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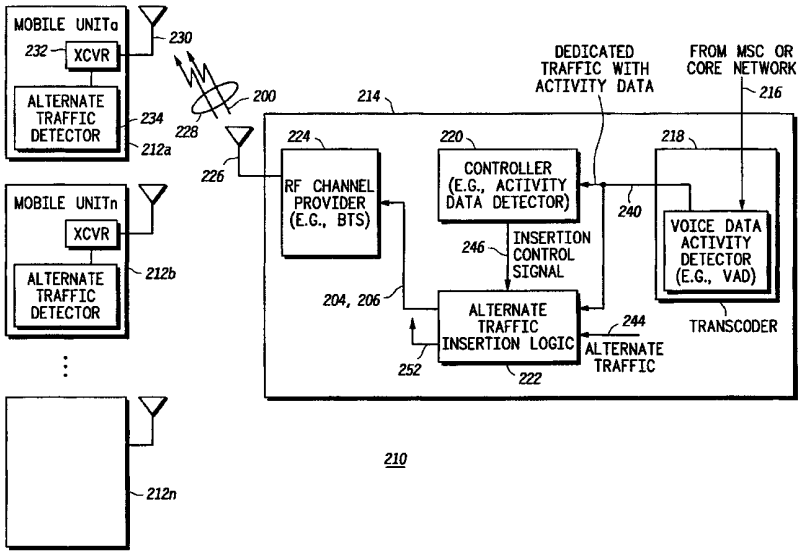
(54) Title: METHOD AND APPARATUS FOR IMPROVING BANDWIDTH ALLOCATION IN A WIRELESS COMMUNICATION SYSTEM



(57) Abstract: A system and method multiplexes voice and data to transfer data both in uplink and downlink communications during silence periods in a voice call or other communication having periods of detected inactivity. Multiplexed information, such as dedicated and alternate traffic (204), may be transferred to and from a common mobile unit incorporating multiple applications or to a different mobile unit that is not involved in a voice call. This results in improved efficiency for the transmission resources and other resources of the system. The system and method employs a bandwidth allocation mechanism, such as alternate traffic insertion logic (222), that provides statistical multiplexing of voice and data, or other information, from the same traffic channel, such as a timeslot in a TDMA system, during periods of detected inactivity (208).

WO 01/37451 A1

METHOD AND APPARATUS FOR IMPROVING BANDWIDTH ALLOCATION IN A WIRELESS COMMUNICATION SYSTEM

Field Of The Invention

The invention relates generally to wireless telecommunication systems, and more particularly to systems employing multiplexing of packet switched and bursty circuit switched traffic over a wireless interface.

Background of the Invention

In time division multiple access (TDMA) wireless communication systems, frequency division multiple access (FDMA) wireless communication systems, and other systems, it is well known that voice information alternates between active and inactive (silence) periods. Bits generated by a voice coder (vocoder) during silence periods do not typically possess significant information content and therefore are typically discarded without significant detrimental impact on voice quality. Vocoders and TDMA radiotelephone systems such as Group Special Mobile (GSM) employ voice activity detection (VAD) and discontinuous transmission (DTX) modes. For example, packets may be generated that do not contain a minimum level of information content and therefore are marked and do not have to be transmitted. Thus, voice activity detection and discontinuous transmission together may be employed to reduce the interference to other ongoing transmission and prolong better life of mobile units.

As is also known, mobile units may have a plurality of different applications operating that require wireless communication links with one or more base station systems (BSS). For example, if the mobile unit is a laptop computer, a video application may be used to communicate video information, data, or other information. In addition, another application such as a telephone application, may

use a same modem or a different modem to communicate voice information to and from the mobile unit.

Generally, voice is transported in GSM type systems in a circuit switched manner. This leads to an inefficient utilization in the air interface since the single time slot cannot be shared amongst multiple voice calls or between voice and data calls during periods of inactivity. In a more recently proposed system, such as GPRS, a packet switched network is overlaid on the existing GSM network. The general packet radio service (GPRS) network is described generally in the European Standard GSM03.60 V6.2.0, incorporated herein by reference, available from European Telecommunications Standard Institute, F-06921 Sophia Antipolis Cedex, France. However, a problem arises when periods of inactivity for a given mobile unit or application of a mobile unit are effectively wasted during normal speech since there are silent periods of unused bandwidth.

Consequently, there exists a need for improving the bandwidth utilization in such systems by attempting to reuse traffic channels during periods of detected voice inactivity. Such a system should accommodate reuse of a traffic channel for a same or other mobile during the inactivity.

Brief Description Of The Drawings

The invention will be more readily understood in view of the following drawings wherein:

FIG.1 is a diagram illustrating a prior art TDMA packet stream having active and inactive periods;

FIG. 2.1 is a diagram illustrating a stream of TDMA packets generated in accordance with one embodiment of the invention;

FIG. 2.2 is a block diagram illustrating one embodiment of a system that improves bandwidth allocation and a TDMA or FDMA wireless communication system, in accordance with one embodiment of the invention;

FIG. 3 is a flow chart illustrating one example of the operation of the system shown in FIG. 2.2 during a downlink communication;

FIG. 4 is a block diagram illustrating one example of a system for improving bandwidth allocation in a TDMA or FDMA wireless communication system from an uplink perspective in accordance with one embodiment of the invention; and

FIG. 5 is a flow chart illustrating one example of the operation of the system shown in FIG. 4.

Detailed Description Of The Preferred Embodiment

Briefly, a system and method multiplexes voice and data to transfer data both in uplink and downlink communications during silence periods in a voice call or other communication having periods of detected inactivity. Multiplexed information, such as dedicated and alternate traffic, may be transferred to and from a common mobile unit incorporating multiple applications or to a different mobile unit that is not involved in a voice call. This results in improved efficiency for the transmission resources and other resources of the system. The system and method employs a bandwidth allocation mechanism that provides statistical multiplexing of voice and data, or other information, from the same traffic channel, such as a timeslot in a TDMA system, during periods of detected inactivity.

FIG. 1 illustrates a conventional representation of a TDMA packet stream generally indicated as 10, that includes a series of packets contained in slots within frames. In this example, a series of active frames 12a and 12b are shown, as well an inactivity period 14 indicated by silence identification frames (SID frames) 16. The SID frames represent a beginning of a period of inactivity. As shown, the "1"'s indicate that information was sent, and the "0"'s indicate that no packets were sent. As known in the art, some systems generate the SID frame information during voice calls when silence occurs within a communication to

modify. Other frames, such as discontinuous transmission frames and start transmission frames 18 may also be embedded in the inactivity period as known in the art. Non-use of time slots by a mobile unit or application during the inactivity period wastes bandwidth.

FIG. 2.1 diagramatically illustrates a TDMA packet stream 200 also having active periods 202a, 202b. However, in contrast to conventional systems, the TDMA packet stream 200 is generated using the disclosed invention. The result is inserted alternate traffic 204 and 206 inserted in an inactive period 208. The inserted alternate traffic 204 and 206 may be associated with a same mobile unit but a different application running in the mobile unit, a different mobile unit not involved in the voice communication, or any other suitable entity or application. An application includes any software, firmware or other executable instructions, non-executable instructions that are used to perform a process.

FIG. 2.2 illustrates a TDMA wireless communication system 210, such as a GSM system or any other suitable system, which in this embodiment includes a plurality of mobile units 212a-212n that are in operative communication with a radio access network element 214, such as a base station system (BSS), or other suitable network element. For purposes of illustration, and not limitation, the invention will be described with reference to a TDMA type of the radiotelephone system. However, it will be recognized that any suitable wireless communication system may also be used. Accordingly, a time slot in every frame is allocated to a voice call or application for its entire duration. However, variable bit rate applications or other suitable communication systems may also be used. Also, for purposes of illustration, the wireless communication system 210 as shown, will be described from a downlink communication perspective. A description of an uplink communication is described with reference to FIGs 4-5.

The network element 214 receives voice or other information 216 from any suitable source such as from a mobile switching center from the core network

or any other suitable source. The network element 214 may include, for example, a transcoder 218, a controller 220, alternate traffic insertion logic 222 and a radio frequency (RF) channel providing circuit 224. By way of example, the network element 214 may be a base station system (BSS) in a cellular radiotelephone system. The controller 220 and alternate traffic insertion logic 222 may be components of a base site controller (BSC), including but not limited to digital signal processors, microprocessors, state machines, other hardware, software, firmware, any suitable combination thereof or any other suitable structure. The radio frequency channel providing circuit 224 may be a transceiver of a base transceiver station (BTS) in a cellular network or any other suitable system or subsystem implemented in any suitable fashion including but not limited to digital signal processors, microprocessors, state machines, other hardware, software, firmware, any suitable combination thereof or any other suitable structure. However, it will be recognized that the structures and functions may be moved or incorporated in any suitable part of a network or plurality of network elements as desired. The RF channel providing circuit 224 transmits information through antenna 226 to a plurality of mobile units 212a-212n over a suitable wireless link 228.

The mobile unit 212a may include, for example, a receiving and transmitting antenna or antennas 230, a conventional receiver circuit 232 and an alternate traffic detector 234. The alternate traffic detector 234 may be any suitable processing device or devices, such as a microprocessor, digital signal processor, discrete logic, other hardware, including state machines, software, firmware or any suitable combination thereof. Each of the mobile units may be running one or a plurality of different software applications that require an interface bandwidth.

The transcoder 218 may be any conventional transcoder that may include, for example, voice activity detection (VAD) using a voice activity detector 242 as known in the art. The transcoder 218 evaluates the information 216 to detect

voice data activity and outputs information 240 with activity data 241 and the traffic channel information 243. The voice activity detector 242 may, for example, insert activity data 241 in a frame to indicate periods of silence. For example, SID frames. For packet switching networks, the transcoder 218 may send keep alive bits as the activity data 241 without inserting data to the fill in bandwidth. The information 240 includes the dedicated traffic that is dedicated to the particular mobile unit or application. For example, if the mobile unit 212a is assigned time slot TS_3, the information 240 will include the dedicated traffic to be inserted in time slot TS_3 in addition to including SID information. The information 240 is received by the controller 220 and by the alternate traffic insertion logic 222. In addition, the alternate traffic insertion logic 222 receives not only the dedicated traffic associated with the mobile unit 212a or an application, but it also receives alternate traffic 244 from another suitable source. The alternate traffic 244 is associated with a second application or another mobile unit or other entity. The alternate traffic 244 is considered alternate since it is not dedicated to the time slot TS_3 for the mobile unit 212a. The controller 220 and alternate traffic insertion logic 222 may be a suitably programmed microprocessor, computer, digital circuitry, firmware, or any other suitable combination of hardware or software. The controller 220 analyzes the information 240 from the dedicated traffic channel to detect periods of inactivity. For example, the controller may analyze the activity data 241 information, such as the SID frames, to determine when silence is occurring so that it can generate an insertion control signal 246 to control the alternate traffic insertion logic 222 so that the alternate traffic insertion logic 222 inserts the alternate traffic 244 in a dedicated traffic channel (TS_3 time slot) such as during inactive period 208.

For example, if the dedicated traffic is voice traffic for mobile unit 212a, the alternate traffic 244 may be, for example, audio or video or other suitable information for a different application running, for example, on mobile unit 212b. Accordingly, the time slot TS_3 during the inactivity period is filled with alternate traffic information for the mobile unit 212b. Accordingly, the alternate traffic

insertion logic 222 alternately outputs dedicated traffic or alternate traffic 204, 206 for suitable modulation and transmission by the RF channel providing circuit 224. The controller 220 and alternate traffic insertion logic 222 adapt dynamically to the change in traffic types (e.g., data and voice).

When a mobile unit such as mobile unit 212a receives the TDMA packets stream 200, it is able to discard inappropriate frames or slots such as those containing the alternate traffic 204, 206. It makes this determination using the alternate traffic detector 234. The alternate traffic detector 234 may be a suitable software module operating on a processing unit such as a microprocessor, or can be implemented using a hardware circuit, a combination of software, firm hardware, or any other suitable structure which can determine which frames or slots during the inactive period 208 contain the alternate traffic 204, 206.

In this embodiment, the alternate traffic insertion logic 222 generates traffic differentiation data 252, such as one or more bits indicating which of the time slots contain the alternate traffic 204, 206. The alternate traffic detector 234 then evaluates the received TDMA packets and searches for the traffic differentiation data 252. The traffic differentiation data 252 then indicates to the receiving mobile unit which of the shared time slots contain dedicated traffic for the mobile unit and which contain alternate traffic for an alternate application or alternate mobile unit.

FIG. 3 illustrates one example of the operation of the system in FIG. 2.2 during a downlink communication. As shown in block 300, the process includes generating information and activity data 241, such as SID frames based on voice activity detection or any other suitable inactivity detection. This may be performed, for example, by the network element 214 or any other suitable element. The process further includes, as shown in block 302, detecting periods of information inactivity in dedicated traffic channels based on the activity data 241. As shown in block 304, the network element 214 may generate an allocation

bit map which is computed on the downlink communication. The allocation bit map may then be broadcast as soon as the network element 214 transmits a downlink SID frame. As known in the art, the bitmap may be a table that informs mobiles as to when they should be receiving data in an uplink and downlink communication. The traffic differentiation data may be one or more bits, for example in a midamble, in a timeslot to indicate the presence of alternate data in the timeslot. The SID frame signals the beginning of the silence period. The allocation bit map contains identification of an application and time slot information indicating which time slot radio blocks are assigned to which resource user. As such, the network element 214 reallocates some of the time slot radio blocks that are available during inactivity or are detected during inactivity periods for use by other applications or mobile units.

As shown in block 304, once the network element, such as through controller 220, determines the inactivity periods based on the activity data 241 (e.g., SID frames), the controller 220 then generates the insertion control signal 246 to control the insertion of alternate traffic in suitable time slots that are not active for a given mobile. As shown in block 308, the method continues by inserting the alternate traffic associated with other applications or mobile units in a period of detected inactivity. Referring again to FIG. 2.1, this may be done, for example, by placing data in the frames or slots during the inactivity period that normally do not contain or are detected not to contain voice information. In one embodiment, as part of the insertion process, the alternate traffic insertion logic 222 inserts the traffic differentiation data 252, such as one or more bits, along with the inserted alternate traffic so that the mobile units can determine which time slots contain traffic that is not dedicated for them. The traffic differentiation data 252 may be a bit field or bits set in a midamble of a timeslot or may be any suitable mechanism.

As shown in block 310, the traffic differentiation data 252 is included with the inserted alternate traffic 244. However, it will be recognized that any suitable

differentiation mechanism may be used other than the insertion of bits with the alternate traffic information. As shown in block 312, the network element 214 then transmits the activity data 241, the allocation bit map and alternate traffic 204, 206, along with the traffic differentiation data 252, for communication to a plurality of applications or mobile units. As shown in block 314, one or more mobile units receive and analyze communicated information. As shown in block 316, the mobile units detect the inserted alternate traffic 204, 206 based on the traffic differentiation data 252. As shown in block 318, if the traffic differentiation data 252 indicates that a given time slot is dedicated to a different mobile unit, the receiving mobile unit ignores the detected inserted alternate traffic 204, 206. This is shown in block 318. The process continues as required.

In addition, referring back to block 302, if the network element 214 detects that there are no periods of information inactivity, meaning that the voice communication or other communication has recommenced, the method includes preempting the transmission of alternate traffic as shown in block 320. The preemption may be performed in a number of different ways. One example includes the controller 220 controlling the alternate traffic insertion logic 222 to output the dedicated traffic 240 in the appropriate time slot. However, collisions may occur if suitable notification and suitable timing constraints are not implemented.

Accordingly, FIG. 4 illustrates the system 210 during an uplink communication wherein the dedicated traffic time slot is reclaimed by the mobile unit or application. The network element 214 includes a reclaim message generator 402. As such, the network element 210 may reclaim for the first application or first mobile unit, bandwidth associated with the inserted traffic for the period of inactivity. The reclaiming may be done when the network element 214 detects that voice has commenced. As shown, the mobile units 212a-212n also include a reclaiming algorithm such as a suitable software module 400 which can initiate the reclaiming of a traffic channel time slot in the uplink mode.

The reclaim message generator 402 may be a suitably programmed processing unit, or any other suitable structure. The reclaim message generator 402 is responsive to a traffic reclaim request 404 generated by a mobile unit or other application desiring to reclaim a dedicated time slot formerly in the inactivity period. The traffic reclaim request 404 may be provided over a shared control channel or a separate and dedicated reclaim control channel. The reclaim message generator 402 provides a reclaim message 406 to another application indicating that the dedicated application requires transmission of dedicated traffic. In other words, the reclaim message generator 402 generates the reclaim message 406 to the application or mobile unit that was using the alternate traffic so that alternate traffic is no longer placed in the dedicated time slots. It will be recognized that the traffic reclaim request 404 may be implicit as further described below.

Other reclaim techniques may also be used. For example, a packet random access channel may be shared among voice and data calls. The mobile unit communicating voice uses this channel to indicate voice activity. The mobile unit informs the network element that it wants the dedicated channel back by virtue of the reclaim request 404. The reclaim request 404 in this embodiment is generated over a shared control channel. The shared control channel may be, for example, a packet random access channel which is used to generate other control information for the mobile unit.

Another alternative reclaiming approach includes providing a dedicated real time packet random access channel which is used exclusively for active packetized voice and other real time connection oriented services. The dedicated reclaim channel may be provided on a per carrier or on a per cell basis, for example. For example, one definable segment, such as one frame out of N frames, or one out of eight time slots in a frame may be reserved for the reclaiming channel.

In another alternative embodiment, the network element 214 controls the alternate traffic insertion logic 222 to insert information in only a portion of the available inactivity bandwidth such that the alternate traffic insertion logic 222 inserts the alternate traffic in only a portion of the total inactivity bandwidth during a designated period of inactivity. Remaining radio blocks are left for the voice call that is currently in the silence period, so that it can reclaim time slots that are immediately available without requiring messages to other mobile units. For example, the network element 214 assigns one out of every eight bursts, for example, (a 20 millisecond period) to be set aside for use by the voice information for the mobile unit that is currently in a silence period. This allows existing mobile units to operate using the remaining bandwidth during an inactivity period with minimum impact on voice quality since the mobile unit having the dedicated communication can quickly use the time slot set aside for the voice portion during the inactivity period.

In yet another embodiment, the mobile unit may be sending SID frames on a regular basis. If one, or a succession of frames, is received that is not decoded as a SID frame, the network element treats this lack of SID frame as a voice activity trigger causing the alternate traffic to be preempted and thrown off the time slot. As such, the network element may notify the alternate application that the mobile unit in the current voice call has reclaimed the channel based on detection of recommencement of activity.

Another alternative reclaiming technique includes an inband technique wherein each mobile unit includes a reclaim message generator 402 that generates a reclaim bit pattern and designated time slot at an increased power level. This helps facilitate detection by network element receiving radio equipment. In such a system, the transmission of the reclaim bit pattern is transmitted during the mid amble sequences such as in a GSM type system, or may alternatively transmit the reclaim bit patterns through time intervals that are reserved for parts of the data burst.

FIG. 5 illustrates, for example, the operation of an embodiment of FIG. 4. As shown in block 500, the method includes analyzing a communication from a first mobile unit by a network element. As shown in block 502, the network element 214 through the voice activity detector 242 detects inactivity frames and generates activity data 241, such as SID frames. As shown in block 504, the network element 214 allocates its uplink inactivity radio blocks, such as time slots, for a second alternate mobile unit and updates an allocation bit map as known in the art.

As shown in block 506, the method includes sending a notification message 407 to the alternate mobile unit to transmit alternate data in a dedicated inactivity slots of the first mobile unit. As shown in block 508, the method includes generating, for example by the first mobile unit, the traffic claim request 400. The network element processes the traffic reclaim request as shown in block 510 and sends a reclaim message to the second mobile unit to notify the mobile unit to stop using the time slots of inactivity of the first mobile unit to avoid collisions. This is shown in block 512. As shown in block 514, the mobile unit then resumes dedicated traffic transmission. Since the time slots are now being reused by the first mobile unit, the network element then again updates the allocation bit map as shown in block 516. The process then continues for each mobile unit and each application in each mobile unit seeking to use inactivity periods.

Accordingly, the above disclosed system and methods allows statistical multiplexing of voice and data and other information in a wireless communication network to provide increased utilization of an air interface. This can translate into higher revenue for network operator and provides other advantages. As indicated, mobile units are able to inform the network element at the start of silence in active bursts. The time slot rescheduling or insertion technique allows multiplexing of one or more voices in one or more data connections on the same time slot or

group of time slots. Moreover, the network element can route voice and data frames to switch voice and data traffic to different protocol stacks and route them separately.

It should be understood that the implementation of other variations and modifications of the invention in its various aspects will be apparent to those of ordinary skill in the art, and that the invention is not limited by the specific embodiments described. It is therefore contemplated to cover by the present invention, any and all modifications, variations, or equivalents that fall within the spirit and scope of the basic underlying principles disclosed and claimed herein.

Claims

1. A method for improving bandwidth allocation in a TDMA or FDMA wireless communication system comprising the steps of:

detecting periods of inactivity in a dedicated traffic channel, dedicated to a first application; and

inserting alternate traffic associated with a second application in the dedicated traffic channel during detected periods of inactivity.

2. The method of claim 1 including the step of analyzing activity data from the dedicated traffic channel to detect the periods of inactivity.

3. The method of claim 1 including the steps of:

detecting inserted alternate traffic that is inserted in a dedicated traffic channel; and

ignoring the detected inserted alternate traffic based on received traffic differentiation data.

4. The method of claim 1 including the step of receiving dedicated traffic and the alternate traffic and inserting the alternate traffic in response to a control signal.

5. The method of claim 1 wherein the first and second applications are associated with a same mobile unit.

6. A wireless communication system radio access network element comprising:

a controller operatively coupled to detect periods of inactivity in a dedicated traffic channel, dedicated to a first application; and

alternate traffic insertion logic, operatively responsive to the controller and operatively coupled to receive both dedicated traffic

associated with the first application and alternate traffic associated with a second application, that inserts the alternate traffic in the dedicated traffic channel during detected periods of inactivity.

7. The network element of claim 6 wherein the controller analyzes information from the dedicated traffic channel to detect the periods of inactivity.

8. The network element of claim 6 wherein the alternate traffic insertion logic inserts traffic differentiation data when alternate traffic has been inserted.

9. The network element of claim 6 wherein the first and second applications are associated with a same mobile unit.

10. The network element of claim 6 wherein the first and second applications are associated with different mobile units.

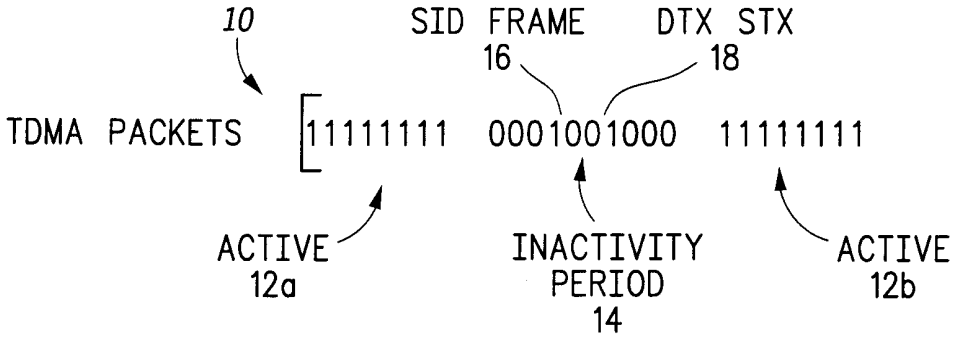


FIG.1
-PRIOR ART-

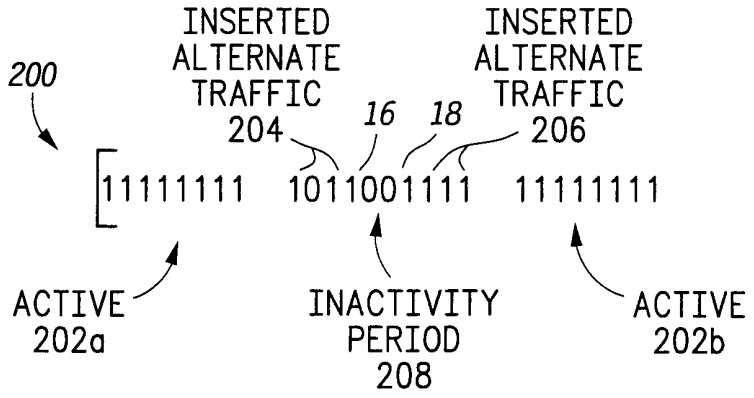


FIG.2.1

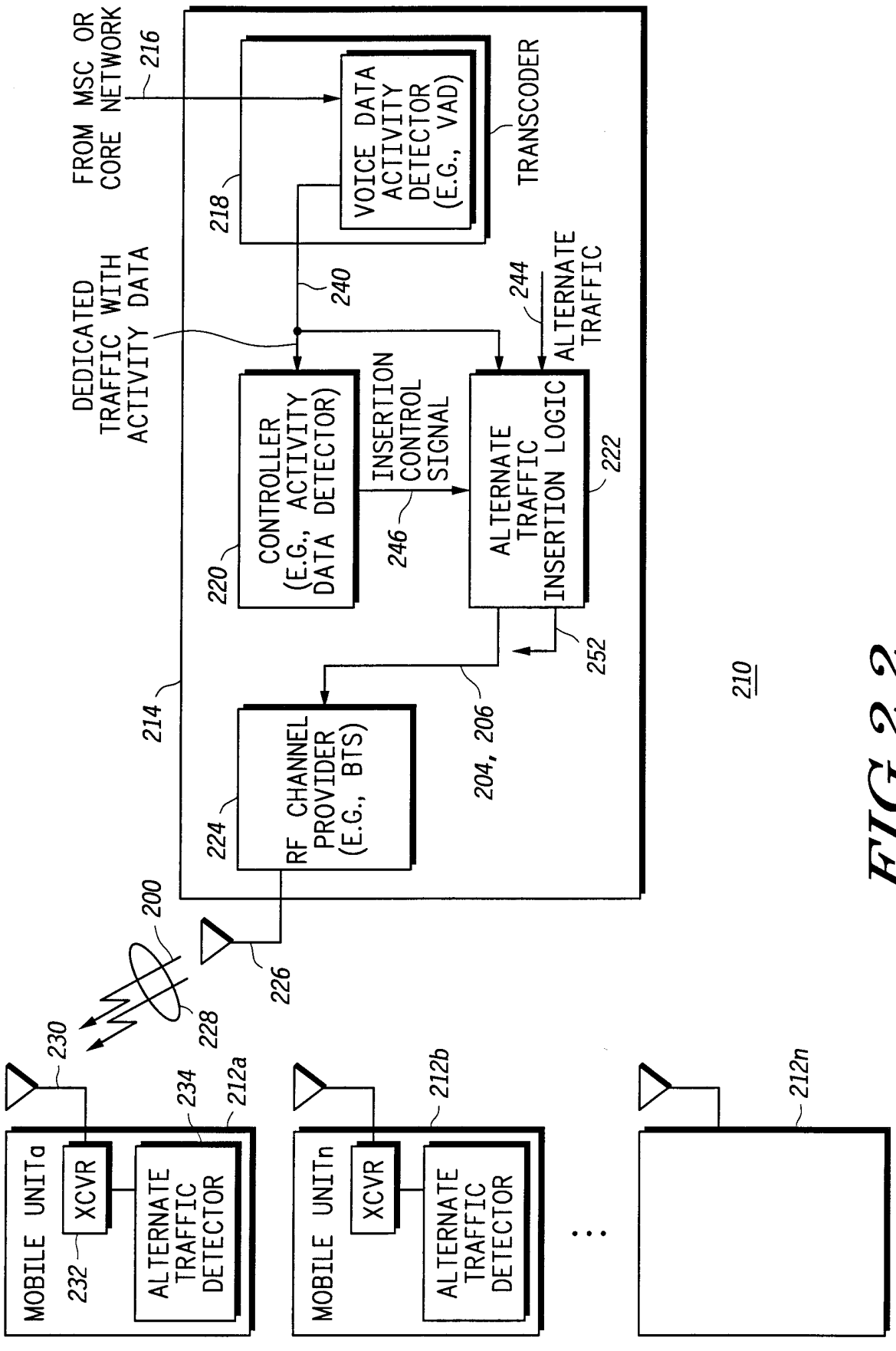

FROM MSC OR CORE NETWORK
216
VOICE DATA ACTIVITY DETECTOR (E.G., VAD)
TRANSCODER
218
240
DEDICATED TRAFFIC WITH ACTIVITY DATA
244
ALTERNATE TRAFFIC
CONTROLLER (E.G., ACTIVITY DATA DETECTOR)
220
INSERTION CONTROL SIGNAL
246
ALTERNATE TRAFFIC INSERTION LOGIC
222
252
214
204, 206
RF CHANNEL PROVIDER (E.G., BTS)
224
200
226
228
230
234
212a
MOBILE UNITa
XCVR
232
ALTERNATE TRAFFIC DETECTOR
212b
MOBILE UNITn
XCVR
ALTERNATE TRAFFIC DETECTOR
212n
210

FIG.2.2

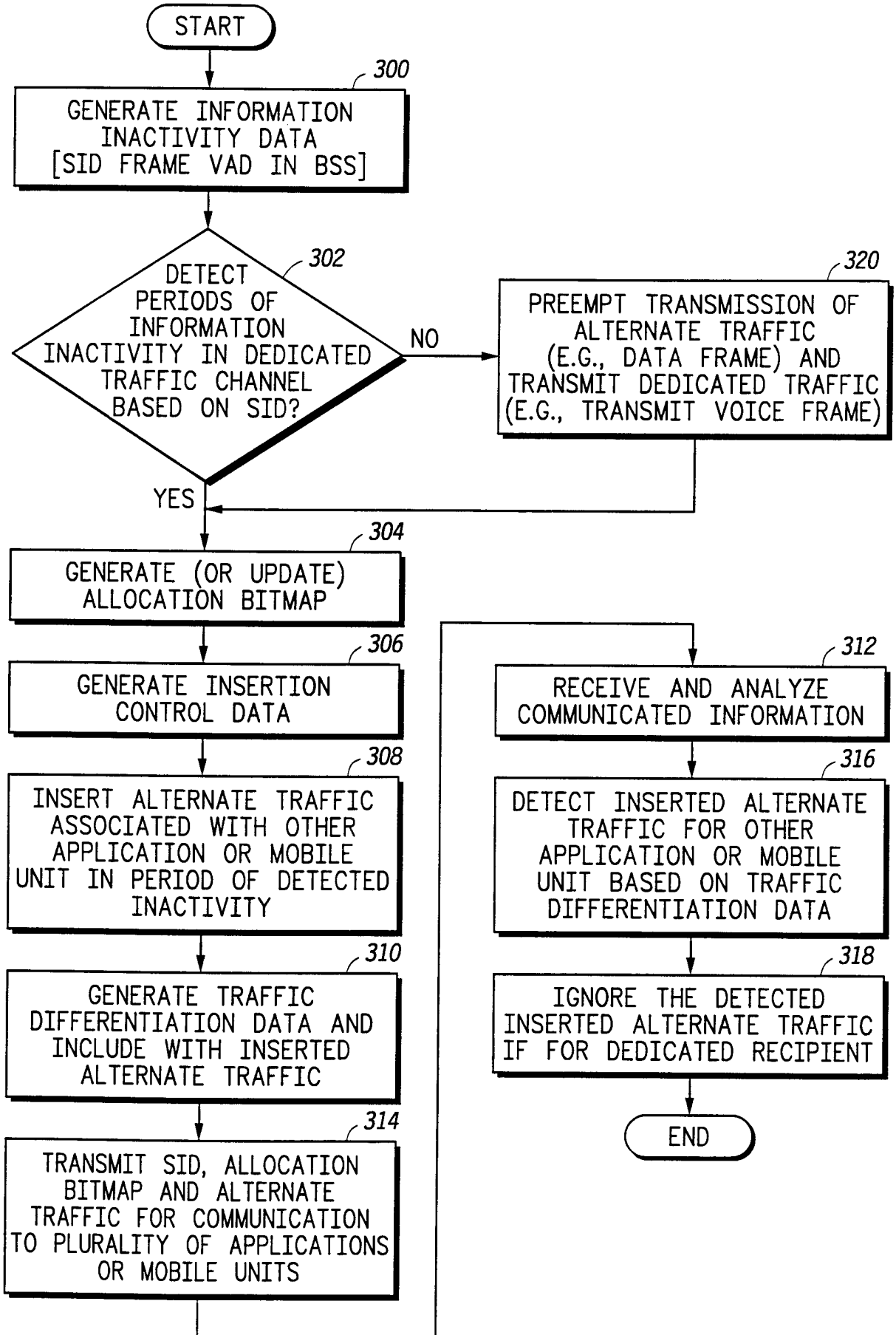

START
300
GENERATE INFORMATION INACTIVITY DATA [SID FRAME VAD IN BSS]
302
DETECT PERIODS OF INFORMATION INACTIVITY IN DEDICATED TRAFFIC CHANNEL BASED ON SID?
NO
320
PREEMPT TRANSMISSION OF ALTERNATE TRAFFIC (E.G., DATA FRAME) AND TRANSMIT DEDICATED TRAFFIC (E.G., TRANSMIT VOICE FRAME)
YES
304
GENERATE (OR UPDATE) ALLOCATION BITMAP
306
GENERATE INSERTION CONTROL DATA
308
INSERT ALTERNATE TRAFFIC ASSOCIATED WITH OTHER APPLICATION OR MOBILE UNIT IN PERIOD OF DETECTED INACTIVITY
310
GENERATE TRAFFIC DIFFERENTIATION DATA AND INCLUDE WITH INSERTED ALTERNATE TRAFFIC
314
TRANSMIT SID, ALLOCATION BITMAP AND ALTERNATE TRAFFIC FOR COMMUNICATION TO PLURALITY OF APPLICATIONS OR MOBILE UNITS
312
RECEIVE AND ANALYZE COMMUNICATED INFORMATION
316
DETECT INSERTED ALTERNATE TRAFFIC FOR OTHER APPLICATION OR MOBILE UNIT BASED ON TRAFFIC DIFFERENTIATION DATA
318
IGNORE THE DETECTED INSERTED ALTERNATE TRAFFIC IF FOR DEDICATED RECIPIENT
END

FIG.3

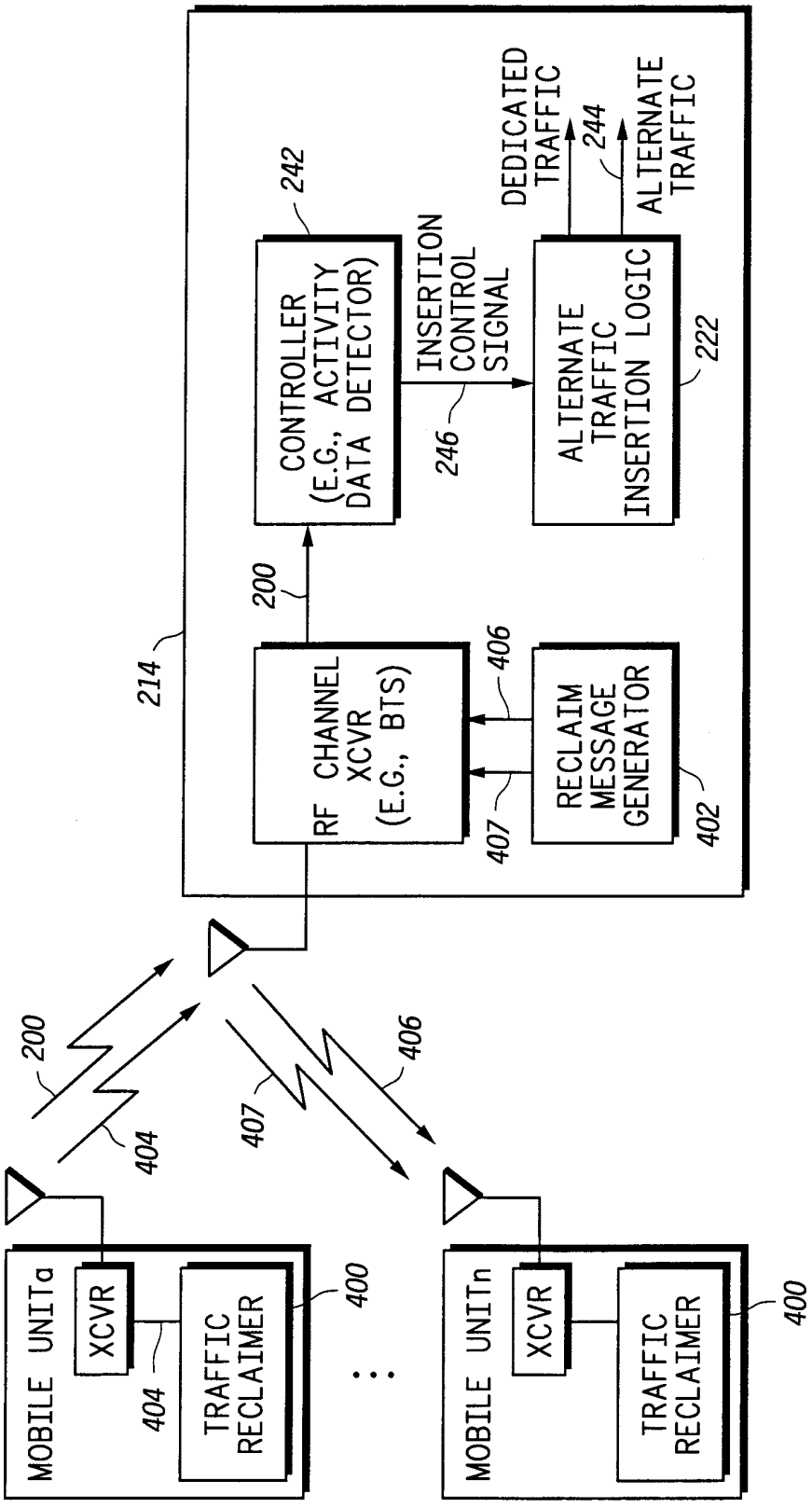

MOBILE UNITa
XCVR
TRAFFIC RECLAIMER
404
400
MOBILE UNITn
XCVR
TRAFFIC RECLAIMER
400
200
404
407
406
214
RF CHANNEL XCVR (E.G., BTS)
200
406
407
RECLAIM MESSAGE GENERATOR
402
CONTROLLER (E.G., ACTIVITY DATA DETECTOR)
242
INSERTION CONTROL SIGNAL
246
ALTERNATE TRAFFIC INSERTION LOGIC
222
DEDICATED TRAFFIC
244
ALTERNATE TRAFFIC
210

FIG. 4

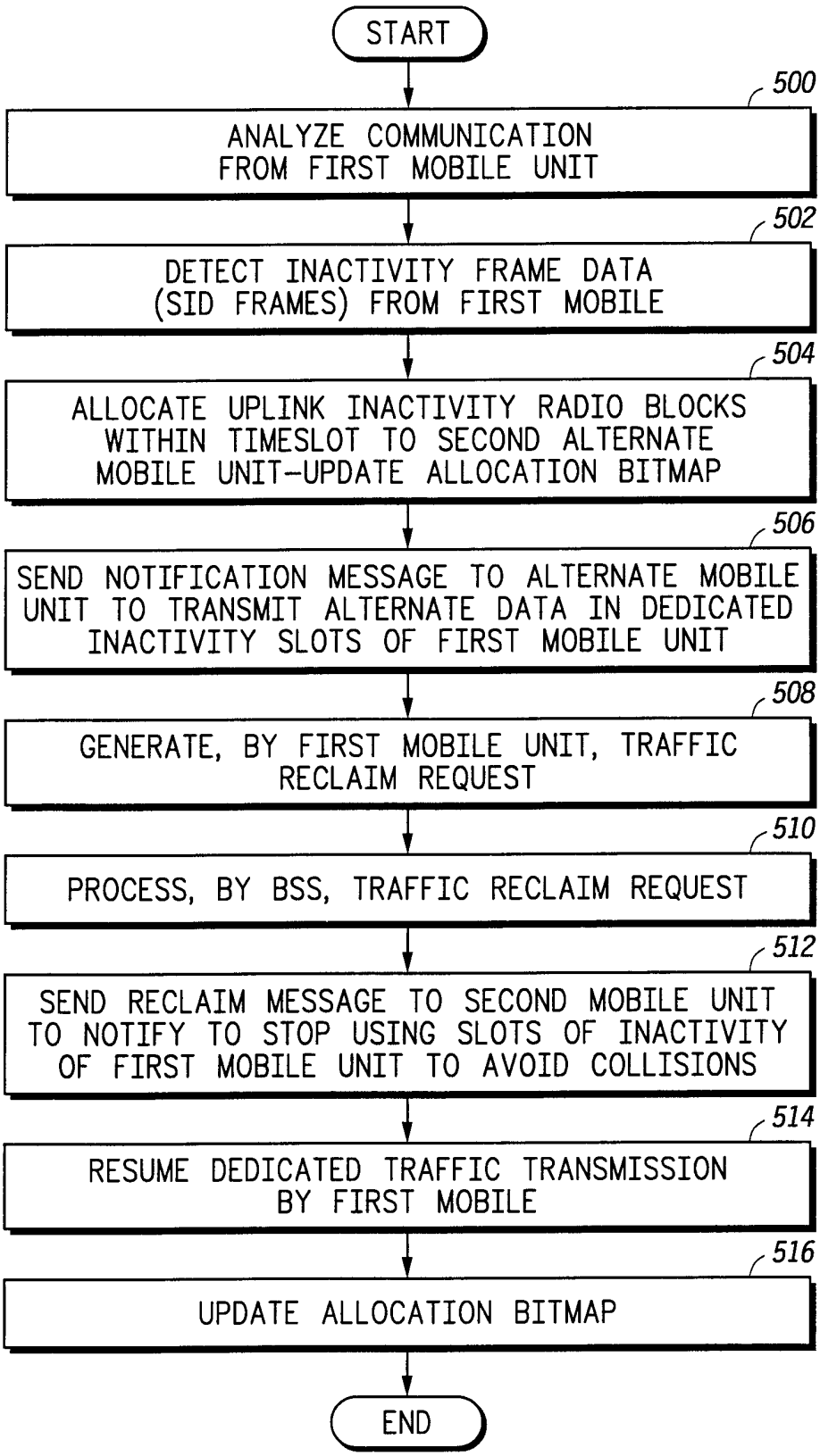

START
500
ANALYZE COMMUNICATION FROM FIRST MOBILE UNIT
502
DETECT INACTIVITY FRAME DATA (SID FRAMES) FROM FIRST MOBILE
504
ALLOCATE UPLINK INACTIVITY RADIO BLOCKS WITHIN TIMESLOT TO SECOND ALTERNATE MOBILE UNIT-UPDATE ALLOCATION BITMAP
506
SEND NOTIFICATION MESSAGE TO ALTERNATE MOBILE UNIT TO TRANSMIT ALTERNATE DATA IN DEDICATED INACTIVITY SLOTS OF FIRST MOBILE UNIT
508
GENERATE, BY FIRST MOBILE UNIT, TRAFFIC RECLAIM REQUEST
510
PROCESS, BY BSS, TRAFFIC RECLAIM REQUEST
512
SEND RECLAIM MESSAGE TO SECOND MOBILE UNIT TO NOTIFY TO STOP USING SLOTS OF INACTIVITY OF FIRST MOBILE UNIT TO AVOID COLLISIONS
514
RESUME DEDICATED TRAFFIC TRANSMISSION BY FIRST MOBILE
516
UPDATE ALLOCATION BITMAP
END

FIG.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/25937

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H04B 7/212; H04J 3/00, 3/12, 3/16
US CL :370/522, 524, 528, 468, 345, 321, 322, 337, 347
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 370/522, 524, 528, 468, 345, 321, 322, 337, 347

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

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

EAST DATABASE
search terms: tdma, silence period, silence interval, dedicated channel

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, P	US 6,122,271 A (MCDONALD et al.) 19 September 2000, col.3, line 30 to col.4, line 45.	1-10
A, P	US 6,031,832 A (TURINA) 29 February 2000, See entire document.	1-10
A	US 5,870,397 A (CHAUFFOUR et al.) 09 February 1999, see entire document.	1-10
A	US 5,742,589 A (MURATA) 21 April 1998, see entire document.	1-10

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

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 01 NOVEMBER 2000	Date of mailing of the international search report 17 JAN 2001
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