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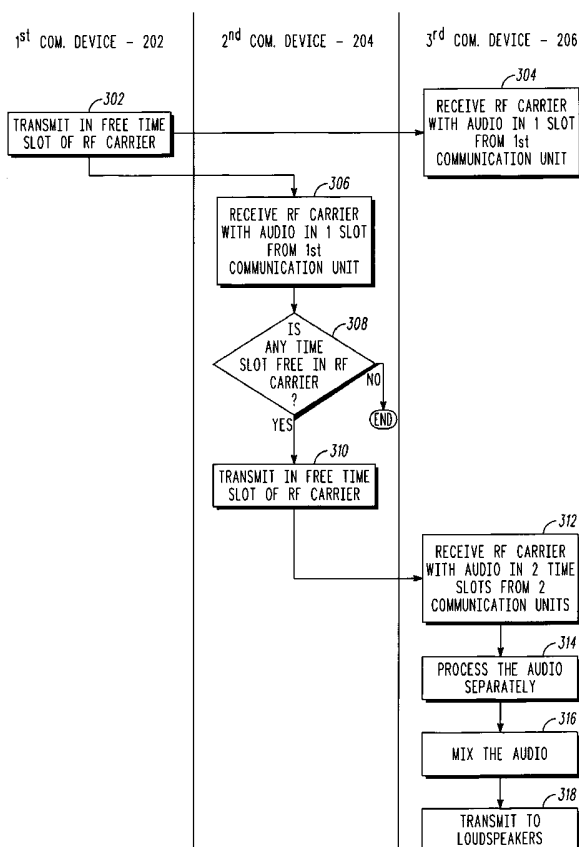
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(54) Title: WIRELESS COMMUNICATION NETWORK, WIRELESS COMMUNICATION UNIT AND METHOD OF OPERATION THEREFOR



(57) Abstract: A method of communication in a wireless digital communications network comprising at least three communication units, the method comprises the following steps: transmitting (302) audio in a vacant time slot of a RF carrier on a RF channel by a first communication unit. A second communication unit, despite transmission on said RF carrier on said RF channel, transmits (310) audio in another vacant time slot of said RF carrier on said RF channel. A third communication unit receives (312) audio from said first and second communication units in two time slots of said RF carrier on said RF channel and separately processes (314) audio from said two time slots.



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**WIRELESS COMMUNICATION NETWORK, WIRELESS COMMUNICATION
UNIT AND METHOD OF OPERATION THEREFOR**

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Field of the Invention

The present invention relates to communication in a wireless digital communications network, in general, and in particular, to a unit, method and system for
10 communication in a mobile communication network.

Background of the Invention

In a cellular communication system (such as for example the Global System for Mobile communication (GSM) and
15 TETRA (TERrestrial TRunked RADio)), a geographical region is divided into a number of cells each of which is served by a base station. One base station, also termed a Base Transceiver Station (BTS), with a switching
20 infrastructure is referred as a node of the network. The switching infrastructure supporting BTS may be shared with other BTSs. The system infrastructure in a TETRA system is generally referred to as a switching and management infrastructure (SwMI), which substantially contains all of the communication elements apart from
25 communication units (also referred as subscribers or mobile stations (MSs)). This includes base transceiver stations (BTSs) connected to a conventional public-switched telephone network (PSTN) through base station controllers (BSCs) and mobile switching centres (MSCs).
30 In geographical terms reference to a node is a reference to an area served by one BTS, and in network terms

reference to a node is a reference to one BTS and supporting it infrastructure. A communication unit referred also as subscriber or mobile station (MS) or communication unit is served via a radio communication link by the base station of the cell within which the communication unit is operating.

One of the basic advantages of the cellular communications systems is that communication unit may move from one geographical location to another one while receiving services from the network. To provide seamless service there are regions of overlapping coverage of two base stations. As the communication unit moves from area served by a first base station towards area served by a second base station it enters the region of overlapping coverage. Within the region of overlapping coverage the communication unit changes the serving base station. This is known as cell reselection or handover.

The communication link from a BTS to a communication unit is generally referred to as a downlink communication channel. Conversely, the communication link from a communication unit to a BTS is generally referred to as an up-link communication channel.

25

To enable communication between two communication units such as handsets operating in two different cells a fixed network interconnects the base stations. The fixed network is operable to route data between any two base stations and this way allows for communication between these two remote handsets. In addition, the fixed network

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may comprise gateway functions for interconnecting to external networks such as the Public Switched Telephone Network (PSTN). This allows communication units to communicate with landline telephones and other
5 communication terminals connected by a landline. Additionally the fixed network is adapted to perform functions required for managing a conventional cellular communication network including routing data, admission control, resource allocation, subscriber billing, mobile
10 station authentication etc.

TETRA is a Time Division Multiple Access (TDMA) system wherein 25 kHz wide channels are divided into four time slots. Each time slot has duration of 14.167 msec and
15 four timeslots are combined into a time frame having duration of 56.67 msec. The time frames are combined into multiframes comprising 18 time frames. Frame number 18 is reserved as a control frame wherein control information may be communicated during an active call.

20

TETRA communications systems may be used as commercially operated cellular communication systems. However, their main target users are organizations or groups such as emergency services. Special functions and services
25 implemented in a TETRA system make this system especially suitable for services like police, paramedics, fire rescuers and others. One of such functions provided by a TETRA system, which is especially useful for the emergency services, is control of group calls as well as
30 managing the membership of these groups. Other features and services provided by TETRA systems include push-to-

talk channel allocation, broadcast calls etc. In addition to trunked mode operation wherein remote communication units communicate via a base station, TETRA systems provide for the possibility of communication directly
5 between remote units without participation of the infrastructure. This is known as Direct Mode Operation (DMO). Communication which requires participation of the infrastructure is known as Trunked Mode Operation (TMO).

10 One example of a digital communication system 100 known in the art is with great simplification depicted in FIG. 1. The system 100 comprises a plurality of communication units 102 - 108. Only one audio signal at a time is allowed to be transmitted on a given RF carrier of a RF
15 channel. This signal is transmitted by a transmitting communication unit 102 to a receiving communication unit 106. Another communication unit 104 trying to transmit on the same RF carrier of the RF channel which is busy will be denied access. This can be disadvantageous in certain
20 situations.

Summary of the Invention

There is a need for a method and an apparatus for wireless communication, which alleviates or overcomes the
25 disadvantages of the prior art.

According to a first aspect of the present invention there is provided a wireless communication unit for use in a digital communication system, the communication unit
30 being as claimed in claim 1 of the accompanying claims.

According to a second aspect of the present invention there is provided a wireless digital communications network as claimed in claim 7 of the accompanying claims.

5 According to a third aspect of the present invention there is provided a method of communication in a wireless digital communications system as claimed in claim 10 of the accompanying claims.

10 Further features of the present invention are as defined in the accompanying dependent claims and are disclosed in the description of embodiments of the invention later.

The present invention beneficially allows for
15 simultaneous reception of calls from more than one transmitter and for producing good quality audio output in one receiving wireless communication unit. In practice this allows for example a person in command using that unit to listen to two persons transmitting at the same
20 time. Separation of the two or more signals on the radio path and audio processing path, and mixing them prior to output ensures clear and good quality of the audio signal.

25 **Brief description of the drawings**

The present invention will be understood and appreciated more fully from the following detailed description of embodiments of the invention taken in conjunction with the accompanying drawings in which:

FIG. 1 is a diagram illustrating a wireless digital communications network operating in accordance with a method known in the art,

5 FIG. 2 is a diagram illustrating a wireless digital communications network operating in accordance with one embodiment of the present invention,

FIG. 3 is a flow chart illustrating a method of
10 communication in a wireless digital communications network in one embodiment of the present invention,

FIG. 4 is a block diagram illustrating a wireless communication unit in accordance with one embodiment of
15 the present invention.

Description of embodiments of the invention

The following description focuses on an embodiment of the
20 invention applicable to a TETRA cellular communication system. However, it will be appreciated that the invention is not limited to this application but may be applied to many other communication systems (e.g. APCO Project 25 and other digital mobile communications
25 systems).

Referring to FIG. 2 and FIG. 3 one embodiment of communication in a wireless digital communications network 200 according to the present invention is shown.
30

In the network 200 that comprises plurality of communication units 202 - 208 a first communication unit 202 transmits 302 audio in a vacant time slot of a RF carrier on a RF channel. A second communication unit 204
5 can hear that there is transmission on this RF carrier on said RF channel. The RF carrier on the RF channel is flagged as busy if it is in use. Despite the fact that the RF carrier on said RF channel is busy the second communication unit 204 transmits 310 audio in another
10 vacant time slot of said RF carrier on said RF channel. In consequence transmission on said RF channel by said second communication unit 204 occurs at the same time as transmission on said RF channel by said first communication unit 202, but both transmitting
15 communication units 202, 204 use different time slots of the same RF carrier on RF channel.

A third communication unit 206 receives 312 audio from said first 202 and said second 204 communication units in
20 two time slots of said RF carrier on said RF channel and separately processes 314 audio from said two time slots.

A controller of the third communication unit 206, after processing the received two audio signals, mixes 316 the
25 processed audio from said two time slots and sends 318 said mixed audio to a loudspeaker of the third communication unit 206.

In one embodiment the audio section of the third
30 communication unit 202 may be equipped with a stereo amplifier and said controller after processing sends said

separated audio to separate channels of the stereo amplifier.

A significant advantage of this solution is that by
5 transmitting in separate time-slots it is possible to
avoid interference on radio transmission path. In
consequence signal that is received by the third
communication unit 206 can be separated and each audio
stream can be processed independently. This allows for
10 production of undisturbed, clear audio signals in the
loudspeakers of the third communication unit.

In a practical implementation, the third communication
unit 206 may be used by a person in command during
15 operation of special services like police, security,
firefighters, etc. This allows the person in command to
listen to more than one other person sending a wireless
communication at the same time.

20 For the user of the second communication device 204 it
means that he or she can deliver the information
immediately without waiting for termination of the call
that has started earlier (i.e. in the example shown on
FIG. 3 the call between the first communication unit 202
25 and the third communication unit 206).

In one embodiment, in every time slot of said RF carrier
audio from another communication unit is transmitted.

30 In yet another embodiment said audio transmission from at
least two communication units 202, 204 transmitted in at

least two time slots of said RF carrier on said RF channel is received by a talk group (e.g. communication units 206, 208).

- 5 In one embodiment, the communication between said communication units 202 - 208 is carried out in a direct mode. Alternatively the communication is carried out in a trunked mode.
- 10 When the communication is carried out in a trunked mode said third communication unit 206 registers with the infrastructure as a receiving parallel audio. Said registration is an instruction for the infrastructure to allow transmission of more than one audio signal on the
- 15 same RF channel

With reference to FIG. 2 a wireless digital communications network 200 in one embodiment of the present invention is shown. The network 200 comprises at

20 least three communication units 204 - 206 and a first communication unit 202 transmits audio in a vacant time slot of a RF carrier on a RF channel. A second communication unit 204, despite detected transmission on said RF carrier of said RF channel transmits audio in

25 another vacant time slot of said RF carrier on said RF channel. In this situation the signal that is received by recipient of this transmission, i.e. a third communication unit 206, consists of mixture of two audio signals that use two different time-slots of said RF

30 carrier of said RF channel. The third communication unit 206 after receiving audio from said first 202 and said

second 204 communication units in two time slots of said RF carrier on said RF channel and processes separately audio from said two time slots.

5 In one embodiment, when the communication is carried out in a trunked mode the wireless digital communications network 200 allows for registration of said third communication unit 206 with the infrastructure as a communication unit that receives parallel audio and said
10 registration is an instruction for the infrastructure to allow transmission of more than one audio signal on the same RF channel to said third communication unit 206.

With reference to FIG. 4, a wireless communication unit
15 400 in one embodiment of the present invention is shown. The wireless communication unit 400 comprises a controller 402, a memory 430, a receiver section 422, a transmitter section 420, a radio frequency (RF) switch 424, an antenna 426. To allow a user an easy operation of
20 the communication unit it further comprises a display 408, a keyboard 410, a microphone 412 and a loudspeaker 402 which together form a user interface 404. An analog-to-digital converter 418 interconnects the microphone and the controller 402. The received audio signals are
25 transferred from said controller 402 via a digital-to-analog converter 432 to an amplifier 434 and then to the loudspeaker. As a controller 402 a microprocessor is used. Said controller 402 is configured to allow the transmitter section 420 for transmission in a vacant time
30 slot on a RF carrier of RF channel even if a second

communication unit transmits on said RF carrier of said RF channel.

In one embodiment, the communication unit 400 is adapted to receive parallel audio (signals representing audio information) from at least two communication units in at least two time slots of said RF carrier on said RF channel and separately process audio from said at least two time slots.

10

The controller 402 of the communication unit 400, while operating in trunked mode, registers said communication unit 400 with the network as receiving parallel audio. The request for registration is sent by the transmitter section 420. After such registration the infrastructure of the network is instructed to allow for transmission of more than one communication unit on the same RF channel.

15

The user interface 404 of the communication unit 400 allows for manual configuration by the user to register the communication unit with the network as receiving parallel audio.

20

In another embodiment the user of the communication unit 400 may switch off one or more of said audio signals. The audio signals to be switched off are selected by the user of the communication unit 400 using the user interface 404. In one embodiment the user is presented on a display screen 408 a list of received audio signals and he or she may select the signals to be switched off. It is clear that equally he or she may select the signal that should

25

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be kept and the remaining ones are to be switched off. The switching off signals may be carried out on various stages of processing in the communication unit. It may be done by discarding particular timeslots from processing
5 at initial stage of said processing or in another embodiment, the switching off may take place in the audio section by excluding the signal from transmitting to the loudspeaker. However it is clear for those skilled in the art that by disabling a particular audio signal at an
10 earlier stage of said processing saves processing resources of the controller 402. It is envisaged that, for the purpose of selecting the signals to be switched off, voice commands can be used if the communication unit is capable of speech recognition.

15

In one embodiment, the communication unit 400 (representing an example of the units 202 - 206) may be implemented as a portable or mobile communication unit.

20 In one embodiment, the second communication unit 204 is adapted to transmit a voice call, while at least one of the remaining frames is used for transmission of (non-voice) data.

Claims

1. A communication unit (400) for use in a wireless digital communications system (200), the communication unit being operable to receive in parallel, in at least two time slots on a RF channel, signals representing audio information from at least two other communication units and to process separately (314) said signals received in said at least two time slots.
2. A communication unit according to claim 1 which is further operable to produce from said signals at least two audio output signals contemporaneously, optionally mixed together.
3. A communication unit according to claim 1 or claim 2 including:
a transmitter section (420); and
a controller (402);
wherein said controller (402) is configured to control transmission by the transmitter section (420) in a vacant time slot on a RF carrier of a RF channel even if a second communication unit is transmitting in another time slot of said RF carrier of said RF channel.
4. A communication unit (400) according to claim 3, wherein said controller (402) and said transmitter section (420) are configured to register said communication unit with a network serving the communication unit as receiving parallel audio signals.

5. A communication unit (400) according to any one preceding claims, wherein said controller (402) is adapted to be manually configured by a user of the communication unit (400) to receive parallel audio signals.

6. A communication unit (400) according to any one of claims 2 to 5 which is adapted to switch off at least one of said audio signals, wherein the audio signals to be switched off are selectable by a user of the communication unit (400) using the user interface (404).

7. A wireless digital communications system (200) comprising at least three communication units (202 - 206), wherein:

a first communication unit (202) is adapted to transmit a signal representing audio information in a vacant time slot of a RF carrier on a RF channel;

a second communication unit (204) is adapted to transmit a signal representing audio information in a another vacant time slot of said RF carrier on said RF channel;

and

a third communication unit (206) is adapted to receive the signals from said first and second communication units in two time slots of said RF carrier on said RF channel and to process separately audio from said two time signals;

and wherein said first and second communication units are operable to communicate with the third communication unit in either a direct mode or a trunked mode via a system infrastructure.

8. A wireless digital communications system (200) according to claim 7 including a system infrastructure adapted to allow for registration of said third
5 communication unit (206) as receiving parallel audio signals and in response to said registration to allow transmissions of more than one signal representing audio information on the same RF channel to be sent in parallel to the third communication unit.

10

9. A system according to claim 7 or claim 8 and wherein said system is a communications network operable in accordance with TETRA or APCO Project 25 standards. communications network.

15

10. A method of communication in a wireless digital communications network (200) comprising at least three communication units (202 - 206), the method comprising the steps of:

20 in a first communication unit (202):

- transmitting (302) audio in a vacant time slot of a RF carrier on a RF channel;

in a second communication unit (204):

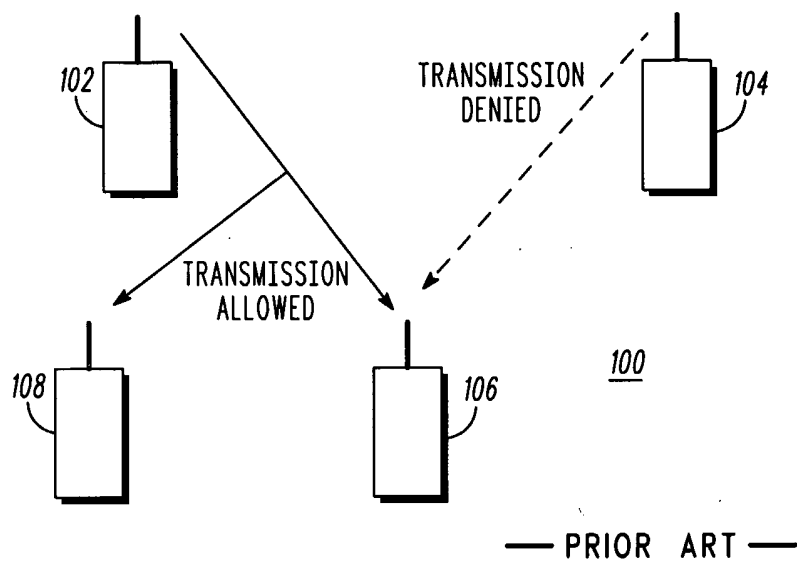
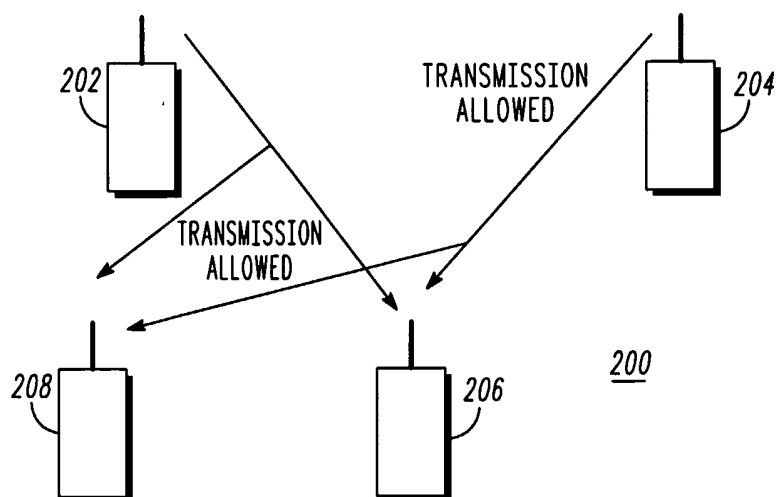
- transmitting (310) audio in another vacant time slot of
25 said RF carrier on said RF channel;

in a third communication unit (206):

- receiving (312) audio from said first and second communication units in two time slots of said RF carrier on said RF channel;

30 - separately processing (314) audio from said two time slots.

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**FIG. 1****FIG. 2**

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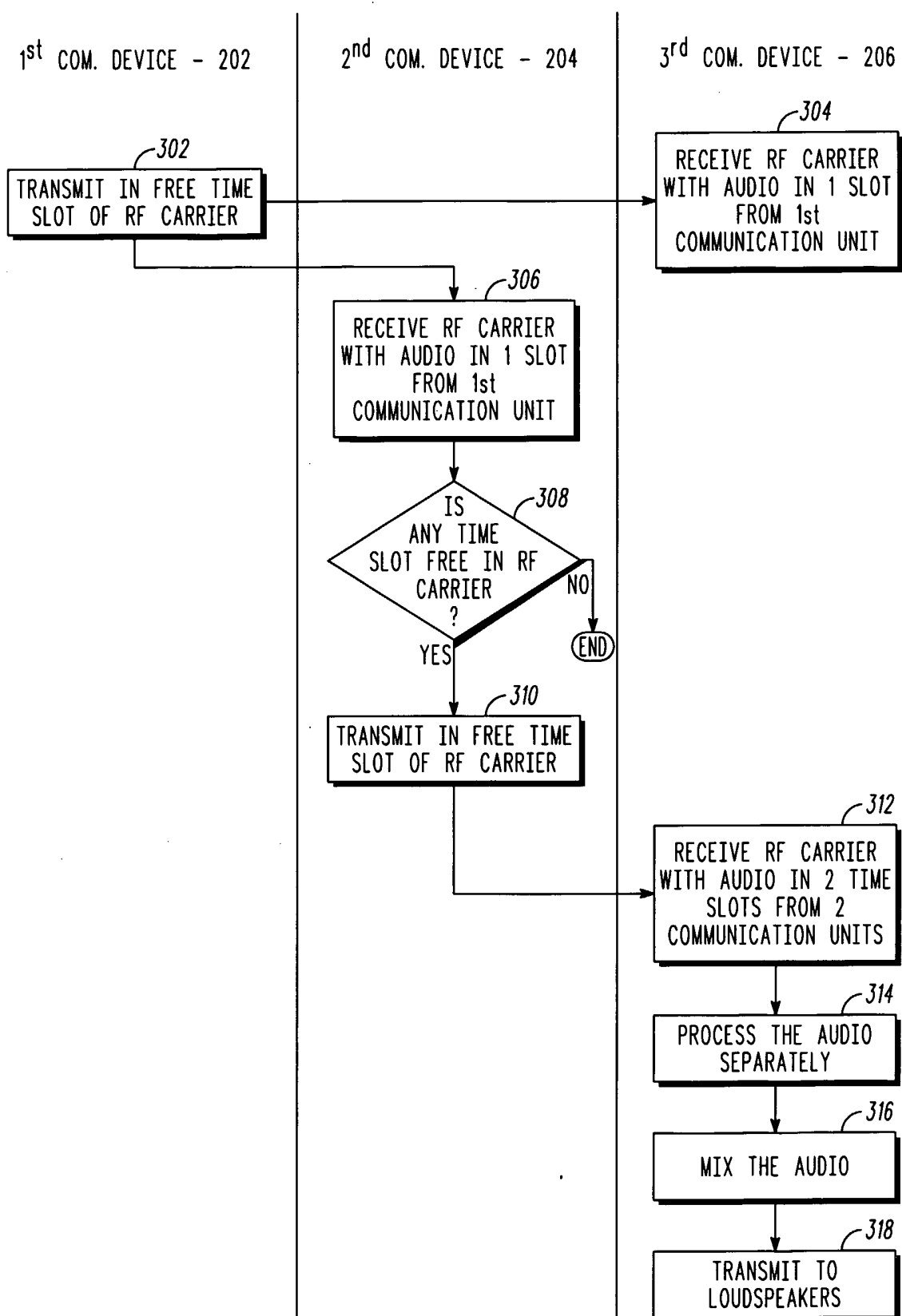
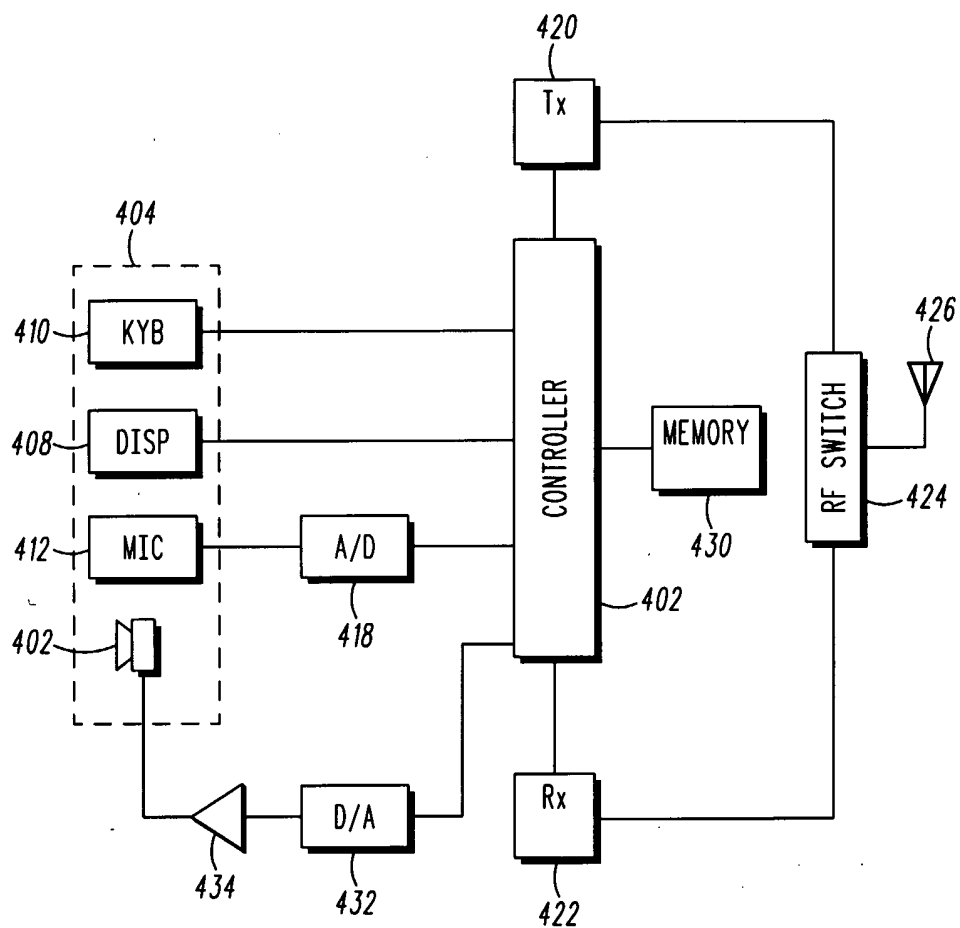


FIG. 3

3/3

400**FIG. 4**