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TRANSMISSION OF MOBILE UNIT REQUESTS IN WIRELESS UPLINK SYSTEMS

Abstract

Access request transmissions are effected in a wireless communications system by assigning each mobile unit (302) a unique dedicated uplink resource. Specifically, each mobile unit is assigned (603) channel segments with distinct time slot indices and/or waveform indices, where waveforms with distinct indices are orthogonal. A base station (301) can identify (702) the mobile that has made an access request from the dedicated uplink resource. Therefore, no mobile identification number is needed in the uplink request message. Then, the base station can transmit a request response message on a shared downlink resource that may include the identification number of the requesting mobile unit to acknowledge reception of the request. The mobile unit may transmit on a shared uplink resource an acknowledgment of reception of the downlink request response message.

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COMPLETE SPECIFICATION

FOR A STANDARD PATENT

ORIGINAL

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Invention Title:	Transmission of Mobile Unit Requests in Wireless Uplink Systems

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

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TRANSMISSION OF MOBILE UNIT REQUESTS IN WIRELESS UPLINK SYSTEMS

Related Application

United States Patent application Serial No. (R.Laroia-J. Li-S. V. Uppala Case 23-15-8) was filed concurrently herewith.

Technical Field

This invention relates to wireless communications systems and, more particularly, to wireless communications between mobile units and base stations.

Background of the Invention

The basic mechanism in wireless communication systems for a base station and one or more mobile units to communicate is to exchange messages by utilizing a so-called segment. One such wireless system is the Orthogonal Frequency Division Multiplex (OFDM) system. A segment, as shown in FIG. 1, is a combination of a time slot index and a waveform index. A time slot is a basic time unit having a unique time slot index associated with it. During any particular time slot interval there could be several waveforms that are transmitted and received that may or may not be orthogonal. Each waveform has a unique waveform index. Messages of particular interest in wireless communication systems are mobile unit requests on an uplink.

Typically, the same uplink resource is shared by more than one mobile unit to convey access requests to a base station. As shown in FIGs. 2A and 2B, different mobile units may be assigned segments that have the same time slot index, and either the same waveform index or different waveform indices, but the waveforms that are not orthogonal. In FIG. 2A one mobile unit, for example #1, is transmitting a request while another mobile unit, for example #2, is not. Consequently, there is no collision between the request from mobile unit #1 with a request from mobile unit #2. However, since requests from the individual mobile units may arrive at a base station randomly, there is a distinct possibility of a collision between requests from mobile unit #1 and mobile unit #2, as shown in FIG. 2B. Consequently, both requests must be re-transmitted

resulting in undesirable delay.

Moreover, because there is no power control of the mobile unit during the access request process and because the nature of the request transmissions is random and bursty, the uplink request process is very slow and its reliability is less than desirable.

Summary of the Invention

Problems and limitations of prior mobile unit and base station access request transmissions are addressed by assigning each mobile unit a unique dedicated uplink resource. Specifically, each mobile unit is assigned segments with distinct time slot indices and/or waveform indices, where waveforms with distinct indices are orthogonal.

A base station can identify the mobile that has made an access request from the dedicated uplink resource. Therefore, no mobile identification number is needed in the uplink request message. Then, the base station can transmit a request response message on a shared downlink resource that may include the identification number of the requesting mobile unit to acknowledge reception of the request.

The mobile unit may transmit on a shared uplink resource an acknowledgment of reception of the downlink request response message.

Brief Description of the Drawing

FIG. 1 is a graphical representation of a segment useful in describing the invention;

FIGs. 2A and 2B are graphical representations of a prior contention-based transmission of mobile unit requests on an uplink;

FIG. 3 shows, in simplified block diagram form, details of a base station and a mobile unit in which the invention may be employed;

FIGs. 4A and 4B are graphical representations of a contention-free transmission of mobile unit requests on an uplink and including a shared downlink resource for transmitting request response messages useful in describing the invention;

FIG. 5 is a graphical representation of the transmission of acknowledgments for downlink request response messages on a shared uplink resource useful in describing an aspect of the invention;

FIG. 6 is a flowchart illustrating the steps in a process employed in a base station to detect reception of mobile unit requests and transmit downlink request response messages; and

FIG. 7 is a flowchart illustrating steps in a process employed in a mobile unit to transmit requests, receive request response messages and transmit acknowledgments in accordance with the invention.

Detailed Description

FIG. 3 shows, in simplified block diagram form, details of a base station and a mobile unit in which the invention may be employed. Specifically, shown are base station 301 and mobile unit 302. It is noted that only a single mobile unit 302 is shown but, typically, a set including a number of mobile units, shares a base station 301. In this example, base station 301 includes transmitter 303, receiver 304 and controller 305 for transmitting and receiving wireless messages via antenna 306. Controller 305 is employed to control operation of transmitter 303 and receiver 304, in accordance with the invention. Similarly, in this example, mobile unit 302 includes transmitter 307, receiver 308 and controller 309 for transmitting and receiving wireless messages via antenna 310. Controller 309 is employed to control operation of transmitter 307 and receiver 308, in accordance with the invention.

FIGs. 4A and 4B are graphical representations of a contention-free transmission of mobile unit requests on an uplink and including a shared downlink resource for transmitting request response messages useful in describing the invention. Specifically, to eliminate the problem of collision between mobile unit requests on the uplink resource, each mobile unit is assigned a dedicated uplink resource. The dedicated uplink resource is not shared with any other mobile unit. To this end, each mobile unit is assigned segments, as shown in FIG. 1, with distinct time slot indices and/or waveform indices, where waveforms with distinct indices are orthogonal. As shown in FIGs. 4A and 4B, this is realized by assigning mobile unit #1 and mobile unit #2 two different time slots.

After receiving a mobile request, base station 301 can identify which mobile 302

has transmitted the request. This is realized by employing the dedicated uplink resource assigned to the mobile unit 302 that transmitted the request on the uplink. Then, base station 301 can transmit a request response message on a downlink, which may include the identification of the mobile unit 302 that transmitted the request on the uplink in order to acknowledge the request. It is noted that the downlink resource for transmitting the request response messages is not dedicated to any particular mobile unit or units, but is a shared resource for all mobile units sharing base station 301. It is also important to note that segments for transmitting downlink request response messages from base station 301 do not necessarily have a one-to-one mapping to dedicated segments for transmitting uplink requests from mobile unit 302. As shown in FIG. 4A, after receiving a request from mobile unit #1, base station 301 transmits back a request response message in a downlink segment. In another instance, as shown in FIG. 4B, after receiving a request message from mobile unit #2, base station 301 transmits back a request response message in the same downlink segment as the request response message transmitted to mobile unit #1.

FIG. 5 is a graphical representation of the transmission of acknowledgments for downlink request response messages on a shared uplink resource useful in describing an aspect of the invention. For a given amount of the total uplink resource, the amount of a dedicated resource for an individual mobile unit is generally smaller than what may be available in the prior contention-based implementation. As a result, dedicated mobile unit request transmission may not be reliable in a wireless channel. In particular, if an uplink mobile unit request is not received by base station 301, the mobile unit request must be re-transmitted, which is very similar to the collision situation in the contention-based implementation. On the other hand, the error of false alarm, where base station 301 perceives receiving some mobile unit request that has not really been transmitted, also causes wasted use of the system resource.

In order to improve reliability without introducing any significant amount of resource overhead, additional acknowledgment segments are added on the uplink for each downlink request response message. As shown in FIG. 5, an uplink

acknowledgment segment is slaved to a downlink request response segment. Therefore, acknowledgment segments are not dedicated for any particular mobile units, but shared by all mobile units. Whichever mobile unit transmits a request in its dedicated uplink segment and detects its own identification number in one of the request response message segments transmits an acknowledgment in the corresponding acknowledgment segment. Thus, each segment on the shared uplink resource has a one-to-one correspondence to a response message. Clearly, although acknowledgment segments are shared, no collision occurs unless two mobile units transmit their requests and both detect their identification numbers in the same request response message segment. In such an instance, at least one of the mobile units must have decoded the request response message in-error. The advantage of employing a shared resource for transmitting acknowledgments is that acknowledgment segments can be made to contain sufficient energy to ensure needed reliability without causing any significant system resource overhead.

FIG. 6 is a flowchart illustrating the steps in a process employed in base station 301 to detect reception of mobile unit requests and transmit request response messages. Thus, step 601 causes base station 301 to monitor mobile unit request time slots. Step 602 tests to determine if any mobile unit requests have been detected. If the test result in step 602 is No, control is returned to step 601 and steps 601 and 602 are iterated until step 602 yields a YES result. The YES result in step 602 indicates the detection of a mobile unit request in a dedicated uplink resource. Thereafter, step 603 causes the transmission of a request response message on the downlink. It is noted that the request response message may include the identification number of the mobile unit that transmitted the request. Step 603 also causes a traffic channel to be assigned to the requesting mobile unit. Then, step 604 tests to determine if an acknowledgment has been received from the mobile unit that the request response message was directed to. If the test result in step 604 is NO, the assigned traffic channel is retracted by base station 301, and control is returned to step 601 and steps 601 through 604 are iterated until step 604 yields a YES result. A YES result in step 604 indicates that an

acknowledgment has been received from the mobile unit that a request response message was transmitted toward. Step 605 causes base station 301 to receive data traffic in the assigned traffic channel from the requesting mobile unit, for example mobile unit 302.

FIG. 7 is a flowchart illustrating steps in a process employed in a mobile unit to transmit requests, receive request response messages and transmit acknowledgments in accordance with the invention. Step 701 causes a mobile unit, for example mobile unit 302, to transmit on the uplink a request in its dedicated time slot to a base station, for example base station 301. Then, step 702 tests to determine if a request response message from base station 301 has been received in a shared request response message downlink resource, namely, a downlink time slot. If the test result in step 702 is NO, control is returned to step 701 and steps 701 and 702 are iterated until step 702 yields a YES result. That is, a request response message has been received in the shared downlink request response message time slot indicating that base station 301 has received the request from this mobile unit, i.e., mobile unit 302. Thereafter, step 703 causes mobile unit 302 to transmit an acknowledgment of receiving the request response message in a shared acknowledgment time slot. Then, step 704 causes mobile unit 302 to transmit data traffic on the traffic channel assigned to it by base station 301.

The above-described embodiments are, of course, merely illustrative of the principles of the invention. Indeed, numerous other methods or apparatus may be devised by those skilled in the art without departing from the spirit and scope of the invention.

The claims defining the invention are as follows:

1. A method for use in a wireless communications mobile unit, the method comprising the steps of:

transmitting an access request message on a wireless uplink to a base station on a uplink resource dedicated to a particular mobile unit, wherein no identification of the particular mobile unit need be transmitted to the base station;

detecting a received request response message on a wireless downlink from said base station on a downlink resource shared with other mobile units;

transmitting an acknowledgment message indicative of reception of said request response message to the base station on a shared uplink acknowledgment resource slaved, i.e., which has a one-to-one correspondence, to said shared downlink response resource on which said response message was received; and

transmitting data traffic on a traffic channel assigned by the base station,

wherein latency is reduced and reliability is improved.

2. A method for use in a wireless communications base station comprising the steps of:

monitoring received request time slots to detect an incoming request from at least one mobile unit on a time slot dedicated to said at least one mobile unit;

determining whether any requests have been received; and

assigning a traffic channel to said at least one requesting mobile unit;

if at least one request has been received, transmitting a request response message on a shared downlink response resource to an at least one requesting mobile unit;

determining whether an acknowledgment message has been received from said at least one requesting mobile unit on a shared uplink acknowledgment resource that is slaved, i.e. which has a one-to-one correspondence, to said downlink response resource on which said response message was transmitted, indicating that said at least one mobile unit has received said response message; and

if an acknowledgment message has been received, receiving data traffic from said at least one requesting mobile unit,

wherein latency is reduced and reliability is improved.

3. The method as defined in claim 1 for further use in a wireless communications system including one or more base stations and one or more mobile units;

the method further comprising the steps of:

in a base station;

monitoring received request time slots to detect an incoming request from at least one mobile unit on a time slot dedicated to said at least one mobile unit;

determining whether any requests have been received; and

assigning a traffic channel to said at least one requesting mobile unit;

if at least one request has been received, transmitting a request response message on a shared downlink response resource to an at least one requesting mobile unit;

determining whether an acknowledgment message has been received from said at least one requesting mobile unit on a shared uplink acknowledgment resource that is slaved, i.e. which has a one-to-one correspondence, to said downlink response resource on which said response message was transmitted, indicating that said at least one mobile unit has received said response message; and

if acknowledgment message has been received, receiving data traffic from said at least one requesting mobile unit,

wherein latency is reduced and reliability is improved.

4. The method as defined in claim 1 wherein said dedicated uplink resource is a segment including distinct time slot indices and/or waveform indices, said waveforms with distinct indices being orthogonal, and said shared downlink resource including a number of response time slots based on a number of mobile units that are sharing said shared downlink resource, said number of response time slots including at least one timeslot.

5. The method as defined in claim 4 wherein the number of response time slots is less than the number of mobile units and said shared downlink resource includes a number of segments equal to said number of response messages and each of said shared downlink resource segments has a one-to-one correspondence to a response message.

6. The method as define din claim 1 wherein said shared uplink resource includes a number of segments based on a prescribed relationship to the number of response messages, said number of segments on said shared uplink resource being equal to said number of response messages and each of said segments on said shared uplink resource has a one-to-one correspondence to a response message.

7. The method as defined in claim 2 wherein said dedicated uplink resource is a segment including distinct time slot indices and/or waveform indices, said waveforms with distinct indices being orthogonal, and said shared downlink resource including a number of response time slots based on a number of mobile units that are sharing said shared downlink resource, said number of response time slots including at least one time slot.

8. The method as defined in claim 7 wherein the number of response time slots is less than the number of mobile units and said shared downlink resource including a number of segments equal to said number of response messages and each of said shared downlink resource segments having a one-to-one correspondence to a response message.

9. The method as defined in claim 2 wherein said shared uplink resource includes a number of segments based on a prescribed relationship to the number of response messages, and said number of segments on said shared uplink resource being equal to said number of response messages and each of said segments on said shared uplink resource has a one-to-one correspondence to a response message.

10. Apparatus for use in a wireless communications mobile unit, the apparatus comprising:

means adapted to transmit an access request message on a wireless uplink to a base station on a uplink resource dedicated to a particular mobile unit, wherein no identification of the particular mobile unit need be transmitted to the base station;

means adapted to detect a received request response message on a wireless downlink from said base station on a downlink resource shared with other mobile units;

said means adapted to transmit being adapted to transmit an acknowledgment message indicative of reception of said request response message to the base station on a shared uplink acknowledgment resource, which has a one-to-one correspondence, to said shared downlink response resource on which said response message was received; and

means adapted to transmit data traffic on a traffic channel assigned by the base station;

wherein latency is reduced and reliability is improved.

11. Apparatus for use in a wireless communications base station, said apparatus comprising:

means adapted to monitor received request time slots to detect an incoming request from at least one mobile unit on a time slot dedicated to said at least one mobile unit;

means adapted to determine whether any requests have been received; and

means adapted to assign a traffic channel to said at least one requesting mobile unit;

means, responsive to at least one request being received, adapted to transmit a request response message on a shared downlink response resource to an at least one requesting mobile unit;

means adapted to determine whether an acknowledgment message, indicating that said at least one mobile unit has received said response message on which said response message was transmitted, has been received from said at least one requesting mobile unit on a shared uplink acknowledgment resource, which has a one-to-one correspondence, to said downlink response resource; and

means, responsive to an acknowledgment message being received, adapted to receive data traffic from said at least one requesting mobile unit;

wherein latency is reduced and reliability is improved.

12. A method for use in a wireless communications mobile unit, said method being substantially as described herein with reference to Figs. 6 or 7.

13. Apparatus for use in a wireless communications mobile unit, said apparatus being substantially as described herein with reference to Fig. 3.

DATED this tenth Day of November, 2003

Lucent Technologies Inc

Patent Attorneys for the Applicant

SPRUSON & FERGUSON

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FIG. 1

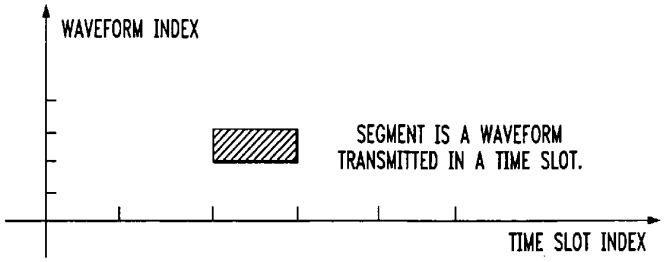


FIG. 2A

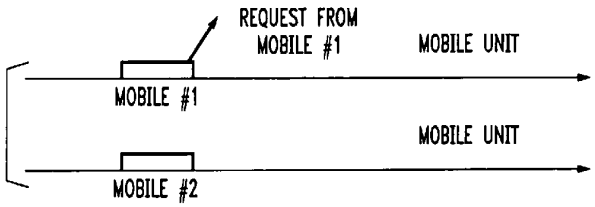


FIG. 2B

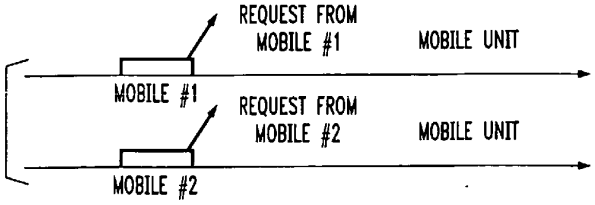


FIG. 3

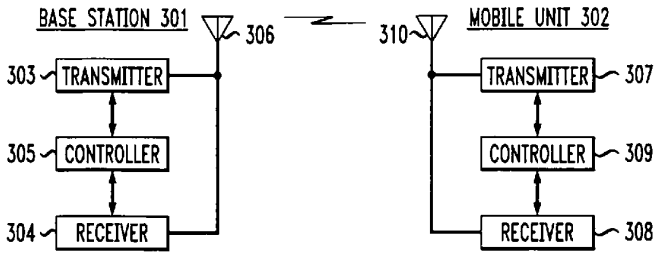


FIG. 4A

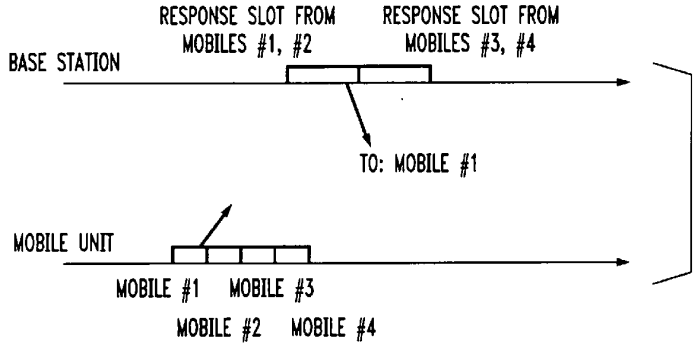


FIG. 4B

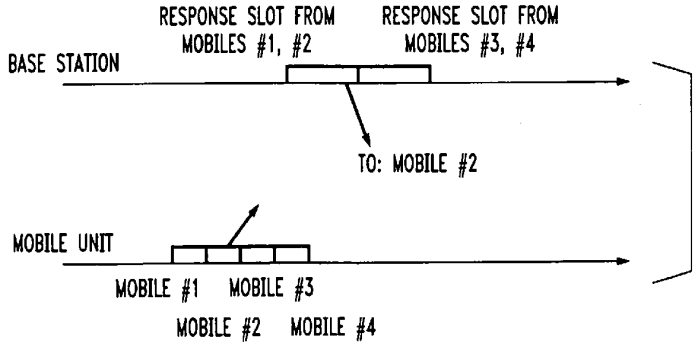


FIG. 5

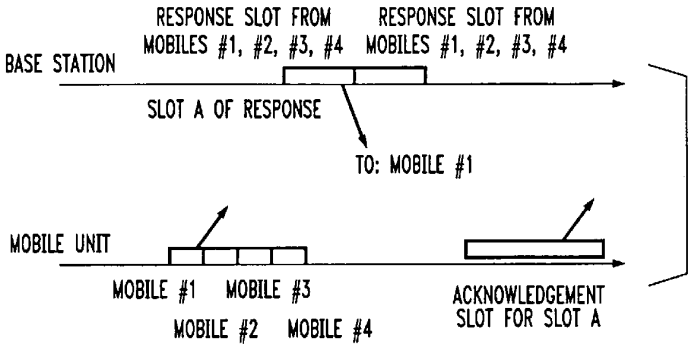

RESPONSE SLOT FROM MOBILES #1, #2, #3, #4
RESPONSE SLOT FROM MOBILES #1, #2, #3, #4
BASE STATION
SLOT A OF RESPONSE
TO: MOBILE #1
MOBILE UNIT
MOBILE #1
MOBILE #3
MOBILE #2
MOBILE #4
ACKNOWLEDGEMENT SLOT FOR SLOT A

FIG. 6

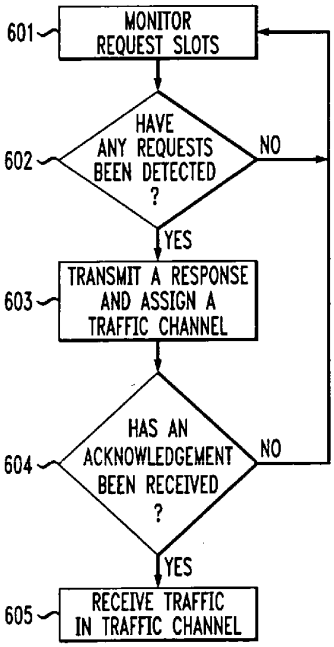
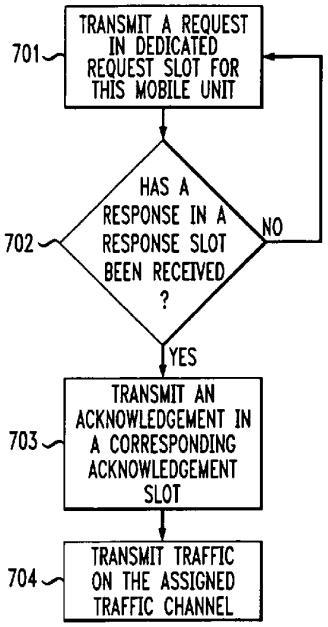

601
MONITOR REQUEST SLOTS
602
HAVE ANY REQUESTS BEEN DETECTED ?
NO
YES
603
TRANSMIT A RESPONSE AND ASSIGN A TRAFFIC CHANNEL
604
HAS AN ACKNOWLEDGEMENT BEEN RECEIVED ?
NO
YES
605
RECEIVE TRAFFIC IN TRAFFIC CHANNEL

FIG. 7


701
TRANSMIT A REQUEST IN DEDICATED REQUEST SLOT FOR THIS MOBILE UNIT
702
HAS A RESPONSE IN A RESPONSE SLOT BEEN RECEIVED ?
NO
YES
703
TRANSMIT AN ACKNOWLEDGEMENT IN A CORRESPONDING ACKNOWLEDGEMENT SLOT
704
TRANSMIT TRAFFIC ON THE ASSIGNED TRAFFIC CHANNEL