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(54) **HANDS-FREE WIRELESS COMMUNICATION IN A VEHICLE**

FREIHÄNDIGE DRAHTLOSE KOMMUNIKATION IN EINEM FAHRZEUG

COMMUNICATION SANS FIL EN MODE MAINS LIBRES DANS UN VEHICULE

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to wireless communications systems. In particular, the present invention relates to a method and apparatus for providing hands free communications in a vehicle through any communication device capable of wireless communications.

BACKGROUND OF THE INVENTION

[0002] A system according to the preamble of claim 1 is known from US 5,535,274.

[0003] Wireless telephones, including cellular telephones have become increasingly popular as a means for persons to remain in telephone, data and messaging contact with others, even when away from their home or office. In particular, wireless telephones allow persons traveling in vehicles to place and receive telephone calls, data and messages even while moving at high rates of speed. As wireless telephone technology has advanced, the telephones themselves have become smaller and smaller and more feature rich. In addition, and in particular with the implementation of various digital technologies, the stand-by and talk times provided by battery operated telephones have increased. The decrease in telephone size, the increase in features and the improvements in the battery life of wireless telephones have made the battery-operated wireless telephone an increasingly common communication device.

[0004] However, the small size and battery operated configuration of many wireless telephones can be disadvantageous when such telephones are used in automobiles. In particular, the small size of such telephones can make dialing and other operations difficult. In addition, even with advanced battery compositions and power-saving strategies, the batteries of wireless telephones eventually need to be recharged. Finally, the configuration of most wireless telephones requires that they be held to the face of the user in order to use the speaker and microphone that are integral to the telephone.

[0005] In order to address some of the disadvantages associated with the use of portable wireless telephones in vehicles, various "car kits" are known. At a most basic level, these car kits provide an interconnection between the telephone and the electrical system of the vehicle. These simple systems therefore allow the telephone to be powered by the electrical system of the car, and also to charge the telephone's battery. Other "car kits" provide a cradle fixed to the interior of the vehicle for holding the telephone, and require that the telephone be lifted from the cradle for use. Other simple "car kits" combine the interconnection to the vehicle's electrical system and the cradle for holding the telephone in a single device. However, these basic systems require that the user of the telephone remove at least one hand from the vehicle's controls in order to operate the telephone, and that the user hold the telephone to his or her face during calls.

[0006] At a next level, some conventional "car kits" provide basic speaker phone functions. These systems provide a microphone and speaker, external to the telephone, and adapted for use at a distance from the user. Therefore, with such a system, a telephone call could be conducted without requiring that the telephone be held to the face of the user. In order to provide a speaker phone capability, the device must generally interface with proprietary electrical contacts provided on the exterior of the telephone. Generally, telephone manufacturers provide electrical contacts for supplying power and for the input and output of audio signals on the exterior of the telephone. Additionally, various contacts for access to and the provision of telephone control signals may also be provided. Through these contacts, it is possible to control various functions of the telephone.

[0007] However, adaptors for physically securing the telephone to the interior of the automobile, and for electrically interconnecting the telephone to the automobile and to processors for providing desired functionalities can be expensive. In particular, the cost of providing a hands-free control system in a vehicle to accommodate a number of different wireless telephones can be cost prohibitive because the physical and electrical characteristics of telephones vary by manufacturer and by model.

[0008] For the above-stated reasons, it would be advantageous to provide an improved method and apparatus for providing a hands-free wireless communications device in a vehicle. In addition, it would be advantageous to provide a method and apparatus that allows for a single interface module containing many of the components necessary to provide the desired functions that can be used with any of a plurality of pocket devices provided for interfacing with supported telephones. In addition, it would be advantageous to provide such a method and apparatus that i can be implemented at an acceptable cost, that allows the user to easily and economically expand the provided functions, and that is reliable in operation.

SUMMARY OF THE INVENTION

[0009] In accordance with the present invention, a system for providing hands-free wireless communications with the features of claim 1 is provided. In particular, the disclosed system generally includes an interface module, a pocket or cradle and a wireless communications device. In general, the pocket is adapted to interface a particular wireless communications device or family of devices to a common interface module that may be functional with different pocket designs. The pocket and the interface module interact with the wireless communication device to economically provide for the hands-free operation of the wireless communication device.

[0010] A pocket in accordance with the present invention is adapted to be mechanically and electrically interconnected to a particular communications device or set of devices. Mechanical features of the pocket include surface features to allow the communications device to be held by the pocket and electrical connectors for mating with various electrical connectors provided with the communications device. Provisions for the electrical interconnection of the pocket and the communications device include, in addition to the above-mentioned electrical contacts, signal lines and processing capabilities. Accordingly, the pocket may provide for the passage of, e.g., radio frequency signals and digital data signals through the pocket without processing by the pocket. In addition, the pocket may include a processor for converting telephone control and other signals between the proprietary interface of the communications device and the application programming interface (API) of the system, allowing the pocket to pass telephone control and other information between the pocket processor and the interface module using a pocket-IM communications bus. Because the physical and electrical characteristics of communications devices such as wireless telephones varies, a pocket may be provided for each unique combination of physical and electrical characteristics found among supported communications devices.

[0011] The pocket is also adapted for mechanical and electrical interconnection to the interface module. The mechanical interconnection may include the provision of a common mounting system for joining the pocket and interface module together, including electrical contacts, or simply electrical contacts where the interface module is remotely located from the pocket. Electrical interconnections between the pocket and interface module may also be according to a common standard, and may include signal paths for various signals. At least some of the signals present between the pocket and the interface module may be formatted according to the above-mentioned API. According to an embodiment of the present invention, the interface module may be interconnected to any of a plurality of pockets.

[0012] The interface module generally contains a digital signal processor for sending and receiving commands transmitted over the pocket-IM communications bus, and for controlling other functions. For instance, the digital signal processor of the interface module may perform various signal processing functions to remove noise, as well as acoustic echos and line echos, from audio signals passed between the telephone and a speaker, as well as from a microphone to facilitate hands-free communications. The digital signal processor may also serve to interpret voice commands issued by a user concerning control of the system. Other potential functions of the interface module digital signal processor include wireless data processing or forwarding, the storage of voice memoranda, text to speech functions, and for interfacing the system to other communication devices, such as personal information managers (PIMs), GPS receivers, vehicle communications busses, Bluetooth devices, and other devices.

[0013] According to one embodiment of the present invention, the pocket in part controls access by a user to the functional capabilities of the system. Accordingly, a pocket may interconnect a communications device to an interface module in such a way that power may be supplied to the device, and audio communications passed to and from that device. However, the pocket may not allow for the recording of voice memoranda, even though the interface module may contain the processing, control and storage components necessary to provide that functionality. A second pocket may enable the user to access the voice memorandum recording capability of the interface module. Yet another, third pocket may additionally provide for the storage of voice memoranda in the pocket itself. Accordingly, this third pocket may allow a user to easily take recorded memoranda to, e.g., an interface module type device located in the user's home or office for playback of the memoranda. Still another pocket, used in combination with a suitable interface module, may enable a text to speech functionality. In this way, the system of the present invention allows a single model of interface module to optionally support a wide variety of communications devices and to provide a wide variety of functions. Therefore, the communications devices supported and the functional capabilities of the system can, at least in part, be determined by the pocket used as part of the system.

[0014] The system of the present invention allows a user to change, for example, his or her wireless telephone, while continuing to use the system, even where the physical and electrical characteristics of the new wireless telephone are different from the old, by purchasing a new pocket, while continuing to use the original interface module. In general, a user may gain access to additional capabilities by substituting a pocket enabling or providing a first set of capabilities for a pocket that enables or provides those additional capabilities. In this way, the system of the present invention enables a user to change his or her communications device without having to replace the interface module, and to upgrade the capabilities of the system by obtaining a pocket having the desired additional capabilities.

[0015] According to another embodiment of the system of the present invention, various models of interface modules may be available, allowing a user to determine the capabilities of the system at least in part by the interface module chosen. Accordingly certain interface modules may have less capabilities and be offered at a lower price than certain other interface modules that are more recent or that are more expensive but that offer expanded capabilities. Different models of interface modules may also be offered to provide or support new features. The various models of interface modules are preferably compatible, at least in part, with any pocket.

[0016] According to one embodiment of the system of the present invention, the system can provide a text to speech function to, for example, provide an audio output of textual data received by the communications device.

This capability may be built into the interface module, or may be added to the interface module by the addition of a daughter board containing additional componentry to support the text to speech function.

[0017] The system is also capable of handling communications involving separately identifiable vehicle subsystems using processing or server functionalities of the interface module and/or associated daughter board. The vehicle having the vehicle subsystems has a unique IP address to allow communications over the Internet, In communications with the vehicle subsystem, the vehicle IP address is utilized outside the vehicle while, inside the vehicle, the communication can be mapped to, or otherwise associated with, the particular vehicle subsystem involved with the communication.

[0018] According to the present invention, there is provided a system for communicating in a vehicle, comprising: a communication device for wirelessly receiving and sending information; a holding member that releasably supports said communications device, said holding member including an electrical connector; a first processor housed by said holding member that receives communication device control signals from the said communication device; an interface module including a second processor and interface module memory; and at least a first communications link between said first processor and said second processor.

[0019] Said first processor may translate said communication device control signals to be compatible with said interface module and output said communication device control signals to said second processor.

[0020] Said communication device control signals may include functions, operations, and/or states of said communication device including related to availability of said communication device for information transfers.

[0021] Said first processor may execute with information that enables said first processor to function with said communication device and not another communication device.

[0022] The system may further include a microphone for receiving voice information and wherein said interface module includes a voice recognition module that converts said voice information to digital information.

[0023] The system may further include at least a first speaker for outputting audio information and wherein said interface module includes a text-to-speech module that converts digital information to said audio information.

[0024] The system may further include at least a first vehicle bus operatively associated with peripheral devices in the vehicle for transferring information relative to said peripheral devices, said vehicle bus communicating with said second processor.

[0025] The system may further include a memory housed by said holding member that is in communication with said first processor, said holding member memory storing digital information obtained from voice information input to said interface module.

[0026] Additional advantages of the present invention will become readily apparent from the following discussion, particularly when taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027]

Fig. 1A illustrates a system for providing wireless communications in a vehicle according to an embodiment of the present invention;

Fig.1B illustrates a pocket according to another embodiment of the present invention;

Fig. 2 is a rear perspective view of a pocket according to an embodiment of the present invention;

Fig. 3 is a schematic illustration of a system for providing wireless communications in a vehicle according to an embodiment of the present invention;

Fig. 4A is a schematic representation of a system for providing wireless communications in a vehicle according to an embodiment of the present invention;

Fig. 4B is a schematic representation of a system for providing wireless communications in a vehicle according to another embodiment of the present invention;

Fig. 5 is a schematic illustration of a pocket according to an embodiment of the present invention;

Fig. 6 illustrates functional compatibilities between components of a system for providing wireless communications in a vehicle according to an embodiment of the present invention;

Fig. 7 illustrates the pocket communications state machine according to an embodiment of the present invention;

Fig. 8 illustrates the architecture of the interface module software according to an embodiment of the present invention;

Fig. 9 illustrates a typical communications scenario according to an embodiment of the present invention;

Fig.10 illustrates a pocket worst case communications scenario; and

Fig.11 illustrates an interface module worst case communications scenario.

DETAILED DESCRIPTION

[0028] With reference to **Fig. 1A,** an embodiment of a system **100** for providing wireless communications in a vehicle is depicted. The system **100** generally includes any communications device capable of wireless communications (e.g. wireless telephone) **102,** a first holding assembly or pocket **104,** and an interface module (IM) **106.** The telephone **102** may have, or be compatible or otherwise operatively associated with, any current or future wireless technology, including, but not limited to, analog technologies such as the Advanced Mobile Phone

System (AMPS), or digital systems such as a code division multiple access (CDMA) system, a time division multiple access (TDMA) system such as the Global System for Mobile Communications (GSM), a third generation (3G) system, such as wide band CDMA (W-CDMA), multicarrier CDMA, Time Division Duplex CDMA, or 3G EDGE (Enhanced Data Rates for GSM Evolution), or a combination of these and other air link technologies, such as the Bluetooth standard. In addition, the telephone **102** can be a wireless communications device other than a c wireless telephone, such as a satellite telephone, a radio, a software defined radio, a personal digital assistant, with or without wireless telephone capability or other service. In general, the telephone **102** is designed by its manufacturer to operate on batteries **107** and to be small in size to allow for easy portability. In addition, the telephone **102** generally features a built-in speaker **108** and microphone **110** to provide for the input and output respectively of audio signals when the telephone **102** is held to the head of the user.

[0029] The telephone **102** includes a keypad **112** to allow the user to dial numbers and to access the internal capabilities of the telephone **102,** such as stored directories of telephone numbers, voice mail, paging or other features that may be provided by the telephone **102.** User-defined functions such as directories of the telephone numbers maybe stored in internal memory provided in the telephone **102.** In addition, a typical telephone 102 includes a visual display **114** for displaying the number to be called or other information, such as the contents of a memory location or the number from which an incoming call originates. The telephone **102** will generally include baseband frequency amplifiers associated with the speaker **108** and the microphone **110.** The telephone **102** also includes a radio frequency section for transmitting and receiving signals at the telephone's **102** operating frequencies. An electrical connector **116** is generally provided to allow the telephone **102** to be electrically connected to external devices. For example, the telephone **102** may be connected to an external power supply through the electrical connector **116.** In addition, the connector **116** generally includes contacts for the transmission of control and data signals to the telephone **102.** In some telephones **102,** provision may also be made for the interconnection of a coaxial radio frequency cable to a radio frequency port **118,** allowing the telephone **102** to utilize an external antenna.

[0030] The pocket **104** generally includes a recess **120** shaped to receive the exterior of the telephone **102.** The recess **120** may include surface features **122,** such as friction pads or protrusions shaped to mate with receiving features on the telephone **102,** to mechanically interconnect the telephone **102** and the pocket **104.** The pocket **104** is also provided with an electrical connector **124** that mates with the electrical connector **116** of the telephone **102** when the telephone **102** is properly positioned within the recess **120** of the pocket **104.** The pocket **104** may also be provided with a coaxial connector **126** for interconnection with a coaxial connector **118** on the telephone **102.** Therefore, the pocket **104** is electrically connected to the telephone **102** through the electrical connections **116** and **124** and the coaxial connectors **118** and **126.**

[0031] The interface module 106 includes locating protuberances **128** for receiving locating apertures **130** located on the back side of the pocket **104** (see Fig. 2). The locating protuberances **128,** together with latch tabs **132** cooperate with the locating apertures **130** to mechanically interconnect the pocket **104** to the interface module **106.** The interface module **106** also features an electrical connector **134** that mates with an electrical connector **136** located on the back of the pocket **104** (see **Fig. 2).** The interface module **106** additionally includes a coaxial connector **138** for connection to a cooperating coaxial connector **140** located on the back of the pocket **104** (see **Fig. 2).**

[0032] In the system of the present invention, the telephone **102** generally serves to transmit and receive radio frequency signals, and to demodulate and modulate those signals to and from the baseband frequencies (e.g., the audible frequencies or digital data communication frequencies). The telephone **102** then provides the baseband frequencies to the pocket **104** through the mating of the electrical connectors **116** and **124.** The pocket **104** also holds the telephone **102** securely in place. The electrical connector **136,** in cooperation with the electrical connector **134** on the interface module **106,** completes the electrical interconnection of the telephone **102** to the interface module **106,** and in turn to the vehicle. The interface module **106** also serves to mechanically interconnect the pocket **104,** and in turn the telephone **102,** to the vehicle, as the interface module **106** is generally rigidly affixed to the vehicle. The radio frequency connectors **118,126,138,** and **140** also cooperate to carry radio frequency signals from the telephone **102** to an antenna mounted on the exterior of the vehicle. Therefore, in summary, the pocket **104** generally serves to mechanically and electrically interconnect the telephone **102** to the interface module **106** and in turn to the vehicle.

[0033] Referring now to **Fig. 1B,** an alternative embodiment of the pocket **104** of the present invention is illustrated. According to the embodiment of the pocket **104** illustrated in **Fig. 1B,** a plurality of control buttons **142** are provided. The control buttons **142** allow the user to access certain advanced features of the pocket **104** provided with select embodiments of the system **100** and in particular of the pocket **104.** These advanced functions will be discussed in detail below.

[0034] Referring now to **Fig. 3**, the major internal components of the telephone **102,** the pocket **104,** and the interface module **106,** as well as relevant components integral to the automobile **302** are illustrated. As described generally above, the telephone **102** mayprovide various electronic signal paths. Therefore, the telephone **102** may accept power from an external source through a power supply line **303.** The transmission of analog audio signals from the telephone **102** to the pocket **104** may be made through the analog audio output line **304,** and analog audio signals may be transmitted from the pocket **104** to the telephone **102** through the analog audio input signal line **306.** The telephone **102** may also be provided with one or more signal lines **308** for receiving and transmitting digital data or digital audio signals. Other signal lines that may be provided include a clock signal line **310,** a frame synch signal line **312,** and telephone control signal bus **314.** Telephone control signals passed over the telephone control signal bus **314** may include signals to turn the telephone **102** on or off; to indicate that data is ready to be sent from the telephone, or that the telephone is ready to receive data; to request power or a change in power; to lock and unlock the telephone; to mute the telephone; to indicate an incoming call; to change the telephone language; to auto answer; to convey or request call timer information, current call status, call restriction data, telephone display data, calling number data, serial message data, cellular system information, or telephone system information; to request or control the telephone volume; to recall or write telephone numbers or other information from the telephone's memory; to simulate a telephone keypress; to dial a number; caller identification data; and to initiate the send command or the end command. All of the various electrical lines **303, 304,306,308,310,312** and **314** may be a part of the electrical connector **116** on the exterior of the telephone **102.** The telephone **102** may also be provided with a radio frequency signal line **316** in the form of the coaxial connector **118.**

[0035] As described above, the pocket **104** is provided with an electrical connector **124** for electrically interconnecting the pocket **104** to the telephone **102.** Some of the electrical signals passing through the connector **124** are simply carried through the pocket **104** to the electrical connector **136,** and thereby are passed on to the interface module **106** directly. Other of the signals are manipulated or processed within the pocket **104.** For example, the analog audio output signal **304** is amplified in the pocket **104** by an analog audio amplifier **318.** In addition, a microprocessor **320** processes telephone control signals on the telephone control signal bus **314** that are passed between the telephone **102** and the pocket **104,** and communication on the pocket-IM bus **322** passed between the pocket **104** and the interface module **106.** Pocket memory **324** may be associated with the microprocessor **320.** The pocket memory **324** may be any addressable storage space, such as ROM, RAM, EEPROM, flash memory, or a combination of memory types. All or a portion of the memory **324** may be removable from the pocket **104.** The pocket **104** also includes a ground signal **326** for signaling to the interface module **106** through electrical connectors **134** and **136** the presence or absence of the pocket **104.**

[0036] The interface module **106** includes processing hardware and software including at least one microprocessor and/or a digital signal processor **328,** a programmable power supply **330,** a DC to DC power converter **332,** a near-end coder/decoder (CODEC) **334,** a far-end CODEC **336,** one or more universal asynchronous receivers/transmitters **338** (UART), and IM memory **340.** The IM memory **340** may be any addressable storage space, such as ROM, RAM, EEPROM, flash memory or a combination of memory types. All or a portion of the memory **340** may be removable from the interface module **106.** The interface module **106** also includes a multiplexer **342,** an analog audio amplifier **344,** and ground lines **326** and **346** for establishing a common ground between the pocket **104** and the interface module **106.** The interface module **106** may additionally include an interface **348** for interconnecting the interface module **106** to various external subsystems **378.** The interface **348** may conveniently be mounted to a daughter board **380** to facilitate expanding the capabilities of the interface module **106.** The daughter board may also have a microprocessor including server capabilities. Instead of such a daughter board 380, all of its capabilities and the interface module components and their functionalities could be integrated on a single chip. In general, the provision of the interface **348** allows the interface module **106** to serve as a communications hub for various external subsystems **378.** These external subsystems **378** may include personal computers, auto PCs, Global Positioning System (GPS) units, Personal Digital Assistants (PDA); devices for the storage of digital audio for playback through the automobile's stereo, such as devices storing music in the MP3 format; the data network or communications bus of vehicles, such as a controller area network (CAN), other data network or communications busses, visual displays; devices using the Bluetooth communications protocol or some other communications protocol; or other electronic systems. In connection with possible implementation of Bluetooth technology, such may be integrated with the interface module 106, as well as being incorporated with the pocket **104.** In such a case, the Bluetooth technology need not be part of the wireless telephone **102** or other wireless communication device. According to this embodiment, the pocket **104** and the interface module **106** could cooperatively function to provide services for associated Bluetooth devices. In this configuration, the number of signal conducting wires is substantially reduced. However, one or more wires may be necessary or appropriate for providing charging functions and/or providing an external antenna connection.

[0037] With respect to facilitating communications with the vehicle having the wireless communications device **102,** particularly communications to vehicle subsystems **378** using the Internet, the vehicle subsystems **378** can be configured to be separately accessible. These individualized communications are achieved, preferably not by assigning separate Internet protocol (IP) addresses to each of the vehicle subsystems **378,** but by incorporating an address-related mapping technique. In accordance with the preferred embodiment, the particular vehicle has only one IP address, or at least the number of IP addresses associated with the vehicle and vehicle subsystems is less than the total number of vehicle subsystems. In the case in which the vehicle has only one IP address, it is necessary to be able to direct the received communication to the desired vehicle subsystem. This can be accomplished by assigning or correlating ports or other identifiers to each of the vehicle subsystems for which there is interest in allowing such communication. When a communication is received for a designated vehicle subsystem **378,** the interface module **106** and/or associated daughter board **380** functions to map the contents of the received communication to the port or other identifier associated with a particular vehicle subsystem **378** that is to be the recipient of this communication. In a preferred embodiment in which it is desirable to communicate with a number or a fleet of vehicles from a common site outside the vehicle, each of the vehicles in the fleet would be assigned a separate IP address. However, the identifiers or ports associated with each of the vehicle subsystems in this fleet would have the same or corresponding port or other identifier. For example, vehicle subsystem 1 in vehicle 1 would have the same port number or other identifier as vehicle subsystem 1 in vehicle 2, although the IP addresses of vehicle 1 and vehicle 2 would be different. This configuration is highly beneficial in managing fleet vehicles, particularly sending/receiving information relative to each of a number of vehicle subsystems in a large number of vehicles. Relatedly, such configuration makes it easier to identify and locate each of the vehicle subsystems in a fleet since the same vehicle subsystem **378** in one vehicle has the same identifier as an identical vehicle subsystem in another vehicle in the fleet.

[0038] With regard to sending a first communication to a first vehicle subsystem located in a first vehicle, a communication can be prepared at a site remote from the vehicle. The communication packet includes an IP address for the first vehicle. The communication packet also includes address-related (e.g. port) information or other identifying information associated with the first vehicle subsystem that is to receive this first communication packet. The first communication packet is transmitted over the Internet to the first vehicle having the IP address in the communication packet. This communication packet is then received by the wireless telephone or other wireless communication device **102.** Subsequently, a determination is made regarding the ultimate location or vehicle subsystem recipient of the first communication packet. This determination might be made by processing hardware and software in the interface module **106** and/or other processing hardware/software including possibly a server on the daughter board **380.** As part of the processing or determination procedures, mapping or other correlation can be provided between the information in the first communication packet related to identifying the particular vehicle subsystem that is to receive the communication packet and a port or other identifier associated with this vehicle subsystem. After the mapping is completed, the communication packet can be directed to the determined first vehicle subsystem, which was designated as the recipient of this communication. As can be appreciated, in the case in which the same communication is to be sent to the same vehicle subsystem located in a number of vehicles in a fleet, only the IP address for each vehicle need be changed to its dedicated vehicle IP address. As can be further appreciated, when it is desirable to send a communication to a second vehicle subsystem located in the first vehicle, either at the same time or at different times, the same IP address associated with that first vehicle can be utilized, while the mapping function to enable the communication to be received by the second vehicle subsystem can be handled within the vehicle.

[0039] Similarly, in communicating from the vehicle to the site outside the vehicle, such as a common site associated with sending/receiving communications to/from a fleet of vehicles, and involving the transmission of data or other information from one or more vehicle subsystems in the vehicle, the network address translation (NAT) can also be accomplished. In particular, the server or other processing hardware/software conducts an address translation by which the vehicle IP address is provided before the communication is sent over the Internet. Such a communication could also include identifying information that identifies the accompanying data as emanating from the particular vehicle subsystem. Consequently, the communication to the site outside the vehicle is accomplished using a single IP address, regardless of which vehicle subsystem might be providing data to the site over the Internet.

[0040] Additionally, the interface module **106** is provided with various signal paths for interconnecting the interface module **106** to the pocket **104** and the vehicle or automobile 302. Signal paths between the pocket **104** and the interface module **106** include the analog audio input signal path **306** and the amplified analog audio output signal path **350.** Digital data signal paths **308** and clock **310** and frame synch **312** signal paths may also be provided between the pocket **104** and the interface module **106.** The pocket-IM communications bus **322** also runs between the pocket **104** and the interface module **106.** The bus 322 may be a serial bus or any other appropriate bus. Various power lines may also run between the pocket **104** and the interface module **106,** such as the telephone power supply line **303** and the pocket power line **352.** The interface module power enable line **354** connects the microprocessor **320** of the pocket **104** to the DC to DC power convertor **332** in the interface module **106.** The ground **326** and pocket sense **346** lines also pass between the pocket **104** and the interface module **106.** Radio frequency signals are passed through the interface module **106** from the pocket **104** to an antenna **356** mounted on the automobile **302** over the radio frequency signal line **316.** Additionally, a signal indicating the position of the automobile's **302** ignition switch **358** is passed through the interface module **106** to the microprocessor **320** of the pocket through the ignition signal line **360.**

[0041] Signal paths between the interface module **106** and the automobile **302** include the radio frequency signal line **316,** which passes from the phone **102,** through pocket **104** and the interface module **106** to the antenna 356 on the automobile 302. In addition, near-end audio input **370** and audio output **372** lines connect the near-end CODEC **334** to the microphone 368 and the speaker **366,** respectively. The audio output line **372** passes through an analog audio amplifier **344** before continuing on to the speaker **366.** The mute line **362** connects the interface module microprocessor **328** to the entertainment system **373** of the automobile **302.** The main power line **374** connects the DC to DC power convertor **332** of the interface module **106** to the electrical power supply **364** of the automobile **302.** The ignition signal line **360** passes through the interface module **106,** between the microprocessor **303** of the pocket **104** and the ignition switch **358** of the automobile **302.** Additionally, one or more custom interface signal lines **376** may connect the interface **348** of the interface module **106** to various other subsystems **378** located in the automobile **302.**

[0042] As a result of the above-mentioned signal paths, in addition to being mechanically interconnected to the automobile **302,** the interface module **106** is electrically connected to certain of the automobile's **302** components. Therefore, the interface module **106** may be interconnected to an antenna **356** provided on an exterior of the automobile **302.** Also, the interface module **106** is interconnected to the electrical power supply **364** of the automobile 302, and may also be connected to the ignition switch 358 of the automobile **302** to signal operation of the system **100** when the automobile 302 is running. Speakers **366** located within the automobile **302** may conveniently be utilized by the system **100** to provide an audible signal from the telephone **102.** The speakers **366** may or may not be a part of the automobile's **302** audio entertainment system **373.** Also, the speakers **366** may be part of a headset worn by the user. For receiving audible signals (e.g. the voice of a user), a microphone 368 may be located within the interior of the automobile 302, and that signal processed by the interface module 106 and provided to the telephone 102 via the pocket 104. The interface module 106 of the system 100 may also be interconnected to the audio system 373 of the automobile 302 to mute signals other than those transmitted from the telephone 102 to the speakers 366.

[0043] Preferably, the system **100** is provided in a variety of models offering differing capabilities to suit the needs and budgets of individual users. These differing capabilities are provided by varying the functionality supported by the pocket 104 and/or the interface module **106.** Referring now to Figs. **4A** and **4B,** embodiments of the system **100** having differing capabilities are illustrated schematically.

[0044] With reference now to **Fig. 4A,** a telephone **102,** pocket **104,** interface module **106,** and automobile **302** of an embodiment of the system **100** are illustrated schematically. With respect to the telephone 102, the radio frequency 316, power 303, audio 304 and 306, control 314, and digital data signal lines 308 are illustrated. It is noted that, while the digital data path 308 is shown at the telephone 102, it is not passed through the pocket 104 to the interface module 106. This is because the embodiment of the pocket 104 illustrated in Fig. 4A does not support digital data signals 308, and thus does not provide a digital data line.

[0045] The pocket 104 of the embodiment illustrated in Fig. 4A includes signal paths for the radio frequency 316 and power 303 signals. For at least the incoming analog audio signal, an amplifier 318 is provided. Telephone control data line 314 is interconnected to the microprocessor 320 located in the pocket 104. Therefore, it can be seen that, in the embodiment shown in Fig. 4A, the pocket 104 provides interconnections to all of the telephone's 102 electrical inputs and outputs, except for those outputs for digital data or digital audio.

[0046] The pocket 104 of the embodiment shown in Fig. 4A amplifies audio signals provided from the telephone 102, and includes a microprocessor 320 for providing an interface for control data 314 passed between the telephone 102 and the interface module **106.** As illustrated in **Fig. 4A,** a universal asynchronous receiver transmitter (UART) **402** may be associated with the microprocessor 320 for aiding the transmission of flow control data between the telephone 102 and the pocket 104. In one embodiment, a single UART **402**, which is part of the microprocessor 320, is provided on the pocket 104 side of the telephone control signal path established between the pocket 104 and the interface module 106. Because a UART 338 is provided in the interface module 106, no additional UART is necessary. By eliminating an additional UART, the cost of the pocket 104, and in particular the cost of the microprocessor 320, can be kept to a minimum. However, in certain applications, such as those in which the interface module 106 is located at a distance from the pocket 104, it may be necessary to provide an additional line driver in the pocket 104.

[0047] The interface module's 106 major components are shown in Fig. 4A as the interface module microprocessor **328,** the power supply **330,** the near-end **334** and far-end **336** CODECs, the UART **338,** and the IM memory **340.** The interface module **106** is also illustrated as providing a signal path for the radio frequency signal 316. The interface module microprocessor 328 provides a variety of advanced functions that will be described in greater detail below. The power supply 330 provides a constant voltage or a constant current, according to the requirements of the particular telephone 102, for powering the telephone 102 and charging the telephone's 102 battery 107. The CODECs 334 and 336 provide for the conversion of analog audio signals to digital signals that can be processed by the interface module microprocessor 328, and likewise convert digital audio signals emanating from the interface module microprocessor 328 into analog signals usable by the analog audio inputs of the telephone 102 or the speakers 366 of the automobile 302. As described above with respect to the pocket 104, the UART 338 of the interface module 106 facilitates the communication of telephone 102 control data between the pocket 104 and the interface module **106** across the pocket-IM bus **322.** The IM memory **340** allows voice memos or other data to be stored in digital form. In addition, the IM memory **340** may be used to store word models and voice prompts used to support voice recognition features. As an additional function, the IM memory **340** may be used to correct errors in the code resident in the interface module microprocessor 328.

[0048] The automobile 302 is, in the embodiment illustrated in Fig. 4A, shown as being connected to the radio frequency 316, power 374, audio 370 and 372 and control 362 line. However, the data line 308 is not shown as being interconnected to the data line 308 of the telephone 102. This is because the pocket 104 of the embodiment makes no provision for transmitting such data 308 to or from the telephone 102.

[0049] Referring now to Fig. **4B,** a telephone **102,** pocket **104,** interface module **106,** and automobile 302 of yet another embodiment of the system 100 are illustrated schematically. The system **100** illustrated in **Fig**. **4B** includes all of the various signal lines and structures described above with respect to the embodiment illustrated in **Fig. 4A.** However, in addition, the embodiment illustrated in **Fig. 4B** includes a digital data line **308** from the telephone **102** through the pocket **104** to a second UART **402** located in the interface module **106.** The second UART **402** of the interface module **106** is connected to a third UART **404** in the interface module 106. The interface signal line 376 runs between the third UART 404 of the interface module 106 and the automobile 302. Thus, the embodiment of the system 100 illustrated in **Fig. 4B** provides a direct path for digital data or audio from the telephone **102** to the interface module 106, including the interface module microprocessor 328, and from the interface module 106 to the automobile 302. The provision of these digital data lines 308 and 376 allows the system 100 to support additional features, as will be described in greater detail below.

[0050] Referring now to Fig. 5, an embodiment of the pocket 104 of the present invention is illustrated schematically. As shown in Fig. 5, the pocket 104 generally includes an electrical connector 124 for providing electrical connectivity between the pocket 104 and the telephone 102. Additionally, a radio frequency connector 126 may be provided for the transmission of radio frequency signals across the pocket 104 to the interface module 106. The radio frequency signal line 316 thus travels between the radio frequency connector 126 at the interface of the telephone 102 and the pocket 104, and the radio frequency connector 140 at the interface of the pocket 104 and the interface module 106. An electrical connector 136 provides other electrical connections between the pocket 104 and the interface module 106. As discussed above, digital data lines 308 can be provided in the pocket 104 to pass digital data or digital audio signals directly from the telephone 102 to the interface module 106, without manipulation by componentry within the pocket 104. Other signal lines that are provided for transmission of signals across the pocket 104 without manipulation by the pocket **104** are the clock signal line **310** and the frame synch signal line **312.** Also, one or more power supply lines 303 transmit power from the interface module 106 directly to the telephone 102.

[0051] As discussed above, an analog audio amplifier 318 receives analog audio signals from the telephone 102 over the analog audio analog output line 304. The analog signals received at the amplifier 318 are then amplified a selected amount and passed to the interface module **106** over the amplified analog output line **350.** Also shown in **Fig. 5** is an analog audio input amplifier 502 which may be provided to selectively amplify analog audio signals from the interface module 106 before they are passed to the telephone 102 over analog audio input line 306.

[0052] A voltage regulator 504 may be provided in the pocket 104 for providing the correct voltage level to power the microprocessor 320. For example, the voltage regulator 504 may take a 5 volt signal supplied by the DC to DC power convertor 332 in the interface module 106 over power line 352, and produce a 3 volt output. The 3 volt output may then be supplied to the microprocessor 320 over regulated power supply line 506.

[0053] The signals provided from the interface module 106 through the electrical connector 136 to the pocket 104 include communication signals transmitted over the pocket-IM communication bus 322. The communication bus 322 terminates in the microprocessor 320 at serial input/output pins 508. As will be described in greater detail below, the communication signals received at the serial I/O pins **508** are decoded before being sent to the microprocessor UART **510** for transmission to the telephone **102** over the telephone control lines 314. Other signal lines passing between the interface module 106 and the pocket 104 include a plurality ofin-circuit programming signal lines 512, which may be used to program or re-program the pocket microprocessor 320. The ignition signal line 360 and mute line **362** are also provided. Additional I/O signal lines **514** may be provided between the microprocessor 320 and the telephone 102. A pocket detect ground 326 for interconnection to the interface module 106 is also provided. Additionally, memory 324 may be provided in the pocket 104 for use in association with the microprocessor 320. According to one embodiment of the pocket 104, the microprocessor 320 includes inputs for receiving signals from buttons **142** (see **Fig. 1B)** on the exterior of the pocket **104.**

[0054] As mentioned above, the telephone 102 may generally be used to transmit and receive voice and data signals over an air link to a base station, such as a cell in a cellular phone system. Additionally, the telephone 102 will typically allow for the storage of indexed lists of phone numbers to provide the user with a customized list or directory of telephone numbers. The telephone **102** is also provided with a speaker **108** and microphone **110** to allow the user to engage in conversations over the telephone **102** when the telephone **102** is held to the face of the user. A keypad **112** is typically used to enter numbers and initiate dialing, answer incoming calls, and to enter phone directory information. A visual display **114** is also typically provided for displaying the number to be called, memory location entries, or other information. The phone **104** may be powered by a battery **107** so that the telephone 102 is easily portable.

[0055] However, the telephone **102** is typically not provided with features allowing for easy hand held use in an automobile. For instance, placing a call typically requires the user to enter the number using the keypad **112,** or again using the keypad **112,** to select from an entry in a user-defined directory. Using the keypad requires that the user remove his or her eyes from the road to view the keypad **112** and the display **114,** and to remove a hand from the automobile's **302** controls to enter the number or select the desired option. This is, of course, disadvantageous where the user is driving the automobile **302.** Although some telephones **102** are available with built-in voice recognition features, they are "near talk" systems, and are not well suited for use in vehicle or other "far talk" environments. Therefore, it is desirable to provide a system to allow the reliable hands-free operation of the telephone **102.**

[0056] As can be appreciated, the telephone **102** may be produced by any one of a number of manufacturers, who each may produce a variety of different models. Accordingly, the physical shape of the telephone **102,** as well as the physical configuration of the electrical connector **116** and the particular signal lines provided by the electrical connector **116** may vary greatly. Additionally, the communications protocol recognized by the telephone **102** is generally proprietary to the manufacture of the telephone **102** and may vary among telephone models **102** produced by a single manufacturer.

[0057] In order to accommodate the variety of physical, electrical, and communications protocol variations among telephones **102,** the present invention provides a plurality of different pocket **104** configurations. Thus, a pocket **104** may be provided to mate with the various physical configurations of different telephones **102.** Accordingly, the recess **120** and surface features **122** are generally determined by the physical characteristics of the telephone **102** meant to be accommodated by the particular pocket **104.** In addition, the electrical connector **124** is physically configured to mate with the electrical connector **116** on the telephone 102. Where the telephone **102** provides a coaxial connector **118** for a radio frequency signal line, the pocket **104** may provide a mating coaxial connector **126.** In this way, a particular telephone **102** may mechanically mate with the corresponding pocket **104.**

[0058] As mentioned above, the particular electrical signal lines provided by telephone **102** and the communications protocol used by the telephone **102** may vary between manufacturers, and even among the various models of telephones **102** produced by a particular manufacturer. Therefore, in order to electrically connect the telephone **102** to the pocket **104** and the interface module **106** and in turn the automobile **302,** provisions must be made to accommodate these differences. Accordingly, the pocket **104** may be designed to accommodate the particular configuration and type of electrical signal lines provided by the telephone **102.** In a physical sense, this is done by connecting the provided signal lines (e.g. **304, 306, 308, 310, 312, 314, 303** and **316)** to the corresponding contacts, if so provided, in the electrical connector **116** and **118** of the telephone **102.**

[0059] Additionally, the pocket **104** is provided with a microprocessor **320** and associated pocket memory **324** for interfacing with the provided telephone control signals **314** of the telephone **102.** In this way, the electrical and communications protocols of the telephone **102** can be accommodated by the particular pocket **104** designed for use with the particular telephone **102.** Specifically, the memory **324** of the pocket **104** contains code that allows the pocket **104** to translate between commands formatted in the API of the system **100** and the proprietary communications interface of the telephone **102.** Although the pocket **104** is physically and electrically configured for use with particular telephones, it is desirable that the interface module **106** be capable of operating with any of the provided pockets **104** and associated telephones **102.** Providing a common interface module **106** may reduce the cost of the system **100,** as only the pocket **104** need be varied to accommodate the wide variety of telephones **102** available in the marketplace. To further increase the advantages gained by using a common interface module **106,** many of the components necessary to provide the functions of the system **100** are located in the interface module **106.** Conversely, the number and cost of components necessary for the pocket **104** to provide the desired functions are kept to a minimum. In addition, although the interface module **106** may be capable of carrying out a certain number of functions, all of these functions may not be available to a user who has a pocket **104** that allows access to only a limited number of the potentially available functions. Also, the functions supported by a particular pocket **104** may be varied according to the operational functions available using the particular telephone **102** or according to the functions supported by the particular pocket **104.**

[0060] With reference now to Fig. 6, a plurality of pockets **104a, 104b, 104c, 104d, 104e**, **104f, 104g** and **104h** are shown, each having differing physical and/or functional compatibilities, but that are all physically and functionally compatible with a common interface module **106.** The pockets A1 **104a,** A2 **104b**, A3 **104c,** and A4 **104d** may, for instance, be compatible with the physical characteristics of telephones A1 **102a,** A2 **102b,** and A3 **102c** produced by a single manufacturer A. Pockets B1 **104e, B2104f,** B3 **104g** and **B4104h** may be physically compatible with telephones B1 **102d, B2102e,** B3 **102f** and B4 **102g** produced by manufacturer B, or alternatively produced by manufacturer A, but having different physical characteristics from telephone **102a, 102b** and **102c.** Although in the example the pockets 104a-d are physically compatible with the telephones **102a-c**, and the pockets **104e-h** are physically compatible with telephones **102d-g,** all the various functionalities of telephones **102a-c** may not all be supported by the pockets **104a-d** and all the various functionalities of the telephones **102d-g** may not all be supported by the pockets **104e-h.** Similarly, the functional or other capabilities of the pockets **104a-h** may not all be supported by all of the telephones **102a-g.** In **Fig. 6,** the functional compatibilities between the individual pockets **104a-h** and the individual telephones **102a-g** are illustrated by arrows. A solid arrow from a pocket **104** to a telephone **102** indicates that all of the functions of the particular telephone **102** are supported by the particular pocket **104,** while solid arrows from a telephone **102** to a pocket **104** indicate that all of the particular pocket's **104** capabilities are supported by the particular telephone **102.** A dotted line from a telephone **102** to a pocket **104** indicates that only a subset of the pocket's **104** capabilities are supported by the particular telephone **102,** while a dotted line from a pocket **104** to a telephone **102** indicates that only a subset of the particular telephone's **102** capabilities are supported by the particular pocket **104.**

[0061] As an example, telephones A1 **102a,** A2 **102b,** and A3 **102c** may share common physical attributes, allowing any of those telephones to be mechanically interconnected to any of the pockets A1 **104a,** A2 **104b,** A3 **104c,** and A4 **104d.** However, the telephones A1 **102a**, A2 **102b**, and A3 **102c** may have differing functional capabilities. Likewise the pockets A1 **104a,** A2 **104b,** A3 **104c,** and A4 **104d** may support different functions. For instance, pockets A1 **104a,** A2 **104b,** and A3 **104c** may support all of the functional capabilities of telephones A1 **102a** and A2 **102b,** but only a subset of telephone A3's **102c** capabilities while pocket A4 **104d** may support all of the functional capabilities oftelephones A1 **102a,** A2 **102b** and A3 **102c.** Telephones A1 **102a** and A2 **102b** may support all of the functional capabilities of pockets A1 **104a,** A2 **104b,** and A3 **104c,** but only a subset of the functional capabilities of pocket A4 **104d,** while telephone A3 102c may support all of the functional capabilities of pockets **A1 104a,** A2 **104b,** A3 **104c** and A4 **104d**. Examples of the interaction between pockets **104** having differing functional capabilities and telephones **102** having differing functional capabilities will now be explained in the context of various examples.

[0062] The pocket A1 **104a** may be a level one pocket supporting only the most basic functions provided by the system **100.** Thus, the pocket A1 **104a** may provide basic speaker phone functions when interconnecting telephones **A1 102a,** A2 **102b** or A3 **102c** to the interface module **106.** The basic speaker phone functions may comprise the provision of a speaker **366** and microphone **368,** to allow the user to carry on a conversation transmitted over a wireless link by the telephone **102** without having to hold the telephone 102 to his or her face. Thus, with reference now to **Fig. 3,** the pocket A1 **104a** may provide analog audio signal lines **304** and **306** to support analog audio signals from and to the telephone **102,** where the telephone, e.g. telephone A1 **102a,** provides an analog audio input and output. The pocket A1 **104a** may also provide analog audio amplifiers **318** and **502** (see **Fig.** 5) to allow for the gain of the analog audio signals to be adjusted. The pocket A1 **104a** then provides connections for the analog audio signals to the interface module **106.** Where the telephone A1 **102** provides a digital input or output, for example, telephone A2 **102b,** the pocket A1's **104a** digital audio signal lines 308 pass the digital audio signal directly to the interface module **106.** In general, the capabilities and specifications of the telephone **102** are communicated to the interface module **106** by the pocket **104** via the pocket-IM communications bus when the pocket **104** is initially interconnected to the interface module **106.**

[0063] The pocket A1 **104a** also may provide a power line **303** for charging the battery **107** of the telephone **102** and/or providing electrical power to operate the telephone **102.** The pocket A1 **104a** additionally includes telephone control signal lines **314** between the telephone **102** and the microprocessor **320.** Finally, the pocket A1 **104a** may provide a radio frequency signal line **316,** where a radio frequency output connector 118 is provided by the telephone **102.**

[0064] According to the embodiment of the system **100** having a level one pocket A1 **104a,** the telephone **102** is physically held in position in the automobile **302,** and is provided with speaker phone functionality. Thus, where a telephone call is placed from a remote site to the telephone **102,** the user must generally press a button on the keypad **112** of the telephone **102** to enable communications with the telephone at the remote site. The establishment of the communications link with the remote site is signaled to the pocket **104** by the telephone **102** over the telephone control signal lines **314.** The form of the signal given by the telephone **102** is generally proprietary to the manufacturer of the telephone **102.** Accordingly, it may consist of a serial digital message, or simply by a change in the voltage at an electrical contact on the telephone **102.** The pocket **104,** and in particular the microprocessor **320,** is programmed to recognize the particular message sent from the telephone **102** to indicate that a call is in progress. The microprocessor **320** then converts the message from the telephone **102** into one complying with the application programming interface (API) of the system **100.** This message may be transmitted from a serial I/O port provided on the microprocessor **320** over the pocket-IM communication bus **322** to the far-end UART **338** and from there to a parallel input/output port provided on the interface module microprocessor **328** of the interface module **106.** The interface module microprocessor **328** reviews the call-in-progress message that originated in the telephone **102** and that was translated into the API of the system **100,** and generally configures the system **100** so that it is ready to handle the call. In particular, the interface module microprocessor **328** activates the mute signal line **362** to mute any output from the automobile's **302** audio system **373.** When the telephone provides an analog audio input **306** and an analog audio output **304,** the interface module microprocessor **328** may also activate the analog audio output amplifier **318.** Thus, where the telephone **102** provides an analog audio signal, that signal may be amplified by the analog audio amplifier **318** and passed to the interface module **106** wherein the analog signal is digitized by the far-end CODEC **336.** The now digital audio signal is then passed to the multiplexer **342** and on to the interface module microprocessor **328** at a serial I/O port. The interface module microprocessor **328** then may perform a variety of signal processing functions on the audio signal. These functions may include acoustic echo cancellation, line echo cancellation, noise reduction, and frequency equalization. The digital signal processor may also provide partial full duplex operation, and automatic volume control functions. The processed digital audio signal is then passed from a serial I/O port of the interface module microprocessor **328** to the near-end CODEC **334** where the digital audio signal is converted back into an analog signal. The analog signal may then be amplified to line level and conditioned in the analog audio amplifier **344** before being amplified by the audio system **373** or by a power amplifier associated with the speaker **366** and output by the speaker **366.**

[0065] Voice signals from the user in the automobile **302** are picked up at the microphone **368,** which may feature built-in noise reduction capabilities, and digitized by the near-end CODEC **344,** before being passed to the serial I/O port of the interface module microprocessor **328.** Again, various signal processing functions may be carried out in the interface module microprocessor **328,** before the digital audio signal is passed to the multiplexer **342** and on to the far-end CODEC **336.** The far-end CODEC **336** transforms the digital audio signal into an analog signal that is passed to the telephone **102** for transmission over the air link to the remote site.

[0066] Where the telephone **102** provides digital audio inputs and outputs, for example, telephones A2 **102b** and A3 **102c**, the transmission of signals through the system **100** is generally as described above, except that the digital audio signals are passed between the telephone **102** and the interface module microprocessor **328** via the multiplexer **342,** without any intervening amplification, and without passing through the far end CODEC **336.**

[0067] The level one pocket A1 **104a** may also provide the telephone **102** with power for charging the battery **107** and operating the telephone **102** over power line **303**. In general, the microprocessor **320** of the pocket **104** will have been programmed to request the proper voltage or current from the programmable power supply **330** of the interface module **106.** Of course, the power needs of the telephone **102** may vary according to the operational state of the telephone **102** or the charge of the battery **107.** Therefore, the telephone **102** may request, for example, that power be supplied at a first voltage when the telephone 102 is in an idle state, and at a second voltage when the telephone **102** is in an active state. The signal requesting differing voltages may be passed from the telephone **102** over the telephone control signal lines **314** to the microprocessor **320** where the request is translated to the API of the system **100.** The interface module microprocessor **328** may then control the programmable power supply **330** to provide the requested power. The pocket may also include a current limiter or voltage regulator as required.

[0068] Because the pocket **104** is designed to provide a predetermined set of functionalities and to be used with a predetermined telephone or set of telephones **102,** the microprocessor **320** and in particular the memory **324** associated with the microprocessor **320** will have been programmed to translate the particular signals of the telephone **102** into commands included in the API of the system **100.** In addition, the pocket **104** will have been programmed with the power requirements of the telephone **102.** This information regarding the functions supported and requirements of the telephone **102** may be communicated over the pocket-IM communications bus **322** to the interface module microprocessor **328** when the pocket **104** is plugged into the interface module **106.** The pocket **104** also communicates information regarding the functions supported by the pocket **104** to the interface module **106.** In general, the interface module **106** is activated when the pocket **104** is plugged into the interface module **106** and the pocket sense ground **326** is established between the pocket **104** and the interface module **106.**

[0069] A second pocket 104b, known as a level two pocket, may provide additional functionalities. For example, the pocket 104b may support audible prompts, voice commands and voice memorandum recording. As illustrated in **Fig. 6,** the functionalities of pocket A2 **104b** are fully supported by telephones A1 **102a,** A2 **102b** and A3 **102c,** even though it provides this additional functionality. Also, the interface module **106** may be identical to the one described with reference to pocket A1 **104a.** With respect to the basic speaker phone functions provided by the system **100** in connection with pocket A2104b, the functions and interconnections are as described above with respect to the pocket A1 **104a.**

[0070] In order to support voice commands, the pocket A2 **104b** must be programmed to convey appropriate messages between the telephone **102b** and the interface module **106.** For instance, the pocket A2 **104b** must be capable of providing the telephone **102** with a telephone control signal directing the telephone **102** to pick up an incoming call. This is in contrast to the example given above with respect to pocket A1 **104b** in which the user must press a button on the keypad **112** of the telephone

102 to pick up an incoming call. In addition, the microprocessor **320** of the pocket **104b** must include API commands for functions such as answering an incoming call. Apart from enabling additional functionalities such as voice recognition and voice memorandum recording, the pocket A2 **104b** is, according to one embodiment of the present invention, the same as pocket **A1 104a.**

[0071] Audible voice prompts are, according to an embodiment of the system 100 of the present invention, provided to guide a user operating the system **100.** Audible prompts are particularly advantageous when used in connection with voice recognition functions because they facilitate operation of the system **100** without requiring that the user look at the system **100** itself. For example, the system **100** may acknowledge commands given by the user, or provide the user with information concerning the status of the system **100.** The audible prompts may be pre-recorded and stored in the pocket memory **324** and/or the IM memory **340,** with or without compression. Alternatively or in addition, the audible prompts may be generated from text stored in memory **324** or **340** using a text to speech functionality (described below). According to one embodiment, the voice prompts are stored in easily changed memory **324** or **340** cartridges, to allow the existing system **100** to be upgraded, or to accommodate a different or an additional language.

[0072] The interface module **106** may include speech recognition functions to enable the system **100** to recognize voice commands. The interface module used in connection with pocket A2 **104b** may be identical to the interface module **106** used in connection with pocket A1 **104a**. Alternately, the interface module **106** used in connection with pocket A2 **104b** may be enhanced to provide voice recognition functions. Even if the interface module **106** is provided in various models offering differing capabilities, any interface module **106** is preferably compatible, at least in part, with any pocket 104. In general, speech models are stored in the IM memory **340** or the pocket memory **324** to enable the system **100** to recognize universal commands such as "answer call" or "place call." Different memory **324** or **340** cartridges may be provided to conveniently upgrade the speech models or change them to a different language. In addition, provision maybe made in the interface module **106** for storing user defined commands, such as "call home" or "call Mary." According to one embodiment of the present invention, the user defined commands and voice memoranda may be stored in removable memory **324** or **340** to facilitate their use in other systems **100** or in compatible devices, to archive memoranda, or to allow the use of different command sets. The removable memory **324** or **340** may comprise a RAM memory card. The pocket A2 **104b** may be provided with buttons **142** (see **Fig. 1B)** to enable the user to signal the system **100** to enter a voice command mode or voice memo record mode.

[0073] The operation of the system **100** in processing a voice command will now be explained in the context of an example. Where a telephone call is not in progress (i.e. the telephone **102** is on-hook), a user may command that a general voice recognition mode be entered by uttering a special initiator word (e.g., "CellPort"). The system **100** may also be provided with a "barge-in" capability to allow voice recognition mode to be entered even while a telephone call is in progress (i.e. the telephone **102** is off-hook). Alternatively, the user may press a button **142a** provided on the exterior of the pocket **104b** to place the system **100** in voice recognition mode. Upon receiving the signal to enter voice recognition mode, the processor **320** sends a message across the pocket-IM communication bus **322** to the interface module microprocessor **328** via the UART **338.** The message sent by the microprocessor **320** is formatted according to the API of the system **100.** Upon receiving the message to enter voice recognition mode, the interface module microprocessor **328** activates or otherwise communicates with the microphone **368.** When a voice command is used, the interface module microprocessor **328** will cause the system **100** to enter a general voice recognition mode after a prescribed voice command has been issued by the user

[0074] Voice commands issued by the user are converted into analog electrical signals by the microphone **368** and passed through the near-end CODEC **334,** where the analog signals are digitized. The digitized voice commands are then compared in the interface module microprocessor **328** to the standard and customized speech models stored in the flash memory **340.** If, for example, the user issues the command "call home," the interface module microprocessor **328** will attempt to match those words to the stored word models. Upon finding a match, the interface module microprocessor **328** will initiate action according to the command. Thus, when the command "call home" is received, a signal to initiate a telephone call will be formatted in the API of the system **100,** and passed to the microprocessor **320** of the pocket A2 **104b**, where the API command is translated into a signal understood by the telephone **102.** Where the telephone number associated with "home" is stored in memory **324** or **340,** the command to the telephone **102** may consist of the digits of the telephone number and the send command. Alternatively, where the telephone **102** allows access to telephone directories stored in its internal memory, the command from the interface module microprocessor **328** may be in the form of a command to retrieve a number from a specified memory location in the telephone **102** and to initiate the send function.

[0075] The functions provided by the level two pocket **A2104b** may also include provisions for voice memo recording. Thus, by pressing the associated buttons **142b**, or by issuing the appropriate voice command, such as "take a memo", the system **100** may be configured to record a voice message. Such a capability is useful, for instance where a user wishes to give him or herself a reminder to do something without having to write the reminder down with pencil and paper. The voice memorandum capability is also useful for recording directions or a telephone number given by the person at the other end of the communications link. In voice memo recording mode, the voice message is converted to an analog electrical signal by the microphone **368** and transmitted to the near-end CODEC **334** where the signal is digitized. The digital voice memo is then processed and compressed by the interface module microprocessor **328** and stored in memory **340.** When the user wishes to retrieve the voice memo, the user may press a button **142c** on the pocket A2 **104b** causing a command to be sent from the microprocessor **320** across the pocket-IM communication bus **322** to the interface module microprocessor **328,** in the API of the system. The interface module microprocessor **328** then retrieves the message from memory **340,** decompresses the message, performs signal processing functions, and provides a digital output of the message to the near-end CODEC **334,** which converts the memo to an analog signal that is then amplified by the amplifier **344** and output at the speaker or headset **366.** Where the command to replay a previously recorded voice memo is in the form of a voice command, the recognition of the voice command by the interface module microprocessor **328** initiates the retrieval of the voice message from memory **340** for playback through the speaker **366.** In addition or as an alternative to playback through the speaker **366,** the memorandum may be transmitted to another device for playback. For example, the memorandum could be transmitted by the telephone **102** to a remote telephone or device, or it could be transmitted to a computer or other external subsystem **378** for playback.

[0076] A next level of functionality may be provided by the system **100** in connection with a pocket A3 **104c.** The additional functions provided by the pocket **104c** may include storage for voice memos, directories and customized voice commands in the pocket **104.** As illustrated in **Fig**. **6,** the functionalities of pocket A3 **104c** are fully supported by telephones A1 **102a,** A2 **102b** and A3 **102c.** The interface module **106** may be identical to the interface module used in connection with any of the pockets A1-A4 **104a-c** and B1-B4 **104e-h.** The functionalities pocket A3 **104c** shares with pockets A1 **104a** and A2 **104b** maybe executed in the same manner as described above.

[0077] The pocket A3 **104c** is provided with memory **324** sufficient to allow the recordation of voice memos and for the storage of voice commands and directories programmed by the user in the pocket A2 **104c.** In addition, a UART may be provided in the pocket A3 **104c** to synchronize the transfer of voice memos and voice command data between the interface module **106** and the pocket **104.** In general, the voice memo recording function using the pocket A3 **104c** is identical to the function when carried out by pocket **A2 104b.** However, the provision of additional memory **324** in the pocket A3 **104c** allows for voice memos to be stored in the pocket A3 **104c.** According to one embodiment of the present invention, voice memoranda may be stored in the pocket memory **324** as each memorandum is recorded. Alternatively, voice memoranda may be stored initially in the interface module memory **340,** and later transferred to the pocket memory **324** automatically when the system **100** has the resources available to complete such a transfer. As yet another alternative, the user may initiate a transfer of voice memoranda data to the memory **324** in the pocket A3 **104c** by, for example, pressing a button provided on the pocket A3 **104c** or by issuing an appropriate voice command. Control logic provided in the pocket microprocessor **320** and/or the interface module microprocessor **328** may be provided to control whether data already written to the memory **324** is overwritten by new data. For example, the user maybe notified when the memory **324** is full, and given a choice as to whether old data should be overwritten. After the voice memoranda has been transferred to the pocket memory **324,** the pocket A3 **104c,** which is easily disconnected from the interface module **106,** can then be taken to, for example, the user's office. The pocket A3 **104c** may then be interconnected to a device in the office having a microprocessor and associated speaker, similar to the interface module **106,** for playback of stored messages. The UART **402** in the pocket A3 **104c** allows the memo data to be transmitted over a dedicated line for storage in the pocket A3 **104c.**

[0078] The ability to store customized directories and voice commands in the pocket A3 **104c** allows a user to use those customized features in any car equipped with a suitable interface module **106.** Therefore, by moving the telephone 102 and the pocket A3 **104c** different users may share an automobile, while retaining access to their own directories and commands. This feature is also useful where a user rents an automobile provided with an interface module **106,** as all of the user's personalized information can be carried in the pocket A3 **104c**.

[0079] A further level of functionality may be provided by the system **100** in connection with pocket A4 **104d**. As illustrated in **Fig. 6,** the functionalities of pocket A4 **104d** are fully supported by telephone A3 **102c,** but only partially supported by telephone A1 **102a** and telephone A2 **102b**. Pocket A4 **104d** fully supports the functionalities of telephones A1-A3, 102a-c. The additional functionalities provided or enabled by pocket A4 **104d** may include text to speech capability. The text to speech function allows the system **100** to convert information received in the form of written text to audible speech. However, the text to speech function generally requires a telephone **102** capable of receiving textual information. According to the example illustrated in **Fig. 6**, telephone A3 **102c** is the only telephone from manufacturer A having e-mail or Internet browsing capabilities. In the example of **Fig. 6**, telephones **A1 102a** and A2 **102b** lack the capability to receive information in the form of text and therefore cannot fully support the text to speech function. However, it should be noted that some text to speech capability may be possible in connection with telephones A1 **102a** and A2 **102b,** for example where information in the display **114** of the telephone **102a** or **102b**, such as caller

ID information, is provided at the electrical connector **116** of the telephone **102a** or **102b**, in which case the information can be presented to the user as audible speech. In addition, the text to speech function may service other subsystems **378** capable of providing textual output. Generally, the pocket **104d** provides all of the functions described above with respect to pockets A1-A3, **104a-c**.

[0080] The pocket A4 **104d** is provided with commands in the microprocessor **320** to support the receipt of textual information from the telephone **102c**. The information received by the telephone **102c** is formatted into the API of the system **100** by the microprocessor **320** and transmitted to the interface module **106** over the digital data signal line **308** or the pocket-IM communication bus **322.** According to one embodiment of the present invention, the interface module **106** for use in connection with the pocket A4 **104d** includes an additional processor at the custom interface **348,** which may be conveniently mounted on a daughter board **380,** for performing the text to speech function. Generally, the processor at the custom interface **348** transforms the received text into digitized speech, which can then be passed to the interface module microprocessor **328,** and from there to the near-end CODEC **334** for conversion to an analog audio signal. The analog audio signal is then output through the speakers **366.** The use of an additional processor at the custom interface **348,** which can be added to the normal interface module **106,** is desirable in that it allows for the use of a specialized processor for handling the relatively complex text to speech translation function. Additionally, it allows interface modules **106** not intended for use with a text to speech enabled pocket **104** and telephone **102** to be produced at a lower cost. As alternatives, the interface module microprocessor **328** may be sufficiently powerful or robust to perform the text to speech function, or an enhanced interface module **107,** having a text to speech enabled interface module microprocessor **328** may be offered in addition to the normal interface module **106.** As a further alternative, an enhanced microprocessor **320** in the pocket, or an additional microprocessor, may be provided in the pocket A3 **102c** to handle the text to speech function. Apart from enabling additional and/or different functionalities, such as text to speech, the pocket A3 **104c** is generally the same as pocket A1 **104a** and A2 **102b.**

[0081] In connection with the above description of pockets A1-A4 **104a-d** and their functional capabilities, a user may generally choose the capabilities of the system 100 according to the user's needs and desires by choosing the appropriate pocket A1-A4 **104a-d.** Thus, a user owning any of telephones A1-A3 **102a-c** can choose a system **100** having basic hands-free capabilities by purchasing pocket A1 **104a** and interface module **106.** By purchasing pocket A2 **104b** and an interface module **106,** a user may obtain voice command and voice recording capabilities. The use of pocket A3 **104c** in connection with an interface module 106 provides the user with a system **100** that allows voice memos and programmed voice command information to be stored in the easily transported pocket A3 **104c**. Accordingly, it is the pocket A1 **104a,** A2 **104b,** or A3 **104c** that determines what capabilities the system **100** provides when used in connection with either a telephone A1 or A2 **102a** or **102b.** Also, when purchasing a new pocket **104** in order to obtain advanced features or to accommodate a different telephone **102,** the user need not replace the interface module **106.** Furthermore, the same interface module **106** may be used in connection with pockets A1-A3 **104a-c**.

[0082] A system **100** providing text to speech capabilities may be obtained by using an interface module **106** with an additional or an enhanced processor or an enhanced interface module **107,** pocket A4 **104d,** and telephone **A3 102c.** Although the interface module **106** or **107** used in connection with pocket A4 **104d** in this example provides enhanced capabilities, it should be noted that, except for the text to speech function, pocket **A4104d** is fully supported and fully compatible with the general interface module **106.** Similarly, pocket A4 **104d** can be used with telephones A1 or A2 **102a** or **102b.**

[0083] With continued reference to **Fig. 6,** the relationship between telephones B1-B4 **102d-g**, pockets B1-B-4 **104e-h**, and interface module **106** are illustrated. In general, pockets B1-**B4 104e-h** provide the four levels of functionality described above with respect to pockets **A1-A4 104a-d,** but are designed to physically and electrically interconnect with telephones B1-B4 **102d-g** produced by manufacturer **B.** However, the pockets B1-B-*4* **104e-h** are designed to work with the same interface module **106** as pockets **A1-A4 104a-d.**

[0084] As shown in **Fig. 6,** pockets B1 and B2 **104e** and **104f** are fully compatible with telephones B1 and B2 **102d** and **102e,** but only partially compatible with telephones B3 and B4 **102f** and **102g**. Additionally, pockets B3 and B4 **104g** and **104h** fully support the functional capabilities of telephones B3 and B4 **102f** and **102g,** but are only partially compatible with telephones B1 and B2 **102d** and **102e.** This situation may occur, for instance, where telephones B1 and B2 **102d** and **102e** feature an older interface used by manufacturer B, while telephones B3 and B4 **102f** and **102g** use a newer interface. Therefore, even though the telephones B1-B4 **102d-g** may have the same physical characteristics, changes to the interface used to control and send data to and from the telephones **102d-g** will affect their compatibility with the pockets **104e-h**. According to an embodiment of the system **100,** where a user has upgraded their telephone **102,** but wishes to use a pocket having an interface adapted for an earlier model of the telephone **102,** provided that the telephone **102** and pocket **104** are still physically compatible, the pocket **104** can be upgraded by modifying the memory **324** of the pocket **104** to enable the pocket **104** to properly interact with the telephone **102.**

[0085] Modifications to the memory **324** may be made by transmitting the upgrade to the memory **324** through a physical connection to a component of the system **100.** For example, the pocket **104** may be connected to a personal computer that has been used to download a programming upgrade from an Internet website, or to read new programming code distributed on a floppy disk, CD ROM, or other storage medium. Alternatively, the interface module **106** could be connected to a personal computer, and new programming code loaded onto the memory **340** of the interface module **106.** Regardless of whether the pocket **104** or the interface module **106** is used to initially receive the updated programming code, the programming code resident in the pocket memory **324,** the interface module memory **340** or both can be modified using the above-described methods. Where a telephone **102** capable of downloading information from the Internet is available, that telephone **102** may be used to download new programming code to upgrade the pocket **104** and/or the interface module **106.** Another method of upgrading the programming code of the system **100** is for the user to purchase an upgraded pocket **104** that contains new programming code for upgrading the code stored in the interface module memory **340.** Similarly, an interface module **106** containing the necessary code may be used to upgrade the code resident in the pocket memory **324.** As yet another method of upgrading the code resident in the memory **324** or **340,** all or portions of the memory **324** or **340** may be augmented or replaced by memory **324** or **340** having upgraded programming code.

[0086] However, modifying the memory **324** to properly translate between a new telephone interface and the API of the system **100** will not be sufficient where the manufacturer has made changes to the physical configuration of the telephone **102.** Also, changes to the memory **324** alone will not be sufficient where the user has, for instance, purchased a new telephone from a different manufacturer having a different physical configuration. In these instances, compatibility with the system **100** may be regained by purchasing a new pocket **104** that is compatible with the user's new telephone **102.** The purchase cost of a pocket **104** is preferably much less than the purchase cost of both a pocket **104** and an interface module **106,** as the interface module **106** originally purchased by the user may be used with the new pocket **104.**

[0087] The multiple-processor multiple-bus configuration of the system **100** allows the system **100** to be designed using modular units. In particular, the system **100** provides a pocket **104** for at least every combination of physical and electrical characteristics found in supported telephones **102.** The system **100** allows the use of a common interface module **106** by converting the unique physical and electrical characteristics of supported telephones **102** to a common electrical and physical interface at the pocket **104.** Therefore, common system components can be placed within the interface module **106,** while particular attributes required by particular telephones **102** can be accommodated by the pocket **104.** In this way, the cost of the system **100** can be reduced and the flexibility increased.

[0088] The application programming interface (API) of the system **100** is the common language used to communicate commands and information between the pocket **104** and the interface module **106.** Translation between the interface of the telephone **102** and the API of the system **100** is performed in the pocket **104,** and in particular in the microprocessor **320.** After translation in the microprocessor **320,** commands and information originating at the telephone **102** can be transmitted using the API to the interface module **106** over the pocket-IM communication bus **322.** Commands and data originating at the interface module **106** and at the system **100** follow the reverse course, with commands and data formatted in the API of the system **100** being translated into the telephone's **102** unique interface at the microprocessor **320** of the pocket **104.**

[0089] Where the system **100** is to be interconnected with subsystems 3 78 in addition to the telephone **102,** an additional processor or custom interface **348** may be provided to perform translation between the API of the system **100** and the interface of the subsystem **378** to which the system **100** is interconnected. Preferably, the custom interface ***348*** may be provided in the form of an add-on or daughter board **380** that can be interconnected to the interface module microprocessor **328** using provided electrical contacts. Thus, connectivity to various other subsystems **378** may be achieved without requiring changes to the interface module's **106** main components or to the pocket **104** presently in use. Alternatively, the subsystem **378** can communicate using the API of the system **100,** without requiring any translation. For example, the interface required to communicate with an external subsystem **378** may be resident in the interface module **106.** The custom interface **348** and daughter board **380** may simply provide a mechanical connection, or may not be provided at all where the external subsystem **378** interface is resident in the interface module **106.**

[0090] As mentioned above, the external subsystem **378** may comprise a variety of electronic devices. The subsystem **378** may include protocol based units and close-ended devices. The protocol based units can include networks and busses having associated components or peripheral devices that are interconnected. The close-ended devices are referred to herein as devices that do not have International Standards Organization (ISO) network layering and typically constitute a terminating communication node in the context of data flow ending or originating from such device, and not typically acting as a link or pass-through device for information or data transfers. An example of such a close-ended device might be a global positioning system (GPS) that is useful in providing vehicle location information, or a hardware device, such as a vehicle sensor, from which data can be obtained for a particular vehicle component to which the sensor is operably connected.

[0091] In addition to the GPS, the external subsystem **378** may include an Internet Protocol (IP) stack comprised of a number of network layers that are commonly involved in transfers using the Internet. The external subsystem **378** can also include an intelligent transportation system data bus (IDB) and/or an on-board diagnostics (OBD) system that are involved with monitoring and providing information related to vehicle components.

[0092] The external subsystem **378** may also include a controller area network (CAN) found in at least some vehicles and which includes a bus along which a number of vehicle elements communicate for supplying information concerning such elements. The CAN is operatively connected to each of a plurality of vehicle devices that transmit, receive, or both transmit and receive desired data. For example, the vehicle devices include transducers or other physical devices that detect and provide information useful to applications software for processing to obtain information that is then transmitted for storing in memory for later transmission, or even for immediate transmission without processing, upon receipt of the proper request or command. Other available networks could be utilized, instead of CAN, such as Arcnet, which has a protocol similar to CAN. Where the external subsystem **378** includes one of a plurality of vehicle busses, the hardware supplied for interconnecting the external subsystem to the interface module **106,** such as the daughter board **380,** may include provisions for signaling to the interface module microprocessor **328** the format of the output required by the particular external subsystem **378.** For example, the daughter board **380** may comprise cabling, and the presence or absence of a resistor between two signal paths may be used to indicate to the microprocessor **328** the proper voltage at which signals are to be transferred to and from the external subsystem **378.** For further information regarding obtaining information or data from vehicle devices, see U.S. Patent No. 5,732,074, filed on January 16,1996 and assigned to the assignee of the present invention. The external subsystem 378 may also comprise an analog/digital converter (ADC), a standard serial bus, a universal serial bus (USB), an RS232 connection, a user datagram packet/ Internet protocol stack, as well as one or more other custom proprietary devices.

[0093] Other devices that may comprise the external subsystem **378** may include a PCMCIA (Personal Computer Memory Card Interface Association) unit, which may include a storage device for storing desired information or data. The external subsystem **378** may also include a device capable of communication using the Bluetooth protocol, which provides a standard protocol for the wireless communication of information between disparate devices.

[0094] With reference now to **Fig. 7,** the pocket communications state machine is illustrated. Generally, in the system **100,** the pocket **104** and the interface module **106** are in a master and slave relationship. As shown in **Fig. 7,** at state **702,** the pocket **104,** and in particular the microprocessor **320,** awaits a message from the telephone **102.** Upon receiving a telephone message, the pocket **104** enters state **704** in which the telephone request is handled. After handling the telephone request, the pocket **104** then enters state **706** in which the telephone request is sent to the interface module **106.** Next, the pocket **104** awaits a message from the interface module **106** in state **708.** If no message is received from the interface module **106,** the pocket **104** then returns to state **702.** A system **100** also includes the timer that operates in cooperation with determining whether or not a message is received. During normal operation, when no response is received from the interface module **106,** another pulse or heartbeat is sent at predetermined times. However, if there is no response within a time interval associated with the timer timing out, a hardware reset line is enabled to reset the interface module **106.** Where an interface module **106** message is received, the pocket handles the message in state **710,** following which it returns to state **702.** Where no telephone message is received, the pocket **104** periodically polls the interface module **106** at state **712.** According to an embodiment of the present invention, the pocket **104** polls the interface module **106** every 72 milliseconds (i.e., the pocket **104** heartbeat rate is 72 milliseconds). After polling the interface module **106** in state **712,** the pocket **104** enters state **708** in which it awaits a message from the interface module **106.** If no message from the interface module **106** is received within 10 milliseconds of polling the interface module **106,** the pocket **104** returns to state **702,** in which it awaits a telephone **102** message. According to one embodiment of the present invention, communications between the pocket **104** and the interface module **106** occur at 19,200 baud, using eight data bits, one parity bit, and no stop bit. However, other communication rates can be used, and may even be varied.

[0095] Referring now to **Fig. 8,** the architecture of the interface module **106** software showing the relationships among the various software objects, is illustrated. In general, the top level loop is the digital signal processor object **802.** Thus, the power supply control **804,** audio control **806,** flash file system **808,** user interface **810,** voice memo recording **812,** voice recognition **814,** and pocket communications **816** objects can all be entered from the main loop **802** directly. Other software objects or modules are addressed in response to interrupts. Accordingly, communications between the pocket **104** and the interface module **106** generate an interrupt causing the software to enter the UART object **818.** Activity concerning the near-end CODEC **334** is handled at object **820** across the interrupt boundary from the voice memo recording **812** and voice recognition **814** objects. Sound processing **822** and far-end CODEC **824** objects are associated with the near-end CODEC **820** object.

[0096] The progression of a typical communication scenario is illustrated in **Fig. 9.** In Fig. 9, message A is shown originating in the telephone **102** from which it is transmitted through the pocket **104** to the interface module **106.** Response A originates in the interface module **106,** is transmitted through the pocket **104** and arrives at the telephone **102** as response a. A second message, message b, originates at the telephone **102,** is passed through the pocket **104,** and arrives at the interface module **106** as message B. Response B originates from the interface module **106,** passes through the pocket **104** and arrives at the telephone **102** as response b. Next, message c, which originated in the interface module **106** is shown queued and awaiting attention. At the line labeled "synch 2" message c is released to the pocket **104,** the pocket **104** generates response C, and response C is sent to the interface module **106.**

[0097] With reference now to **Fig.10,** a pocket **104** worst case scenario is illustrated. In **Fig. 10,** message A, is shown queued in the interface module **106.** Message A is released after synch 2 to the pocket **104.** At the time Message A is released, Message b is received from the telephone **102.** In response to this situation, the pocket can immediately pass Message A to the telephone and return Response A to the interface module, while delaying handling of Message B from the telephone, or the pocket can communication Message B to the interface module as Message B while delaying the handling of Message A.

[0098] With reference now to **Fig. 11,** an interface module **106** worst case scenario is illustrated. In **Fig. 11,** Message C is shown queued in the interface module **106.** Shortly after Message C is queued, Message a is received at the telephone **102** and is communicated through the pocket **104** and to the interface module **106** as Message A. Then while Message C continues to be queued, Response A is communicated to the telephone **102** as Response a. Message B is then received at the telephone **102** and is communicated to the interface module **106** through the pocket **104** as Message B. The interface module **106** then sends Response B through the pocket **104** into the telephone **102** as Response b. Following the receipt of Response b at the telephone **102,** a synchronization signal, labeled Synch 2, is sent from the pocket **104** to the interface module **106,** causing the release of the queued message. Message C is then delivered to the pocket **104,** and Response C delivered from the pocket **104** to the interface module. Therefore, in this worst case scenario, Message C could not be handled until Messages A and B had been dealt with, and the synchronization signal received.

[0099] According to one embodiment of the system **100** of the present invention, the interface module **106** is provided with programming instructions necessary for communicating with the telephone **102.** According to this embodiment, the pocket **104** need not be provided with a microprocessor **320** or memory **324.** Instead, the pocket **104** may simply provide a physical interconnection to the telephone **102,** and for the transfer of signals from the telephone **102** directly to the interface module **106.** Where the interface module **106** is not intended to interconnect to telephones **102** having a variety of physical characteristics, the pocket **104** need not be a component that is separate and distinct from the interface module **106.** According to one embodiment, the interface module **106** may be provided with programming code enabling it to interface with a variety of telephones **102.** Thus, the pocket **104** may provide a signal to the interface module **106,** for example, by providing differing voltage levels at input pins associated with the interface module **106** microprocessor **328** to indicate the type and capabilities of the telephone **102.** The interface module **106** may use this information to select the appropriate command set for communicating with the telephone **102.** The interface module **106** may be upgraded to provide advanced capabilities, or to communicate with additional telephones **102** through upgrades to the programming code generally stored in the interface module memory **340.** The upgrades may be provided to the interface module **106** by interconnecting the interface module **106** to a personal computer that has read or downloaded the code upgrade, or by downloading the upgrade through an Internet-enabled telephone **102** directly to the interface module **106.**

[0100] The text to speech functionality described above with respect to certain embodiments of the present invention may be augmented by the ability to visually display textual information. Accordingly, textual information may be displayed, for example, on a screen associated with an external subsystem **378.** Thus, textual information may be displayed on the screen of a personal digital assistant (PDA), a personal computer, or a display screen provided by the automobile **302.** The system **100,** upon receipt of textual information, may in a default mode provide a visual output of text where a visual display is interconnected to the system, and an audible output. The user may also select whether textual information is to be provided audibly or visually. For example, a user may command the system **100** to "read e-mail." Alternatively, the user may command the system **100** to "display e-mail."

[0101] The system **100,** particularly in connection with an automobile **302,** may provide a variety of useful, automated functions. For example, the interface module **106** may be provided with a custom interface **348** that includes a telematics module to monitor activity occurring on an external subsystem **378.** For instance, where a first external subsystem **378** is a vehicle bus, a message indicating a low fuel status transmitted over the bus may be decoded by the custom interface **348.** The custom interface **348** may then cause a query to be transmitted over the wireless link provided by the telephone **102** to a central station interconnected to the Internet. The query, which may be transmitted from the telephone **102** according to the Internet protocol, may request the location and prices of fuel available in the area. The response to the query may be provided to the user of the system **100** through a visual display provided as, for example, a second external subsystem **378,** or may be provided audibly to the user through the text to speech capabilities of the system **100.** According to one embodiment, the query includes information concerning the location of the automobile **302.** Such information maybe provided automatically, for example, from a GPS receiver interconnected to the system **100** as a third external subsystem **378.**

Alternatively, location information may be provided by a telephone **102** capable of receiving GPS data.

[0102] In accordance with the present invention, a method and apparatus for hands-free wireless communications are provided. The invention in its broader aspects relates to an economical method and apparatus for providing various levels of hands-free functionality in combination with wireless communications devices. In particular, the present invention provides a method and apparatus allowing for a wide variety of telephones and pockets to be used with a common interface module.

[0103] The foregoing discussion of the invention has been presented for purposes of illustration and description. Further, the description is not intended to limit the invention to the form disclosed herein. Consequently, variations and modifications commensurate with the above teachings, within the skill and knowledge of the relevant art.

Claims

1. A system (100) for communicating, comprising:

a communication device (102) for wirelessly receiving and sending information;
a holding member (104) that releaseably supports said communication device (102), said holding member (104) being physically and electrically configured for use with said communication device (102), said holding member (104) including an electrical connector (124); and
an interface module (106) including a first processor (328) and interface module memory (340), said first processor (328) for sending commands and for performing signal processing functions, said interface module (106) being additionally capable of receiving signals passed directly from said holding member (104) to the said first processor (328) and capable of operating with another communication device and another holding member;

characterised by a second processor (320) housed by said holding member (104), said second processor (320) being configured to receive communication device control signals from said communication device (102) and translate said control signals for output to said first processor (328), said translated control signals being compatible with said interface module (106), with at least a first communications link between said first processor and said second processor for transmission of said translated control signals and said commands; and
in that said first processor (328) is for sending commands to said second processor (320).

2. A system (100), as claimed in Claim 1, wherein:

said communication device (102) control signals include signals related to availability of said communication device for information transfers.

3. A system (100), as claimed in Claim 1, wherein:

said communication device (102) includes a microphone (110) for receiving voice information, said interface module (106) including a voice recognition module that converts said voice information to digital information.

4. A system (100), as claimed in Claim 1, wherein:

at least a first speaker is provided for outputting audio information and in which said interface module (106) includes a text-to-speech module that converts digital information to said audio information.

5. A system (100), as claimed in Claim 1, further including:

a vehicle bus operatively associated with said interface module (106), said vehicle bus in communication with a number of peripheral devices in the vehicle for transferring information relative to each of said peripheral devices.

6. A system (100), as claimed in Claim 1, further including:

a holding member memory housed by said holding member (104) that is in communication with said second processor (320), said holding member memory storing information related to an input received from said interface module.

7. A system (100), as claimed in Claim 1, wherein:

said signal processing functions include substantially removing noise, acoustic echoes and line echoes from audio signals.

8. A system (100), as claimed in Claim 1, wherein:

said first processor (328) processes data, controls storage of information, and interfaces the system to at least one vehicle device.

9. A system (100) for communicating and being able to use a first communication
device and a second communication device having at least physical characteristics different from the first communication device, comprising:

a first holding assembly (104) that can be physically and electrically connected to the first communication device and including a first holding assembly processor (320);
a second holding assembly (104b) that can be physically and electrically connected to the second communication device and including a second holding assembly processor;
an interface module (106) that can communicate with each of the first and second communication devices and including at least an interface module processor (328) and an interface module memory;

wherein when said first holding assembly (104) is connected to the first communication device, said first holding assembly processor (320) translates control signals from the first communication device to be compatible with said interface module (106), and when said second holding assembly (104b) is connected to the second communication device, said second holding assembly processor translates control signals from the second communication device to be compatible with said interface module (106), and said interface module processor for performing a number of signal processing functions.

10. A system (100), as claimed in Claim 9, wherein:

said number of signal processing functions of said interface module processor (328) includes receiving digital information and converting said digital information to audio information that is output by a speaker.

11. A system (100), as claimed in Claim 9, wherein:

said number of signal processing functions include substantially canceling acoustic echoes, line echoes and noise from said audio information.

12. A system (100), as claimed in Claim 9, wherein:

said control signals include a plurality of the following: turning the first communication device on or off; indicating that data is to be sent from the first communication device, indicating that the first communication device is ready to receive data; requesting power or a change in power; locking and unlocking the first communication device; muting the first communication device; indicating an incoming transmission; providing auto answer for the first communication device; requesting transmission timer information, controlling volume of the first communication device; recalling or writing information from memory of the first communication device; simulating activation of the first communication device; and dialing a number.

13. A system (100), as claimed in Claim 9, wherein:

said interface module (106) is configured to operate with voice inputs and said second holding assembly supports at least one more function than said first holding assembly including one of: supporting said voice inputs, recording of voice, access of voice recording by said interface module, storage of voice information and text-to-speech capability.

Patentansprüche

1. System (100) zur Kommunikation, umfassend:

Eine Kommunikationsvorrichtung (102) zum drahtlosen Empfangen und Senden von Information;
ein Halteteil (104), das lösbar die Kommunikationsvorrichtung (102) hält, wobei das Halteteil (104) körperlich und elektrisch ausgestaltet ist für die Verwendung mit der Kommunikationsvorrichtung (102), wobei das Halteteil (104) einen elektrischen Verbinder (124) aufweist; und
ein Interfacemodul (106), das einen ersten Prozessor (328) und einen Interfacemodulspeicher (340) aufweist, wobei der erste Prozessor (328) dem Senden von Befehlen und dem Durchführen von Signalverarbeitungsfunktionen dient, wobei das Interfacemodul (106) zudem fähig ist, Signale zu empfangen, die direkt von dem Halteteil (104) zu dem ersten Prozessor (328) weitergegeben wurden und fähig ist, um mit einer anderen Kommunikationsvorrichtung und einem anderen Halteteil zu arbeiten;
gekennzeichnet durch einen zweiten Prozessor (320), der von dem Halteteil (104) aufgenommen ist, wobei der zweite Prozessor (320) konfiguriert ist, um Kommunikationsvorrichtungs-Steuersignale von der Kommunikationsvorrichtung (102) zu empfangen und die Steuersignale umzusetzen zwecks Abgabe an den ersten Prozessor (328), wobei die umgesetzten Steuersignale kompatibel sind mit dem Interfacemodul (106), und mit wenigstens einer ersten Kommunikationsverbindung zwischen dem ersten Prozessor und dem zweiten Prozessor zur Übertragung der umgesetzten Steuersignale und der Befehle; und
durch Ausgestaltung des ersten Prozessors (328) zum Senden von Befehlen an den zweiten Prozessor (320).

2. System (100) nach Anspruch 1, bei welchem:

Die Steuersignale der Kommunikationsvorrichtung (102) Signale aufweisen, welche die verfügbarkeit der Kommunikationsvorrichtung für Informationaübertragungen betreffen.

3. System (100) nach Anspruch 1, bei welchem:

Die Kommunikationsvorrichtung (102) ein Mikrofon (110) zum Empfang von Sprachinformation aufweist,
das Interfacemodul (106) ein Spracherkennungsmodul aufweist, das die Sprachinformation in digitale Information umwandelt.

4. System (100) nach Anspruch 1, bei welchem:

Wenigstens ein erster Lautsprecher vorgesehen ist zur Abgabe von Audioinformation und bei dem das Interfacemodul (106) ein Text-zu-Sprache-Modul aufweist, das digitale Information in die Audioinformation umwandelt.

5. System (100) nach Anspruch 1, des weiteren aufweisend:

Einen Fahrzeugbus, der betriebsmäßig in Verbindung steht mit dem Interfacemodul (106), wobei der Fahrzeugbus mit mehreren Peripheriegeräten in dem Fahrzeug kommuniziert, um Information bezüglich jedes Peripheriegerätes zu übertragen.

6. System (100) nach Anspruch 1, des weiteren aufweisend:

Einen Halteteilspeicher, der von dem Haltetteil (104) aufgenommen ist, das mit dem zweiten Prozessor (320) in Verbindung steht, wobei der Halteteilspeicher Information in Bezug auf ein von dem Interfacemodul empfangenes Eingangssignal speichert.

7. System (100) nach Anspruch 1, bei welchem:

Die Signalverarbeitungsfunktionen im wesentlichen das Entfernen von Rauschen, Nachhall und Leitungsechos aus Audiosignalen beinhalten.

8. System (100) nach Anspruch 1, bei welchem:

Der erste Prozessor (328) Daten verarbeitet, das Speichern von Information steuert und das System mit wenigstens einem Fahrzeug koppelt.

9. System (100) zur Kommunikation und das fähig ist, eine erste Kommunikationsvorrichtung zu verwenden und eine zweite Kommunikationsvorrichtung, die zumindest physikalische Eigenschaften hat, die unterschiedlich zu denen der ersten Kommunikationsvorrichtung sind, umfassend:

Eine erste Halteanordnung (104), die körperlich und elektrisch mit der ersten Kommunikationsvorrichtung verbindbar ist und einen ersten Halteanordnungsprozessor (320) aufweist;
eine zweite Halteanordnung (104b), die körperlich und elektrisch mit der zweiten Kommunikationsvorrichtung verbindbar ist und einen zweiten Halteanordnungsprozessor aufweist;
ein Interfacemodul (106), das mit der ersten und der zweiten Kommunikationsvorrichtung kommunizieren kann und wenigstens einen Interfacemodulprozessor (328) und einen Interfacemodulspeicher aufweist;

wobei, wenn die erste Halteanordnung (104) mit der ersten Kommunikationsvorrichtung verbunden ist, der erste Halteanordnungsprozessor (320) Steuersignale von der ersten Kommunikationsvorrichtung umsetzt, so daß sie kompatibel zu dem Interfacemodul (106) sind und wenn die zweite Halteanordnung (104b) mit der zweiten Kommunikationsvorrichtung verbunden ist, der zweite Halteanordnungsprozessor Steuersignale von der zweiten Kommunikationsvorrichtung umsetzt, damit sie kompatibel sind mit dem Interfacemodul (106), und der Interfacemodulprozessor der Durchführung mehrerer Signalverarbeitungsfunktionen dient.

10. System (100) nach Anspruch 9, bei welchem:

Die mehreren Signal verarbeitungsfunktionen des Interfacemodulprozessors (328) das Empfangen digitaler Information und Umwandeln der digitalen Information in Audioinformation beinhalten, die über einen Lautsprecher ausgegeben wird.

11. System (100) nach Anspruch 9, bei welchem:

Die mehreren Signalverarbeitungsfunktionen im wesentlichen das Löschen von Nachhall, Leitungsechos und Rauschen aus der Audioinformation beinhalten.

12. System (100) nach Anspruch 9, bei welchem:

Die Steuersignale mehreres des Folgenden beinhalten:
Anschalten oder Ausschalten der ersten Kommunikationsvorrichtung; Anzeigen, daß Daten von der ersten Kommunikationsvorrichtung ausgesandt werden sollen, Anzeigen, daß die erste Kommunikationsvorrichtung bereit zum

Empfang von Daten ist; Anfordern von Leistung oder Änderung der Leistung; Sperren und Freigeben der ersten Kommunikationsvorrichtung; Unterdrücken der ersten Kommunikationsvorrichtung; Anzeigen einer eintreffenden Übertragung; Liefern einer automatischen Antwort für die erste Kommunikationsvorrichtung; Anfordern einer Übertragungszeittaktinformation, Steuern der Lautstärke der ersten Kommunikationsvorrichtung; Abrufen oder Schreiben von Information aus dem bzw. in den Speicher der ersten Kommunikationsvorrichtung; Simulieren einer Aktivierung der ersten Kommunikationsvorrichtung; und Wählen einer Nummer.

13. System (100) nach Anspruch 9, bei welchem:

Das Interfacemodul (106) derart konfiguriert ist, daß es mit Spracheingaben arbeitet und die zweite Halteanordnung wenigstens eine Funktion mehr als die erste Halteanordnung unterstützt, einschließend eine aus: der Unterstützung der Spracheingaben, der Aufzeichnung der Sprache, dem Zugriff auf Sprachaufzeichnung durch das Interfacemodul, dem Speichern der Sprachinformation und der Text-zu-Sprache-Möglichkeit.

Revendications

1. Système (100) pour communiquer, comprenant :

un dispositif de communication (102) pour recevoir et envoyer des informations sans fil ;
un membre de maintien (104) qui supporte de manière libérable ledit dispositif de communication (102), ledit membre de maintien (104) étant configuré de manière physique et électrique pour une utilisation avec ledit dispositif de communication (102), ledit membre de maintien (104) comprenant un connecteur électrique (124) ; et
un module d'interface (106) comprenant un premier processeur (328) et une mémoire de module d'interface (340), ledit premier processeur (328) servant à envoyer des commandes et à effectuer des fonctions de traitement de signal, ledit module d'interface (106) étant en outre capable de recevoir des signaux passés directement dudit membre de maintien (104) au dit premier processeur (328) et capable de fonctionner avec un autre dispositif de communication et un autre membre de maintien ;

caractérisé par un deuxième processeur (320) hébergé par ledit membre de maintien (104) ledit deuxième processeur (320) étant configuré pour recevoir des signaux de commande de dispositif de communication dudit dispositif de communication (102) et convertir lesdits signaux de commande pour la sortie vers ledit premier processeur (328), lesdits signaux de commande convertis étant compatibles avec ledit module d'interface (106), avec au moins une première liaison de communication entre ledit premier processeur et ledit deuxième processeur pour la transmission desdits signaux de commande convertis et desdites commandes ; et
en ce que ledit premier processeur (328) sert à envoyer des commandes vers ledit deuxième processeur (320).

2. Système (100) selon la revendication 1, dans lequel :

lesdits signaux de commande du dispositif de communication (102) comprennent des signaux liés à la disponibilité dudit dispositif de communication pour les transferts d'informations.

3. Système (100) selon la revendication 1, dans lequel :

ledit dispositif de communication (102) comprend un microphone (110) pour recevoir des informations vocales,
ledit module d'interface (106) comprenant un module de reconnaissance vocale qui convertit lesdites informations vocales en informations numériques.

4. Système (100) selon la revendication 1, dans lequel :

au moins un premier haut-parleur est fourni pour délivrer des informations audio et dans lequel ledit module d'interface (106) comprend un module de conversion de texte en discours qui convertit les informations numériques en lesdites informations audio.

5. Système (100) selon la revendication 1, comprenant en outre :

un bus de véhicule associé de manière opérationnelle au dit module d'interface (106), ledit bus de véhicule étant en communication avec un certain nombre de dispositifs périphériques dans le véhicule pour transférer des informations relatives à chacun desdits dispositifs périphériques.

6. Système (100) selon la revendication 1, comprenant en outre :

une mémoire de membre de maintien hébergée par ledit membre de maintien (104) qui est en communication avec ledit deuxième processeur (320), ladite mémoire de membre de maintien stockant des informations associées à une entrée reçue dudit module d'interface.

7. Système (100) selon la revendication 1, dans lequel :

lesdites fonctions de traitement de signal comprennent la suppression substantielle du bruit, des échos acoustiques et des échos de ligne des signaux audio.

8. Système (100) selon la revendication 1, dans lequel :

ledit premier processeur (328) traite des données, commande le stockage d'informations et assure l'interface du système avec au moins un dispositif de véhicule.

9. Système (100) pour communiquer et être capable d'utiliser un premier dispositif de communication et un deuxième dispositif de communication ayant au moins des caractéristiques physiques différentes du premier dispositif de communication, comprenant :

un premier ensemble de maintien (104) qui peut être connecté de manière physique et électrique au premier dispositif de communication et comprenant un premier processeur d'ensemble de maintien (320) ;
un deuxième ensemble de maintien (104b) qui peut être connecté de manière physique et électrique au deuxième dispositif de communication et comprenant un deuxième processeur d'ensemble de maintien ;
un module d'interface (106) qui peut communiquer avec chacun du premier dispositif de communication et du deuxième dispositif de communication et comprenant au moins un processeur de module d'interface (328) et une mémoire de module d'interface ;

dans lequel lorsque ledit premier ensemble de maintien (104) est connecté au premier dispositif de communication, ledit premier processeur d'ensemble de maintien (320) convertit les signaux de commande du premier dispositif de communication pour qu'ils soient compatibles avec ledit module d'interface (106) et lorsque ledit deuxième ensemble de maintien (104b) est connecté au deuxième dispositif de communication, ledit deuxième processeur d'ensemble de maintien convertit les signaux de commande du deuxième dispositif de communication pour qu'ils soient compatibles avec ledit module d'interface (106) et ledit processeur de module d'interface pour effectuer un certain nombre de fonctions de traitement de signal.

10. Système (100) selon la revendication 9, dans lequel :

ledit nombre de fonctions de traitement de signal dudit processeur de module d'interface (328) comprend la réception d'informations numériques et la conversion desdites informations numériques en informations audio qui sont délivrées par un haut-parleur.

11. Système (100) selon la revendication 9, dans lequel :

ledit nombre de fonctions de traitement de signal comprend l'annulation substantielle des échos acoustiques, des échos de ligne et du bruit desdites informations audio.

12. Système (100) selon la revendication 9, dans lequel :

lesdits signaux de commande comprennent une pluralité de ce qui suit : la mise en marche ou l'arrêt du premier dispositif de communication ; l'indication que les données doivent être envoyées du premier dispositif de communication, en indiquant que le premier dispositif de communication est prêt à recevoir les données ; la demande d'une puissance ou d'un changement de puissance ; le verrouillage et le déverrouillage du premier dispositif de communication ; la mise en sourdine du premier dispositif de communication ; l'indication d'une transmission entrante ; la fourniture d'une réponse automatique pour le premier dispositif de communication ; la demande d'informations de temporisation de transmission ; la commande du volume du premier dispositif de communication ; le rappel ou l'écriture d'informations à partir de la mémoire du premier dispositif de communication ; la simulation de l'activation du premier dispositif de communication ; et la composition d'un numéro.

13. Système (100) selon la revendication 9, dans lequel :

ledit module d'interface (106) est configuré pour fonctionner avec des entrées vocales et ledit deuxième ensemble de maintien supporte au moins une fonction de plus que ledit premier ensemble de maintien y compris l'une de ce qui suit : le support desdites entrées vocales, l'enregistrement de voix, l'accès à l'enregistrement vocal par ledit module d'interface, le stockage d'informations vocales et la capacité de conversion de texte en discours.

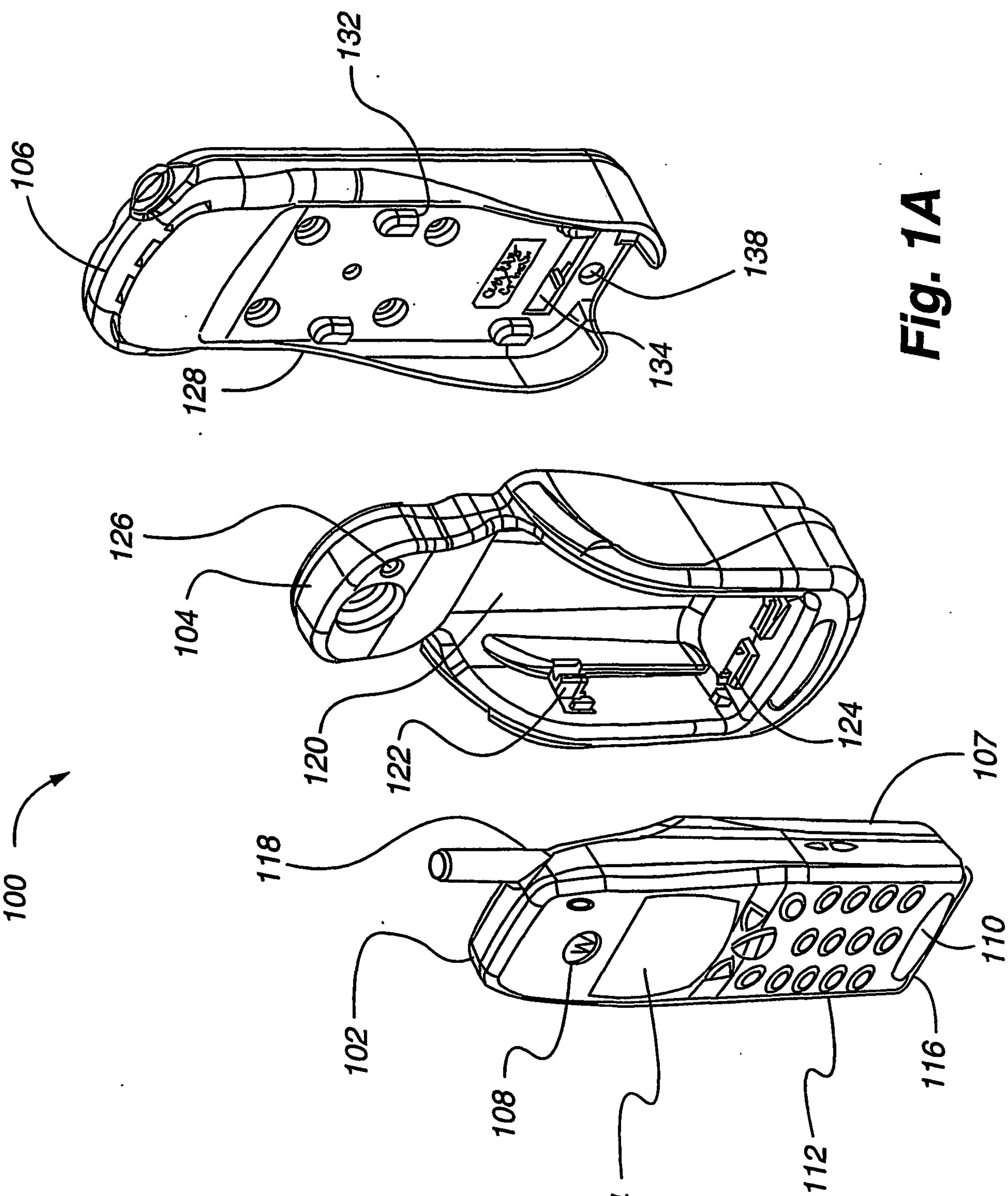

100
102
104
106
107
108
110
112
114
116
118
120
122
124
126
128
132
134
138

Fig. 1A

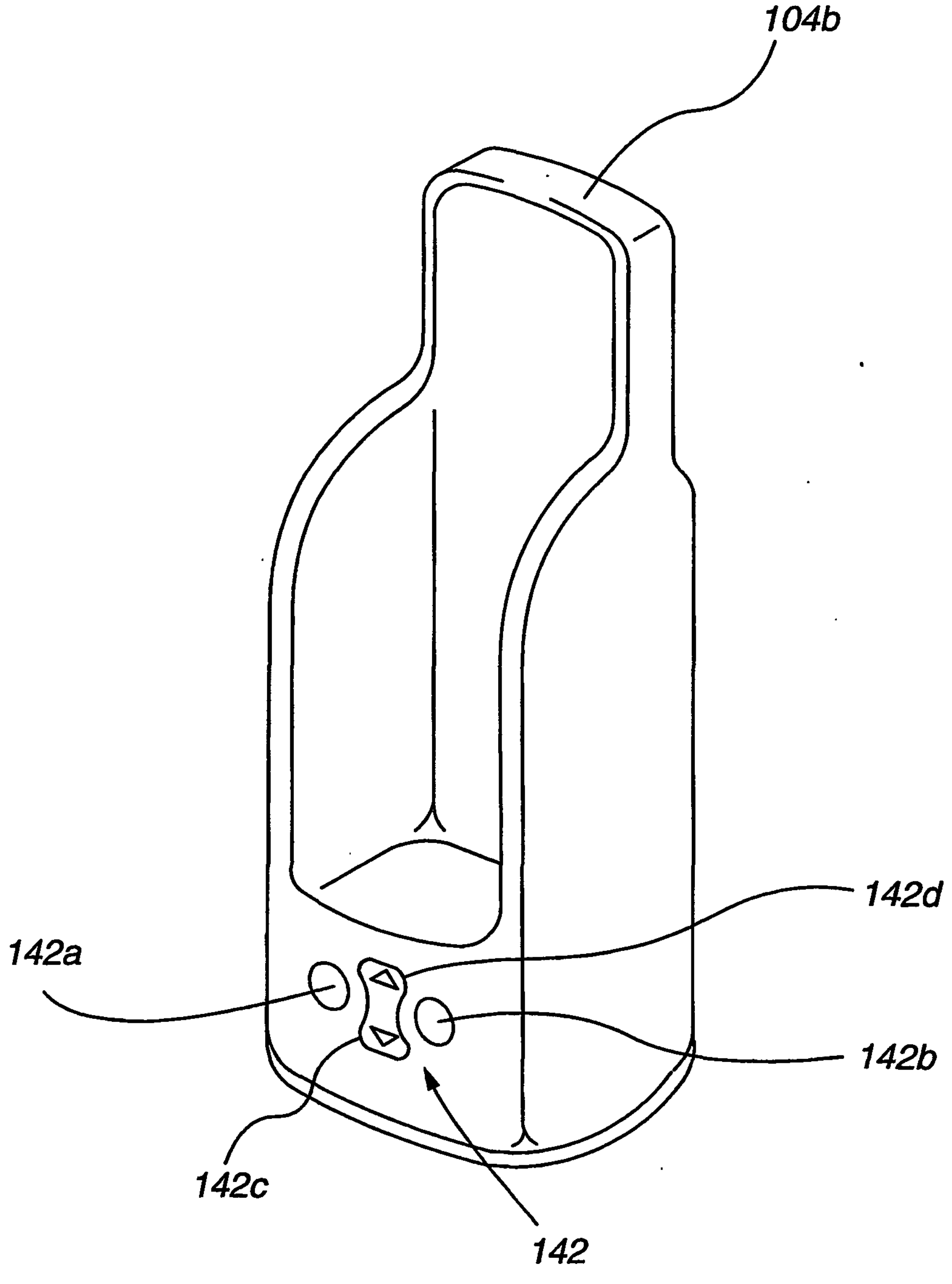


Fig. 1B

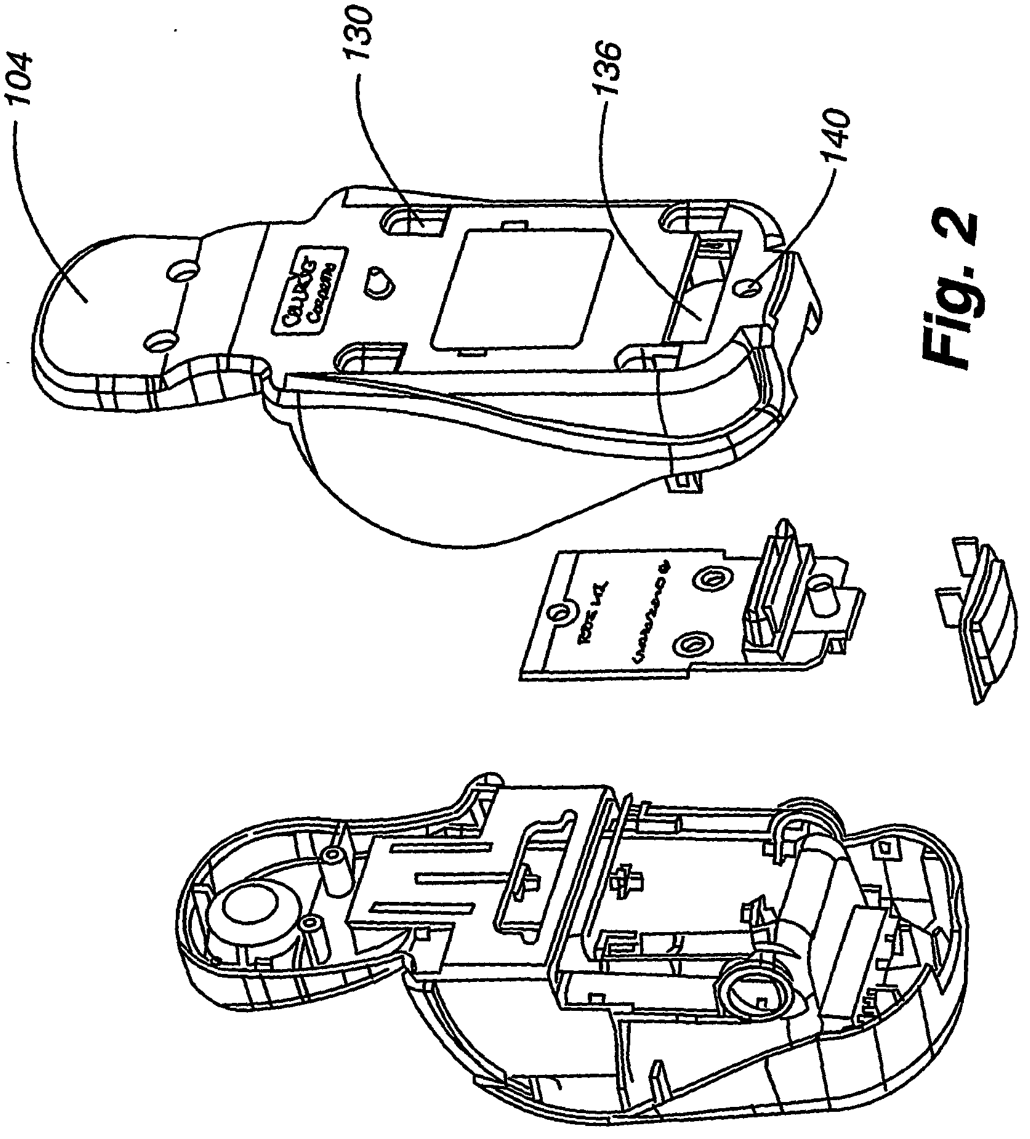


Fig. 2

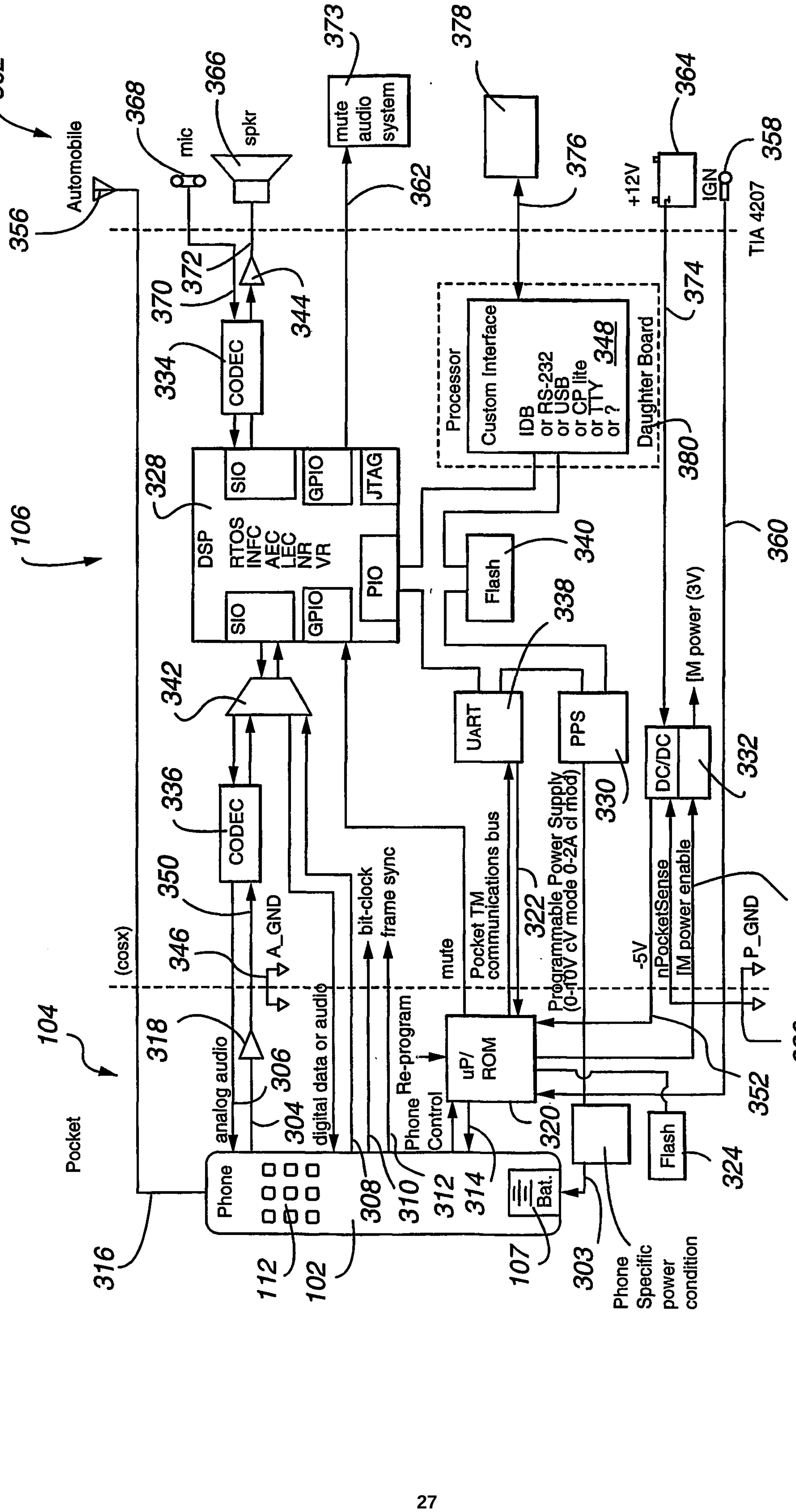

302
Automobile
356
368
mic
366
spkr
373
mute audio system
378
362
376
364
+12V
IGN
358
TIA 4207
370
372
344
334
CODEC
Processor
Custom Interface
IDB
or RS-232
or USB
or CP lite
or TTY
or ?
348
Daughter Board
374
380
106
328
DSP
RTOS
INFC
AEC
LEC
NR
VR
SIO
GPIO
JTAG
PIO
Flash
340
360
338
UART
PPS
330
DC/DC
332
[M power (3V)
342
336
CODEC
350
A_GND
346
(cosx)
bit-clock
frame sync
mute
Pocket TM communications bus
322
Programmable Power Supply (0-10V cV mode 0-2A cl mod)
-5V
nPocketSense
IM power enable
354
P_GND
326
352
104
318
analog audio
306
304
digital data or audio
Re-program
Phone Control
uP/ROM
320
Flash
324
Pocket
Phone
Bat.
308
310
312
314
316
112
102
107
303
Phone Specific power condition

Fig. 3

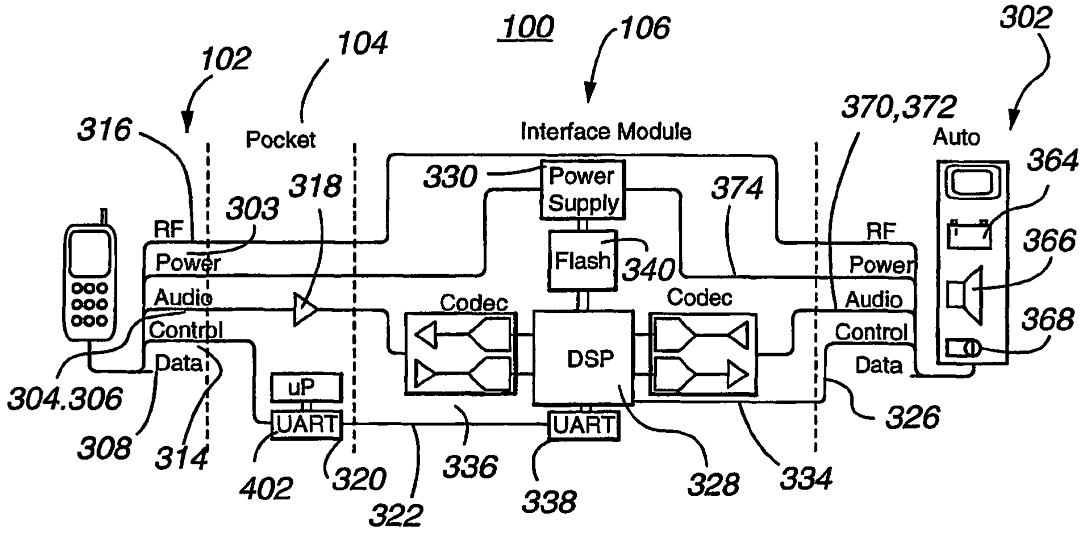

100
102
104
106
302
Pocket
Interface Module
Auto
316
303
318
330
Power Supply
374
370,372
364
366
368
RF
Power
Audio
Control
Data
Flash
340
Codec
DSP
uP
UART
304.306
308
314
402
320
322
336
338
328
334
326

Fig. 4A

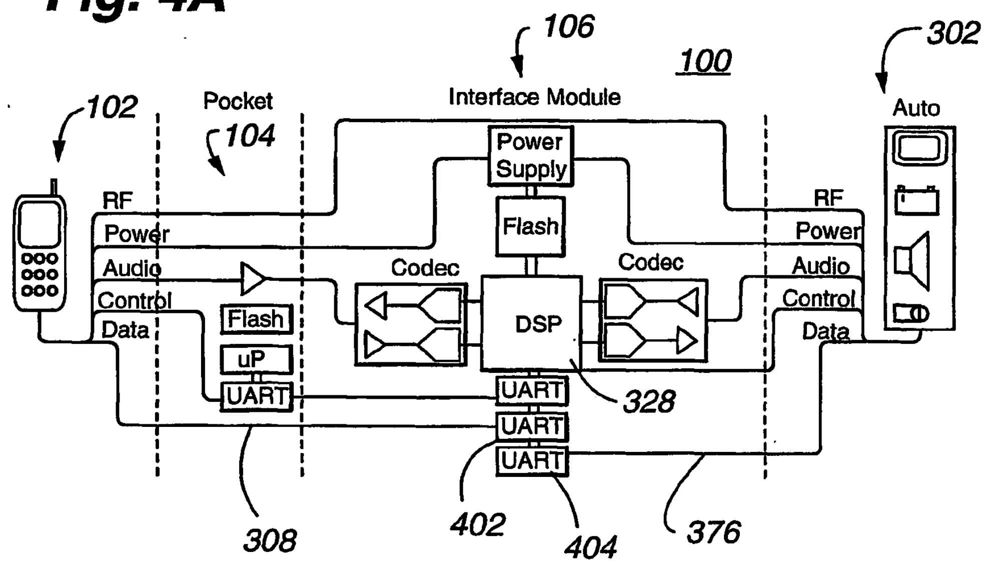

106
100
302
102
Pocket
104
Interface Module
Auto
Power Supply
Flash
RF
Power
Audio
Control
Data
Codec
DSP
uP
UART
328
308
402
404
376

Fig. 4B

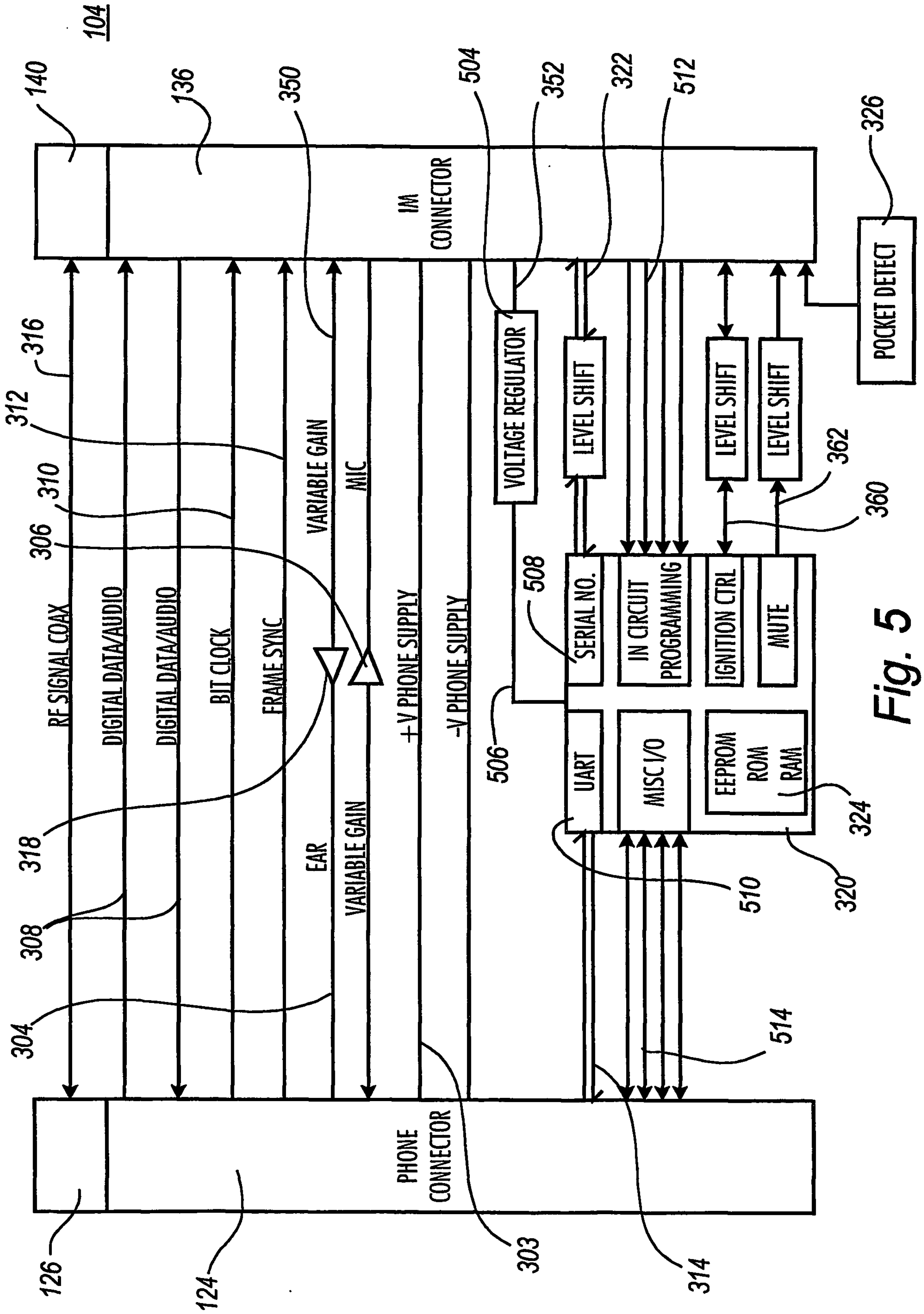

104
140
136
IM CONNECTOR
350
504
352
322
512
326
POCKET DETECT
316
312
310
306
RF SIGNAL COAX
DIGITAL DATA/AUDIO
DIGITAL DATA/AUDIO
BIT CLOCK
FRAME SYNC
VARIABLE GAIN
MIC
+V PHONE SUPPLY
-V PHONE SUPPLY
VOLTAGE REGULATOR
LEVEL SHIFT
LEVEL SHIFT
LEVEL SHIFT
362
360
508
SERIAL NO.
IN CIRCUIT PROGRAMMING
IGNITION CTRL
MUTE
UART
MISC I/O
EEPROM
ROM
RAM
324
506
318
308
EAR
VARIABLE GAIN
510
320
304
514
PHONE CONNECTOR
126
124
303
314

Fig. 5

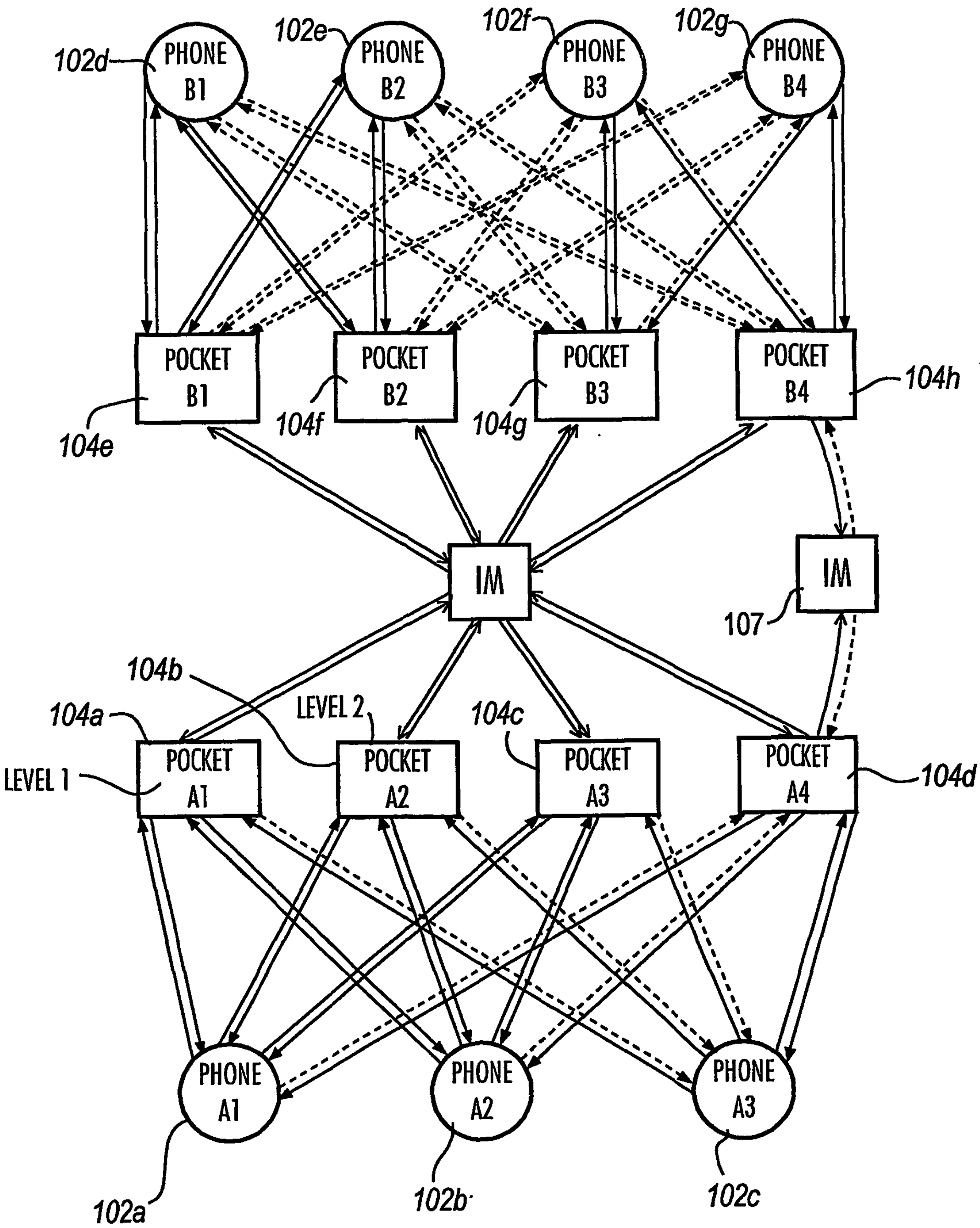

PHONE B1
PHONE B2
PHONE B3
PHONE B4
102d
102e
102f
102g
POCKET B1
POCKET B2
POCKET B3
POCKET B4
104e
104f
104g
104h
IM
IM
107
104b
104a
LEVEL 2
104c
LEVEL 1
POCKET A1
POCKET A2
POCKET A3
POCKET A4
104d
PHONE A1
PHONE A2
PHONE A3
102a
102b
102c

Fig. 6

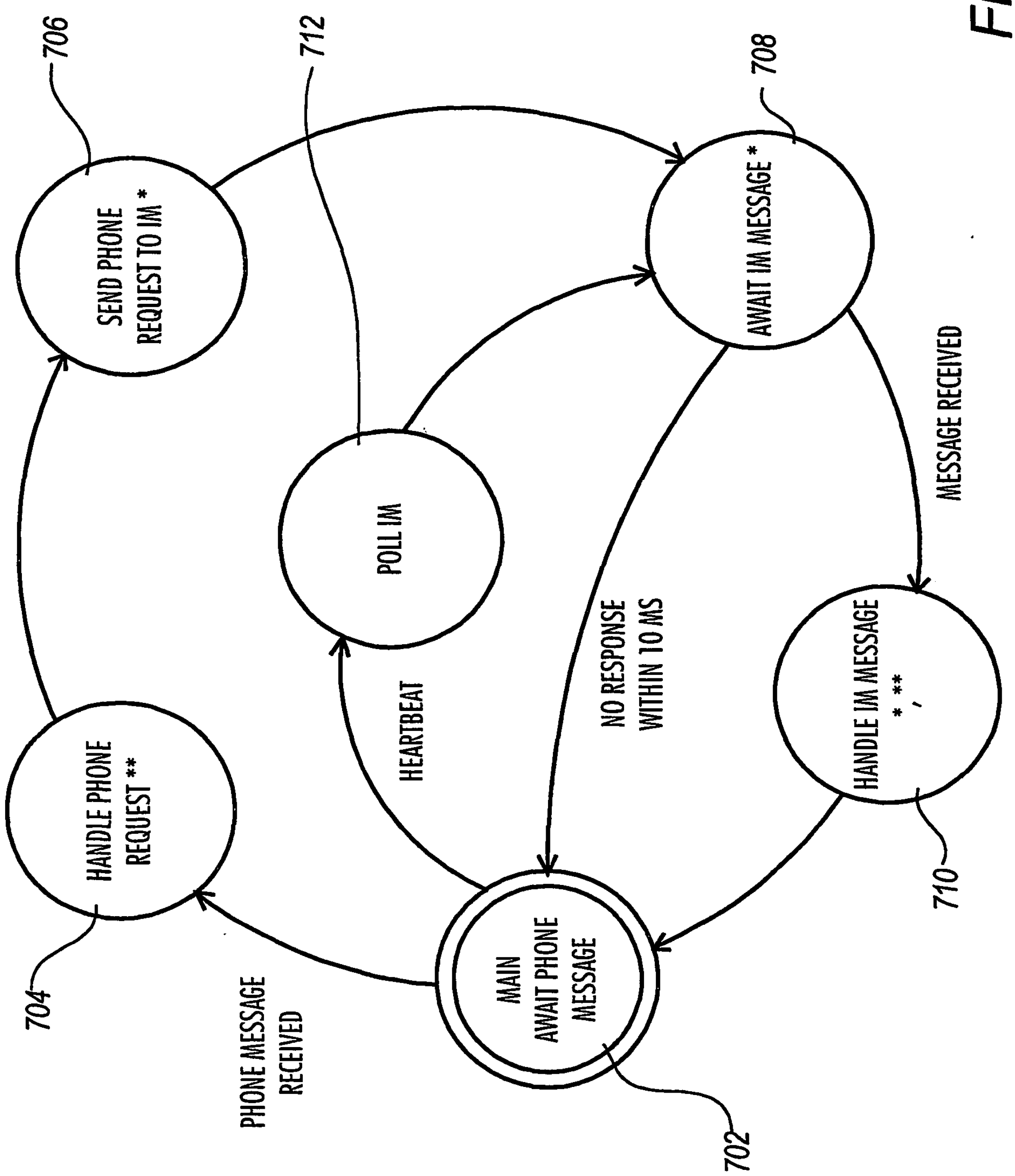

SEND PHONE REQUEST TO IM *
706
712
POLL IM
HANDLE PHONE REQUEST **
704
PHONE MESSAGE RECEIVED
HEARTBEAT
MAIN AWAIT PHONE MESSAGE
702
NO RESPONSE WITHIN 10 MS
AWAIT IM MESSAGE *
708
MESSAGE RECEIVED
HANDLE IM MESSAGE * **
710

Fig. 7

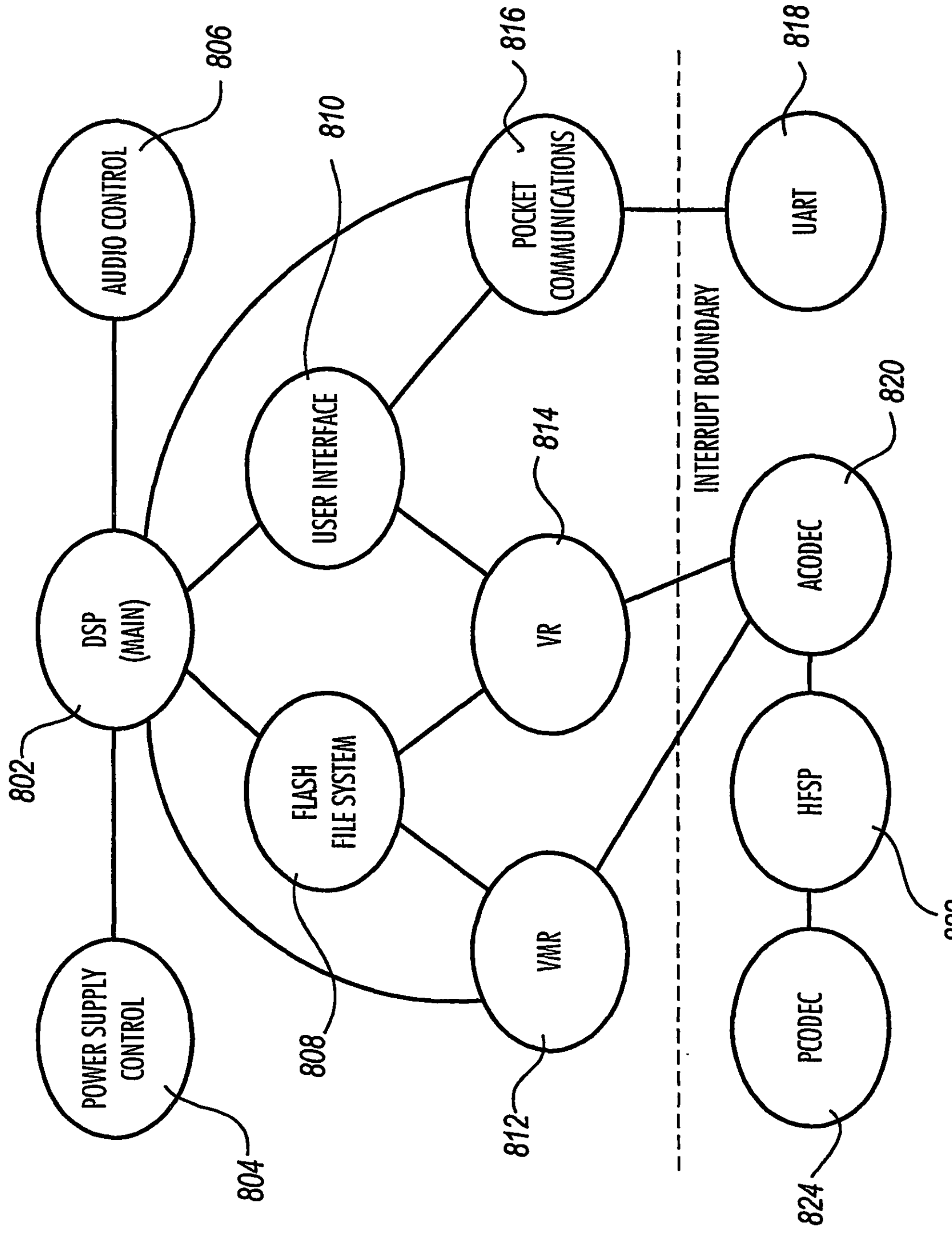
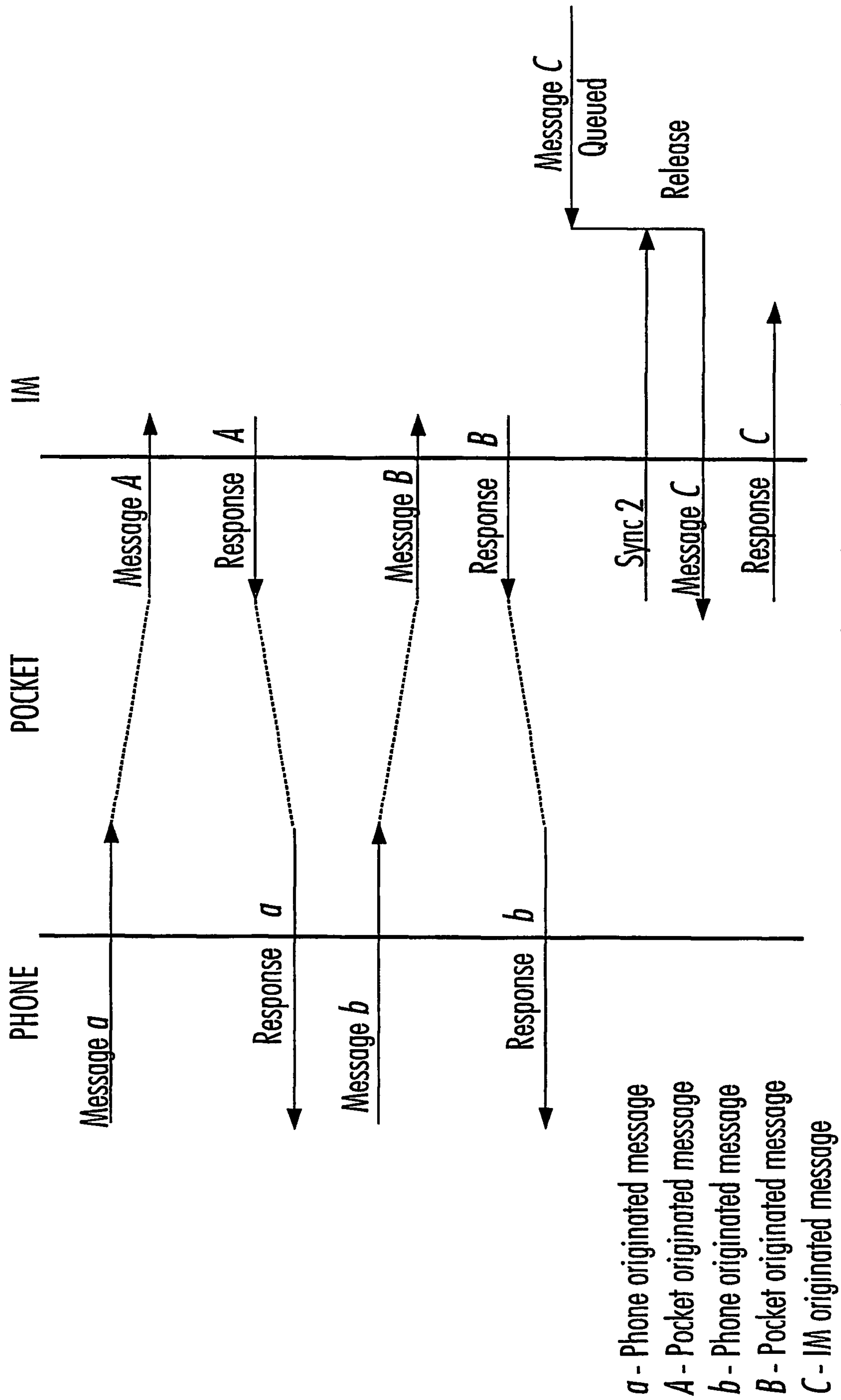

AUDIO CONTROL
806
810
816
POCKET COMMUNICATIONS
818
UART
USER INTERFACE
INTERRUPT BOUNDARY
814
820
DSP (MAIN)
VR
ACODEC
802
FLASH FILE SYSTEM
HFSP
POWER SUPPLY CONTROL
VMR
PCODEC
808
822
812
804
824

Fig. 8



Sync2 occurs every 72 ms (Pocket heartbeat rate)

Fig. 9

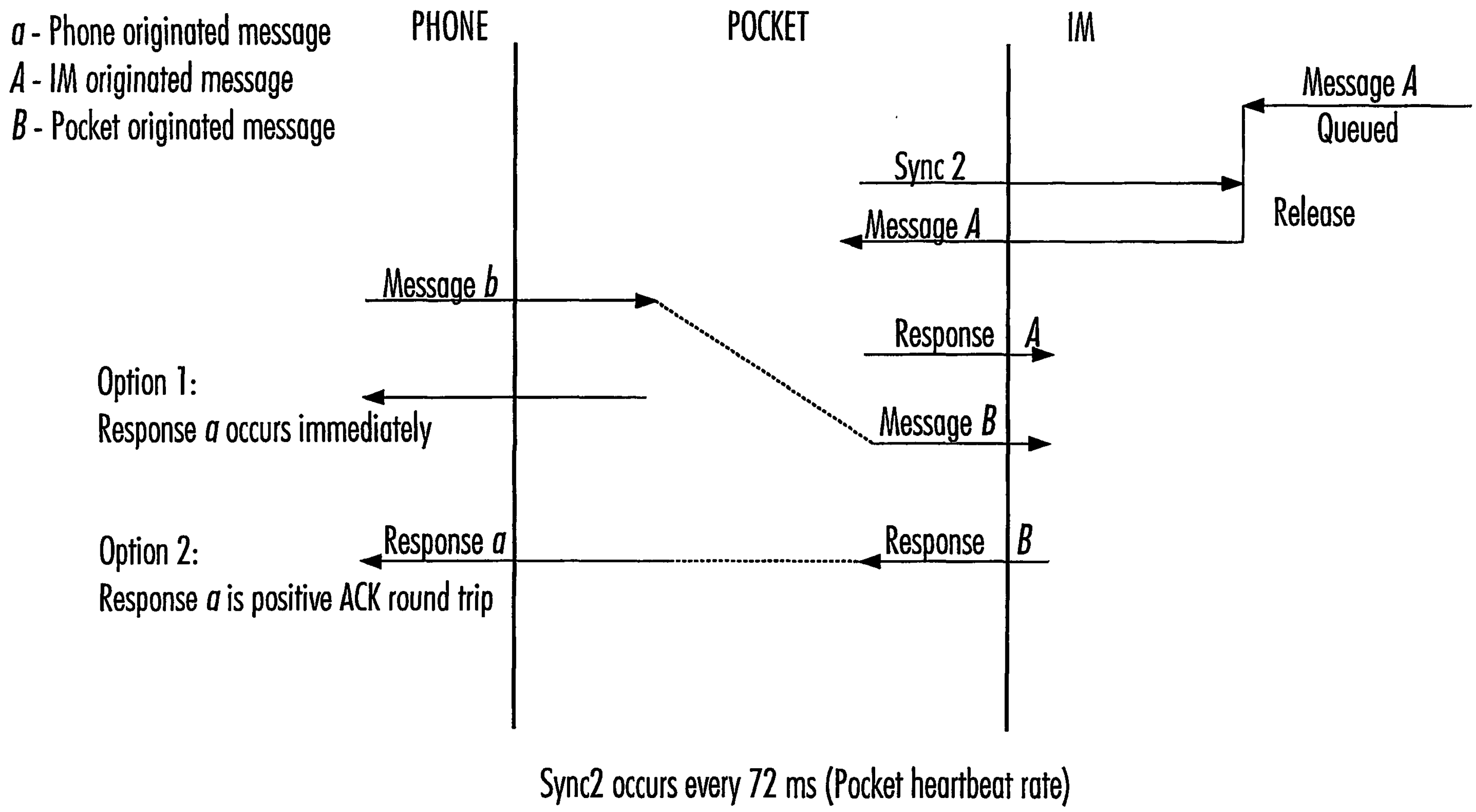

a - Phone originated message
A - IM originated message
B - Pocket originated message
PHONE
POCKET
IM
Message A
Queued
Sync 2
Release
Message A
Message b
Response A
Option 1:
Response a occurs immediately
Message B
Option 2:
Response a is positive ACK round trip
Response a
Response B
Sync2 occurs every 72 ms (Pocket heartbeat rate)

Fig. 10

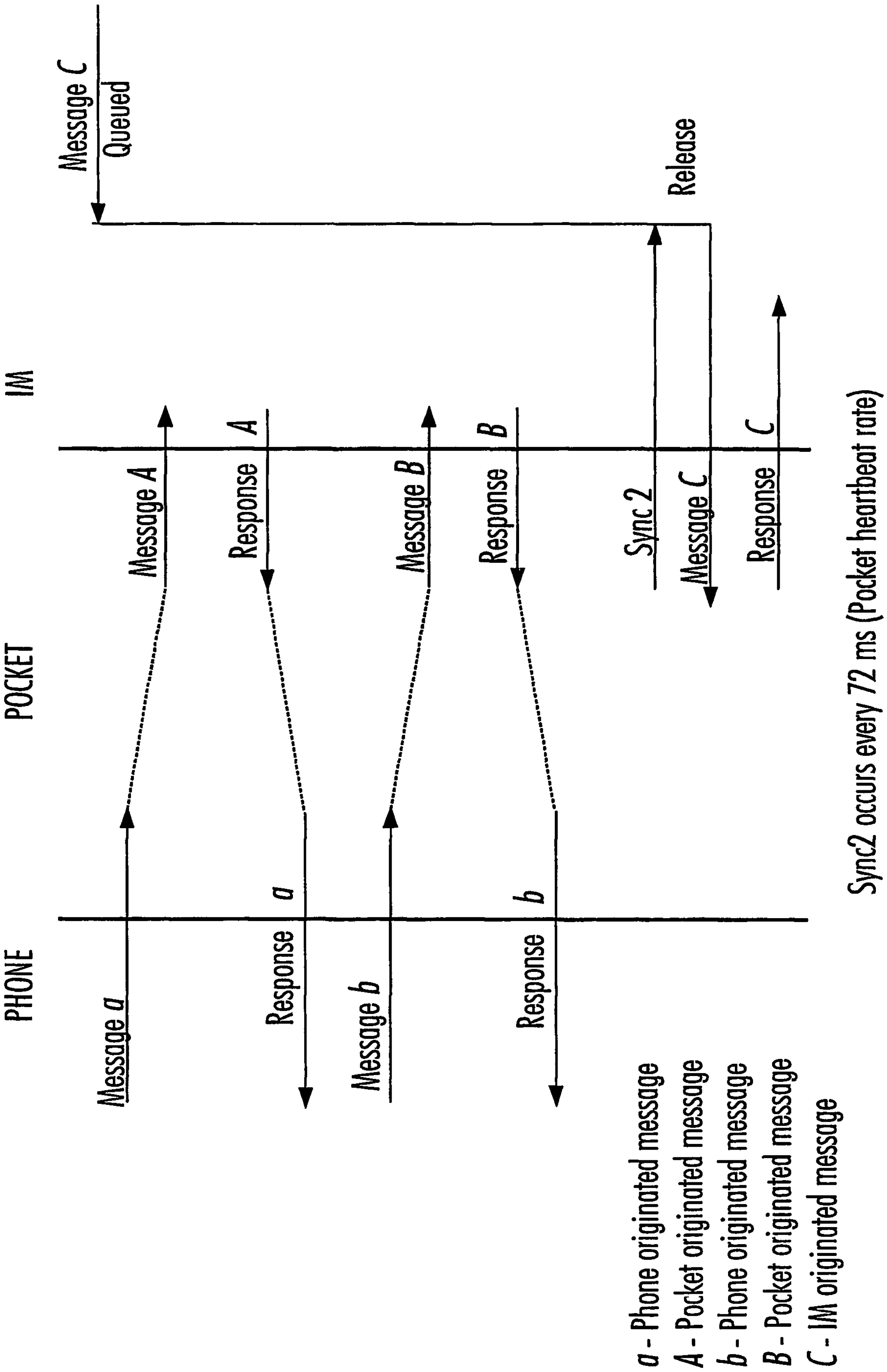

PHONE
POCKET
IM
Message a
Response a
Message b
Response b
Message A
Response A
Message B
Response B
Sync 2
Message C
Response C
Message C
Queued
Release
Sync2 occurs every 72 ms (Pocket heartbeat rate)
a - Phone originated message
A - Pocket originated message
b - Phone originated message
B - Pocket originated message
C - IM originated message

Fig. 11