperature is very slow, on the order of 50 Hz over 10 seconds. During a single day the temperature can change by 20 or 30 degrees Fahrenheit, requiring a time update from the GPS clock approximately every five minutes.

CONCLUSION

Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement which is calculated to achieve the same purpose may be substituted for the specific embodiment shown. For example, the present system may operate where the vehicle owner only has a one-way conventional pager and the vehicle owner contacts the central paging center using a cellular or conventional telephone. Also, the present invention is not limited to the use of frequency hopping spread spectrum signals on the uplink from the vehicle. As described above, the present invention will operate using two-way communication systems based on alternate communication protocols and mediums. Also, the present invention is not so limited to interferometric direction finding. Other techniques may be used such as differential ranging, differential time-of-arrival, GPS, dead reckoning, etc. Thus, this claims of the present invention are intended to cover any adaptations or variations of the present invention. Therefore, it is manifestly intended that this invention be limited only by the claims and the equivalents thereof.

WHAT IS CLAIMED IS:

1. A global two-way paging system, comprising:

a first wireless pager communicating with a first central station at a first geographic location;

a second wireless pager receiving messages from a second central station at a second geographic location; and

an Internet connection between the first central station and the second central station operable for receiving the forwarded a message from the first two-way pager to the second two way pager.

2. The system according to claim 1 wherein the second wireless pager has an address which corresponds to an e-mail address on the Internet.

3. The system according to claim 1 wherein the first wireless pager sends messages to the first central station using spread spectrum communication.

4. The system according to claim 3 wherein the first wireless pager sends messages to the first central station using frequency hopping spread spectrum communication.

5. The system according to claim 1 wherein the second wireless pager receives messages using standard paging frequencies and protocol.

6. The system according to claim 1 wherein the second wireless pager is also a two-way pager.

7. The system according to claim 6 wherein the second central station includes an plurality of internet mail boxes and wherein the second wireless pager accesses an Internet mail box corresponding to the second wireless pager.

8. The system according to claim 6 wherein the second central station includes a link to an information retreival service provider and information is delivered to the second central station via the internet.

9. The system according to claim 6 wherein the second wireless pager is a roaming wireless pager and the second central station updates the location of the second wireless pager to the first central station via the Internet.

10. A global two-way paging system, comprising:

a remote interface server having connections to the interent and to a central station capable of wireless two-way comminication;

a wireless two-way pager communicating with the a central station; and

an information connection through the internet connection to the remote information server operable to provide internet access to the two-way pager.

11. The system according to claim 10 wherein the central station includes an internet mail box and wherein the wireless pager accesses an Internet mail box corresponding to a wireless pager address.

12. The system according to claim 10 wherein the information connection includes an e-mail connection and wherein the wireless pager is addressed with an Internet e-mail address.

13. The system according to claim 10 wherein the information connection includes a connection to an information retrieval service provider and information is delivered to the wireless pager via the Internet.

14. The system according to claim 10 wherein the wireless two-way pager is a roaming wireless pager and the central station updates the location of the wireless two-way pager to a home central station via the Internet.

15. The system according to claims 11 wherein the wireless two-way pager is alerted to a roaming situation by geographic information contained in a synchronization code transmitted by the central station.

16. A method of two-way paging, comprising the steps of:

sending a program command to a remote interface server to retrieve information;

retrieving information from an information retrieval service providers via the Internet; and

forwarding the information to a two-way pager.

17. The method according to claims 16, further including the step of filtering the information and providing a subset of the information to the two-way pager.

18. A method of global two-way paging via the Internet, comprising the steps of:

sending a message from a first wireless two-way pager in a first geographic location;

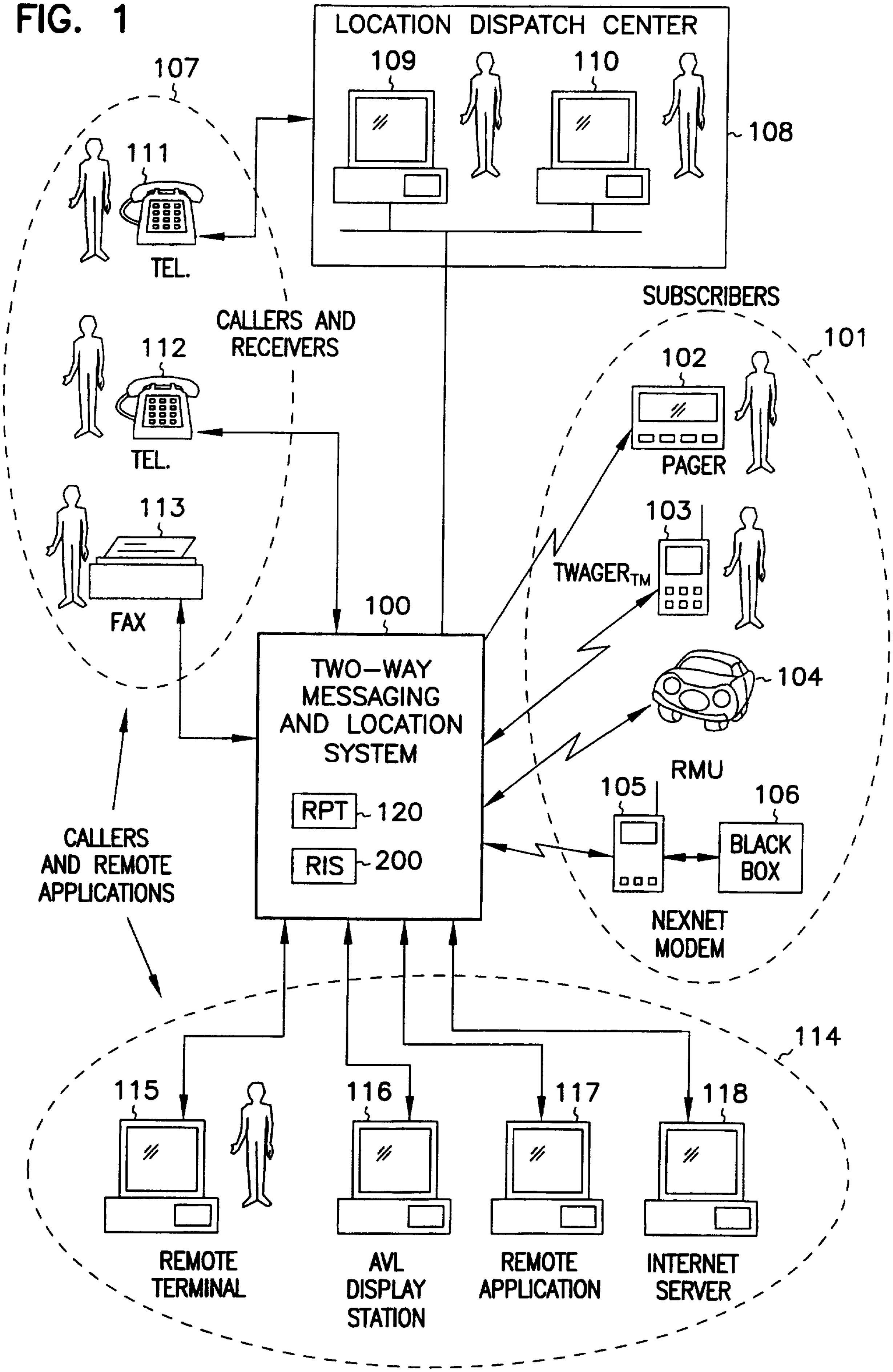
receiving the message at a first central station serving the first geographic location;

forwarding the message to a second central station serving a second geographic location via the Internet; and receiving the message with a second wireless pager.

19. The method according to claim 18 wherein the second wireless pager is a second wireless two-way pager and further including the step of acknowledging the message by the second wireless two-way pager via the same Internet return path.

20. The method according to claim 19 wherein the second wireless two-way pager alerts the second central station of its roaming condition.

FIG. 1


LOCATION DISPATCH CENTER
109
110
108
107
111
TEL.
CALLERS AND RECEIVERS
112
TEL.
113
FAX
SUBSCRIBERS
101
102
PAGER
103
TWAGER TM
104
RMU
105
106
BLACK BOX
NEXNET MODEM
100
TWO-WAY MESSAGING AND LOCATION SYSTEM
RPT 120
RIS 200
CALLERS AND REMOTE APPLICATIONS
114
115
116
117
118
REMOTE TERMINAL
AVL DISPLAY STATION
REMOTE APPLICATION
INTERNET SERVER

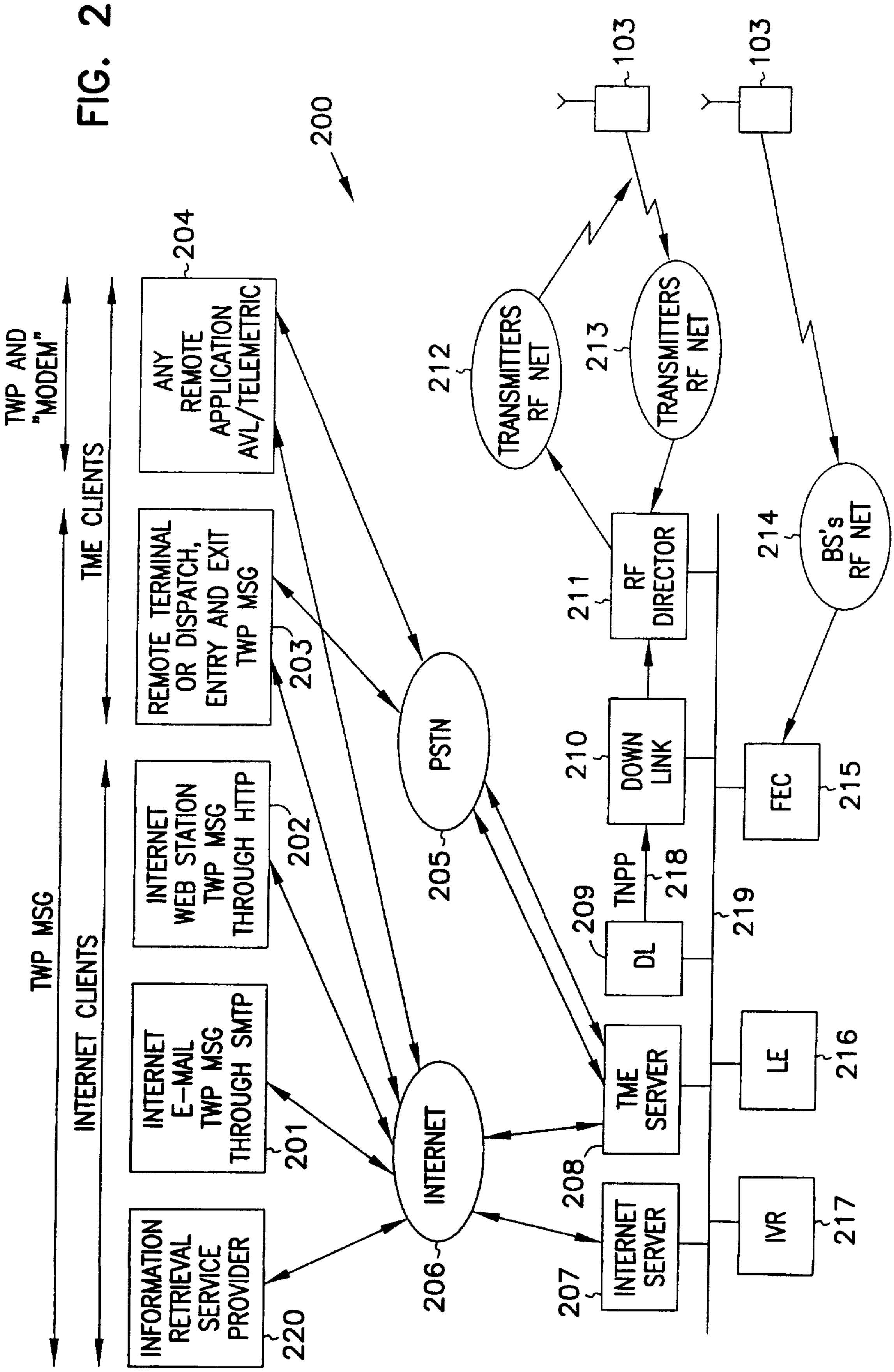

200
TWP MSG
TWP AND "MODEM"
INTERNET CLIENTS
TME CLIENTS
INFORMATION RETRIEVAL SERVICE PROVIDER
220
INTERNET E-MAIL TWP MSG THROUGH SMTP
201
INTERNET WEB STATION TWP MSG THROUGH HTTP
202
REMOTE TERMINAL OR DISPATCH, ENTRY AND EXIT TWP MSG
203
ANY REMOTE APPLICATION AVL/TELEMETRIC
204
PSTN
205
INTERNET
206
INTERNET SERVER
207
TME SERVER
208
DL
209
TNPP
218
DOWN LINK
210
RF DIRECTOR
211
TRANSMITTERS RF NET
212
TRANSMITTERS RF NET
213
BS's RF NET
214
FEC
215
LE
216
IVR
217
219
103
103

FIG. 2

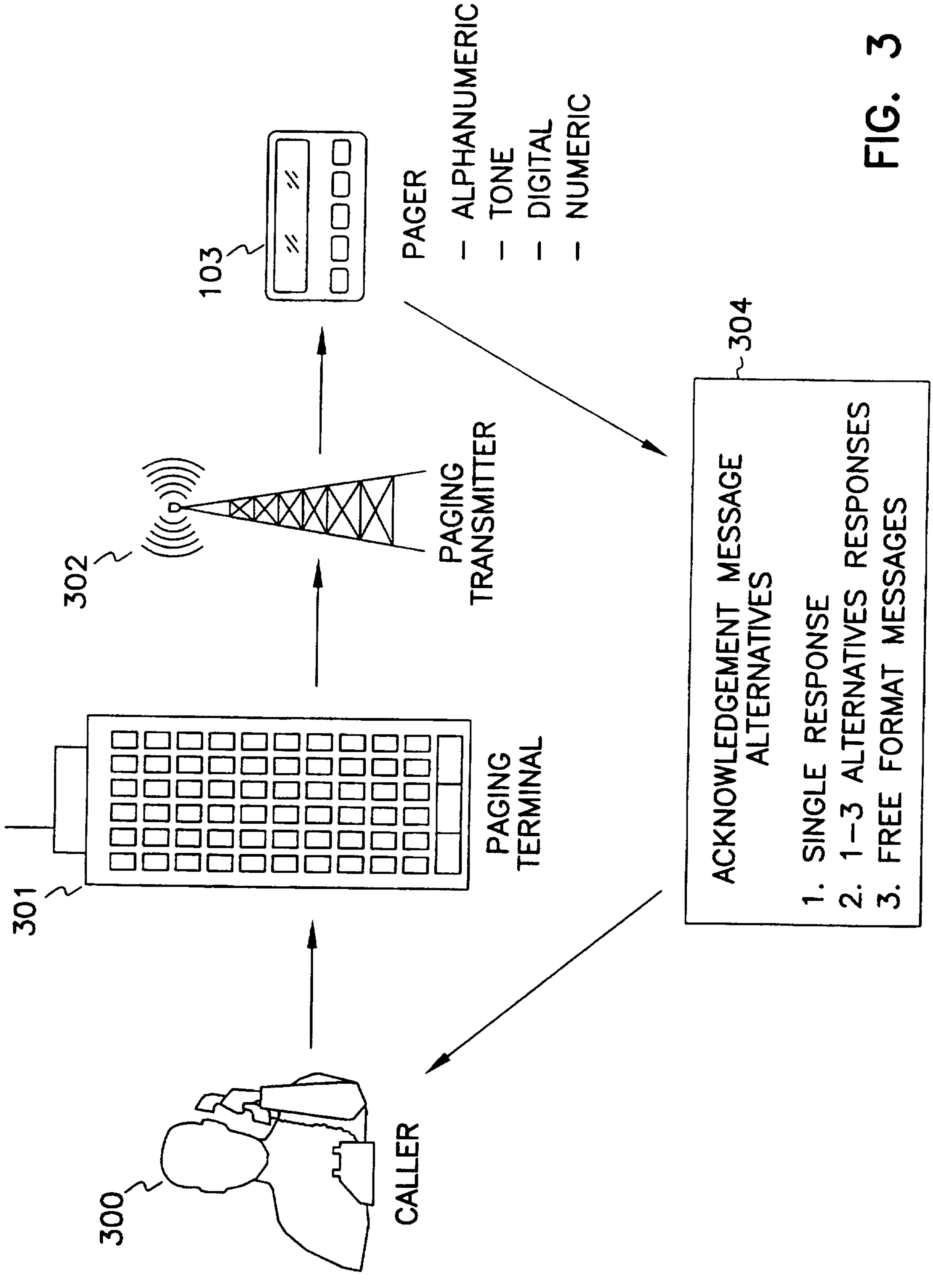

300
CALLER
301
PAGING TERMINAL
302
PAGING TRANSMITTER
103
PAGER
- ALPHANUMERIC
- TONE
- DIGITAL
- NUMERIC
304
ACKNOWLEDGEMENT MESSAGE ALTERNATIVES
1. SINGLE RESPONSE
2. 1-3 ALTERNATIVES RESPONSES
3. FREE FORMAT MESSAGES

FIG. 3

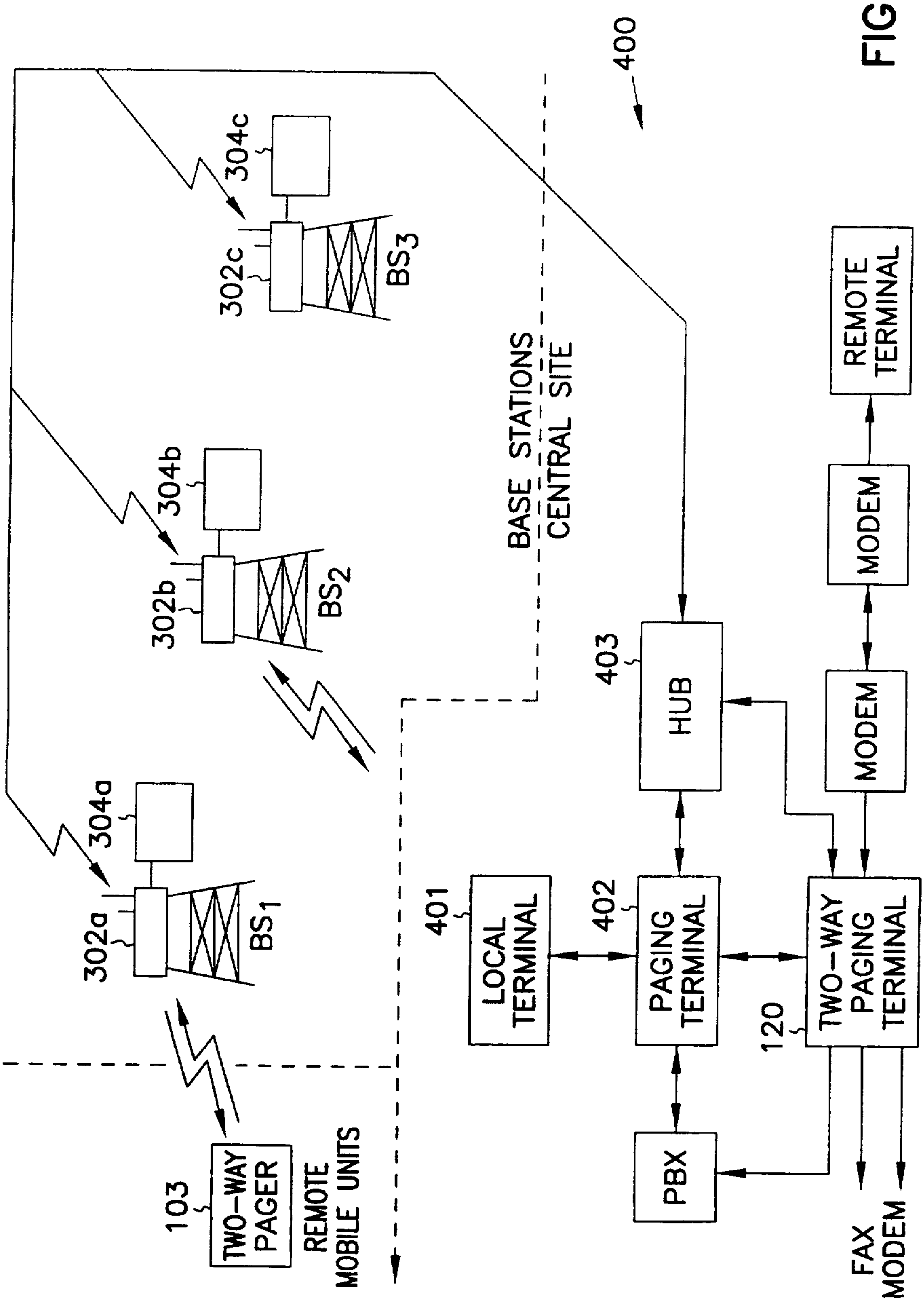

400
304c
302c
BS3
304b
302b
BS2
304a
302a
BS1
BASE STATIONS
CENTRAL SITE
103
TWO-WAY PAGER
REMOTE MOBILE UNITS
401
LOCAL TERMINAL
402
PAGING TERMINAL
403
HUB
120
TWO-WAY PAGING TERMINAL
PBX
MODEM
MODEM
REMOTE TERMINAL
FAX
MODEM

FIG. 4

FIG. 5

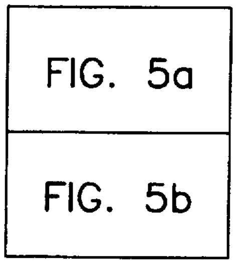


FIG. 5a
FIG. 5b

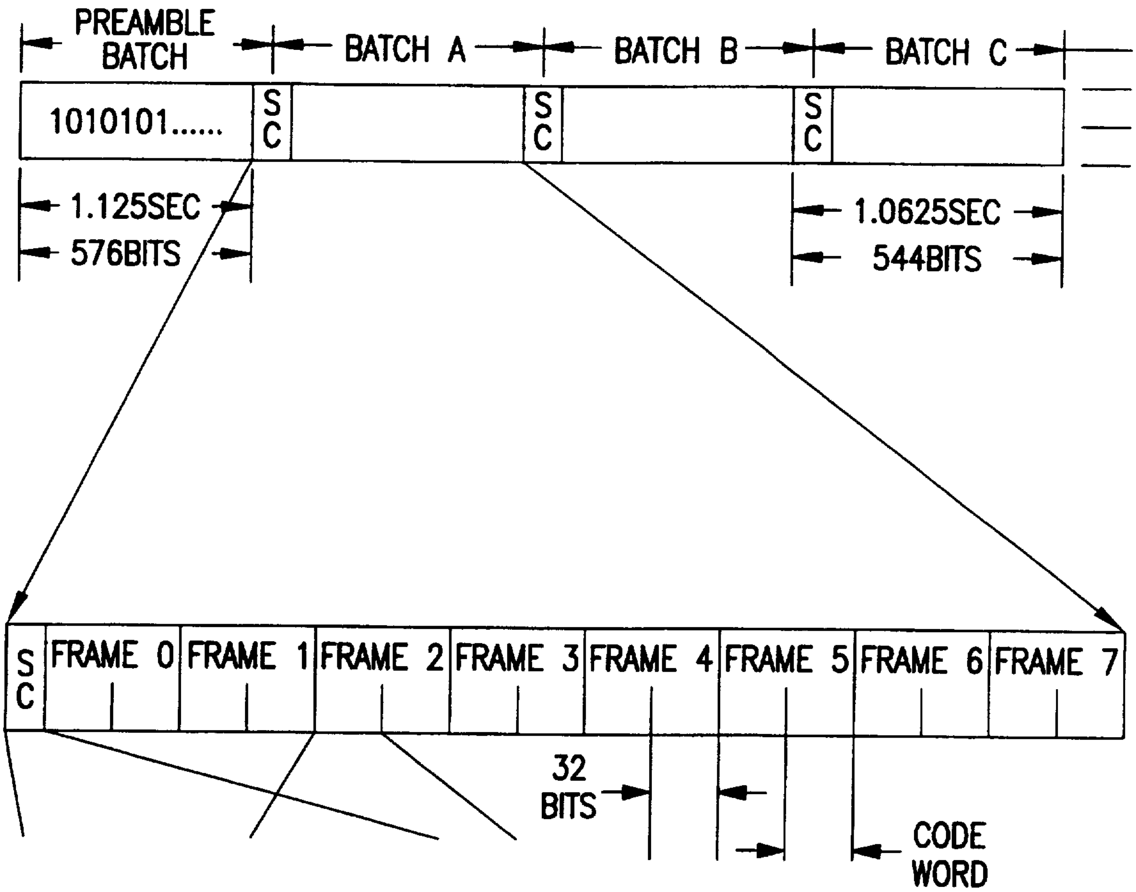

PREAMBLE BATCH
BATCH A
BATCH B
BATCH C
1010101......
S C
S C
S C
1.125SEC
576BITS
1.0625SEC
544BITS
S C
FRAME 0
FRAME 1
FRAME 2
FRAME 3
FRAME 4
FRAME 5
FRAME 6
FRAME 7
32 BITS
CODE WORD

FIG. 5a

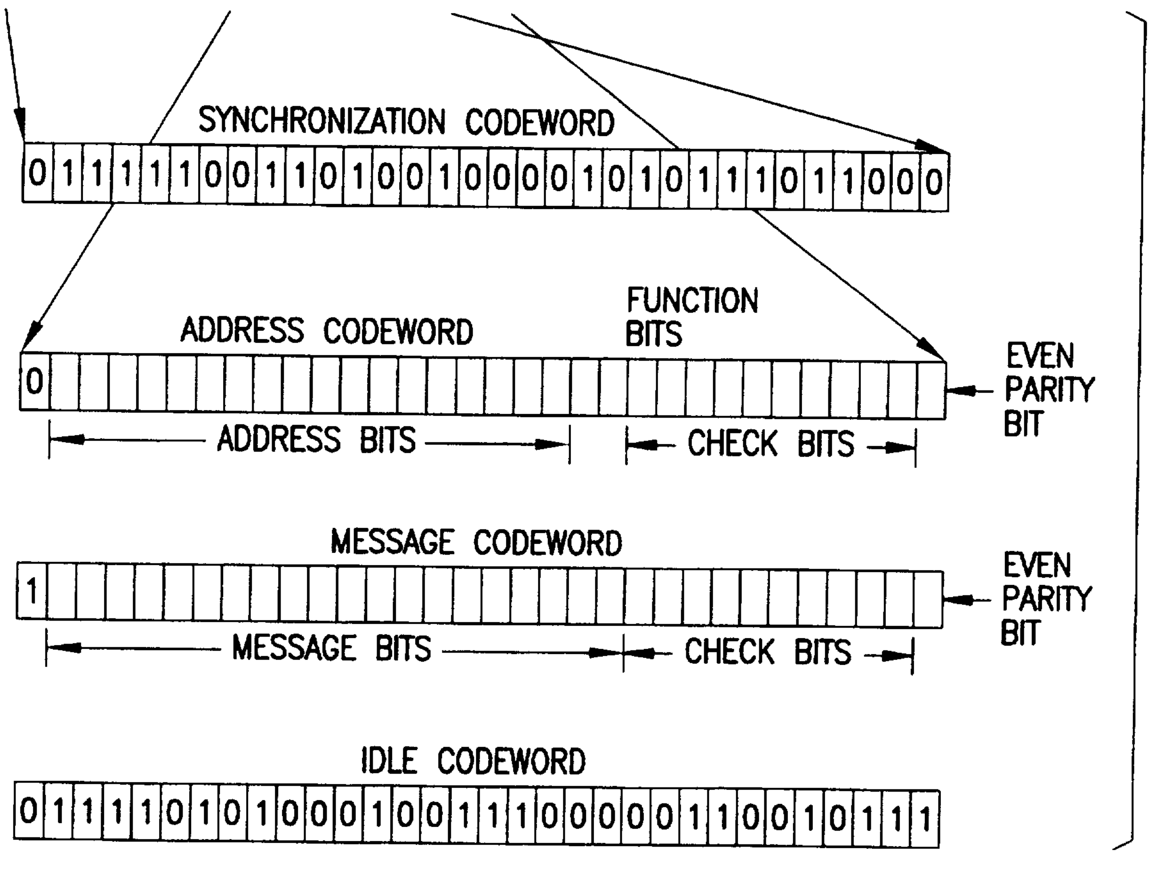
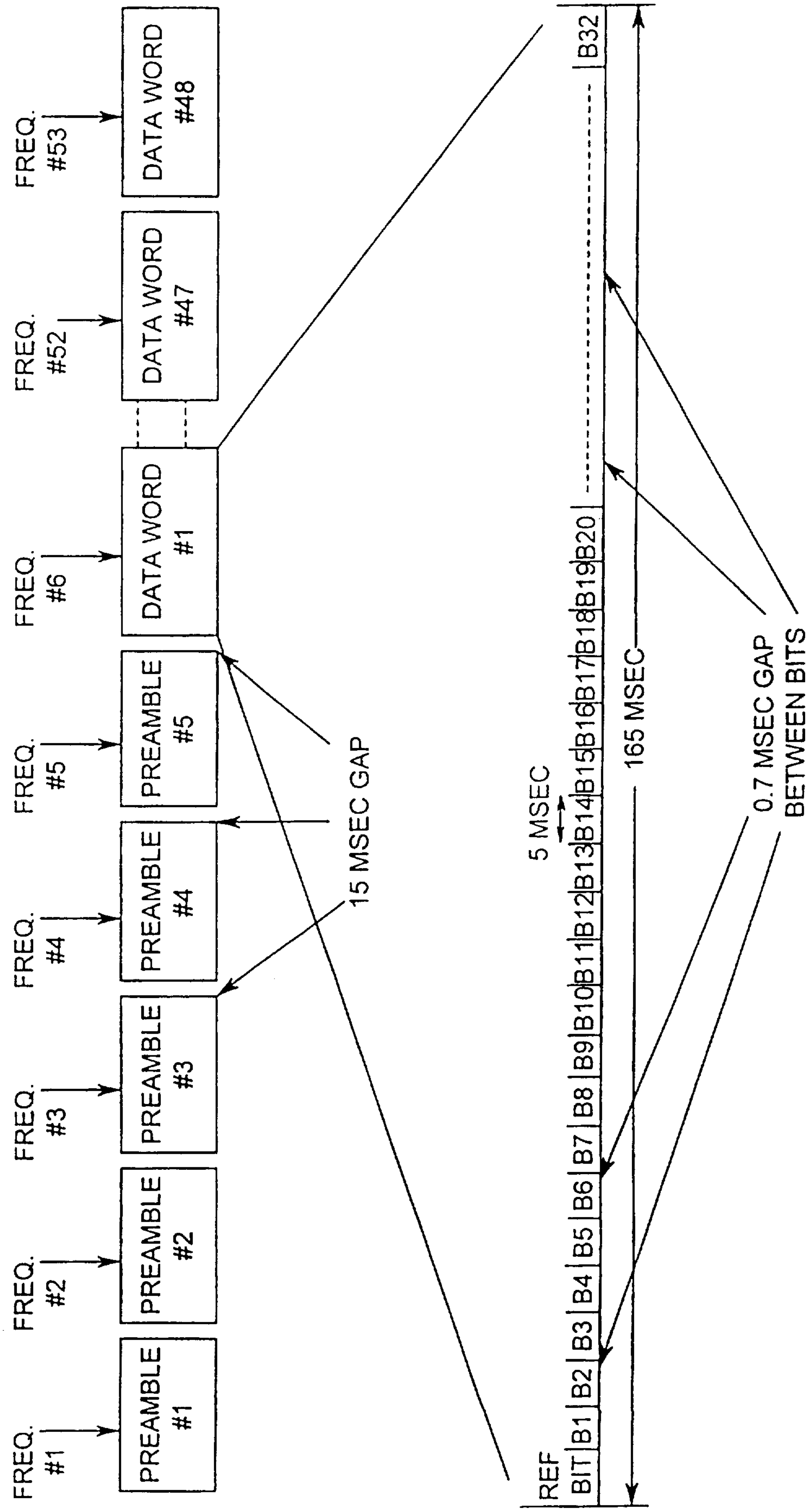

SYNCHRONIZATION CODEWORD
0 1 1 1 1 1 0 0 1 1 0 1 0 0 1 0 0 0 0 1 0 1 0 1 1 1 0 1 1 0 0 0
ADDRESS CODEWORD
FUNCTION BITS
0
ADDRESS BITS
CHECK BITS
EVEN PARITY BIT
MESSAGE CODEWORD
1
MESSAGE BITS
CHECK BITS
EVEN PARITY BIT
IDLE CODEWORD
0 1 1 1 1 0 1 0 1 0 0 0 1 0 0 1 1 1 0 0 0 0 0 1 1 0 0 1 0 1 1 1

FIG. 5b

FIG. 6


FREQ. #1
PREAMBLE #1
FREQ. #2
PREAMBLE #2
FREQ. #3
PREAMBLE #3
FREQ. #4
PREAMBLE #4
FREQ. #5
PREAMBLE #5
FREQ. #6
DATA WORD #1
FREQ. #52
DATA WORD #47
FREQ. #53
DATA WORD #48
15 MSEC GAP
REF BIT
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10
B11
B12
B13
B14
B15
B16
B17
B18
B19
B20
B32
5 MSEC
165 MSEC
0.7 MSEC GAP BETWEEN BITS