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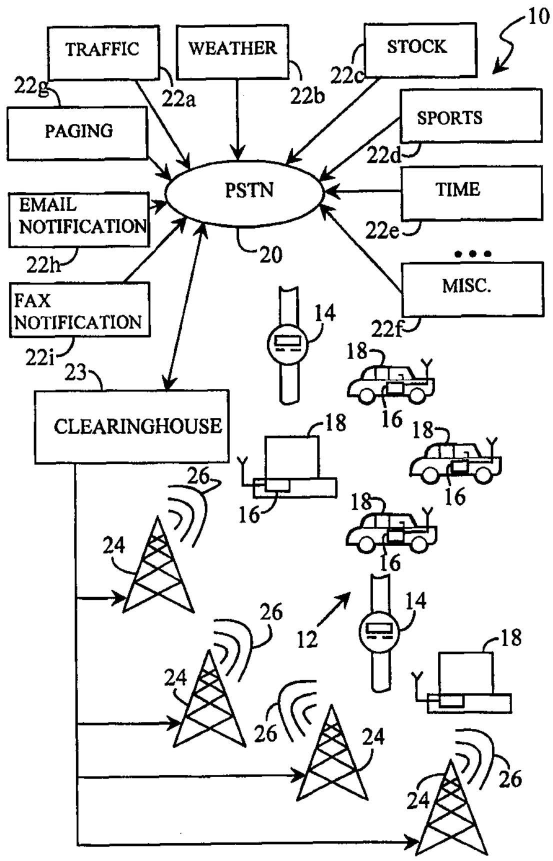
(57) Abstract

A radio signal receiving module (40) integrates into an application device (12) and constantly receives information by radio signal. When the application device (12) is active, the radio receiver module (40) provides an ongoing flow of data. When the application is not active, however, the radio receiver module (40) manages incoming information in a manner allowing rapid storage in a memory device while preserving relative priority between categories of information. Despite a great volume of information arriving in one category, other categories of relatively higher lesser volume information are protected against loss during times when the application device is inactive.



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DATACAST RECEIVER MEMORY BUFFER

FIELD OF THE INVENTION

The present invention relates generally to communication systems, and particularly to communication systems broadcasting a variety of information to a population of receiving devices.

BACKGROUND OF THE INVENTION

Broadcast of information by radio signal, in particular digital information, supports a variety of services. Digital information has been broadcast to and addressed specifically to individual receiving devices, e.g., paging devices, to deliver such information as alphanumeric messages or telephone numbers. Additional information such as traffic, stock, weather, sports, and other such general purpose broadcast information has been provided by radio signal. Receiving devices are programmed to collect particular portions of the data broadcast. For example, a receiving device may be programmed to receive information addressed specifically to it, e.g., paging messages. A receiving device can also collect general interest information such as weather, stock, and the like.

With a broad spectrum of information now available by radio signal, it becomes desirable to integrate radio receiving components into a variety of devices. For example, a car radio can receive, store and display digital information relating to traffic and weather conditions. A personal computer can receive by radio signal information such as email or fax notification. Unfortunately, the manufacturers of such devices generally are not willing to substantially redesign products or invest substantial effort in the integration of radio receiving devices. Preferably, a radio receiving module is inexpensive and can be integrated into the architecture of the companion application device by simple interface and command structure. Accordingly, there arises a need for a small, inexpensive radio receiving device capable of collecting digital information, i.e., data broadcasts, and integrating in modular fashion into existing application devices such as car radios, personal computers, and a variety of consumer devices benefiting from information provided by data broadcast. The radio receiving module provides a stream of broadcast data to the application device which in turn organizes the broadcast data for display or manipulation according to application-specific needs.

Typically, an application device is only intermittently active, i.e., turned on, and during deactivated times the application device cannot collect information received by the receiving device. Accordingly, a memory storage and management responsibility lies with the radio receiving module once it memory resources fill. More particularly, the receiving device must determine where to write new information, i.e., determine, what prior information is to be deleted and therefore not to be made available to the application device.

One must consider, however, the natural limitations of such a small, inexpensive receiving device. More particularly, such a device is likely to have limited processing ability. In the context of a massive volume of broadcast data available to the radio receiving device, including general interest data broadcast as well as personal paging information, the radio receiving module must responsibly manage the collection and storage of information. The device must account for the relatively greater importance of personal paging information as compared to general interest data broadcast. In particular, when receiving and storing information the radio receiving device must not overwrite previously stored higher priority, e.g., personal paging information, when storing new lower priority, e.g., broadcast data, information.

One approach protects high priority messages by tagging information according to a priority scheme. Under such scheme, a just-received information item can be written into memory but only in a location currently holding an older and lesser priority item. The receiving device protects higher priority items against deletion or overwrite when storing a lesser priority item. Unfortunately, this scheme requires the processing element to scan the memory element until an appropriate memory location is found. Conceivably, the processing element searches the entire, or substantially entire, memory element seeking an appropriate storage location. With a constant and high volume of incoming data, however, the processing element must quickly store information without resorting to time-consuming priority tagging and searching schemes. The processing element, despite its limited processing ability, must quickly execute the step of storing new information and stand ready to receive and store a next item in the data broadcast. Accordingly, a complex message prioritization scheme implemented by a limited ability processor suffers from potentially losing messages due to a relatively time consuming process of identifying appropriate storage locations.

US Patent Number 4, 873,519 issued October 10, 1989 and entitled "Paging Receiver Having Independent Memory Areas For Common And Individual Addresses" illustrates a paging receiver with an individual paging number and at least one common paging number and with memory including individual memory capable of storing an individual number and specific memory areas storing message signals following the common paging number. The receiver protects individual address information relative to common paging number information.

Thus, a small inexpensive radio receiver serving as a module integrated into an application device must responsibly store information in the receiver module. When the application device is deactivated, e.g., the car radio turned off or the personal computer turned off, the receiver module continues to receive information and likely fills its memory. As new information arrives, however, the receiver module must protect the relatively higher priority information when storing lesser priority information, i.e., must not overwrite high priority information with low priority information. Once the application device reactivates, information stored in the receiver module transfers to the application device. While the application device is inactive, however, the small, inexpensive radio receiver must manage the incoming information by preserving high priority items despite a great volume of incoming broadcast data.

Because the data stream is ongoing and because relevant or updated information can arrive essentially at any time, the process of storing and prioritizing incoming information must be ongoing and must be conducted quickly if the receiving device is to stand ready to receive a next information item. The subject matter of the present invention addresses these aspects of a small, inexpensive radio receiving module having limited processing ability and adapted for integration into an application device.

SUMMARY OF THE INVENTION

A receiver module incorporated into an application device includes a memory element, a radio receiver, a processor, and a communication port. The radio receiver collects information from a data broadcast including items which may be classified in at least a first and a second category. The processor accepts from the radio receiver each information item and classifies each item according to category. The application device provides a memory configuration command to the module processor whereby the application device establishes memory allocation according to its application-specific needs. Upon receiving an information item from the radio receiver, the processor classifies the information item and immediately stores the information item in the associated portion of memory allocated to that category. According to one aspect of the invention, the processor identifies a next storage location for each category and stands ready to immediately store an information item upon presentation from the radio receiver. The communication port provides a command and data transfer interface allowing the application device to deliver the memory configuration command and allows the module to deliver stored information items to the application device.

The subject matter of the present invention is particularly pointed out and distinctly claimed in the concluding portion of this specification. However, both the organization and method of operation of the invention, together with further advantages and objects thereof, may best be understood by reference to the following description taken with the accompanying drawings wherein like reference characters refer to like elements.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings in which:

FIG. 1 illustrates schematically an information broadcasting system and a population of receiving devices.

FIG. 2 illustrates schematically a time-division multiplexed broadcast protocol used in the broadcasting system of FIG. 1.

FIG. 3 illustrates schematically by block diagram a receiver module and an application device.

FIG. 4 illustrates a memory resource of the receiver module of FIG. 3 and a ring buffer pointer system applied thereto.

FIG. 5 illustrates a configuration procedure initializing the ring buffer arrangement of FIG. 4.

FIG. 6 illustrates by flow chart a procedure conducted by the data broadcasting system of FIG. 1 to place broadcast data in otherwise unused portions of the data transmission.

FIG. 7 illustrates a method of receiving and storing information in the receiver module of FIG. 3.

FIGS. 8-10 illustrate procedures executed by the receiver module of FIG. 3 in response to the application device of FIG. 3 requesting stored information.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates schematically a data broadcasting system 10 and a population 12 of various receiving devices. While only a small sample of population 12 is illustrated in FIG. 1, it will be understood that broadcasting system 10 supports a large number of population 12 members. Broadcasting system 10 supports paging services to wristwatch paging devices 14 in population 12. Paging devices 14 generally collect only information addressed to that particular paging device. Paging devices 14 as provided in the form of a wristwatch are highly miniaturized radio signal receiving devices with highly battery-efficient operation. Accordingly, the circuitry and general architecture of wristwatch paging devices 14 provides a basis for a miniaturized radio receiving module well adapted for integration into application devices as described herein.

Application devices 16 collect a variety of broadcast data available in system 10. Depending on the particular application, e.g., car radio, personal computer, and the like, each application device 16 uses particular portions of information available from broadcasting system 10. For example, an application device 16 serving as a automobile radio collects primarily traffic and weather information. Application devices 16 serving in a personal computer, however, might collect primarily email notification, fax notification, paging, and stock information.

Each application device 16 includes a radio receiver module 40 (FIG. 3) operating in accordance with the present invention. The receiver module 40, discussed more fully below, adapts to a variety of application device environments and may be configured to appropriately and dynamically allocate memory resources according to the particular needs of a particular application device 16. Furthermore, each receiver module 40 integrates into the corresponding application device 16 by simple data transfer and command interface, e.g., serial I/O communication. Receiver modules 40 are thereby easily integrated into the architecture of many types of application devices 16 without imposing upon an application device 16 manufacturer a need to design radio receiving devices, but rather merely include or add the radio receiver module 40. In a preferred form of the present invention, the radio receiver module 40 is a circuit board-mountable component requiring access to a power supply and radio antenna and interacting by serial communication with an application device 16.

Preferably, a receiver module 40 such as contemplated herein has access to a full-time power supply and collects information from broadcasting system 10 on a full-time basis. In an automobile application, for example, receiving module 40 couples to the car battery without an intervening on/off switch. More particularly, module 40 remains coupled substantially full time to the car battery, but could be equipped with a time-delayed off switch (not shown). This arrangement allows module 40 to remain active during times of deactivation for application device 16 but would not remain active indefinitely. For example, module 40 could remain active during typical patterns of application device 16 in activity, but for extended periods of inactivity module 40 could automatically shut down. The receiving module 40 thereby collects information on an ongoing basis even when the associated application device 16 is deactivated, i.e., when the engine and radio are turned off. Similar power arrangements and ability to collect information during a power off condition may be found in other application devices 16, i.e., where a relatively full-time power supply is available for a relatively low power-consuming device such as the receiver module 40 but the associated application device 16, due to its higher power consumption, is not necessarily always activated. Hence, there arises a need for the receiving module to manage a great volume of incoming information in the manner illustrated herein.

Data broadcasting system 10 interacts by way of public switch telephone network (PSTN) 20 with a variety of information sources 22. For example, traffic source 22a provides current traffic conditions relative to a surrounding geographic area. Similarly, weather source 22b provides weather conditions relevant to the surrounding geographic area. Stock information source 22c provides stock-related data. Sports information source 22d provides an ongoing stream of sports-related data. Time information source 22e provides a time standard, e.g., accurate time of day data. Miscellaneous or general interest information source 22f presents information across a variety of topics and interests. Thus, information sources 22 provide an ongoing data stream of various information items. Much of the information available from sources 22a-22f is time-sensitive and becomes stale over time. For example, time of day, traffic, weather, and stock information is generally considered relevant only if maintained current.

Information sources 22g-22i represent sources of information addressed to specific members of population 12. For example, paging information source 22g represents persons initiating transmission of paging messages to members of population 12. Similarly, notification may be provided automatically by a computer system (not shown) whereby an email notification from source 22h may be delivered to a specific member of population 12. A similar notification arrangement may be provided automatically from fax notification information source 22i. Information sources 22g-22i are generally recognized as pertaining to specific members, or groups of members, of population 12.

A clearinghouse 23 collects information from information sources 22 and organizes this information for broadcast according to its broadcast protocol. Clearinghouse 23 couples to a set of radio stations 24 each providing a radio signal broadcast 26. In the embodiment illustrated herein, i.e., a time-division multiplexed protocol, particular time slots must be reserved for broadcast of information addressed to specific members or groups of members of population 12. The remaining time slots, however, may be filled with broadcast data available from information sources 22a-22f.

FIG. 2 illustrates the broadcast protocol represented in each radio signal broadcast 26. Generally, data broadcasting system 10 defines a frame 30 as a succession of subframes 32. Each subframe 32 is divided into many time slots 34 (only one such time slot 34 being marked by reference numeral 34 in FIG. 2). The first three time slots C1-C3 in each subframe 32 carry control and synchronization information. The remaining time slots 34, identified individually in the range 0-1023 (1024 total), in each subframe 32 carry transmission data. Members of population 12 only collecting information specifically addressed thereto, need only activate radio receiving circuitry and collect information during an associated time slot 34. This results in significant battery savings for such members of population 12 as wristwatch paging devices 14. The remaining time slots, i.e., not carrying information addressed to a particular member of population 12, might otherwise remain unfilled during transmission. Under the present invention, however, broadcast data as collected from information sources 22a-22f fill the unused time slots 34 and application devices 16 make use of such broadcast data according to application-specific needs.

FIG. 3 illustrates schematically by block diagram a typical application device 16, in this case a car radio, as coupled under the present invention to a receiver module 40. Application device 16 includes an audio receiver 68 driving an amplifier 70 and speakers 72. In this aspect, application device 16 is fundamentally a car radio, but by incorporation of the inexpensive and miniaturized receiver module 40 device 16 benefits from a variety of broadcast data available from broadcasting system 10 and makes such data available according to particular application programming.

Receiver module 40 is a small circuit board-mountable device with limited terminal connections required for operation. For example, receiver module 40 includes a terminal 42 for coupling to an antenna. Terminals 44 of module 40 implement a simple serial I/O data transfer and module command interface. Terminal 46 couples to a power supply 48, preferably with no intervening on/off switch or with a time delayed on/off switch to protect the car battery over an extended amount of time to provide module 40 with a substantially full-time power supply. Module 40 includes a receiver 50 collecting broadcast signal 26 and delivering this signal to decoder 52 for decoding and error correction according to the transmission protocol of system 10. Receiver 50 and decoder 52 act generally independently of processor 54 in receiving a given data packet. Accordingly, while processor 54 stores a given data packet in a memory 56, receiver 50 and decoder 52 receive the next data packet transmitted by broadcasting system 10. Each data packet, i.e., as broadcast during one of time slots 34, is presented to processor 54 for storage in memory 56, e.g., a RAM. An EPROM memory 58 holds programming for processor 54. Module 40, being generally similar to wristwatch paging device 14, is a physically small and power-efficient device easily integrated into the circuitry of an application device 16 as a module.

Application device 16 includes an application controller 60 interacting with processor 54 of module 40 by way of serial I/O terminals 44. Application controller 60 has an associated application memory 62 for storing and manipulating information according to application-specific needs. Depending on the particular application device 16, application memory 62 may be substantially larger than memory 56 of module 40. Furthermore, application controller 60 may have substantially greater processing ability than processor 54 of module 40. Accordingly, application controller 60 when active, i.e., when application on/off switch 64 couples application device 16 to power supply 48, constantly draws an incoming data flow from module 40. Application controller 60 stores and manages information according to its particular needs and provides such information on its application display 66 to a user, e.g., driver, according to its particular use of broadcast data. For example, application display 66 of a car radio application device 16 may carry a variety of current and relevant traffic and weather information.

Receiver module 40 potentially operates in a variety of environments. For certain applications, memory 56 may be small, e.g., 2k bytes. Other applications may allow a modified, e.g., more expensive, version of module 40 having more memory capacity, e.g., 32 Kbytes. Furthermore, different applications will have different priorities relative to incoming information. For example, some applications benefit by devoting greater portions of memory 56 to personal information, i.e., addressed to a specific member of population 12, and lesser portions to broadcast data, i.e., to general purpose data broadcasts. On the other hand, some applications benefit by devoting greater memory to broadcast data. In accordance with the present invention, receiver module 40 may be configured dynamically by an application device 16 to match application-specific memory allocation requirements.

Module 40 manages memory 56 generally in an indexed or offset address manner to implement a set of ring buffers for quickly storing incoming data. The ring buffers are addressed directly by use of pointers, and thereby facilitate rapid identification of where in memory 56 new data is to be written. Direct addressing within memory 56 as illustrated herein minimizes time required for storing new information items in memory 56. Processor 54 need not scan or evaluate the content of memory 56 prior to writing new information into memory 56. Accordingly, processor 54 collects 100 percent of the information provided by broadcasting system 10, i.e., quickly stores a just-received information item and stands ready to receive the next information item from broadcasting system 10. Information taken from memory 56, i.e., delivered to application device 16, is provided on a first-in-first-out (FIFO) basis. When a particular one of the ring buffers fills, then the oldest member of that ring buffer is overwritten with new data.

FIG. 4 illustrates memory 56 in more detail including the use of ring buffers and offset memory addressing. In FIG. 4, memory 56 is divided into a selected number of ring buffers by establishing ring boundary pointers. In the particular example illustrated, memory 56 is divided into a broadcast ring 100, a group ring 102, and a personal ring 104 by reference to ring boundary pointer a 106 and to ring boundary pointer b 108. A configuration command, e.g., from application device 16 as provided by serial interface or designated at time of manufacture and stored in an EEPROM of module 40, designates memory allocation for rings 100-104 and provides a basis for calculating ring boundary pointers 106 and 108 and thereby dividing memory 56 into three rings. Each of rings 100-104 has an associated pair of ring pointers indicating the current start and end locations for that particular ring. For example, broadcast ring 100 has a start_B pointer 110 and an end_B pointer 112. Similarly, start_G pointer 114 and end_G pointer 116 support management of group ring 102. Start_P pointer 118 and end_P pointer 120 support management of personal ring 104.

While illustrated with three ring buffers, it will be understood that memory 56 may be divided into any selected number of ring buffers with each ring buffer representing a category of information under which each data packet is initially stored immediately following reception in receiver module 40. Furthermore, allocation of memory 56 need not be devoted entirely to ring buffers. As illustrated herein, the region of memory 56 illustrated in FIG. 4 is allocated for ring buffers holding data packets. This region holds n+1 data packets where each data packet corresponds to information broadcast during a particular time slot 34. By providing a value in the range 0..n one specifies a particular data packet storage location within one of ring buffers 100-104. In this aspect, the ring buffers are circular arrays of data packets.

FIG. 5 illustrates by flow chart a memory configuration procedure executed by processor 54 to initially establish empty rings 100-104. In block 130, processor 54 calculates values for ring boundary pointers, i.e., values for pointer a 106 and for pointer b 108, to divide memory 56 into three regions. An application device 16 issues a memory configuration command to receiver module 40 and specifies allocation of memory 56 among rings 100-104. Alternatively, a memory configuration command may be issued at the time of manufacture and stored in an EEPROM of module 40. Such command may not literally include values for pointers 106 and 108, but given such a memory allocation command, e.g., a certain number of bytes or a percentage of memory 56 devoted to each of rings 100-104, values for pointers 106 and 108 may be calculated in block 130. In block 132, pointers 106 and 108 are stored. Block 134 represents assignment of values to each of the pointers 110-120 to establish empty rings 100-104. More particularly, the start and end pointers for each of rings 100-104 are assigned values corresponding to the first storage location allocated to that ring. As described more fully, as information is placed in memory 56 and as information is taken from memory 56, processor 54 manipulates pointers 110-120 to manage ring buffers 100-104 each individually on a first-in-first-out (FIFO) basis.

FIG. 6 illustrates by flow chart a procedure executed to incorporate broadcast data into individually addressed paging data, i.e., to blend information from information sources 22a-22f with information from sources 22g-22i according to data broadcasting system 10 protocol. The procedure executed in FIG. 6 is conducted at each of radio stations 24 just prior to transmission. Each radio station receives from clearinghouse 23 information submitted for transmission and organizes that information into subframes 32 and frames 30. In block 140, a set of individually addressed or group addressed messages are assigned to particular time slots in a subframe 32. The remaining or "empty" time slots are then filled with broadcast data, i.e., information taken from sources 22a-22f. Thus, following block 142 a subframe 32 has been filled completely with transmission data. Continuing to block 144, the current subframe 32 is queued for transmission and is eventually transmitted by radio station 24 in a radio signal 26. In block 146, a next subframe 32 is selected and the process repeats to fill completely that next subframe 32 with transmission data, i.e., first with information addressed to particular ones or groups of population 12 and then filled with broadcast data from information sources 22a-22f.

FIG. 7 illustrates by flow chart processor 54 programming for receiving and storing data taken from a broadcast 26. In FIG. 7, block 160 represents the process of receiving and decoding a data packet, i.e., data broadcast during a particular time slot 34, and presentation of a data packet by decoder 52 to processor 54. In block 162, processor 54 identifies the data packet type, i.e., classifies the data packet for storage into one of its rings 100-104. Thus, by interrogating the content, e.g., a type flag (not shown), of a given data packet processor 54 determines classification according to personal, group, or broadcast categories for storage in memory 56.

If processor 54 determines in decision block 164 that the data packet is to be stored in the personal ring buffer 104, processing branches to block 166 where processor 54 references end_P pointer 120 as an offset into memory 56 and immediately writes the data packet at this location. In block 168, processor 54 increments end_P pointer 120. In this context, incrementing a ring pointer refers to addressing a next data packet in the ring buffer array structure. Decision block 170 determines whether the new value for end_P pointer 120 exceeds the upper boundary of ring 104, in this particular case whether it equals the value n+1 where n represents the upper address of the portion of memory 56 devoted to rings 100-104. If end_P pointer 120 has exceeded the upper boundary of ring 104, then in block 172 processor 54 reassigns end_P pointer 120 to the lower boundary of ring 104, in this particular case to the value of ring boundary pointer b 108.

Decision block 174 determines whether ring buffer 104 has become full with the latest data packet. If end_P pointer 120 equals start_P pointer 118 then ring buffer 104 has become full and processor 54 increments start_P pointer 118 in block 176. Decision block 178 determines whether the new value for start_P pointer 118 has exceeded the upper boundary of ring 104. If it has exceeded the upper boundary, then start_P pointer 118 is assigned the value of pointer b 108. Processing then returns to block 160.

Similar programming applies at decision block 184 when processor element 54 detects that the data packet received is to be stored in the group ring buffer 102. In block 186, the data packet is stored immediately in ring buffer 102 by reference to end_G pointer 116. In block 188, processor 54 increments end_G pointer 116 and tests pointer 116 in decision block 190. If end_G pointer 116 has exceeded the upper boundary, i.e., pointer b 108, then in block 192 processor 54 assigns to end_G pointer 116 the value of pointer a 106 as the lower boundary of group ring 102. Decision block 194 determines whether ring buffer 102 is now full. If full, then in block 196 processor 54 increments start_G pointer 114 and tests pointer 114 in decision block 198 to determine if it has exceeded the upper boundary of ring buffer 102. If it has exceeded the upper boundary, then in block 200 processor 54 assigns to start_G pointer 114 the lower boundary of ring buffer 102, i.e., the value of pointer a 106. Processing then returns to block 160.

If in decision block 204 processor 54 determines that the new data packet is part of a data broadcast, then processing branches from decision block 204 to decision block 205. Decision block 205 represents a broadcast data channel filter allowing microprocessor 54 to ignore certain portions or "logical channels" of the broadcast data provided by system 10. A mask identifying enabled and disabled logical channels available under system 10 may be provided as a command from application device 16 and stored in module 40. Decision block 205 represents a decision as to storing or not storing the just-received data packet as a function of membership in an allowed logical channel. If the data packet is not to be stored, then processing returns to block 160. Otherwise, processing continues in fashion similar to that described relative to placement of new data packets in group ring 102 and personal ring 104. More particularly, in block 206 processor 54 stores the data packet by reference to the end_B pointer 112 and increments pointer 112 in block 208. In decision block 210, processor 54 determines whether end_B pointer 112 has exceeded the upper bound for ring 100. If it has, then in block 212 processor 54 assigns end_B pointer 112 to the lower bound, in this particular example zero, of broadcast ring 100. Continuing to decision block 214, processor 54 determines whether broadcast ring 100 is now full. If full, then in block 216 processor 54 increments start_B pointer 110 and in decision block 218 determines whether the new value for start_B pointer 210 exceeds the upper boundary of ring 100. If it exceeds the upper boundary, then in block 200 processor

54 assigns to start_B pointer 110 the lower boundary, i.e., zero in this case, for ring 100. Processing then returns to block 160.

Thus, as illustrated in FIG. 7 data packets may be immediately stored in one of ring buffers 100-104 without delay. Processor 54 thereby stands ready to receive a next data packet from broadcasting system 10. When one of the ring buffers 100-104 becomes full, the oldest member of that ring buffer is overwritten to hold the new data packet. No matter how much new broadcast data is accepted and stored in module 40, no personal information is deleted. In this manner, module 40 protects the relatively higher priority personal and group data packets, i.e., data packets in rings 102 and 104 and still reliably collects on an ongoing basis the broadcast data to hold in memory 56 the most current updated broadcast data at any given time.

FIGS. 8-10 illustrate programming executed by processor 54 in response to an application device 16 request. Generally, the process of transferring information from module 40 to application device 16 is ongoing and by properly managing the various pointers described herein, i.e., protecting against reference or reassignment during critical times, the procedures illustrated in FIGS. 8-10 may be conducted as background procedures. Each of the procedures illustrated in FIGS. 8-10 are generally similar in operation and only one need be discussed in detail. FIG. 8 illustrates delivery of all data packets from the personal ring buffer 104, FIG. 9 illustrates delivery of all data packets from the group ring buffer 102, and FIG. 10 illustrates delivery of all data packets from the broadcast ring buffer 100. While illustrated in FIGS. 8-10 as delivering all data packets in a given ring buffer, it will be understood that the procedures illustrated in FIGS. 8-10 could be modified to deliver one or a specified number of data packets from a given ring buffer 100-104.

In FIG. 8, processor 54 first outputs the oldest data packet in personal ring buffer 104. Decision block 230 compares the start_P pointer 118 with the end_P pointer 120, however, to detect an "empty ring" condition. When these pointers are equal, then ring 104 is considered empty and processing terminates. Otherwise, programming advances to block 232 where processor 54 outputs by serial transmission to the associated application device 16 the data packet indicated by start_P pointer 118. In block 234, processor 54 increments start_P pointer 118. Decision block 236 detects whether the new value for start_P pointer 118 has exceeded the upper bound for buffer pointer 104, in this particular case equals the value n+1. If not, then processing returns to decision block 230 to again test for an empty ring condition. If the start_P pointer 118 has exceeded the upper bound for personal ring pointer 104, then in block 238 processor 54 assigns to start_P pointer 118 the lower bound value for personal ring 104, in this particular case the value of pointer b 108. Processing then returns to decision block 230. The process illustrated in FIG. 8 continues with each iteration providing a data packet from personal ring 104 until personal ring 104 is empty.

The programming of FIGS. 9 and 10 is substantially identical to that of FIG. 8 but delivers information from the group ring buffer 102 and broadcast ring buffer 100, respectively. Blocks 230, 232, 234, 236, and 238 of FIG. 8 correspond to blocks 240, 242, 244, 246, and 248 of FIG. 9, respectively, and to blocks 250, 252, 254, 256, and 258 of FIG. 10, respectively. In each case, the illustrated programming takes data packets from the associated ring buffer until the ring buffer is empty.

Thus, a radio receiver module 40 may be easily incorporated into an application device 16 through a simple interface and with relatively low power supply requirements. The receiver module 40 proposed under the present invention manages responsibly a high volume of data broadcast information as well as a relatively less frequent lower volume but higher priority personal message traffic using a limited ability processor and simple memory management allowing rapid indexed access to a memory resource. The device thereby accurately collects information in the data broadcast while preserving higher priority personally addressed information. The receiving module remains active always collecting current or updated broadcast data whereby upon reactivation of an associated application device the most recent broadcast data may be transferred to the application device. This occurs while also preserving any personally addressed, high priority information which may have been directed to the receiving device during a time of inactivity by the application device. In this manner, the receiving module may be integrated into an application device and responsibly collect information from a data broadcast.

It will be appreciated that the present invention is not restricted to the particular embodiment that has been described and illustrated, and that variations may be made therein without departing from the scope of the invention as found in the appended claims and equivalents thereof.

CLAIMS

What is claimed is:

1. A radio receiver module incorporated into an application device, said module comprising:

a memory element;

a radio receiver receiving information from a data broadcast, said data broadcast including information items, each item being classified in one of at least a first and a second category;

a processor accepting from said radio receiver each information item received and classifying each information item received in one of said first and second categories, said module receiving a memory configuration command allocating a selected portion of said memory element to said first category of information items and a selected portion of said memory element to said second category of information items, said processor storing upon receipt each information item according to its classification in the corresponding portion of said memory element; and

a communication port coupling said processor and said application device, said communication port receiving at least said configuration command and delivering said information items stored in said memory to said application device.

2. A module according to claim 1 wherein said application device is intermittently deactivated and during deactivation of said application device said receiver module collects and stores said information items overwriting in said memory element an oldest member of a given category with a just received member of said

given category when the corresponding portion of said memory is filled with information items of said given category.

3. A module according to claim 1 wherein said processor element identifies a next available storage location for a given category and upon subsequently receiving a next information item classified in said given category writes said next information item at said next available storage location.

4. A module according to claim 1 wherein said processor maintains a ring buffer in said memory element for each of said at least first and second categories.

5. A communication system comprising:

a broadcasting system providing a data broadcast including information items;

a population of receiver modules each incorporated into an associated application device, each receiver module including a memory element holding information items taken from said data broadcast, each information item being classified by said module into one of at least two categories, each module receiving a memory configuration command establishing selected portions of said memory as being associated with each of said at least two categories, each receiver module storing each information item in said selected portions of said memory element according to classification in said at least two categories.

6. A system according to claim 5 wherein said application device commands said receiver module to deliver said information items from said receiver module to said application device.

7. A system according to claim 5 wherein said application device is intermittently deactivated and during deactivation of said application device said receiver module collects and stores said information items overwriting in said memory element an oldest member of a given category with a just received member of said given category when the corresponding portion of said memory is filled with information items of said given category.

8. A system according to claim 5 wherein said processor element identifies a next available storage location for a given category and upon subsequently receiving a next information item classified in said given category writes said next information item at said next available storage location.

9. A system according to claim 5 wherein said processor maintains a ring buffer in said memory element for each of said at least first and second categories.

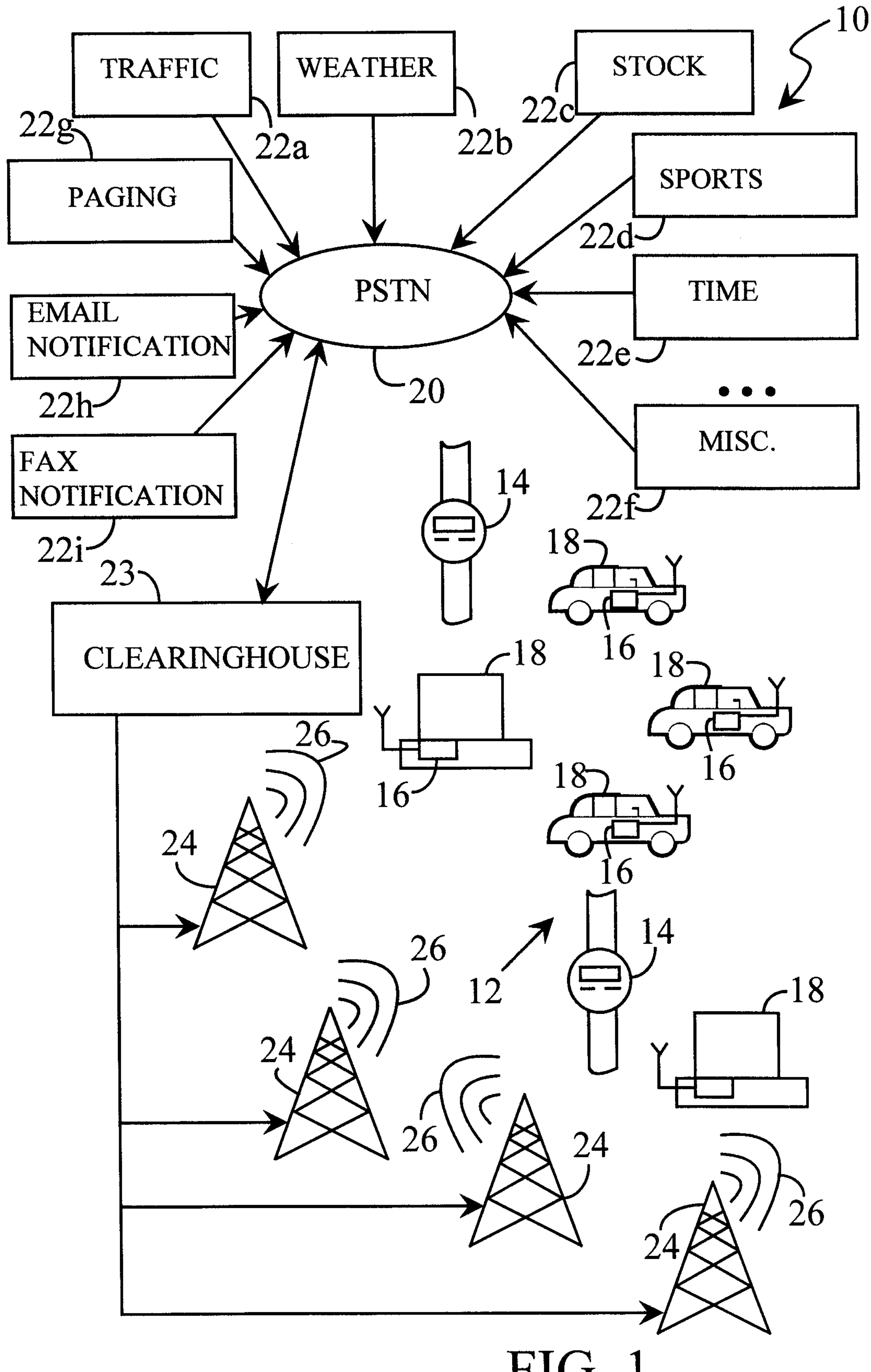
10
TRAFFIC
WEATHER
STOCK
22g
22a
22b
22c
PAGING
SPORTS
22d
PSTN
TIME
EMAIL
NOTIFICATION
22e
22h
20
FAX
NOTIFICATION
MISC.
22f
22i
14
23
18
16
CLEARINGHOUSE
18
18
16
26
16
18
24
16
26
12
14
24
18
26
24
24
26

FIG. 1

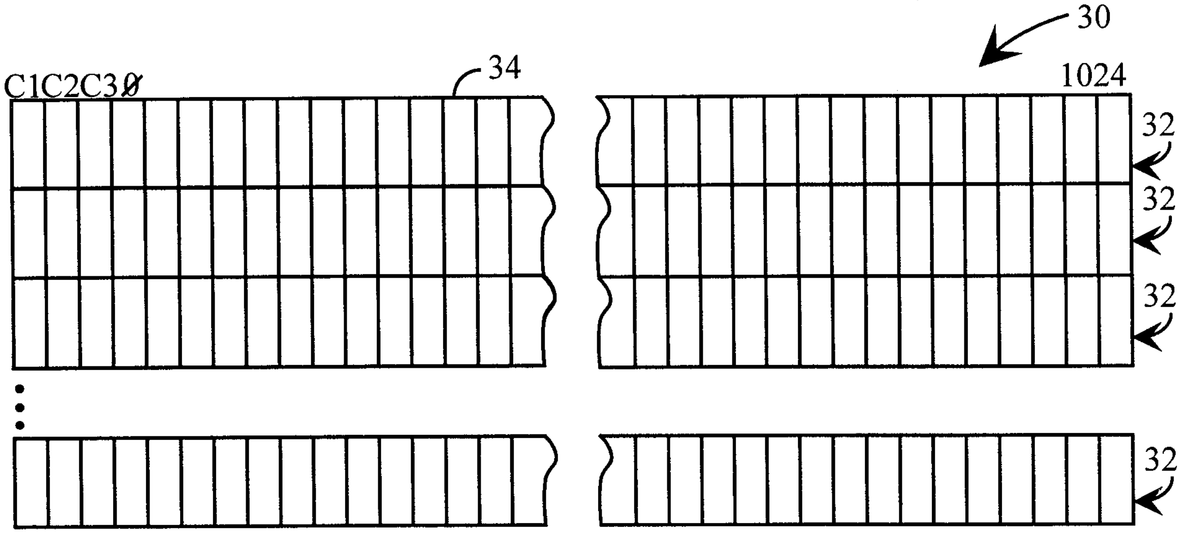
30
34
C1C2C3Ø
1024
32
32
32
32

FIG. 2

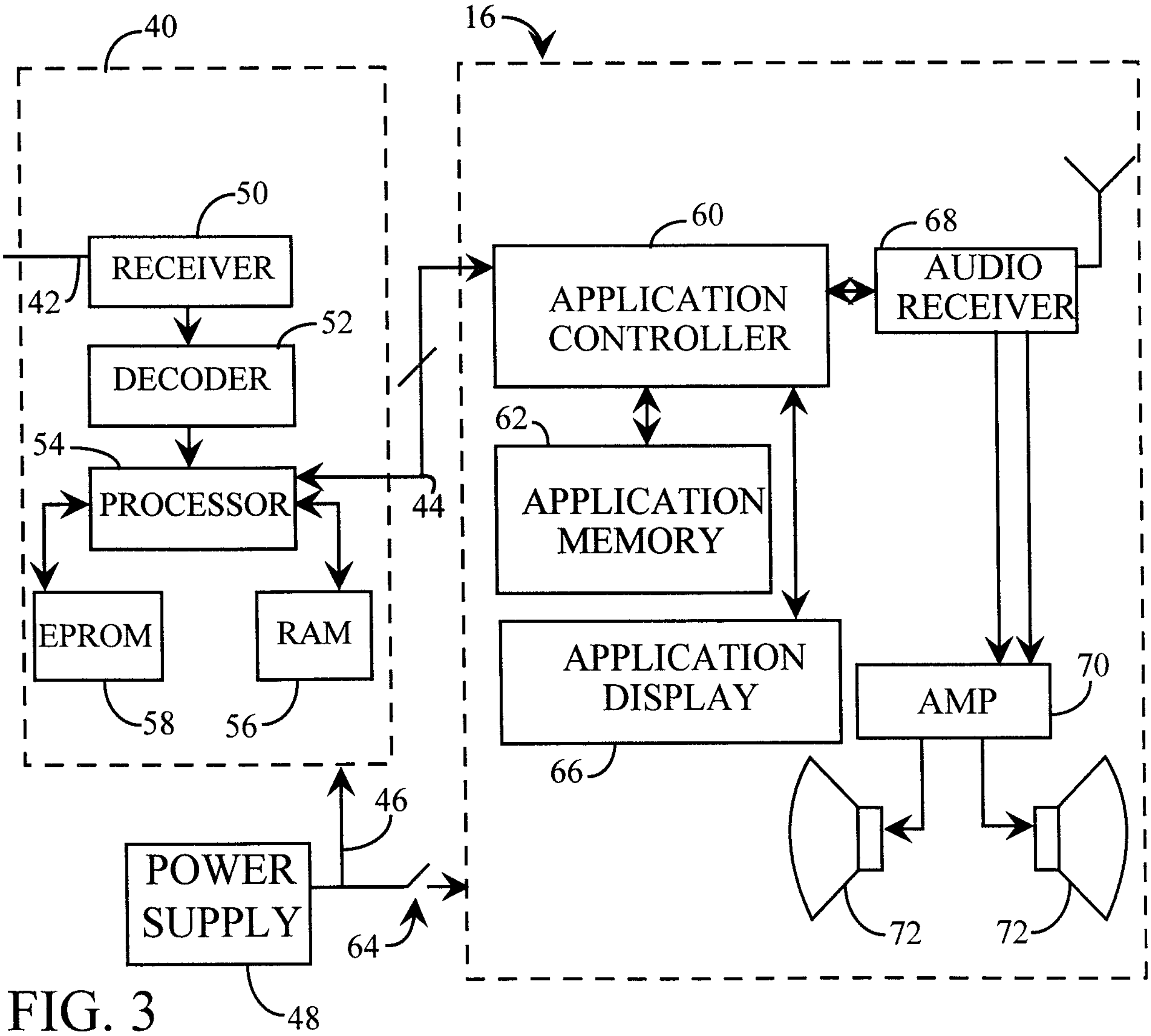
40
16
50
RECEIVER
42
52
DECODER
54
PROCESSOR
44
EPROM
RAM
58
56
46
POWER SUPPLY
48
64
60
APPLICATION CONTROLLER
68
AUDIO RECEIVER
62
APPLICATION MEMORY
APPLICATION DISPLAY
66
70
AMP
72
72

FIG. 3

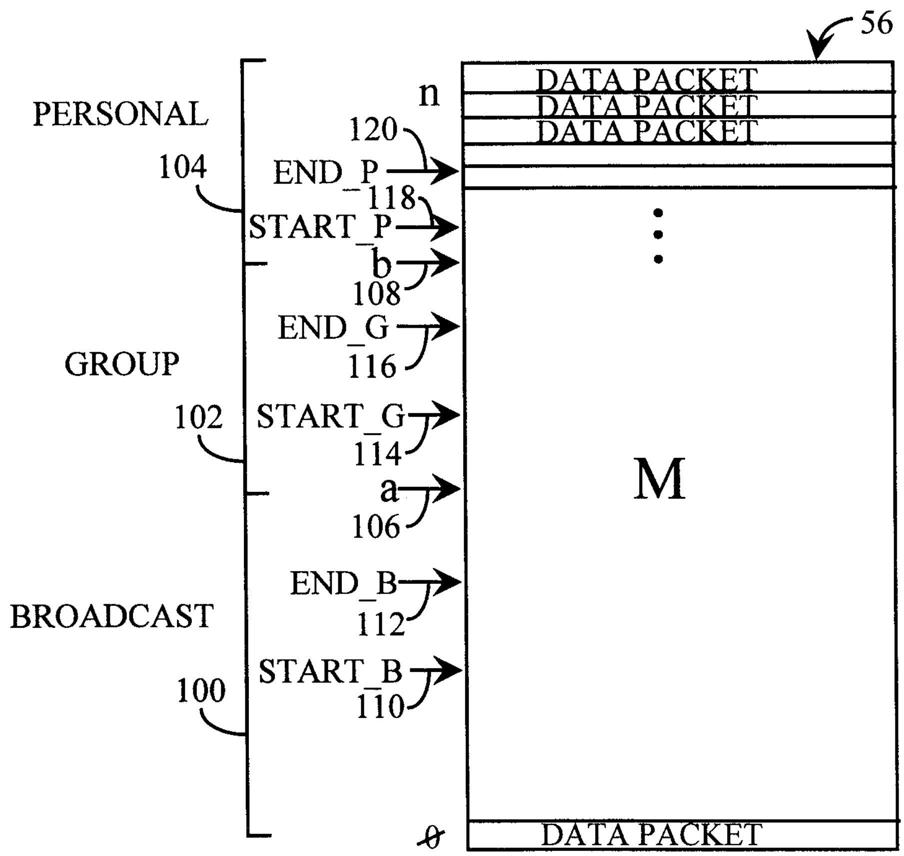
56
DATA PACKET
DATA PACKET
DATA PACKET
n
PERSONAL
104
120
END_P
118
START_P
b
108
END_G
GROUP
116
102
START_G
114
M
a
106
END_B
BROADCAST
112
START_B
100
110
0
DATA PACKET

FIG. 4

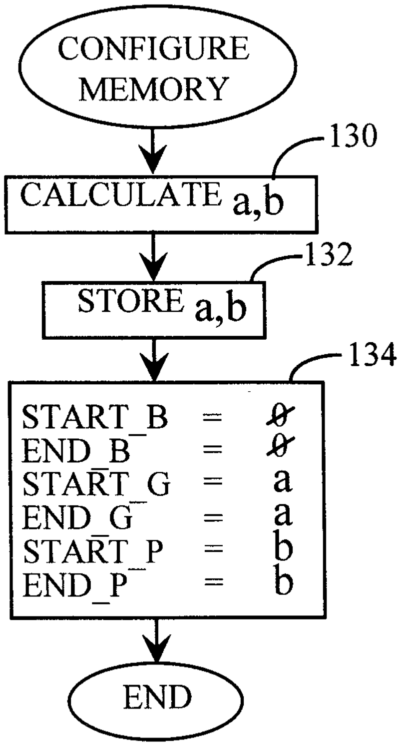
CONFIGURE MEMORY
CALCULATE a,b
130
STORE a,b
132
134
START_B = 0
END_B = 0
START_G = a
END_G = a
START_P = b
END_P = b
END

FIG. 5

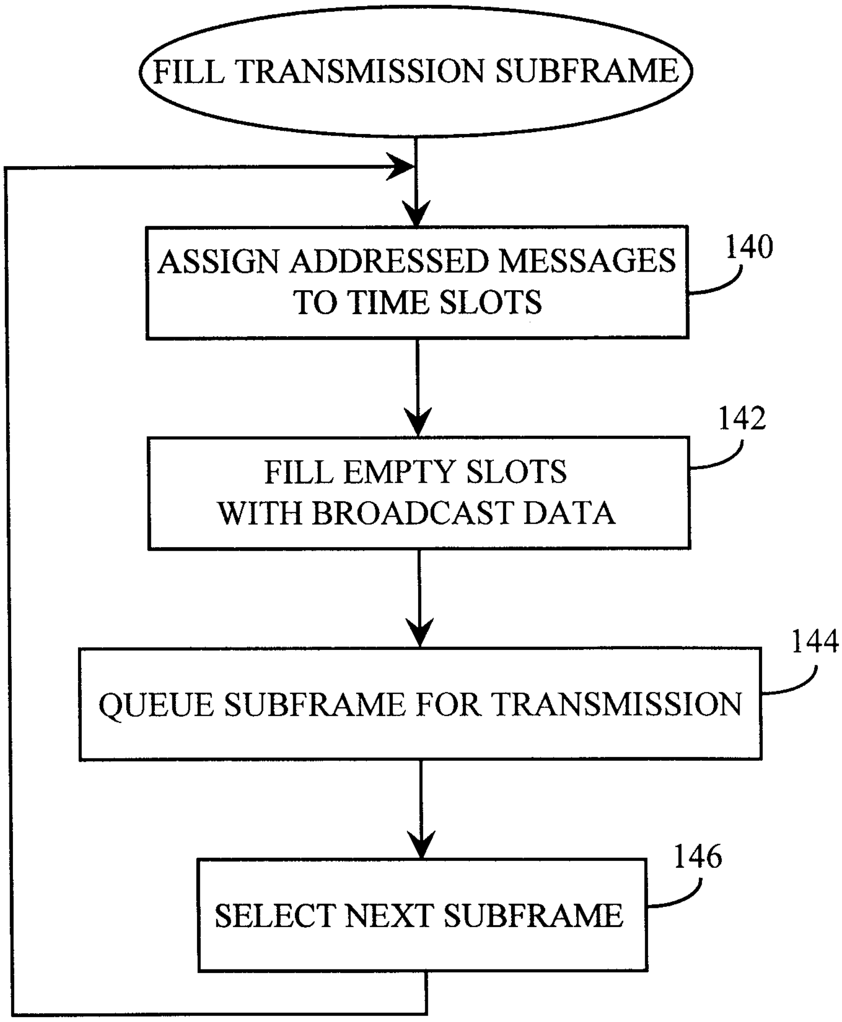
FILL TRANSMISSION SUBFRAME
ASSIGN ADDRESSED MESSAGES TO TIME SLOTS
140
FILL EMPTY SLOTS WITH BROADCAST DATA
142
QUEUE SUBFRAME FOR TRANSMISSION
144
SELECT NEXT SUBFRAME
146

FIG. 6

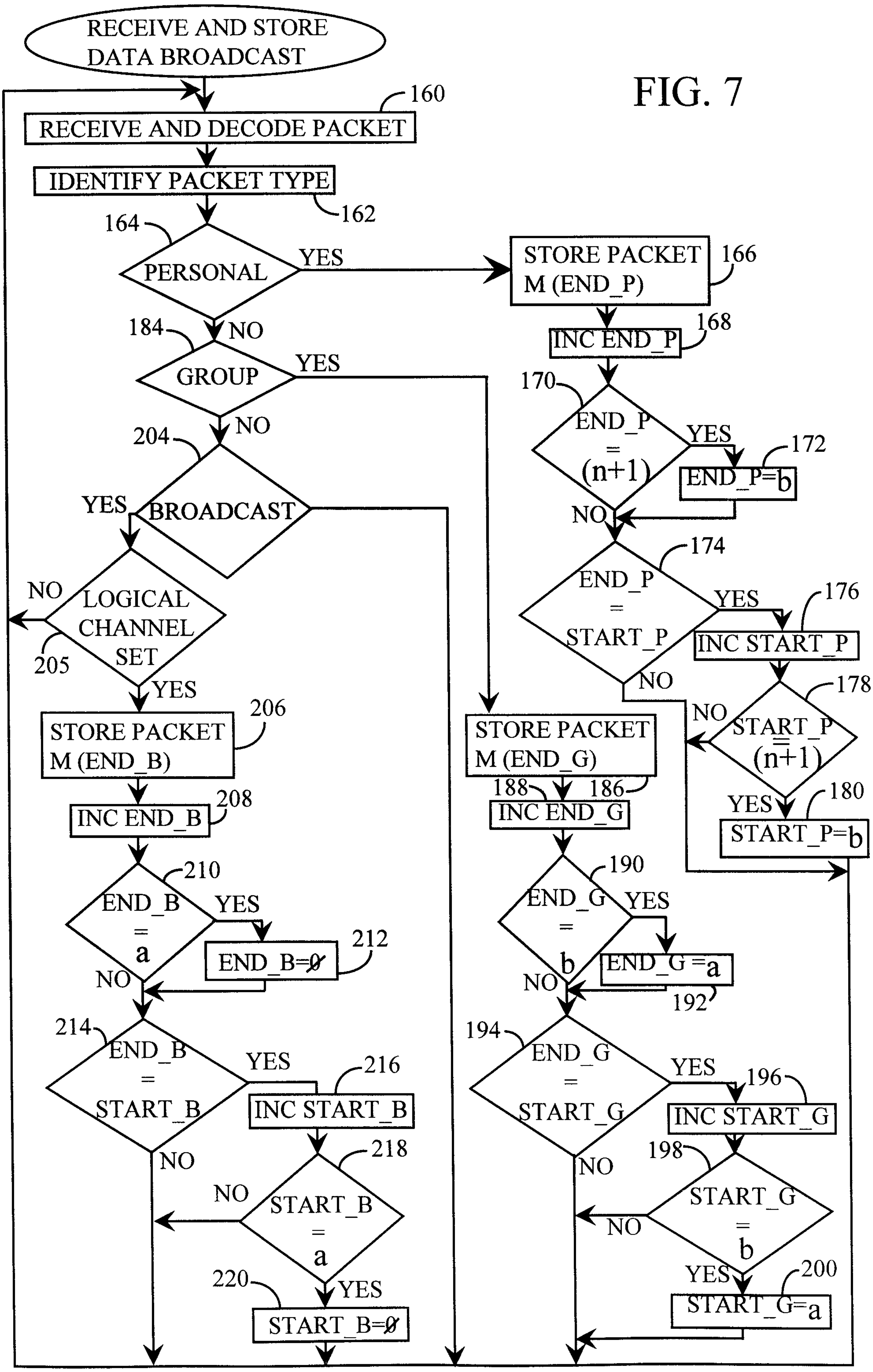
RECEIVE AND STORE DATA BROADCAST
RECEIVE AND DECODE PACKET
160
IDENTIFY PACKET TYPE
162
164
PERSONAL
YES
NO
STORE PACKET M (END_P)
166
INC END_P
168
184
GROUP
YES
NO
170
END_P = (n+1)
YES
END_P=b
172
NO
204
BROADCAST
YES
174
END_P = START_P
YES
INC START_P
176
NO
LOGICAL CHANNEL SET
205
YES
NO
178
START_P = (n+1)
YES
START_P=b
180
STORE PACKET M (END_B)
206
INC END_B
208
STORE PACKET M (END_G)
188
186
INC END_G
210
END_B = a
YES
END_B=0
212
NO
190
END_G = b
YES
END_G =a
192
NO
214
END_B = START_B
YES
INC START_B
216
NO
194
END_G = START_G
YES
INC START_G
196
NO
218
START_B = a
NO
YES
220
START_B=0
198
START_G = b
NO
YES
START_G=a
200

FIG. 7

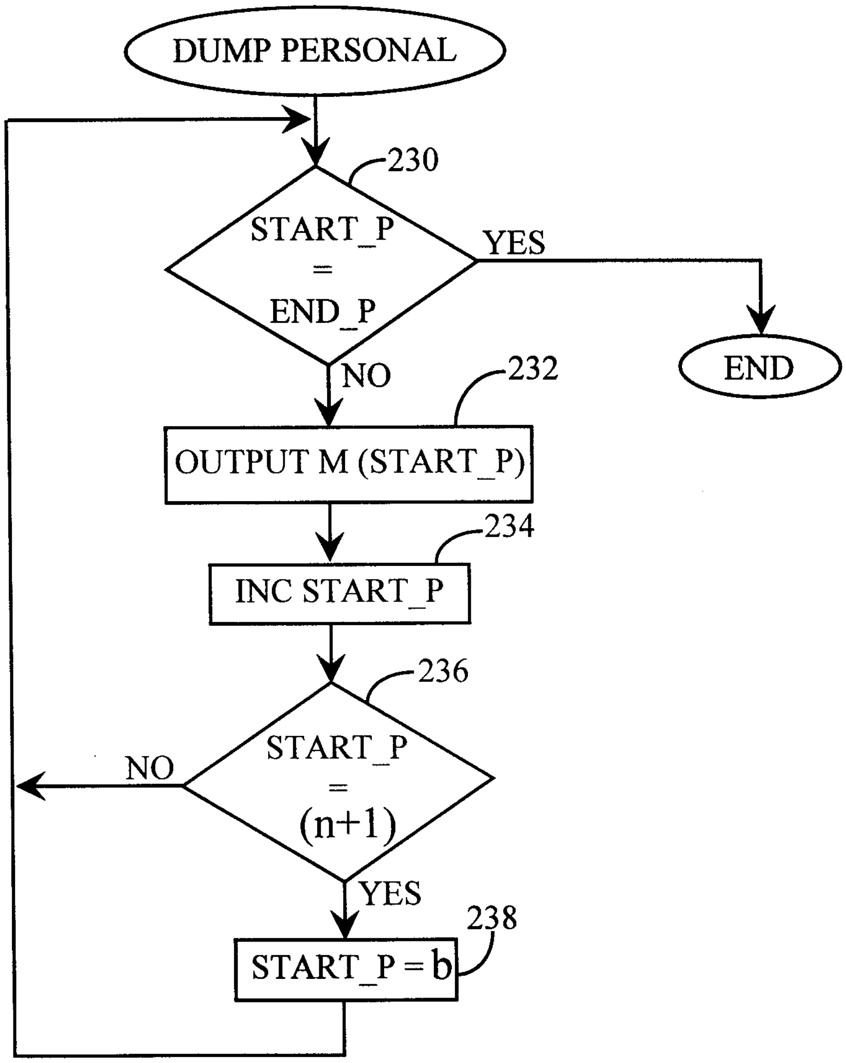
DUMP PERSONAL
230
START_P
=
END_P
YES
END
NO
232
OUTPUT M (START_P)
234
INC START_P
236
START_P
=
(n+1)
NO
YES
238
START_P = b

FIG. 8

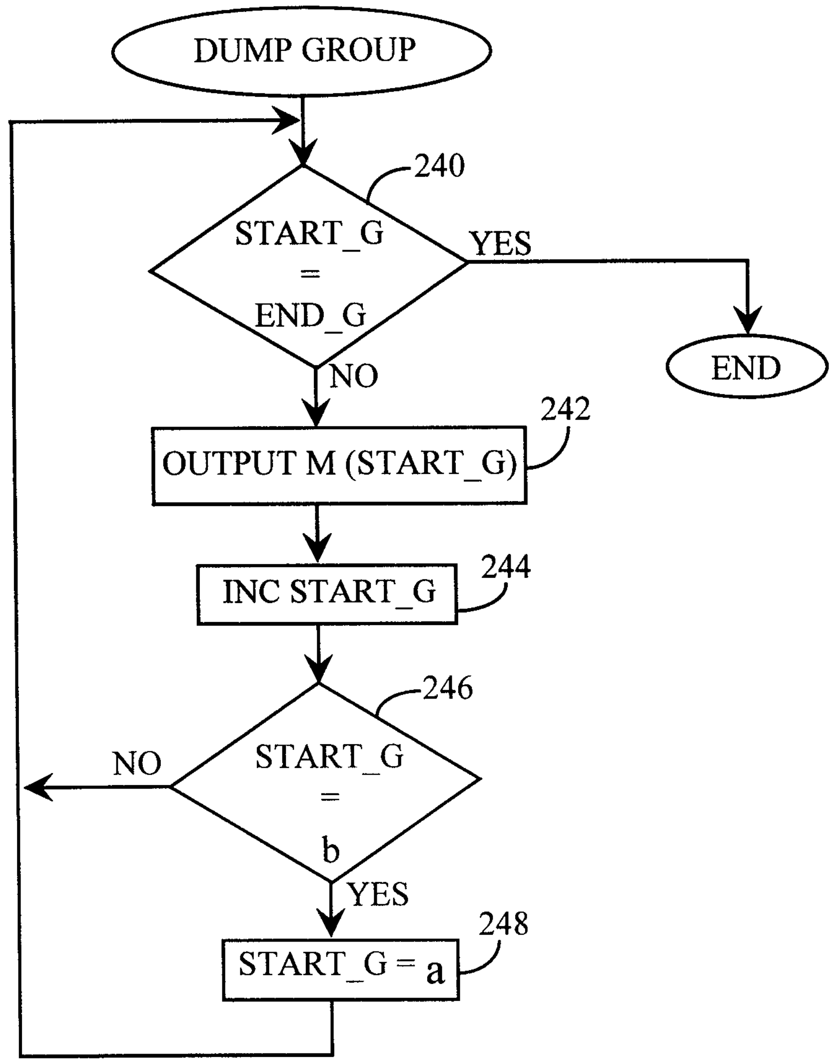
DUMP GROUP
240
START_G = END_G
YES
END
NO
OUTPUT M (START_G)
242
INC START_G
244
246
START_G = b
NO
YES
START_G = a
248

FIG. 9

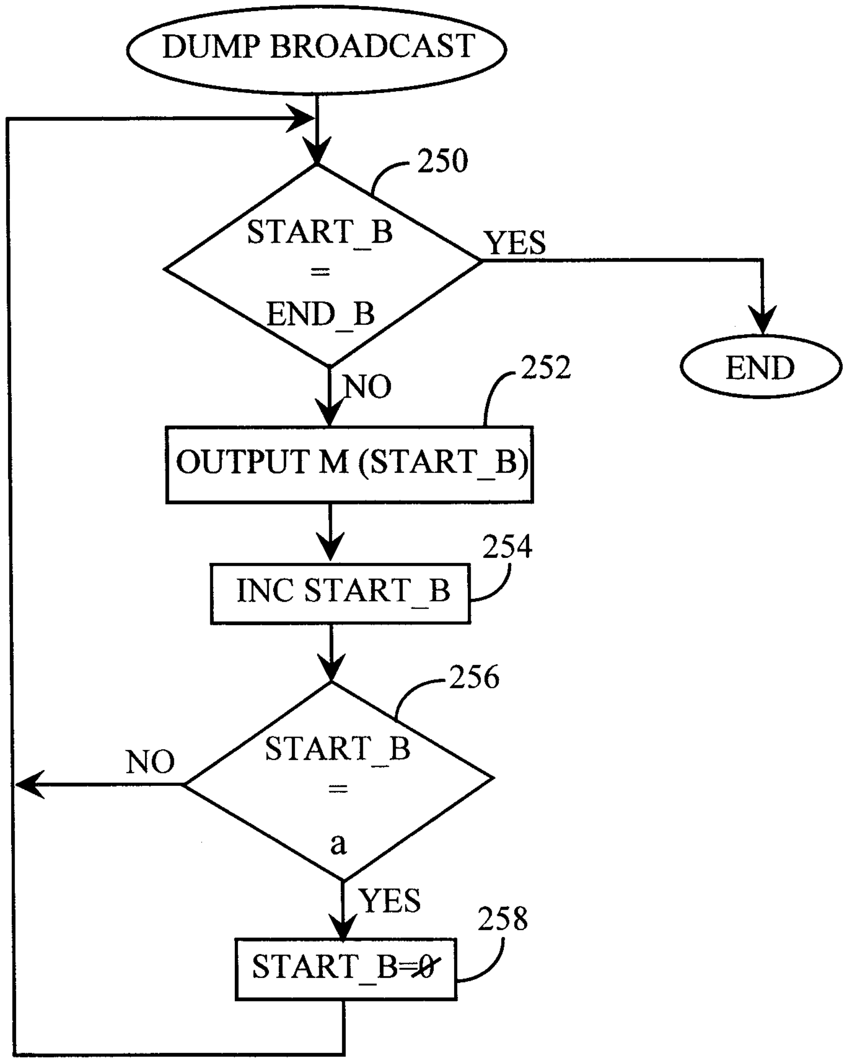
DUMP BROADCAST
250
START_B
=
END_B
YES
END
NO
252
OUTPUT M (START_B)
254
INC START_B
256
START_B
=
a
NO
YES
258
START_B=0

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/24022

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04B 7/00
US CL :455/38.1
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/38.1-38.2, 38.4-38.5, 32.1, 31.1, 185.1-186.1;340/311.1,825.44

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,535,428 A (KING ET AL) 09 JULY 1996, SEE FIGS. 2-3	1-9
Y	US 5,564,073 A (TAKAHISA) 08 OCTOBER 1996, SEE FIGS. 1-9.	1, 5
Y	US 5,241,305 A (FASCENDA ET AL) 31 AUGUST 1993, SEE FIGS. 1 AND 5-9.	1, 5
A,P	US 5,815,170 A (KIMURA ET AL) 29 SEPTEMBER 1998, SEE FIGS. 1-8.	1-9
A,P	US 5,694,120 A (INDEKEU ET AL) 02 DECEMBER 1997, SEE FIGS. 1-4.	1-9
A,P	US 5,694,1/9 A (ONO) 02 DECEMBER 1997, SEE FIGS. 1-6.	1-9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"B"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search
19 JANUARY 1999

Date of mailing of the international search report
30 MAR 1999

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