

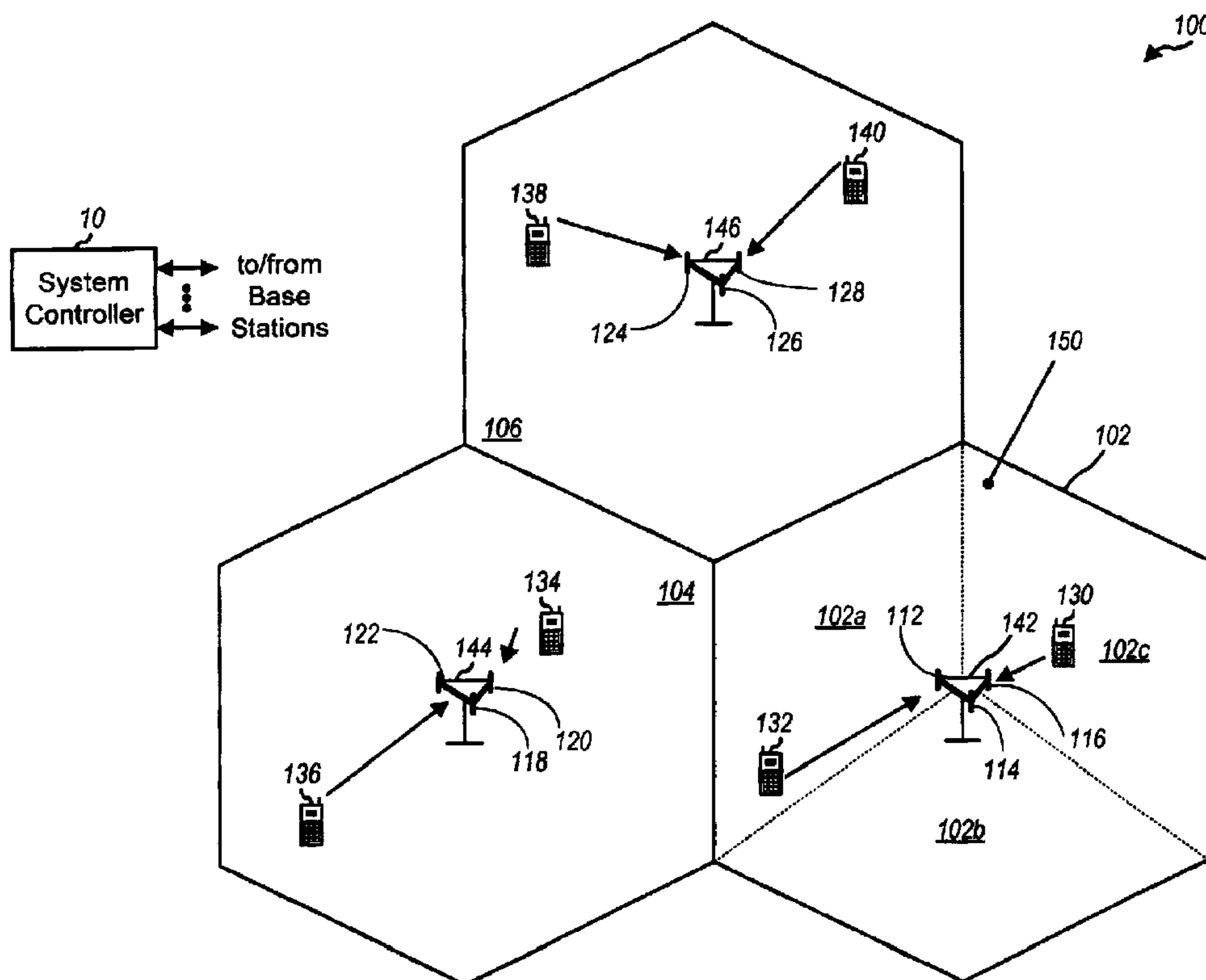


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(54) Title: QUICK PAGING CHANNEL WITH REDUCED PROBABILITY OF MISSED PAGE



(57) Abrégé/Abstract:

Systems and methods of generating quick paging messages having nearly unique identifiers and variable capacity are described. The system generates a quick paging message identifying an access terminal to indicate the presence of a scheduled paging



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

message for that access terminal. The system generates a quick paging notification for each access terminal having a scheduled paging message and generates a compressed nearly unique identifier of each access terminal that is notified in the quick paging message. The compression technique can vary based on the number of bits allocated to the quick paging message as well as the number of access terminals notified in one quick paging message.

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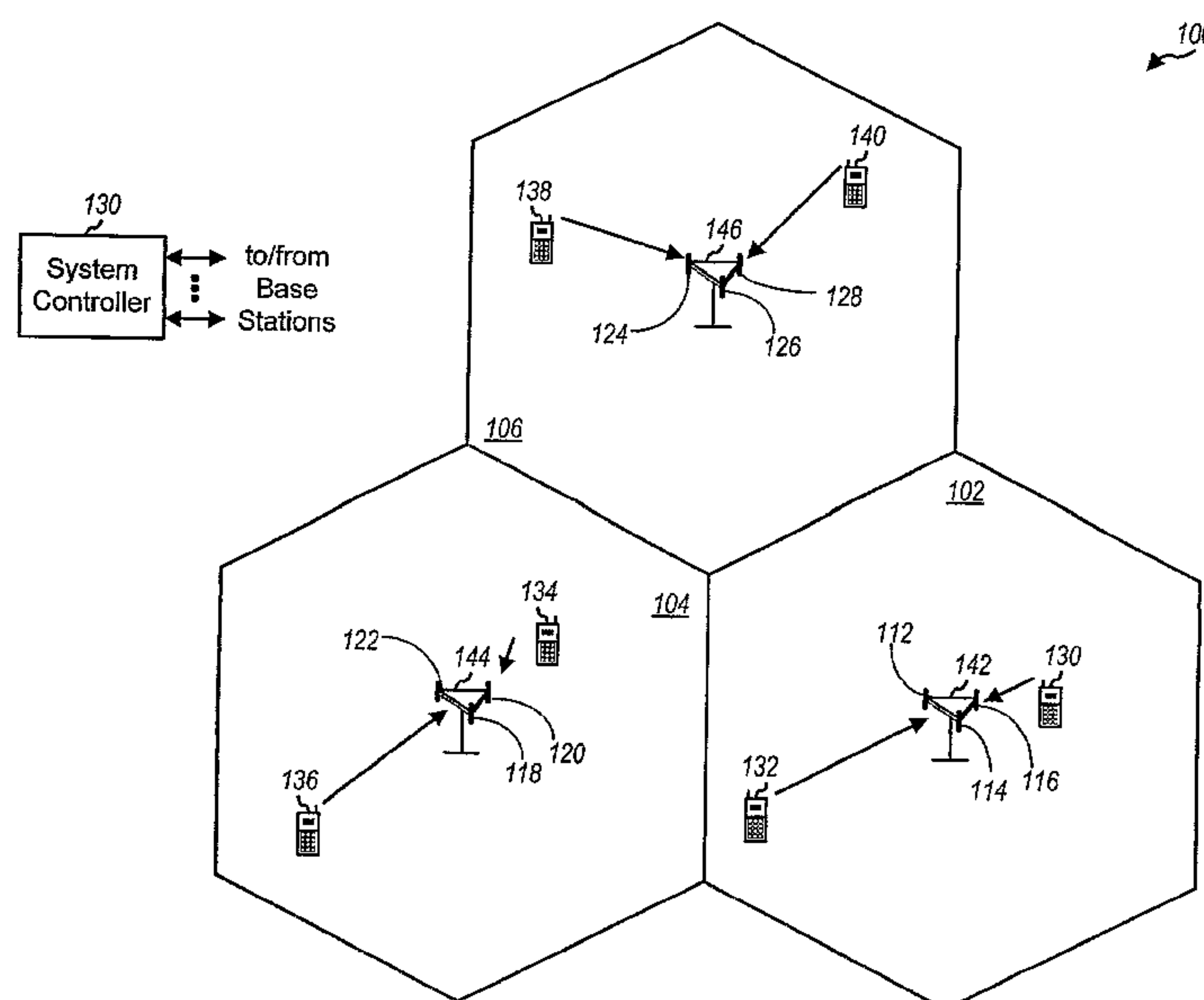
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(54) Title: QUICK PAGING CHANNEL WITH REDUCED PROBABILITY OF MISSED PAGE



(57) Abstract: Systems and methods of generating quick paging messages having nearly unique identifiers and variable capacity are described. The system generates a quick paging message identifying an access terminal to indicate the presence of a scheduled paging message for that access terminal. The system generates a quick paging notification for each access terminal having a scheduled paging message and generates a compressed nearly unique identifier of each access terminal that is notified in the quick paging message. The compression technique can vary based on the number of bits allocated to the quick paging message as well as the number of access terminals notified in one quick paging message.

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QUICK PAGING CHANNEL WITH REDUCED PROBABILITY OF MISSED PAGE

BACKGROUND

[0002] In a random access wireless communication system, a communication link between an access terminal and an access point is not continuous. An access terminal can register with an access point and can remain in an idle state. The access terminal can transition from the idle state to an active state to initiate an active communication link. In the active state, the access terminal is able to receive information from the access point as well as transmit information to the access point.

[0003] For the majority of the time, the access terminal remains in the idle state, awaiting the transition into the active state. The access terminal is typically a mobile device that operates from batteries stored within the device. The access terminals can conserve energy and extend the battery operated run time by transitioning to a low power state, often referred to as a sleep state. However, in many instances, the access terminal cannot immediately transition from the sleep state to the active state.

[0004] The access terminal typically does not have the ability to monitor information transmitted by the access points when it is in the sleep state. Therefore, the access terminals typically periodically transition to an idle state to monitor for messages from the access points.

[0005] Some wireless communication systems incorporate quick paging channels that are used by the access points to indicate the presence of a paging message to an access

terminal. The paging message can direct the particular access terminal to transition to the active state to support active information exchange.

[0006] The wireless communication system can assign a particular bit in a particular message as the quick paging bit for a particular access terminal or group of access terminals. The access terminals can then awaken from a sleep state for a duration that is sufficient to receive the quick paging bit. If the access terminal detects an active quick paging bit, the access terminal becomes aware of a subsequent paging message and can remain in or transition to the idle state to monitor for the paging message. Conversely, if the access terminal fails to detect its assigned quick paging bit, it assumes that there are no imminent paging messages directed to it. In this manner, the access terminals can minimize the time that they need to be in an idle mode, thereby maximizing the time that can be dedicated to a lower power sleep state.

[0007] For example, both CDMA2000 and WCDMA wireless communication systems have a quick paging channel that allows a mobile station to periodically monitor an assigned quick paging bit to detect a presence of a page. When a page is sent to the mobile station, the base station sets the corresponding bit to '1'. If the bit is set, the mobile station, which represents the access terminal, listens to the full page. However, if the access terminal improperly detects the bit to be '0', or determines an erasure indicating the inability to discern the state of the received bit, then a missed page occurs. Therefore, there is a need to reduce the probability of a missed page. However, there remains the need to maintain or increase the battery powered operational time for mobile devices.

BRIEF SUMMARY

[0008] Systems and methods of generating quick paging messages having nearly unique identifiers and variable capacity are described. The system generates a quick paging message identifying an access terminal to indicate the presence of a scheduled paging message for that access terminal. The system generates a quick paging notification for each access terminal having a scheduled paging message and generates a compressed nearly unique identifier of each access terminal that is notified in the quick paging message. The compression technique can vary based on the number of bits

allocated to the quick paging message as well as the number of access terminals notified in one quick paging message.

[0009] Aspects of the disclosure include a method of generating a quick page message in a wireless communication system. The method includes generating a compressed identifier value for at least one access terminal notified in the quick page message, assembling the quick paging message including the compressed identifier, and generating a wireless signal including at least a portion of the quick page message.

[0010] Aspects of the disclosure include a method of generating a quick page message in a wireless communication system. The method includes determining the identity of access terminals scheduled to receive at least one paging message, determining the number of access terminals scheduled to receive at least one paging message, determining a compressed identifier value for each of at least a portion of the access terminals scheduled to receive at least one paging message, and assembling the quick page message based at least in part on the number of access terminals scheduled to receive at least one paging message and the compressed identifier value.

[0011] Aspects of the disclosure include a method of processing a quick page message in a wireless communication system. The method includes receiving a wireless signal having the quick page message, recovering the quick page message from the wireless signal, determining a number of compressed identifier values in the quick page message, and comparing each compressed identifier value from the quick page message with a predetermined compressed identifier value.

[0012] Aspects of the disclosure include an apparatus for generating a quick page message, that includes a paging message counter configured to determine a number of unique access terminals scheduled to receive a paging message, a compressed identifier generator coupled to the paging message counter and configured to generate a compressed identifier for each of at least a subset of the unique access terminals, and a message assembler coupled to the compressed identifier generator and configured to set a count field in the quick page message based on the number of unique access terminals, and further configured to concatenate the compressed identifiers corresponding to each of the subset of unique access terminals.

[0013] Aspects of the disclosure include an apparatus for processing a quick page message that includes a receiver configured to receive a wireless signal having the quick

page message, a receive processor coupled to the receiver and configured to extract the quick page message from the wireless signal, a compressed value module configured to generate a predetermined compressed identifier, and a comparator configured to extract at least one compressed identifier from the quick page message and compare it to the predetermined compressed identifier to determine whether the system is notified of a scheduled paging message.

[0014] Aspects of the disclosure include an apparatus for generating a quick page message, that includes means for generating a compressed identifier value for at least one access terminal notified in the quick page message, means for assembling the quick paging message including the compressed identifier, and means for transmitting a wireless signal including at least a portion of the quick page message.

[0015] Aspects of the disclosure include an apparatus for processing a quick page message that includes means for receiving a wireless signal having the quick page message, means for recovering the quick page message from the wireless signal, means for determining a number of compressed identifier values in the quick page message, and means for comparing each compressed identifier value from the quick page message with a predetermined compressed identifier value.

[0016] Aspects of the disclosure include a processor readable media including instructions that may be utilized by one or more processors. The instructions include instructions for generating a compressed identifier value for at least one access terminal notified in the quick page message, instructions for assembling the quick paging message including the compressed identifier, and instructions for generating a signal including at least a portion of the quick page message, and coupling the signal to a wireless transmitter.

[0017] Aspects of the disclosure include a processor readable media including instructions that may be utilized by one or more processors. The instructions include instructions for receiving a signal having the quick page message, instructions for recovering the quick page message from the signal, instructions for determining a number of compressed identifier values in the quick page message, and instructions for comparing each compressed identifier value from the quick page message with a predetermined compressed identifier value.

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According to one aspect of the present invention, there is provided a method of generating a quick page message in a wireless communication system, the method comprising: generating a compressed identifier value for at least one access terminal to be notified in the quick page message, wherein the compressed
5 identifier value represents a full length identifier that identifies the access terminal, wherein the full length identifier can be determined based on the compressed identifier value; assembling the quick paging message including the compressed identifier based at least in part on a number of access terminals scheduled to receive at least one paging message; and generating a wireless signal including at
10 least a portion of the quick page message.

According to another aspect of the present invention, there is provided a method of generating a quick page message in a wireless communication system, the method comprising: determining the identity of access terminals scheduled to receive at least one paging message; determining the number of access terminals
15 scheduled to receive at least one paging message; determining a compressed identifier value for each of at least a portion of the access terminals scheduled to receive at least one paging message, wherein each compressed identifier value represents a full length identifier that identifies an access terminal, wherein the full length identifier can be determined based on the corresponding compressed
20 identifier value; and assembling the quick page message based at least in part on the number of access terminals scheduled to receive at least one paging message and the compressed identifier value.

According to still another aspect of the present invention, there is provided a method of processing a quick page message in a wireless
25 communication system, the method comprising: receiving a wireless signal having the quick page message; recovering the quick page message from the wireless signal, wherein the quick page message is based at least in part on a number of access terminals scheduled to receive at least one paging message; determining a number of compressed identifier values in the quick page message, wherein each
30 compressed identifier value represents a full length identifier that identifies an access terminal, wherein the full length identifier can be determined based on the

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corresponding compressed identifier value; and comparing each compressed identifier value from the quick page message with a predetermined compressed identifier value.

According to yet another aspect of the present invention, there is provided an apparatus for generating a quick page message, the apparatus comprising: a paging message counter configured to determine a number of unique access terminals scheduled to receive a paging message; a compressed identifier generator coupled to the paging message counter and configured to generate a compressed identifier, wherein each compressed identifier value represents a full length identifier that identifies an access terminal, wherein the full length identifier can be determined based on the corresponding compressed identifier value; and a message assembler coupled to the compressed identifier generator and configured to set a count field in the quick page message based on the number of unique access terminals, and further configured to concatenate the compressed identifiers corresponding to each of the subset of unique access terminals, wherein the message assembler is further configured to set an additional identifier field in the quick page message based in part on the number of unique access terminals scheduled to receive at least one paging message.

According to a further aspect of the present invention, there is provided an apparatus for processing a quick page message, the apparatus comprising: a receiver configured to receive a wireless signal having the quick page message that is based at least in part on a number of access terminals scheduled to receive at least one paging message; a receive processor coupled to the receiver and configured to extract the quick page message from the wireless signal; a compressed value module configured to generate a predetermined compressed identifier; and a comparator configured to extract at least one compressed identifier from the quick page message and compare it to the predetermined compressed identifier to determine whether the apparatus is notified of a scheduled paging message, wherein each compressed identifier value represents a full length identifier that identifies the access terminal, wherein the full length identifier can be determined based on the compressed identifier value.

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According to yet a further aspect of the present invention, there is provided an apparatus for generating a quick page message, the apparatus comprising: means for generating a compressed identifier value for at least one access terminal to be notified in the quick page message, wherein the compressed
5 identifier value represents a full length identifier that identifies the access terminal, wherein the full length identifier can be determined based on the compressed identifier value; means for assembling the quick paging message including the compressed identifier based at least in part on a number of access terminals scheduled to receive at least one paging message; and means for transmitting a
10 wireless signal including at least a portion of the quick page message.

According to still a further aspect of the present invention, there is provided an apparatus for processing a quick page message, the apparatus comprising: means for receiving a wireless signal having the quick page message that is based at least in part on a number of access terminals scheduled to receive
15 at least one paging message; means for recovering the quick page message from the wireless signal; means for determining a number of compressed identifier values in the quick page message, wherein each compressed identifier value represents a full length identifier that identifies an access terminal, wherein the full length identifier can be determined based on the compressed identifier value; and
20 means for comparing each compressed identifier value from the quick page message with a predetermined compressed identifier value.

According to another aspect of the present invention, there is provided a processor readable media including instructions that, when executed by one or more processors, cause the one or more processors to perform a
25 method of generating a quick page message, the method comprising: generating a compressed identifier value for at least one access terminal notified in the quick page message, wherein the compressed identifier value represents a full length identifier that identifies the access terminal, wherein the full length identifier can be determined based on the compressed identifier value; assembling the quick
30 paging message including the compressed identifier based at least in part on a number of access terminals scheduled to receive at least one paging message;

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and generating a signal including at least a portion of the quick page message, and coupling the signal to a wireless transmitter.

According to yet another aspect of the present invention, there is provided a processor readable media including instructions that, when executed by one or more processors, cause the one or more processors to perform a method of generating a quick page message, the method comprising: receiving a signal having the quick page message based at least in part on a number of access terminals scheduled to receive at least one paging message; recovering the quick page message from the signal; determining a number of compressed identifier values in the quick page message, wherein each compressed identifier value represents a full length identifier that identifies an access terminal, wherein the full length identifier can be determined based on the compressed identifier value; and comparing each compressed identifier value from the quick page message with a predetermined compressed identifier value.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The features, objects, and advantages of embodiments of the disclosure will become more apparent from the detailed description set forth below when taken in conjunction with the drawings, in which like elements bear like reference numerals.

[0019] Figure 1 is a simplified functional block diagram of an embodiment of a multiple access wireless communication system.

[0020] Figure 2 is a simplified functional block diagram of an embodiment of a transmitter and receiver in a multiple access wireless communication system.

[0021] Figure 3 is a simplified functional block diagram of an embodiment of a system for generating and transmitting a quick page message.

[0022] Figure 4 is a simplified functional block diagram of an embodiment of a receiver configured to process the quick paging message.

[0023] Figure 5 is a simplified flowchart of an embodiment of a method of generating a quick page message.

[0024] Figure 6 is a simplified flowchart of an embodiment of a method of processing a quick page message.

[0025] Figure 7 is a simplified functional block diagram of an embodiment of a system for generating and transmitting a quick page message.

[0026] Figure 8 is a simplified functional block diagram of an embodiment of a receiver configured to process the quick page message.

DETAILED DESCRIPTION

[0027] A wireless communication system can reduce the probability of missed pages while decreasing the power consumption of an average access terminal through strategic planning and implementation of the number of bits and arrangement of the information supplied in the quick paging message. The wireless communication system can increase the number of bits in the quick paging message identifying each access terminal that is notified of a paging message.

[0028] The wireless communication system can identify the access terminal via a unique access terminal identifier, or a compressed version of the unique identifier. If

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the wireless communication system utilizes the complete unique identifier in the quick paging channel, there is a reduced probability that an access terminal other than the desired access terminals will remain active to monitor the paging message. However, the length of the quick paging message needed to contain all of the unique identifiers notified during a particular quick paging message may be relatively long, and all of the access terminals monitoring the quick paging message need to remain active for the duration needed to monitor the contents of the quick paging message. In such a situation, the average power consumption the access terminals save by not monitoring for paging messages directed to other access terminals may be consumed monitoring lengthy quick paging messages.

[0029] In one embodiment, the wireless communication system generates a compressed version of the unique access terminal identifiers for inclusion in the quick paging message. The compressed identifiers corresponding to the access terminals scheduled for paging messages are included in the quick paging message. The quick paging message can include a field that identifies the number of quick page messages.

[0030] The wireless communication system can generate a quick page message with a constant compressed identifier length and a quick page message length that varies according to the number of quick page messages. Alternatively, the wireless communication system can generate a quick page message that has a variable compressed identifier length and a constant quick page message length. In both embodiments, the wireless communication system may have a maximum number of quick page messages that can populate the quick page message. The wireless communication system can implement a field that identifies additional pages to inform the access terminals monitoring the quick page message that there were more quick pages than could be populated in the quick page message.

[0031] Figure 1 is a simplified functional block diagram of an embodiment of a multiple access wireless communication system 100. A multiple access wireless communication system 100 includes multiple cells, e.g. cells 102, 104, and 106. In the embodiment of Figure 1, each cell 102, 104, and 106 may include an access point 150, as shown in cell 102, for example, that includes multiple sectors.

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FIG. 1 shows an exemplary system controller 10 in the system 100 that may, in addition to other functions, communicate with Base Stations. For example, the system controller 10 may send communications to Base Stations and/or it may retrieve communications from Base Stations, as shown in FIG. 1.

5 **[0032]** The multiple sectors are formed by groups of antennas each responsible for communication with access terminals in a portion of the cell. In cell 102, antenna groups 112, 114, and 116 each correspond to a different sector. For example, cell 102 is divided into three sectors, 102a-102c. A first antenna 112 serves a first sector 102a, a second antenna 114 serves a second sector 102b,
10 and a third antenna 116 serves a third sector 102c. In cell 104, antenna groups 118, 120, and 122 each correspond to a different sector. In cell 106, antenna groups 124, 126, and 128 each correspond to a different sector.

[0033] Each cell is configured to support or otherwise serve several access terminals which are in communication with one or more sectors of the
15 corresponding access points. For example, access terminals 130 and 132 are in communication with access point 142, access terminals 134 and 136 are in communication with access point 144, and access terminals 138 and 140 are in communication with access point 146. Although each of the access points 142, 144 and 146 is shown to be in communication with two access terminals, each
20 access point 142, 144 and 146 is not limited to communicating with two access terminals and may support any number of access terminals up to some limit that may be a physical limit, or a limit imposed by a communications standard.

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[0034] As used herein, an access point may be a fixed station used for communicating with the terminals and may also be referred to as, and include some or all the functionality of, a base station, a Node B, or some other terminology. An access terminal (AT) may also be referred to as, and include some or all the functionality of, a user equipment (UE), a user terminal, a wireless communication device, a terminal, a mobile terminal, a mobile station or some other terminology.

[0035] Each access point, for example 142, generates a quick paging message based on the identities of access terminals within the coverage area that are scheduled to receive paging messages. The access point 142 can generate a compressed identifier for each scheduled access terminal. For example, the access point 142 can generate a hash of the access terminal identifier and populate the quick page message with the hash value.

[0036] An access point, for example 142, may broadcast a frame or block having the quick paging message. Each of the access terminals, 130 and 132 within the coverage area of the access point 142 can receive the quick paging message and process it to determine if an associated quick paging indicator is asserted, indicating the presence of a paging message directed to the access terminal.

[0037] The above embodiments can be implemented utilizing transmit (TX) processor 220 or 260, processor 230 or 270, and memory 232 or 272, as shown in Figure 2. The processes may be performed on any processor, controller, or other processing device and may be stored as computer readable instructions in a computer readable medium as source code, object code, or otherwise.

[0038] Figure 2 is a simplified functional block diagram of an embodiment of a transmitter and receiver in a multiple access wireless communication system 200. At transmitter system 210, traffic data for a number of data streams is provided from a data source 212 to a transmit (TX) data processor 214. In an embodiment, each data stream is transmitted over a respective transmit antenna. TX data processor 214 formats, codes, and interleaves the traffic data for each data stream based on a particular coding scheme selected for that data stream to provide coded data. In some embodiments, TX data processor 214 applies beamforming weights to the symbols of the data streams based upon the user to which the symbols are being transmitted and the antenna from which the symbol is being transmitted. In some embodiments, the beamforming weights may be generated based upon channel response information that is indicative of the condition of the transmission paths between the access point and the access terminal. The channel response information may be generated utilizing CQI information or channel estimates provided by the user. Further, in those cases of scheduled transmissions, the TX data processor 214 can select the packet format based upon rank information that is transmitted from the user.

[0039] The coded data for each data stream may be multiplexed with pilot data using OFDM techniques. The pilot data is typically a known data pattern that is processed in a known manner and may be used at the receiver system to estimate the channel response. The multiplexed pilot and coded data for each data stream is then modulated (i.e., symbol mapped) based on a particular modulation scheme (e.g., BPSK, QPSK, M-PSK, or M-QAM) selected for that data stream to provide modulation symbols. The data rate, coding, and modulation for each data stream may be determined by instructions provided by processor 230. In some embodiments, the number of parallel spatial streams may be varied according to the rank information that is transmitted from the user.

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[0040] The modulation symbols for all data streams are then provided to a TX MIMO processor 220, which may further process the modulation symbols (for example, for OFDM). TX MIMO processor 220 then provides N_T symbol streams to N_T transmitters (TMTR) 222a through 222t. In certain embodiments, TX MIMO processor 220 applies beamforming weights to the symbols of the data streams based upon the user to which the symbols are being transmitted and the antenna from which the symbol is being transmitted from that users channel response information.

[0041] Each transmitter 222a through 222t receives and processes a respective symbol stream to provide one or more analog signals, and further conditions (e.g., amplifies, filters, and upconverts) the analog signals to provide a modulated signal suitable for transmission over the MIMO channel. N_T modulated signals from transmitters 222a through 222t are then transmitted from N_T antennas 224a through 224t, respectively.

[0042] At receiver system 250, the transmitted modulated signals are received by N_R antennas 252a through 252r and the received signal from each antenna 252 is provided to a respective receiver (RCVR) 254. Each receiver 254 conditions (e.g., filters, amplifies, and downconverts) a respective received signal, digitizes the conditioned signal to provide samples, and further processes the samples to provide a corresponding "received" symbol stream.

[0043] An RX data processor 260 then receives and processes the N_R received symbol streams from N_R receivers 254 based on a particular receiver processing technique to provide the rank number of "detected" symbol streams. The processing by RX data processor 260 is described in further detail below. Each detected symbol stream includes symbols that are estimates of the modulation symbols transmitted for the corresponding data stream. RX data processor 260 then demodulates, deinterleaves, and decodes each detected symbol stream to recover the traffic data for the data stream. The processing by RX data processor 260 is complementary to that performed by TX MIMO processor 220 and TX data processor 214 at transmitter system 210. Data may be further output by the RX data processor 260 to a data sink 264.

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[0044] At transmitter system 210, the modulated signals from receiver system 250 are received by antennas 224, conditioned by receivers 222, demodulated by a demodulator 240, and processed by a RX data processor 242 to recover the CQI reported by the receiver system. Data may be further output
5 by the RX data processor 242 to a data sink 244. The reported CQI is then provided to processor 230 and used to (1) determine the data rates and coding and modulation schemes to be used for the data streams and (2) generate various controls for TX data processor 214 and TX MIMO processor 220.

[0045] In the multiple access wireless communication system 200 of
10 Figure 2, the TX data processor 214, in combination with the processor 230 and memory 232, can operate to determine the number of scheduled paging messages corresponding to the receiver systems 250 in the coverage area. The TX data processor 214 can be configured to generate a hash value based on a unique access terminal identifier for each scheduled receiver system 250. The TX data
15 processor 214 can generate a quick paging message that includes the number of receiver systems 250 identified in the quick paging message, and the hash values corresponding to each scheduled receiver system 250.

[0046] Each receiver system 250 can operate to receive the quick paging message and recover the corresponding hash values. The RX processor 260, in
20 combination with the processor 270 and memory 272, can determine whether any hash value in the quick paging message identifies the receiver system 250. The receiver system 250 can monitor for paging messages if it is identified by the hash value. Alternatively, the receiver system 250 can transition to a sleep state and can wait for the next scheduled quick page message if its hash value is not
25 included in the quick page message. In addition, the receiver system 250 may include a Data Source 276, TX Data Processor 278 and Modulator 280 for further receipt and processing of data, as shown in FIG. 2.

[0047] Figure 3 is a simplified functional block diagram of an embodiment of a system 300 for generating and transmitting a page message. The system 300
30 can be, for example, a portion of a transmitter system of Figure 2, or a portion of an access point shown in Figure 1.

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[0048] The simplified functional block diagram of Figure 3 illustrates only a portion of the system associated with generating and transmitting the quick paging message. The simplified functional block diagram does not show related blocks such as those associated with generating or mapping the paging messages that are associated with access terminals identified in the quick paging message and does not show scheduling, processing and transmitting of data, information, or other traffic that can be communicated to an access terminal.

[0049] The system 300 embodiment of Figure 3 includes a timing and synchronization module 302 coupled to a scheduler 304. The scheduler 304 is coupled to a quick page message generator 310, and initiates generation of the quick page message. The quick page message generator 310 optionally couples the quick page

message to an encoder 320. The encoder 320 operates to encode the bits of the quick page message to produce an encoded quick page message. The encoded output is coupled to a TX MIMO processor 330. The TX MIMO processor 330 couples the signal to a transmitter stage 340 that transmits the signal using an antenna 344.

[0050] The timing and synchronization module 302 tracks the timing of the bits, frames, blocks, or packets received and generated by the system 300. In one embodiment, the timing and synchronization module 302 maintains bit synchronization, such that the bits generated by the system 300 have substantially the same period. The timing and synchronization module 302 can also synchronize and track slot and frame timing, where each frame includes a predetermined number of bits. In an OFDM system, a slot may include one or more OFDM symbols, and a frame can include one or more slots.

[0051] A superframe can include a predetermined number of frames. Additionally, specific frames within the superframe can be dedicated to particular information. For example, each superframe can include a preamble of a predetermined length, such as six frames or six OFDM symbols.

[0052] The superframe preamble can be used to populate a broadcast channel that is transmitted to all access terminals within a coverage area of an access point. One portion of the superframe preamble can be allocated to a quick paging channel (QPCH) used to convey the quick page message. For example, the Quick page message can be one frame or OFDM symbol within the superframe preamble. The length of the superframe preamble can be static or can be varied based on the size of the information block allocated to the quick page message.

[0053] In one embodiment, the number of bits allocated to the quick page message is static. In another embodiment, the number of bits allocated to the quick page message is dynamic and determined based at least in part on the number of access terminals that need to be notified in the quick page message. Where the number of bits allocated to the quick page message is dynamic, the system 300 can allocate a number of bits by selecting one of a predetermined set of packet lengths. Alternatively, the system 300 can be configured to allocate any number of bits to the quick page message within a predetermined range or in increments of a single bit.

[0054] The system 300 can be configured to send the size of the quick page message within a field of the message or some other message. In an embodiment, the system 300 does not send the size of the quick page message and relies on the receiver to determine the size of the packet.

[0055] The timing and synchronization module 302 is coupled to a scheduler 304. The scheduler 304 tracks the communication links and information that is to be transmitted by the system 300, and schedules the information, based in part on the system timing. In one embodiment, the scheduler 304 determines that the wireless communication system is attempting to set up an active communication session with an access terminal that is presently in an idle state.

[0056] The quick page message generator 310 determines from the scheduler 304 which of the access terminals within the coverage area of the system 300 are scheduled to receive a page message. The quick page message generator 310 includes a paging message counter 312, an Access Terminal Identification Hash generator 314, and a message assembler 316.

[0057] The paging message counter 312 determines, based on the scheduler 304, the number of access terminal paging messages that are scheduled to be transmitted during the present superframe or other quick page period. The paging message counter 312 determines the number of distinct access terminals that are scheduled to receive paging messages. This number may be used in the quick page message generator 310 for a variety of reasons.

[0058] In an embodiment in which the length of the quick page message is variable, the number of access terminals notified in the quick page messages can be indicative of the length of the quick page message and the number can be included within a field of the quick page message. In an embodiment in which the length of the quick page message is static, the number of bits that are used to identify the access terminals in the quick page message can vary based on the number of access terminals notified in the quick page message. The number of access terminals notified in the quick page message can be included in a field of the quick page message to inform the access terminals of the manner in which the access terminals are identified.

[0059] The Access Terminal Identifier Hash (ATIH) generator 314 is configured to generate a compressed version of an access terminal identifier. Although the following

embodiments describe the compression function as a hash function, the ATIH generator 314 can be virtually any type of compressed identifier generator and can compress the ATI values or some other access terminal identifier using any mapping or algorithm that results in fewer bits.

[0060] Each access terminal has a unique identifier referred to as the access terminal identifier (ATI). If the ATI of the access terminal is carried in the page message, the access terminal knows that the network has data to send.

[0061] The ATIH generator 314 is configured to determine an N bit hash of an ATI, referred to as the ATIH (e.g. $ATIH = HashFunction(ATI)$). In some embodiments, the ATI may be 48 to 128 bits long, while N may be 8 bits. The mapping of the ATI to the ATIH may not be unique, because the ATIH generator 314 may compress the ATI to a representation having fewer bits. The amount of compression performed on the ATI, also referred to as the compression ratio, affects the number of potential access terminal ATI values that will map to the same ATIH.

[0062] The ATIH generator 314 can reserve one or more ATIH values such that no ATI values map to the reserved ATIH values. For example, the ATIH generator 314 may reserve the ATIH value of zero in order to indicate the condition in which no access terminals are to be notified. The ATIH generator 314 can be assured that the no access terminal ATI values will inadvertently map to the zero value by reserving the zero ATIH value.

[0063] If the ATIH of the access terminal is carried in the quick page message, the access terminal determines that the network may have a page to send, and the access terminal monitors the page message for a page directed to it. In contrast, if the ATIH is not carried in the quick page message, the access terminal may conserve power by not reading the page message and may instead transition to a low power sleep state.

[0064] The non-unique mapping of the ATI to ATIH values can cause quick page collisions, where two different access terminals have the same ATIH. In such a situation, the non-unique ATIH included in a quick page message causes more than one access terminal to monitor the page message although there is only a page message for one of the access terminals having the ATIH value. For example, if the ATIH generator 314 generates the same ATIH for two distinct access terminals, AT1 and AT2, and this ATIH is carried in the quick page message, both AT1 and AT2 will monitor the page

message. However, the actual page message may contain only a page for AT1 and not for AT2.

[0065] In an embodiment in which the length of the quick page message is variable, the ATIH generator 314 generates an ATIH value according to a predetermined algorithm. The ATIH generator 314 generates the ATIH corresponding to the ATI for each access terminal to be notified in the quick page message. There may be a practical limit to the length of the quick page message. Therefore, the system 300 may define a maximum number of access terminals that can be expressly identified in the quick page message.

[0066] In an embodiment in which the length of the quick page message is static, the ATIH generator 314 generates an ATIH value based in part on the number of access terminals to be notified in the quick page message. The ATIH generator 314 performs a variable compression of the ATI values, and the rate of compression varies depending at least on the number of access terminals notified in the quick page message. When there are fewer access terminals notified in a quick page message, it may be advantageous for the ATIH generator to use a lower compression ratio in order to decrease the probability of a quick page collision. In some instances, the ATIH generator 314 need not even compress the ATI value, and the ATI and ATIH can be the same value. As the number of access terminals notified in the quick page message increases, the ATIH generator 314 can increase the compression ratio such that the total number of bits in the quick page message used to identify access terminals is approximately the same.

[0067] For example, the system 300 may allocate a fixed number of bits, N_{QP_BLK} to the quick page message. Furthermore, a particular field in the quick page message dedicated to ATIH values can have a maximum length, for example, 35 bits. If the paging message counter 312 determines that only one access terminal needs to be notified in the quick page message, the ATIH generator 314 can generate an ATIH that has less than or equal to 35 bits. If the paging message counter 312 determines that two access terminals are to be notified, the ATIH can be configured to generate ATIH values that have no greater than 17 bits each. Similarly, to notify three access terminals in the quick page message, the ATIH generator 314 generates ATIH values having no greater than 11 bits each. There may be a practical limit to the compression ratio applied by the

ATIH generator 314. Therefore, the system 300 may set a maximum number of access terminals that can be expressly identified in the quick page message.

[0068] As noted above, regardless of whether the quick page message has a static or a dynamic length, the system 300 may define a maximum number of access terminals that can be expressly identified in the quick page message. That is, the quick page message may be sent over a Quick Paging channel that has a limited capacity, e.g. Q bits. There may be some instances in which the paging message counter 312 determines that the number of access terminals to be notified is greater than the maximum number that can be expressly notified. In such a situation, the quick page message can include a field that identifies that there are more quick page notifications than could be contained in the quick page message. Such a field may be referred to as a 'more' or 'additional identifier' field.

[0069] The 'more' field can be one or more bits that, when asserted, indicate that there are more quick pages than could be represented in the quick page message. In such a situation, access some terminals that are not expressly notified may choose to monitor the paging channel for the paging message. In order to minimize the number of non-identified access terminals that need to monitor the paging channel, the quick page message can be populated with the lowest value ATIH values. Then, if the 'more' field is asserted, only those access terminals having an ATIH value greater than the largest ATIH value included in the quick page message need monitor the paging channel for the paging message.

[0070] The ATIH generator 314 can be configured to generate less than or equal to the maximum number of ATIH values. In one embodiment, the ATIH generator 314 generates the ATIH values for the access terminals having the lowest ATIH values. In another embodiment, the ATIH generator 314 generates ATIH values for all access terminals scheduled for paging messages, and another module determines which of the ATIH values to populate the quick page message.

[0071] The message assembler 316 operates to assemble the quick page message based on the number determined by the paging message counter 312. The message assembler 316 populates a field identifying the number of access terminals. If the number of access terminals is greater than the predetermined maximum number, the message assembler 316 uses the value corresponding to the maximum number.

[0072] The message assembler 316 also populates an ATIH field in the quick page message identifying the access terminals. If the number of access terminals to be notified in the quick page message is less than or equal to the maximum number, including zero, the message assembler 316 concatenates the ATIH values corresponding to the access terminals. The message assembler 316 clears the 'more' field, which can be a single bit.

[0073] If the number of access terminals to be notified in the quick page message is greater than the maximum number, the message assembler 316 concatenates the maximum number of ATIH values selected from the lowest ATIH values. The message assembler 316 can sort the ATIH values and populate the quick page message in order of increasing ATIH values. The message assembler 316 asserts the 'more' field.

[0074] The message assembler 316 can zero pad or otherwise populate the quick page message in order to obtain a desired message length. Where the ATIH generator 314 generates differing ATIH values depending on the number of access terminals notified in the quick page message, the message assembler 316 can zero pad the quick page message to provide a consistent quick page message length.

[0075] The encoder 320 is optional and may be omitted from some systems 300. The encoder 320 operates to encode the quick page message. The encoder 320 can implement virtually any type of encoding, and can implement, for example, systematic encoding, block coding, convolutional encoding, turbo encoding, and the like, or some combination thereof. The output of the encoder 320 is an encoded quick page message.

[0076] In one embodiment, the encoder 320 implements a systematic code, such that the redundant bits are appended to the end of the unmodified quick page message. A systematic code can generate, for example, a Cyclic Redundancy Code (CRC), a syndrome, a parity bit, or some other code bits that provide a level of redundancy.

[0077] The encoder 320 couples the encoded quick page message to the TX MIMO Processor 330. In one embodiment, the TX MIMO Processor 330 processes the encoded quick page message and produces an OFDM symbol having the complete encoded quick page message. The TX MIMO Processor 330 can generate the OFDM symbol by allocating the quick page message information across all of the OFDM subcarriers, or across a predetermined subset of all of the subcarriers. For example, the TX MIMO Processor 330 can modulate the quick page message onto all subcarriers

allocated to carrying information. In such an embodiment, the symbol having the quick page message is time division multiplexed with other channels in the OFDM system.

[0078] In some embodiments, the TX MIMO Processor 330 may be able to modulate the Quick page message onto the subcarriers using any one of a predetermined set of modulation types. In an embodiment, the TX MIMO Processor 330 uses QPSK modulation for all the modulation symbols of the QPCH. In other embodiments, the TX MIMO Processor 330 may use some other type of modulation, such as BPSK.

[0079] In another embodiment, the Quick page message information is allocated to a logical channel that is mapped to fewer than all of the subcarriers in the OFDM system. In such an embodiment, the logical channel to physical subcarrier mapping can be static or can be dynamic.

[0080] If the multiple access wireless communication system employs frequency hopping (FH), the quick paging channel (QPCH) can be assigned as a logical channel, sometimes referred to as a hop port, and the logical channel can be mapped to physical channels according to a predetermined frequency hopping algorithm. Thus, in a frequency hopping OFDMA system, the physical subcarrier frequencies assigned to the logical channels change over time. For example, the frequency hopping algorithm can periodically update the logical channel to physical subcarrier mapping, for example, each OFDM symbol, each slot, or following some other predetermined number of OFDM symbols.

[0081] The TX MIMO Processor 330 couples the OFDM symbol to the transmitter stage 340. The transmitter stage 340 transmits the symbol including the quick page message using the antenna 344.

[0082] In the embodiments described above, the transmitter broadcasts the quick page message in an OFDM symbol occurring during a preamble portion of a superframe. The transmitter broadcasts the OFDM symbol to all of the access terminals in the coverage area.

[0083] By transmitting the quick page message in a preamble, a large number of access terminals may be addressed simultaneously. The transmission of the quick page message in a single OFDM symbol allows several access terminals to wakeup concurrently to monitor the quick page message for their respective ATIH values.

[0084] Figure 4 is a simplified functional block diagram of an embodiment of a receiver 400 configured to process the quick page message received over a QPCH. The receiver 400 can be a portion of each of the access terminals of Figure 1, and can be a portion of the receiver system of Figure 2. The simplified functional block diagram of Figure 4 illustrates only those portions of the receiver 400 associated with processing the quick page message. The receiver 400 typically includes other processing modules.

[0085] The receiver 400 receives the OFDM symbol containing and recovers the quick page message. If the quick page message is encoded, the receiver 400 uses the redundant encoding information to increase the probability that the underlying bits in the quick paging block and load control block are successfully recovered. The receiver 400 uses the recovered quick page message information to determine whether to awaken or remain active to monitor for a subsequent paging channel message.

[0086] In one embodiment, if the CRC fails, the access terminal monitors the paging channel as a default action. If the CRC succeeds and a corresponding ATIH is set, the access terminal is instructed to monitor the paging channel. If the CRC succeeds, and the ATIH is absent and the 'more' bit is not asserted, the access terminal returns to a sleep state. If the CRC succeeds, and the ATIH is absent, but the 'more' bit is asserted, the access terminal determines if its ATIH is greater than the largest ATIH in the quick page message. If so, the access terminal monitors the paging messages. If not, the access terminal can transition to the sleep state.

[0087] The receiver 400 includes an antenna 402 that couples a received signal to a receiver front end 410. A synchronization module 420 operates in conjunction with the receiver front end 410. The synchronization module 420 determines, based on the received signal, the symbol timing and from the symbol timing the frame and superframe timing. The receiver front end 410 utilizes the synchronization information to recover the OFDM symbols, and in particular, the OFDM preamble having the OFDM symbol with the quick page message.

[0088] The receiver front end 410 couples the OFDM symbol having the quick page message to the RX MIMO data processor 430. The RX MIMO data processor 430 operates to demodulate the OFDM subcarriers on which the quick page message is modulated to recover the quick page message.

[0089] The RX MIMO data processor 430 demodulates the subcarriers in a complementary manner to which they were modulated. That is, if the subcarriers are QPSK modulated, the RX MIMO data processor 430 performs QPSK demodulation of the subcarriers.

[0090] The quick page message is optionally coupled to the decoder 440, depending on whether the source quick page message is encoded. The decoder 440 operates to decode the quick page message in a complementary fashion to the manner in which the packet was encoded in transmitter. In general, the QPCH decoder 440 performs the complement of the processing performed in the transmitter, including the complement of any interleaving, encoding, scrambling, repetition, and the like or combination thereof performed when generating the quick page message.

[0091] The output of the decoder 440 is coupled to a hash value comparator 450. The hash value comparator 450 is configured to parse the various ATIH values included within the quick page message and compare them against the ATIH value corresponding to the receiver 400. In one condition, where the hash value comparator 450 determines that there are no ATIH values in the quick paging message, the hash value comparator 450 does not need to make any comparisons, and the receiver 400 can transition to a sleep state in order to conserve power.

[0092] The hash value comparator 450 can examine the field in the quick page message identifying the number of ATIH values included within the quick page message. The hash value comparator 450 can determine from the number the length of the quick page message or the format of the ATIH values used in the quick page message, depending on the quick page message embodiment. Recall that in a variable length quick page message embodiment the ATIH format remains the same but the length of the message varies based on the number of quick pages. In a static length quick page message embodiment, the length of the message remains constant but the ATIH format varies based on the number of quick pages.

[0093] The hash value comparator 450 can couple the value corresponding to the number of quick pages, NumPages, to an ATIH module 460.

[0094] The ATIH module 460 is configured to generate the ATIH corresponding to the receiver 400 in a format that coincides with the format of the ATIH value included in the quick page message.

[0095] In one embodiment, the ATIH module 460 receives the NumPages value and generates the ATIH in the proper format using an algorithm. The ATIH module 460 can store the ATI of the receiver 400 and can operate on the ATI using an algorithm to generate the ATIH in the proper format.

[0096] In another embodiment, the ATIH module 460 includes a look up table 462 that stores the different ATIH formats. The ATIH module 460 retrieves the proper ATIH format from the look up table 462 based on the value of NumPages.

[0097] The hash value comparator 450 can also extract the 'more' field from the quick page message. The 'more' field can be a single bit that is asserted when the number of quick pages exceeds the maximum number that can be included within a single quick page message. In the embodiment having a single bit for the 'more' field, the receiver 400 can have two primary branches of operation, depending on the 'more' bit.

[0098] If the 'more' bit is not asserted, the hash value comparator 450 determines whether the ATIH of the receiver 400 is included in the quick page message. If so, the receiver 400 monitors the subsequent paging message. Otherwise, the receiver conserves power by not monitoring the paging message. For example, the receiver 400 can transition to a sleep state and await the next quick page message.

[0099] If the 'more' bit is asserted, the hash value comparator 450 determines whether the ATIH of the receiver 400 is included in the quick page message. If so, the receiver monitors the subsequent paging message. If the hash value comparator 450 determines that the ATIH of the receiver 400 is greater than the largest ATIH in the quick page message, the receiver 400 monitors the subsequent paging message. Otherwise, if the hash value comparator 450 determines that the ATIH of the receiver 400 is not present in the quick page message and is not greater than the largest ATIH in the quick page message, the receiver 400 conserves power by not monitoring the paging message.

[0100] Other modules within the receiver 400 such as the paging module (not shown) can operate on the output of the hash value comparator 450. If the ATIH associated with the access terminal is present in the quick paging message, the paging module can direct the receiver to monitor for the paging message. Alternatively, if the ATIH associated with the access terminal is not present in the quick page message and is not

indicated by the 'more' field, the paging module can direct the receiver to transition to a sleep state until the next occurrence of the quick paging message.

[0101] Figure 5 is a simplified flowchart of an embodiment of a method 500 of generating a quick page message. The method 500 can be performed, for example, by an access point of Figure 1, a transmitter system of Figure 2, or the system of Figure 3.

[0102] The method 500 begins at block 502 where the system determines the identities of the access terminals having paging messages scheduled for transmission. The system can, for example, examine the ATI values in the paging messages to determine the identities of the unique access terminals scheduled to receive a paging message.

[0103] The system proceeds to block 504 and counts or otherwise determines the number of unique access terminals scheduled to receive paging messages. The system proceeds to decision block 510 and determines whether the number of access terminals scheduled to receive paging messages is zero. The system can, for example, compare the count value to the number zero. If so, the system transitions to block 514 and retrieves a reserved value that is indicative of the zero access terminals. The system proceeds from block 514 to block 550 described below.

[0104] If, at decision block 510, the system determines that the number of access terminals is not zero, the system proceeds to decision block 512 to determine if the number of access terminals scheduled to receive paging messages is greater than some predetermined maximum number, Max. If not, the system transitions to block 530 described below.

[0105] If, at decision block 512, the system determines that the number is greater than the predetermined maximum, Max, the system proceeds to block 520. At block 520, the system sets the number of pages in the quick page message, NumPage, to be equal to the maximum number. That is, the system sets NumPage = Max. The system proceeds to block 522 and sets a 'more' flag to indicate the presence of greater than Max quick pages.

[0106] The system proceeds to block 530 and initializes a counter that tracks a loop that determines the ATIH for each access terminal scheduled to receive a paging message, and orders the ATI values for the access terminals in order of smallest to

largest. The system proceeds to block 540 and determines the ATIH of an access terminal according to the order of ATI values sorted upon initialization. In one embodiment, the system can determine the ATIH based in part on the NumPage value. The greater the NumPage value, the fewer the number of bits in the corresponding ATIH.

[0107] The system proceeds to decision block 542 to determine if the counter value is equal to the NumPage value. If not, not all ATIH values have been computed. The system proceeds to block 544 to increment the counter. The system returns from block 544 to block 540 to determine the next ATIH value.

[0108] If, at decision block 542, the system determines that the counter value is equal to the NumPage value, all ATIH values for the present quick page message have been determined. The system proceeds to block 550.

[0109] At block 550, the system begins assembling the quick page message. The system sets the number field, alternatively referred to as the count field, to the NumPage value to indicate the number of ATIH values within the quick paging message and, in some instances, the format of the ATIH value.

[0110] The system proceeds to block 552 and concatenates the ATIH values. In one embodiment, the system concatenates the ATIH values in a predetermined order, such as numeric order. In another embodiment, the system does not order the ATIH values before concatenating them. If there are no ATIH values and instead is only a reserved value indicating the presence of no pages, the system generates the quick paging message with the reserved value.

[0111] The system proceeds to block 554 and zero pads the quick paging message to make the quick page message a predetermined length. The system is not required to pad the quick paging block, and when padding is performed, the system is not required to insert a zero pad, but may include some other bits.

[0112] The system proceeds to block 556 and sets the 'more' field in the quick page message based on the status of the previously determined 'more' flag. The system proceeds to block 560 and generates an OFDM symbol having the quick page message. In one embodiment, the system can QPSK modulate each of the information carrying subcarriers of the OFDM system with portions of the quick page message.

[0113] The system proceeds to block 570 and synchronizes the occurrence of the OFDM symbol with a particular slot in the superframe timing. For example, the system can synchronize the occurrence of the quick page OFDM symbol with a particular position in a superframe preamble.

[0114] The system proceeds to block 580 and transmits the quick page message by frequency converting the OFDM symbol to a desired operating frequency and transmitting the OFDM symbol.

[0115] Figure 6 is a simplified flowchart of an embodiment of a method 600 of processing a quick page message. The method 600 can be implemented, for example, in an access terminal of Figure 1, a receiver system of Figure 2, or a receiver of Figure 4.

[0116] The method 600 begins at block 602, where the receiver receives OFDM symbols, at least one of which includes some or all of the quick page message. The receiver proceeds to block 610 and recovers the quick page message from one or more of the received OFDM symbols. In one embodiment, the receiver synchronizes with superframe timing and recovers the entire quick paging message from a particular OFDM symbol occurring in a preamble of the superframe.

[0117] The receiver proceeds to block 620 and determines the number of ATIH values included in the quick paging message. In one embodiment, the receiver reads a NumPage value from a field in the quick page message. In another embodiment, the receiver may be able to determine the number of ATIH values based in part on a length of the quick page message, a preamble, a reserved termination field, or some combination of factors.

[0118] The receiver proceeds to block 630 and compares the ATIH values in the quick page message to the ATIH value corresponding to the receiver. The receiver may generate its ATIH value using an algorithm, or may retrieve its ATIH value from memory, such as from a look up table. The receiver can generate or retrieve its own ATIH in a format that is based at least in part on the NumPage value.

[0119] The receiver proceeds to decision block 632 to determine if the first ATIH matches the ATIH of the receiver. If so, the receiver need not perform any additional comparisons, and can proceed to block 650 and monitors the paging channel for one or more paging messages.

[0120] If, at decision block 632, the receiver determines that the present ATIH retrieved from the quick paging message does not match the ATIH of the receiver, the receiver proceeds to decision block 640 to determine if all ATIH values in the quick paging message have been examined. If not, the receiver proceeds to block 642 to retrieve the next ATIH from the quick paging message. The receiver then returns to block 630 to perform the comparison of ATIH values.

[0121] If, at decision block 640, the receiver determines that all ATIH values in the quick page message have been examined, the receiver proceeds to decision block 660 to determine whether the 'more' bit in the quick page message is asserted.

[0122] If the 'more' bit is not set, the receiver proceeds from decision block 660 to block 670 and can transition to the sleep state or may otherwise not monitor the paging channel for potential paging messages.

[0123] However, if the receiver determines at decision block 660 that the 'more' bit is set, the receiver transitions to decision block 652 to determine if the ATIH of the receiver is greater than the largest ATIH in the quick page message. If not, the receiver transitions to block 670 and can transition to the sleep state.

[0124] If the receiver determines that the ATIH of the receiver is greater than the largest ATIH in the quick page message, the receiver proceeds from decision block 652 to block 654 and monitors the paging channel for paging messages.

[0125] The above approach has advantage that when the number of quick pages that need to be sent is larger than the maximum number, only access terminals with an ATIH larger than the largest ATIH in the quick page message need to monitor the paging channel. Other access terminals can save power by not monitoring the paging channel.

[0126] When there are exactly the maximum number of pages, the unasserted 'more' bit conveys to all access terminals not identified in the quick page message that there is no paging message to receive on the paging channel. Those users can thus save power by not reading the page message.

[0127] Figure 7 is a simplified functional block diagram of an embodiment of a system 700 for generating and transmitting a quick page message.

[0128] The system 700 includes an optional means for synchronizing timing with a system time 702 that is coupled to a means for scheduling information 704. The

optional means for scheduling information 704 can schedule based on output from the means for synchronizing timing with a system time 702. The means for scheduling information 704 can be configured to determine which of a plurality of access terminals has paging messages scheduled for transmission, and thus, the identities of one or more access terminals notified in the quick page message.

[0129] The means for scheduling information 704 is coupled to a means for generating a compressed identifier value 710 that is configured to generate a compressed identifier value for at least one access terminal notified in the quick page message based on the scheduled paging channel transmissions. The means for generating a compressed identifier value 710 can be coupled to optional means for counting a number of page messages 712 and optional means for compressing an access terminal identifier 714. The means for generating a compressed identifier value 710 also is coupled to a means for assembling the quick page message 716 that operates to generate the quick page message from the components generated in other blocks. For example, the means for assembling the quick page message 716 generates the quick page message including the compressed identifier.

[0130] The means for generating a compressed identifier value 710 optionally couples the quick page message to a means for encoding the quick page message 720. The means for encoding the quick page message 720 can encode the quick page message to generate an encoded quick page message. The means for encoding the quick page message 720 couples the encoded quick page message to an optional means for TX processing the quick page message 730. The means for processing the quick page message 730 can be configured to generate an OFDM symbol having the quick page message. The means for processing the quick page message 730 can also synchronize the OFDM symbol with the system timing, and can synchronize the OFDM symbol to occur during a predetermined slot in a preamble of a superframe.

[0131] The means for processing the quick page message 730 couples the OFDM symbol or symbols having the quick page message to a means for transmitting the a wireless signal 740 that is configured to frequency translate, amplify, filter, and otherwise process a wireless signal including at least a portion of the quick page message, such as the one or more OFDM symbols, to produce an RF signal that can be transmitted via the antenna 744.

[0132] Figure 8 is a simplified functional block diagram of an embodiment of a receiver 800 configured to process the quick page message. The receiver 800 includes an antenna 802 configured to receive a wireless signal, such as one or more OFDM symbols, having the quick paging message.

[0133] The antenna couples the OFDM symbol to a means for receiving a wireless signal having the quick page message 810 that is configured to process, for example, the received OFDM symbols to baseband OFDM symbols or samples. An optional means for synchronizing timing 820 operates to synchronize the received samples to align with the OFDM symbol timing.

[0134] The output of the means for receiving the wireless signal 810 is coupled to a means for recovering the quick page message 830 that is configured to process the OFDM symbol to recover the underlying information modulated on the OFDM subcarriers. For the OFDM symbol or symbols having the quick page message, the means for recovering the quick page message 830 demodulates the OFDM subcarriers to recover the quick page message, which can be an encoded quick page message. The means for recovering the quick page message 830 operates in conjunction with a means for determining a number of compressed identifiers in the quick page message 832 that operates to determine how many quick pages are included in the quick page message. The means for determining a number of compressed identifiers in the quick page message 832 can, for example, include means for reading a count field in the quick page message that is indicative of the number of compressed identifier values or number of quick pages.

[0135] The means for recovering the quick page message 830 couples an encoded quick page message to an optional means for decoding the quick page message 840 that is configured to decode the encoded quick page message in order to recover the quick page message. The output of the means for decoding the quick page message 820 is coupled to a means for comparing the compressed identifier values 850 of the quick page message. The means for comparing the compressed values 850 of the quick page message compares the compressed identifier values, which can be ATIH values, within the quick page message to the predetermined compressed identifier value corresponding to the access terminal or receiver.

[0136] The means for comparing the ATIH values 850 can also examine a 'more' field, such as a 'more' bit in the quick page message to determine if there are more access terminals scheduled for paging messages than could be represented in the quick page message. The receiver can determine what action to take based on the results of the comparison in combination with the results of the 'more' bit in the quick page message.

[0137] A means for determining a compressed identifier value 860 can be configured to generate or otherwise retrieve a compressed identifier value, such as an ATIH, in the format used in the quick page message. In one embodiment, the means for determining a compressed identifier 860 includes a means for storing compressed identifier values 862, and the means for determining a compressed identifier 860 retrieves an ATIH value of a particular format based on, for example, the number of pages in the quick page message.

[0138] Systems and methods are described herein for generating a quick page message and processing a quick page message. The quick page message described herein allows for flexibility in the format of the quick page message to reduce quick page collisions, while maintaining the ability to notify a virtually unlimited number of access terminals in a single quick page message.

[0139] As used herein, the term coupled or connected is used to mean an indirect coupling as well as a direct coupling or connection. Where two or more blocks, modules, devices, or apparatus are coupled, there may be one or more intervening blocks between the two coupled blocks.

[0140] The various illustrative logical blocks, modules, and circuits described in connection with the embodiments disclosed herein may be implemented or performed with a general purpose processor, a digital signal processor (DSP), a Reduced Instruction Set Computer (RISC) processor, an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, for example, a combination of a

DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[0141] For a firmware and/or software implementation, the techniques described herein may be implemented as instructions (for example, procedures, functions, and so on) that perform the functions described herein. The firmware and/or software codes may be stored in a memory and executed by a processor or processors. The memory may be implemented within the processor or external to the processor.

[0142] The steps of a method, process, or algorithm described in connection with the embodiments disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. The various steps or acts in a method or process may be performed in the order shown, or may be performed in another order. Additionally, one or more process or method steps may be omitted or one or more process or method steps may be added to the methods and processes. An additional step, block, or action may be added in the beginning, end, or intervening existing elements of the methods and processes.

[0143] The above description of the disclosed embodiments is provided to enable any person of ordinary skill in the art to make or use the disclosure. Various modifications to these embodiments will be readily apparent to those of ordinary skill in the art, and the generic principles defined herein may be applied to other embodiments without departing from the spirit or scope of the disclosure. Thus, the disclosure is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

WHAT IS CLAIMED IS:

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CLAIMS:

1. A method of generating a quick page message in a wireless communication system, the method comprising:

generating a compressed identifier value for at least one access
5 terminal to be notified in the quick page message, wherein the compressed identifier value represents a full length identifier that identifies the access terminal, wherein the full length identifier can be determined based on the compressed identifier value;

assembling the quick paging message including the compressed
10 identifier based at least in part on a number of access terminals scheduled to receive at least one paging message; and

generating a wireless signal including at least a portion of the quick page message.

2. The method of claim 1, wherein generating the wireless signal
15 comprises generating an Orthogonal Frequency Division Multiplex (OFDM) symbol including at least the portion of the quick page message.

3. The method of claim 2, further comprising wireless transmitting the OFDM symbol during a superframe preamble.

4. The method of claim 1, further comprising:

20 determining the number of access terminals scheduled to receive at least one paging message;

determining whether the number exceeds a predetermined maximum number; and

25 populating a page number field in the quick page message based on whether the number exceeds the predetermined maximum number.

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5. The method of claim 4, wherein populating the page number field comprises populating the page number field with the number if the number does not exceed the predetermined maximum number.

6. The method of claim 4, wherein populating the page number field
5 comprises populating the page number field with the predetermined maximum number if the number exceeds the predetermined maximum number.

7. The method of claim 4, further comprising setting an indicator field in the quick page message based on whether the number exceeds the predetermined maximum number.

10 8. The method of claim 1, wherein generating the compressed identifier value comprises:

determining the number of access terminals scheduled to receive at least one paging message; and

generating the compressed identifier value for at least one of the
15 access terminals based at least in part on the number.

9. The method of claim 8, wherein generating the compressed identifier value based at least in part on the number comprises generating a hash value of an access terminal identifier based on the number.

10. The method of claim 8, wherein generating the compressed identifier
20 value based at least in part on the number comprises:

determining a compressed identifier bit length based on the number;
and

compressing an access terminal identifier to the compressed identifier value having the compressed identifier bit length.

25 11. The method of claim 1, wherein generating the compressed identifier value comprises generating the compressed identifier value based on an access terminal identifier of the at least one access terminal.

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12. The method of claim 1, wherein assembling the quick paging message comprises concatenating a plurality of compressed identifier values.

13. The method of claim 1, wherein assembling the quick paging message comprises:

5 sorting the compressed identifier values, each compressed identifier value corresponding to a distinct access terminal according to a predetermined algorithm; and

 concatenating the compressed identifier values in an order based on the sort.

10 14. The method of claim 1, further comprising wireless transmitting the wireless signal during a superframe preamble.

15 15. The method of claim 1, wherein generating the wireless signal comprises Quadrature Phase Shift Key (QPSK) modulating a plurality of Orthogonal Frequency Division Multiplex (OFDM) subcarriers with distinct portions of the quick page message.

16. A method of generating a quick page message in a wireless communication system, the method comprising:

 determining the identity of access terminals scheduled to receive at least one paging message;

20 determining the number of access terminals scheduled to receive at least one paging message;

 determining a compressed identifier value for each of at least a portion of the access terminals scheduled to receive at least one paging message, wherein each compressed identifier value represents a full length identifier that
25 identifies an access terminal, wherein the full length identifier can be determined based on the corresponding compressed identifier value; and

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assembling the quick page message based at least in part on the number of access terminals scheduled to receive at least one paging message and the compressed identifier value.

17. The method of claim 16, further comprising zero padding a reserved
5 field of the quick page message to a predetermined length.

18. The method of claim 16, further comprising setting a field in the quick page message based in part on the number of access terminals scheduled to receive at least one paging message.

19. The method of claim 16, further comprising generating an
10 Orthogonal Frequency Division Multiplex (OFDM) symbol having at least a portion of the quick paging message.

20. The method of claim 19, further comprising transmitting the OFDM symbol in a predetermined time slot of a superframe of the wireless communication system.

15 21. The method of claim 16, wherein determining the compressed identifier value comprises generating the compressed identifier based at least in part on the number of access terminals scheduled to receive at least one paging message.

22. The method of claim 16, wherein determining the compressed
20 identifier value comprises generating a hash value based at least in part on an access terminal identifier value.

23. The method of claim 16, wherein assembling the quick page message comprises:

concatenating the compressed identifier values in an identifier field;

25 setting count field based on the number of access terminals scheduled to receive at least one paging message; and

setting an additional page field based on the number of access terminals scheduled to receive at least one paging message.

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24. A method of processing a quick page message in a wireless communication system, the method comprising:

receiving a wireless signal having the quick page message;

recovering the quick page message from the wireless signal,

5 wherein the quick page message is based at least in part on a number of access terminals scheduled to receive at least one paging message;

determining a number of compressed identifier values in the quick page message, wherein each compressed identifier value represents a full length identifier that identifies an access terminal, wherein the full length identifier can be
10 determined based on the corresponding compressed identifier value; and

comparing each compressed identifier value from the quick page message with a predetermined compressed identifier value.

25. The method of claim 24, further comprising determining a state of an additional page field in the quick page message.

15 26. The method of claim 24, wherein receiving the wireless signal having the quick page message comprises receiving an Orthogonal Frequency Division Multiplex (OFDM) symbol having at least a portion of the quick page message.

27. The method of claim 24, wherein recovering the quick page message comprises demodulating at least a subset of the subcarriers of an
20 Orthogonal Frequency Division Multiplex (OFDM) symbol.

28. The method of claim 24, wherein determining the number of compressed identifier values comprises reading a count field in the quick page message indicative of the number of compressed identifier values.

29. The method of claim 24, wherein comparing each compressed
25 identifier value comprises:

determining the predetermined compressed identifier value based on the number of compressed identifier values in the quick page message; and

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comparing each compressed identifier value with the predetermined compressed identifier value.

30. The method of claim 29, wherein determining the predetermined compressed identifier value comprises generating the predetermined compressed identifier based on a compression algorithm and the number of compressed
5 identifier values in the quick page message.

31. The method of claim 29, wherein determining the predetermined compressed identifier value comprises retrieving the predetermined compressed identifier from a storage device based in part on the number of compressed
10 identifier values in the quick page message.

32. An apparatus for generating a quick page message, the apparatus comprising:

a paging message counter configured to determine a number of unique access terminals scheduled to receive a paging message;

15 a compressed identifier generator coupled to the paging message counter and configured to generate a compressed identifier, wherein each compressed identifier value represents a full length identifier that identifies an access terminal, wherein the full length identifier can be determined based on the corresponding compressed identifier value; and

20 a message assembler coupled to the compressed identifier generator and configured to set a count field in the quick page message based on the number of unique access terminals, and further configured to concatenate the compressed identifiers corresponding to each of the subset of unique access terminals,

25 wherein the message assembler is further configured to set an additional identifier field in the quick page message based in part on the number of unique access terminals scheduled to receive at least one paging message.

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33. The apparatus of claim 32, wherein the compressed identifier generator generates the compressed identifier for no greater than a predetermined maximum number of unique access terminals.

34. The apparatus of claim 32, wherein the compressed identifier
5 generator generates the compressed identifier based at least in part on the number of unique access terminals.

35. The apparatus of claim 32, wherein the compressed identifier generator generates the compressed identifier based at least in part on an access terminal identifier.

10 36. The apparatus of claim 32, wherein the compressed identifier generator generates the compressed identifier based on a variable compression ratio that depends, in part, on the number of unique access terminals.

37. The apparatus of claim 32, wherein the compressed identifier generator generates a reserved value if the number of unique access terminals is zero.

15 38. An apparatus for processing a quick page message, the apparatus comprising:

a receiver configured to receive a wireless signal having the quick page message that is based at least in part on a number of access terminals scheduled to receive at least one paging message;

20 a receive processor coupled to the receiver and configured to extract the quick page message from the wireless signal;

a compressed value module configured to generate a predetermined compressed identifier; and

25 a comparator configured to extract at least one compressed identifier from the quick page message and compare it to the predetermined compressed identifier to determine whether the apparatus is notified of a scheduled paging message, wherein each compressed identifier value represents a full length

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identifier that identifies the access terminal, wherein the full length identifier can be determined based on the compressed identifier value.

39. The apparatus of claim 38, wherein the receive processor is configured to demodulate at least a subset of subcarriers of an Orthogonal
5 Frequency Division Multiplex (OFDM) symbol to recover the quick page message.

40. The apparatus of claim 38, wherein the compressed value module is configured to generate the predetermined compressed identifier based in part on a number of compressed identifiers contained in the quick page message.

41. The apparatus of claim 38, wherein the compressed value module is
10 configured to retrieve the predetermined compressed identifier from a plurality of predetermined identifiers stored in a storage device based in part on a number of compressed identifiers contained in the quick page message.

42. An apparatus for generating a quick page message, the apparatus comprising:

15 means for generating a compressed identifier value for at least one access terminal to be notified in the quick page message, wherein the compressed identifier value represents a full length identifier that identifies the access terminal, wherein the full length identifier can be determined based on the compressed identifier value;

20 means for assembling the quick paging message including the compressed identifier based at least in part on a number of access terminals scheduled to receive at least one paging message; and

means for transmitting a wireless signal including at least a portion of the quick page message.

25 43. The apparatus of claim 42, wherein the means for transmitting the wireless signal comprises:

means for generating an Orthogonal Frequency Division Multiplex (OFDM) symbol including at least the portion of the quick page message; and

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means for wireless transmitting the OFDM symbol during a superframe preamble.

44. The apparatus of claim 42, further comprising:

means for determining the number of access terminals scheduled to
5 receive a paging message;

means for determining whether the number exceeds a predetermined maximum number; and

means for populating a page number field in the quick page message based on whether the number exceeds the predetermined maximum
10 number.

45. The apparatus of claim 42, wherein the means for generating the compressed identifier value comprises:

determining the number of access terminals scheduled to receive a paging message; and

15 generating the compressed identifier value for at least one of the access terminals based at least in part on the number.

46. An apparatus for processing a quick page message, the apparatus comprising:

means for receiving a wireless signal having the quick page
20 message that is based at least in part on a number of access terminals scheduled to receive at least one paging message;

means for recovering the quick page message from the wireless signal;

means for determining a number of compressed identifier values in
25 the quick page message, wherein each compressed identifier value represents a full length identifier that identifies an access terminal, wherein the full length identifier can be determined based on the compressed identifier value; and

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means for comparing each compressed identifier value from the quick page message with a predetermined compressed identifier value.

47. The apparatus of claim 46, wherein the means for determining the number of compressed identifier values comprises means for reading a count field
5 in the quick page message indicative of the number of compressed identifier values.

48. The apparatus of claim 46, wherein the means for comparing each compressed identifier value comprises:

means for determining the predetermined compressed identifier
10 value based on the number of compressed identifier values in the quick page message; and

means for comparing each compressed identifier value with the predetermined compressed identifier value.

49. A processor readable media including instructions that, when
15 executed by one or more processors, cause the one or more processors to perform a method of generating a quick page message, the method comprising:

generating a compressed identifier value for at least one access terminal notified in the quick page message, wherein the compressed identifier value represents a full length identifier that identifies the access terminal, wherein
20 the full length identifier can be determined based on the compressed identifier value;

assembling the quick paging message including the compressed identifier based at least in part on a number of access terminals scheduled to receive at least one paging message; and

25 generating a signal including at least a portion of the quick page message, and coupling the signal to a wireless transmitter.

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50. A processor readable media including instructions that, when executed by one or more processors, cause the one or more processors to perform a method of generating a quick page message, the method comprising:

receiving a signal having the quick page message based at least in part
5 on a number of access terminals scheduled to receive at least one paging message;

recovering the quick page message from the signal;

determining a number of compressed identifier values in the quick page message, wherein each compressed identifier value represents a full length identifier that identifies an access terminal, wherein the full length identifier can be determined
10 based on the compressed identifier value; and

comparing each compressed identifier value from the quick page message with a predetermined compressed identifier value.

51. The method of claim 1, wherein the full length identifier includes a number of bits ranging from 48 to 128.

15 52. The method of claim 16, wherein the full length identifier includes a number of bits ranging from 48 to 128.

53. The method of claim 24, wherein the full length identifier includes a number of bits ranging from 48 to 128.

54. The apparatus of claim 32, wherein the full length identifier includes a
20 number of bits ranging from 48 to 128.

55. The apparatus of claim 38, wherein the full length identifier includes a number of bits ranging from 48 to 128.

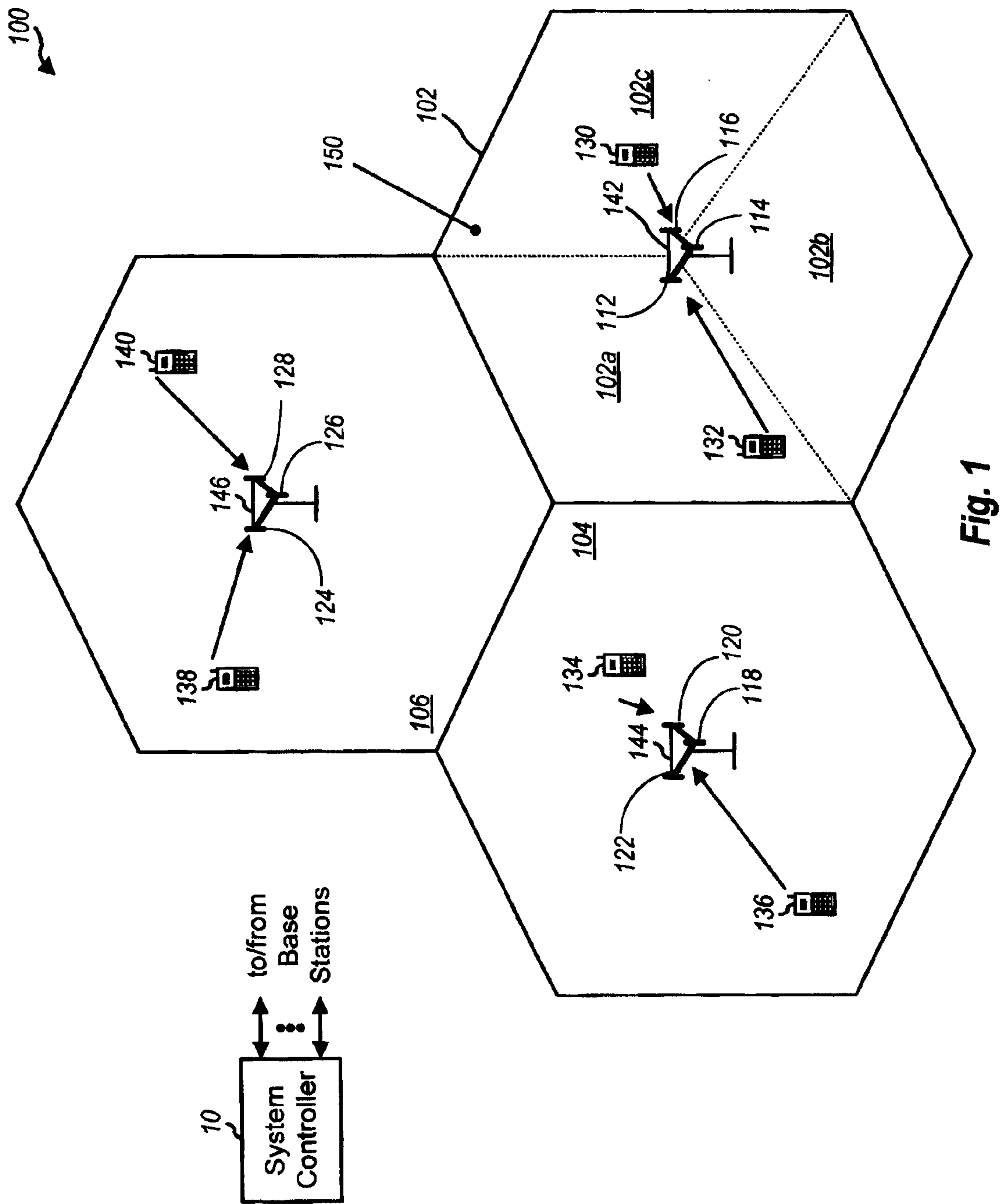




Fig. 2

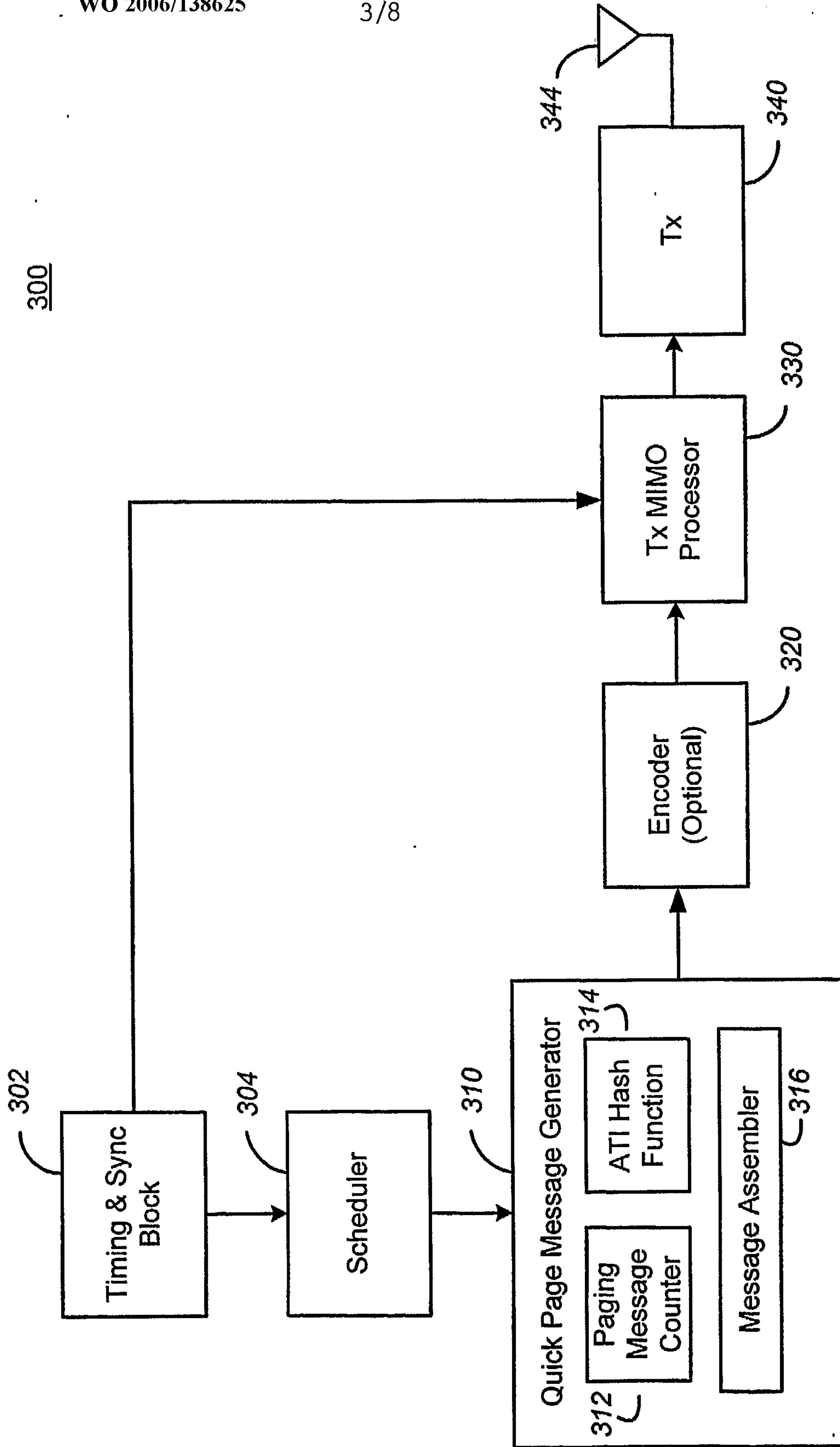


Fig. 3

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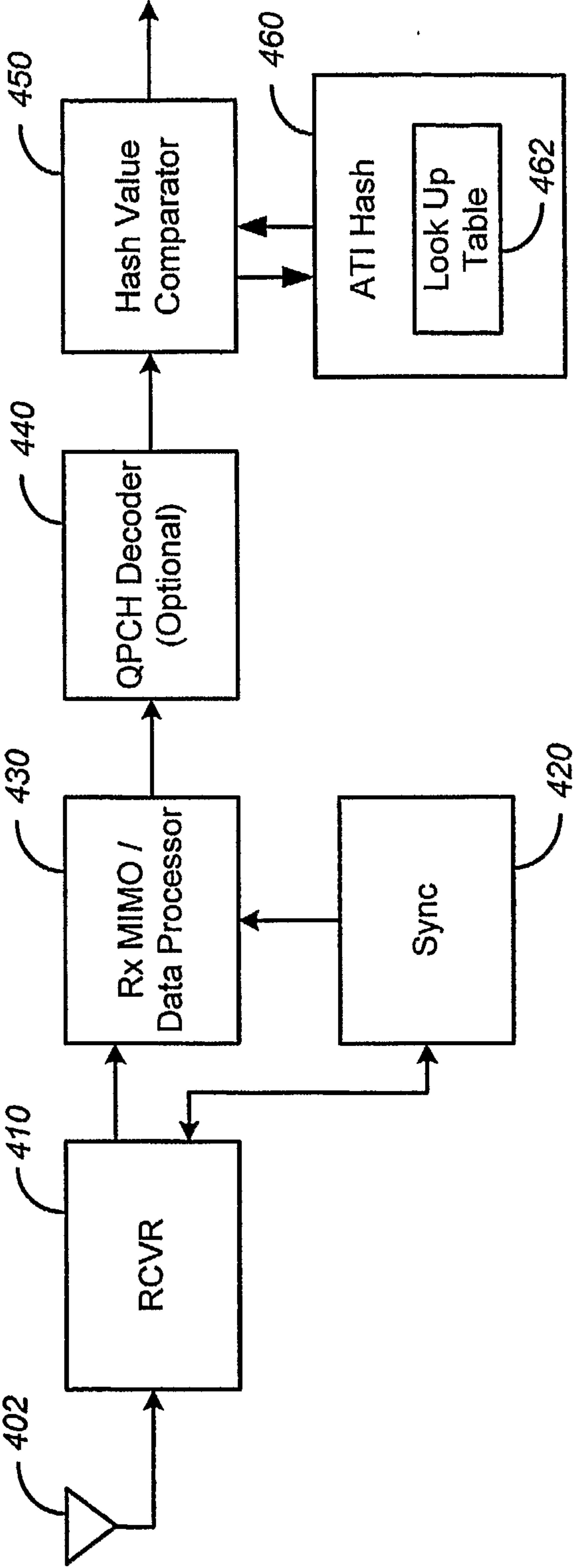


Fig. 4

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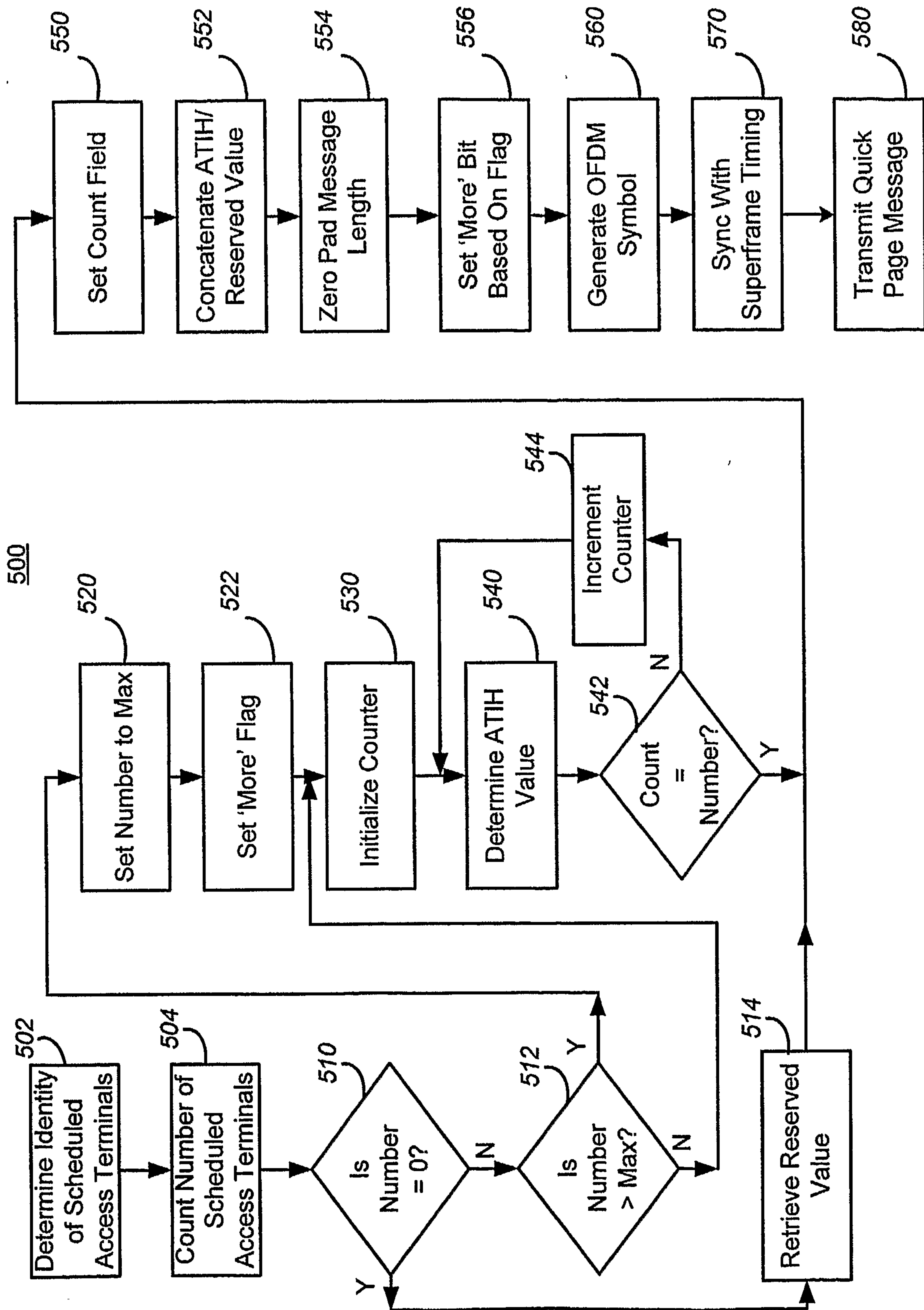


Fig. 5

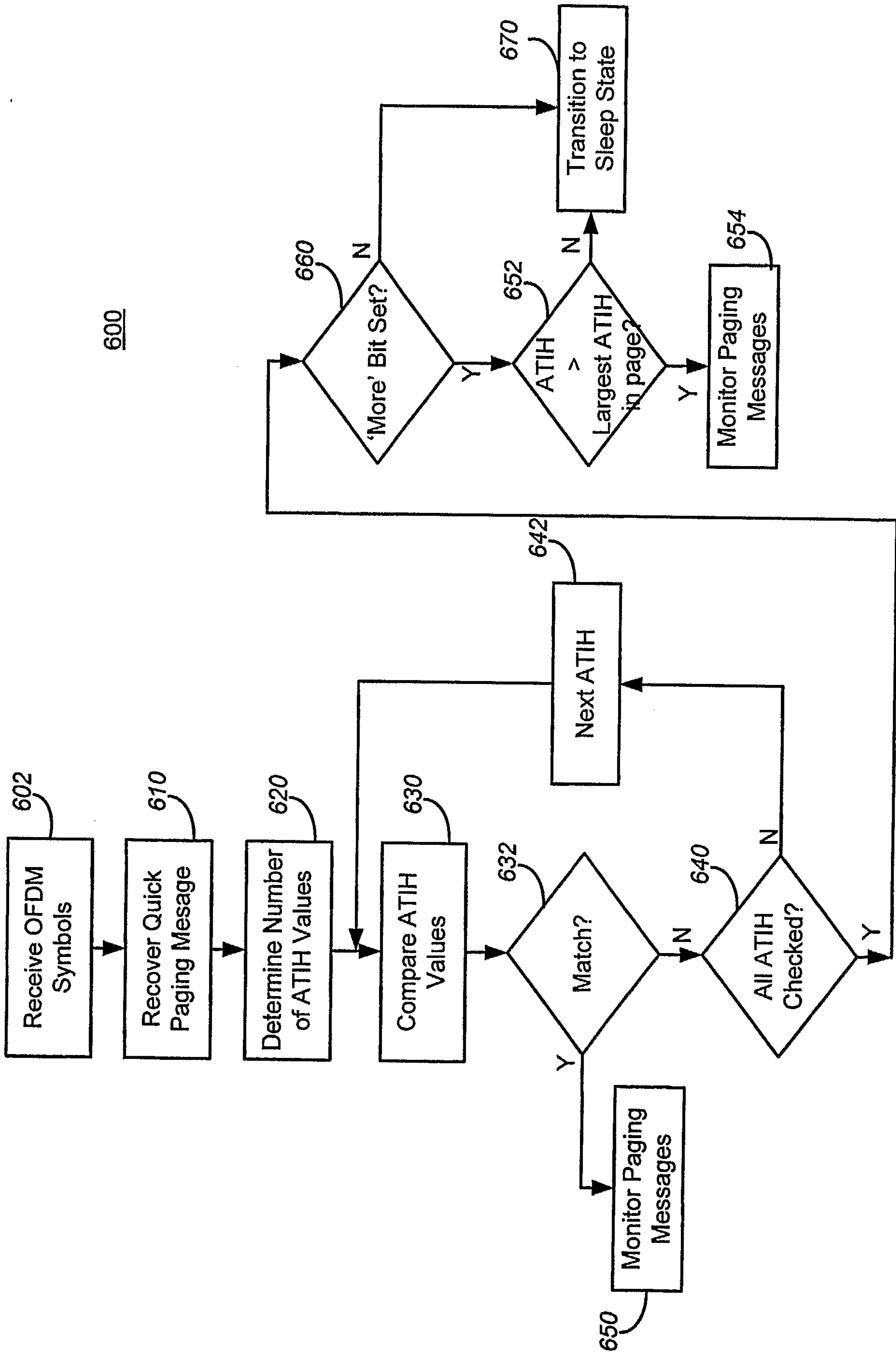


Fig. 6

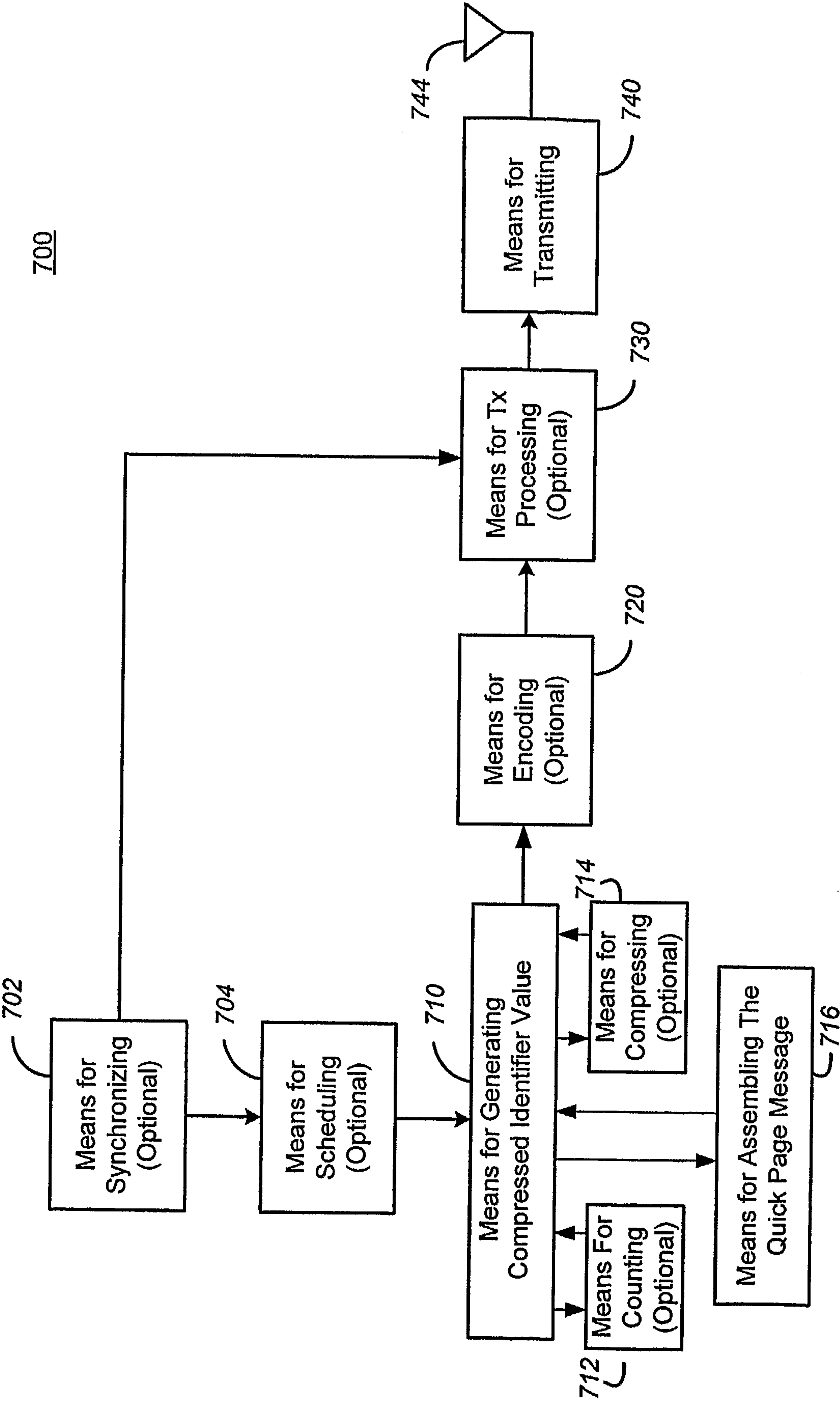
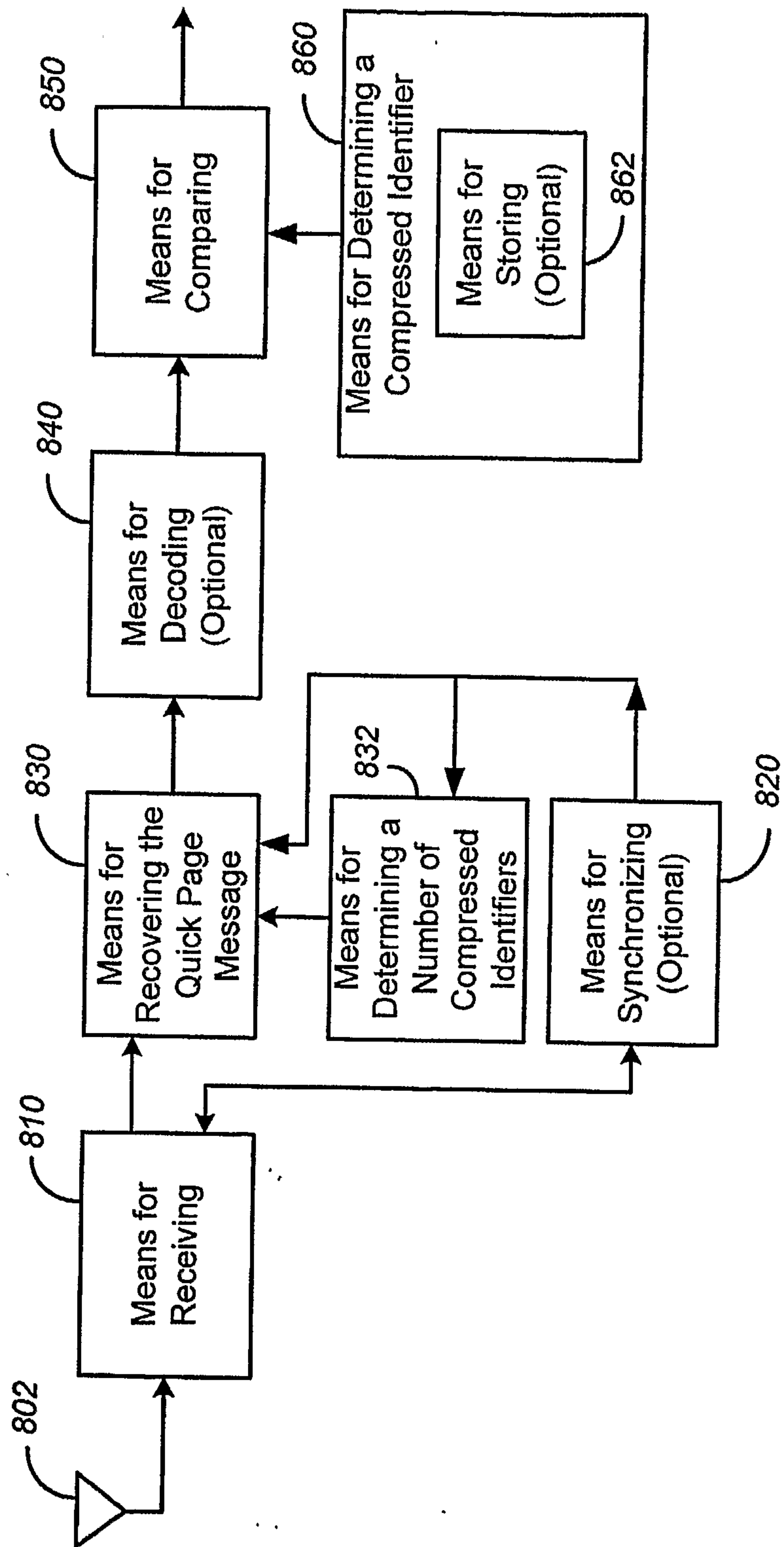


Fig. 7

800**Fig. 8**

