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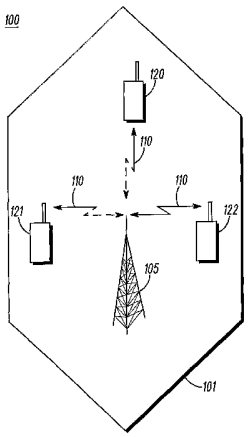
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[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR PROVIDING POWER CONTROL FOR CDMA DISPATCH SERVICES



(57) Abstract: To address the need to provide power control for listening participants of CDMA dispatch services, the concept of "shared channel signaling windows" for shared traffic channels (e.g., 110) is described. In one embodiment, the beginning of a signaling window is announced on the traffic channel and the remote units (e.g., MS 120) with the highest frame error rates compute the shortest transmit delays. For the duration of the window, remote units transmit their power control signaling according to their transmit delays. Thus, listening participants are given an opportunity, according to need, to perform power control signaling on the group traffic channel.

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METHOD AND APPARATUS FOR PROVIDING POWER CONTROL FOR CDMA DISPATCH SERVICES

Reference(s) to Related Application(s)

This application is related to a co-pending application entitled "METHOD AND APPARATUS FOR CDMA SOFT HANDOFF FOR DISPATCH GROUP MEMBERS," filed on even date herewith, and assigned to the assignee of the instant application.

This application is related to a co-pending application, Serial No. 10/027488, entitled "METHOD AND APPARATUS FOR CDMA-DISPATCH SOFT HANDOFF," filed December 20, 2001, which is assigned to the assignee of the present application.

This application is related to a co-pending application, Serial No. 10/027041, entitled "METHOD AND APPARATUS FOR MOBILE-INITIATED, CDMA-DISPATCH SOFT HANDOFF," filed December 20, 2001, which is assigned to the assignee of the present application.

This application is related to a co-pending application, Serial No. 10/027465, entitled "METHOD AND APPARATUS FOR BASE-INITIATED, CDMA-DISPATCH SOFT HANDOFF," filed December 20, 2001, which is assigned to the assignee of the present application.

This application is related to a co-pending application, Serial No. 09/588262, entitled "METHOD AND APPARATUS FOR SELECTING COMMUNICATION CELLS IN A WIRELESS COMMUNICATION SYSTEM," filed June 6, 2002, which is assigned to the assignee of the present application.

This application is related to a co-pending application, Serial No. 10/027193, entitled "METHOD AND APPARATUS FOR QUICKLY ESTABLISHING A CDMA DISPATCH CALL," filed December 20, 2001, which is assigned to the assignee of the present application.

This application is related to a co-pending application, Serial No. 10/027365, entitled "BASE SITE AND METHOD FOR QUICKLY ESTABLISHING A CDMA DISPATCH CALL," filed December 20, 2001, which is assigned to the assignee of the present application.

This application is related to a co-pending application, Serial No. 09/811213, publication number US-2002-0131380-A1, entitled "METHOD AND APPARATUS FOR PROVIDING A DISPATCH PATCH SERVICE IN A CDMA COMMMUNICATION SYSTEM," filed March 16, 2001, which is assigned to the assignee of the present application.

This application is related to a co-pending application, Serial No. 09/781838, publication number US-2002-0110107-A1, entitled "CHANNEL STRUCTURE FOR DATA TRANSMISSION," filed February 12, 2001, which is assigned to the assignee of the present application.

Field of the Invention

The present invention relates generally to communication systems and, in particular, to providing power control for CDMA dispatch services.

Background of the Invention

CDMA systems are interference-limited systems. For example, the IS95/CDMA2000 standard seeks to minimize interference on reverse links (i.e., access channels) during call setup through the use of low power access probes. Additionally, the standard seeks to minimize interference during calls by using closed loop power control techniques.

For wireless telephone calls, the base station (BS) measures signal strength (E/I) received from the mobile subscriber (MS) and sends an up/down power adjustment instruction via a power control sub-

channel (i.e., dedicated bits in a forward link frame). In turn, the MS measures frame error rate (FER), on the forward link, and reports these measurements to the BS using Power Measurement Report messages. In response, the BS adjusts its forward power.

In contrast to telephone calls, dispatch (or group) calls typically involve several MSs, all participating in the call. In a dispatch call, one MS is transmitting (i.e., in talk mode) while the other members of the group are receiving (i.e., in listening mode) at any given time. When the MS with the transmit prerogative releases its "Push-to-talk" (PTT), a message is sent to the BS, and the BS places the traffic channel in an "open mode." While in this mode, any other MS can request a transmit prerogative by signaling a PTT. The BS allocates a transmit prerogative to the first arriving request. While this description is for a single-cell call, it can be applied to a multi-cell call with the addition of a central dispatch call controller, which arbitrates transmit prerogative requests instead of a controlling BS.

In a CDMA system such as that described in U.S. Patent 6,519,239 (U.S. Patent Application 09/443,538), entitled "METHOD AND APPARATUS FOR PROVIDING DISPATCH SERVICE IN A CDMA COMMUNICATION SYSTEM," group call voice frames are transmitted using standard CDMA traffic channel procedures except that a common long code is used instead of an individual long code computed from the MS's ESN. Thus, the MSs in the group call share a single traffic channel. However, in such a system, listening mode MSs cannot request forward power adjustment by the BS. As a result, distant listening MSs, which require greater forward power from the BS, may experience excessive frame error rates and unacceptable voice quality. Therefore, a need exists for an apparatus and method to provide power control for listening participants of CDMA dispatch services.

Brief Description of the Drawings

FIG. 1 is a block diagram depiction of a communication system in accordance with an embodiment of the present invention.

FIG. 2 is a block diagram depiction of a base site and mobile station in accordance with an embodiment of the present invention.

FIG. 3 is a logic flow diagram of a method executed by a base site in accordance with an embodiment of the present invention.

FIG. 4 is a logic flow diagram of a method executed by a remote unit in accordance with an embodiment of the present invention.

Detailed Description of Embodiments

To address the need to provide power control for listening participants of CDMA dispatch services, the concept of "shared channel signaling windows" for traffic channels is described. In one embodiment, the beginning of a signaling window is announced on the traffic channel and the remote units with the highest frame error rates compute the shortest transmit delays. For the duration of the window, remote units transmit their power control signaling according to their transmit delays. Thus, listening participants are given an opportunity, according to need, to perform power control signaling on the group traffic channel.

The disclosed embodiments can be more fully understood with reference to FIGs. 1-4. FIG. 1 is a block diagram depiction of a communication system 100 in accordance with a first embodiment of the present invention. Communication system 100 is a well-known Code Division Multiple Access (CDMA) system, specifically a CDMA2000 system, which is based on the Telecommunications Industry Association

/ Electronic Industries Association (TIA/EIA) standard IS-2000, suitably modified to implement the present invention. (The TIA/EIA can be contacted at 2001 Pennsylvania Ave. NW, Washington, D.C. 20006). In various embodiments, communication system 100 may utilize other cellular communication system protocols such as, but not limited to, IS-95.

Communication system 100 includes radio access network (RAN) entities, such as base site (BS) 105, which comprises one or more base transceiver stations (BTSs). BS 105 has a service coverage area depicted by service coverage area 101. Communication system 100 also includes remote units 120-122. However, the present invention is not limited to remote units that are mobile. Typically, a remote unit comprises a mobile station (MS), but it may instead comprise, for example, a desktop computer wirelessly connected to the RAN.

Those skilled in the art will recognize that FIG. 1 does not depict all of the network equipment necessary for system 100 to operate but only those system blocks and logical entities particularly relevant to the description of embodiments of the present invention. Those skilled in the art are aware of the many types of communication devices necessary for system 100 operation. Furthermore, those skilled in the art are aware of the many ways these entities can be implemented and/or purchased from wireless communications companies such as "MOTOROLA."

FIG. 2 is a block diagram depiction of base site 105 and mobile station 120 in accordance with the first embodiment of the present invention. BS 105 and MS 120 communicate via air interface resource 110. In the first embodiment, air interface resource 110 comprises a CDMA traffic channel for which a common long code is used instead of a CDMA2000 individual long code that is computed from an ESN. The use of a common long code is described in detail in U.S. Patent 6,519,239 (U.S. Patent Application 09/443,538), referenced above. The use of a common long code allows MSs 120-122 to share traffic channel 110.

MS 120 and BS 105 comprise well-known entities such as processors 203 and 213, transmitters 201 and 211, and receivers 202 and 212. Processors, for example, typically comprise components such as microprocessors, digital signal processors, memory, and/or logic circuitry designed to implement algorithms that have been expressed as computer instructions and/or in circuitry. Given an algorithm or a logic flow, those skilled in the art are aware of the many design and development techniques available to implement a processor that performs the given logic. In the first embodiment of the present invention, a known CDMA 2000 BS is adapted using known telecommunications design and development techniques to implement the logic flow depicted in FIG. 3. The result is BS 105. Similarly, a known CDMA 2000 MS is adapted using known telecommunications design and development techniques to implement the logic flow depicted in FIG. 4. The result is MS 120.

Operation of the first embodiment of the present invention occurs substantially as follows. MSs 120-122 are members of a dispatch group. Receiver 202 of BS 105 receives content for the dispatch group from a talking dispatch group member (MS 122) via traffic channel (TCH) 110. This content may include, for example, dispatch group call voice, video, data, text messaging, or any combination of these in the form of broadcast, multicast, or unicast information. The content transmitted by talking MS 122 is retransmitted by BS 105 via the forward link of traffic channel 110 and received by listening MS 121 and 120 (via receiver 212).

When processor 203 of BS 105 detects inactivity in the dispatch content, processor 203 sends, via transmitter 201, an indication to the dispatch group that power control signaling by non-talking (i.e., listening mode) dispatch group members may be transmitted for a period of time. Forward power control signaling such as an MS Power Measurement Report is an example of this type of signaling.

There are at least two types of inactivity detected by BS 105: a relative silence in dispatch group call voice activity and an indication from the talking dispatch group member that another group member may talk. MSs transmit voice at different rates depending on the voice activity. Active voice is transmitted at full rate and half rate, while low activity voice or relative silence is transmitted at quarter rate and eighth rate. Consequently, the BS can detect a low activity or silence period (e.g., via Rate Determination Algorithm (RDA)) by the frame rate. Thus, BS 105 can detect inactivity when at least one eighth rate frame is detected in the dispatch content.

Thus, BS 105 schedules a signaling window so as to minimally affect voice quality. Once low activity / relative silence is detected, the BS issues a "Temporary Transmit Prerogative Suspension" message utilizing a Blank&burst or Dim&burst voice frame coded with TCH 110's common long mask. MSs 120-122 decode it and interpret the message as an indication to perform power control signaling. The "Temporary Transmit Prerogative Suspension" expires after either an indicated or pre-defined number of voice frames (or period of time), and MS 122 then resumes transmitting its voice frames.

Another type of inactivity detected by BS 105 is an indication from the talking dispatch group member (MS 122) that another group member may talk, e.g., a push-to-talk (PTT) release indication. In dispatch call control, after receiving a PTT release from the talking MS, the BS transmits an Order message telling the group MSs that the channel is in an OPEN MODE. Since there is a considerable amount of time between the detection of an open channel by the MS and another user requesting PTT (i.e., requesting a transmit prerogative), this interval lends itself as another power control signaling window. Thus, similar to the "Temporary Transmit Prerogative Suspension" message, an Order message can also indicate that power control signaling may be transmitted. It is possible that a silence or a low activity period preceding the talker releasing PTT may cause the BS to signal a "Temporary

Transmit Prerogative Suspension" window prior to the channel going to an OPEN MODE. In these cases, the window can be extended during the OPEN MODE to allow MSs with higher transmit time delays (as discussed below) to transmit.

Listening MS 120 (i.e., processor 213 via receiver 212) receive the dispatch content via TCH 110's forward link and compute frame error rates (FERs) for the content on the forward link. The FER(s) is compared to a threshold when receiver 212 of listening MS 120 receives the indication that power control signaling may be transmitted. In the first embodiment, this threshold is set to a value of 3% since voice usually cannot tolerate more errors; however, certainly this value can be tuned for more optimal performance in other embodiments. If the threshold is exceeded, processor 213 determines a transmit delay based on the FER / FERs. Since all listening MSs (such as MS 121) are also comparing their FERs to the threshold, only those with excessive FERs compete for the signaling window by determining a transmit delay. This delay is used to reduce the probability of collision on the common traffic channel. However, depending on the window size, the computed transmit delay may in reality amount to a boolean transmit or not indicator, such as when the computed delay does not fit into the window.

Ideally, the MSs compute their transmission delay in such a way that the MS with the highest FER(s) computes the shortest delay. In general, however, a greater transmit delay is determined for a smaller frame error rate. Additional thresholds may be tiered in to map FER ranges to transmit delays. In fact, a highest threshold may be used, above which, the transmit delay is determined to be zero.

As described above, then, processor 213 of MS 120 delays transmission of its power control signaling based on the transmit delay determined. After delaying and assuming the transmit delay is within the signaling window, MS 120 transmits and BS 105 receives the power control signaling via TCH 110. Thus, this first embodiment of the present invention enables a controlling BS to compute its forward power

adjustment based on the power control signaling of at least the most power-needy MSs in the group.

FIG. 3 is a logic flow diagram of a method executed by a base site in accordance with the first embodiment of the present invention. Logic flow 300 begins (302) with the base site receiving (304) dispatch group content via a TCH common to the group. When (306) the base site detects sufficient inactivity in the received content, it transmits (308) an indication to the non-talking group members that power control signaling may be transmitted for a period of time. In response, the base site receives (310) power control signaling from at least one non-talking group member via the common traffic channel, and adjusts its forward power accordingly. Logic flow 300 thus ends (312).

FIG. 4 is a logic flow diagram of a method executed by a remote unit in accordance with an embodiment of the present invention. Logic flow 400 begins (402) with the remote unit receiving (404) dispatch group content via a traffic channel common to the group and determining a FER of the content received. At some point, the remote unit receives (406) an indication that power control signaling by non-talking group members may be transmitted for a period of time. The remote unit compares (408) the FER determined to a threshold. If it is greater, then the remote unit determines (410) a transmit delay. The remote unit delays transmission based on the transmit delay determined, and assuming the signaling window is still open, it transmits (412) its power control signaling to the base site. Logic flow 400 thus ends (414).

In the foregoing specification, the present invention has been described with reference to specific embodiments. However, one of ordinary skill in the art will appreciate that various modifications and changes may be made without departing from the spirit and scope of the present invention as set forth in the appended claims. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense, and all such modifications are intended to be

included within the scope of the present invention. In addition, those of ordinary skill in the art will appreciate that the elements in the drawings are illustrated for simplicity and clarity, and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the drawings may be exaggerated relative to other elements to help improve an understanding of the various embodiments of the present invention.

Benefits, other advantages, and solutions to problems have been described above with regard to specific embodiments of the present invention. However, the benefits, advantages, solutions to problems, and any element(s) that may cause or result in such benefits, advantages, or solutions, or cause such benefits, advantages, or solutions to become more pronounced are not to be construed as a critical, required, or essential feature or element of any or all the claims. As used herein and in the appended claims, the term "comprises," "comprising," or any other variation thereof is intended to refer to a non-exclusive inclusion, such that a process, method, article of manufacture, or apparatus that comprises a list of elements does not include only those elements in the list, but may include other elements not expressly listed or inherent to such process, method, article of manufacture, or apparatus.

The terms a or an, as used herein, are defined as one or more than one. The term plurality, as used herein, is defined as two or more than two. The term another, as used herein, is defined as at least a second or more. The terms including and/or having, as used herein, are defined as comprising (i.e., open language). The term coupled, as used herein, is defined as connected, although not necessarily directly, and not necessarily mechanically. The term program, as used herein, is defined as a sequence of instructions designed for execution on a computer system. A program, or computer program, may include a subroutine, a function, a procedure, an object method, an object implementation, an executable application, an applet, a servlet, a source

code, an object code, a shared library/dynamic load library and/or other sequence of instructions designed for execution on a computer system.

What is claimed is:

Claims

1. A method for providing power control for CDMA dispatch services comprising:

receiving content for a dispatch group from a talking dispatch group member via a traffic channel;

when inactivity is detected in the dispatch content, sending an indication to the dispatch group that power control signaling by non-talking dispatch group members may be transmitted; and

in response to sending the indication, receiving power control signaling from a non-talking dispatch group member via the traffic channel.

2. The method of claim 1, wherein inactivity in the dispatch content comprises an indication from the talking dispatch group member that another group member may talk.

3. A method for providing power control for CDMA dispatch services comprising:

receiving dispatch group content via a traffic channel;

receiving an indication that power control signaling by non-talking dispatch group members may be transmitted; and

in response to receiving the indication, transmitting power control signaling via the traffic channel.

4. The method of claim 3, further comprising determining a transmit delay.

5. The method of claim 4, further comprising, after receiving the indication, delaying transmission of the power control signaling based on the transmit delay determined.

6. The method of claim 4, wherein determining the transmit delay comprises determining a frame error rate for content received via the traffic channel.

7. The method of claim 3, further comprising:

determining a frame error rate for content received via the traffic channel; and

when the frame error rate is greater than a threshold, determining a transmit delay based on the frame error rate.

8. The method of claim 3, wherein receiving the indication comprises receiving an indication that power control signaling may be transmitted for a period of time.

9. A base site comprising:

a transmitter;

a receiver; and

a processor, coupled to the transmitter and the receiver, adapted to receive content for a dispatch group from a talking dispatch group member via the receiver and a traffic channel, adapted to send, via the transmitter, an indication to the dispatch group that power control signaling by non-talking dispatch group members may be transmitted, when inactivity is detected in the dispatch content, and adapted to receive power control signaling from a non-talking dispatch group member via the traffic channel in response to sending the indication.

10. A remote unit comprising:

a transmitter;

a receiver; and

a processor, coupled to the transmitter and the receiver, adapted to receive dispatch group content via the receiver and a traffic channel, adapted to receive an indication that power control signaling by non-talking dispatch group members may be transmitted, and adapted to transmit power control signaling via the transmitter and the traffic channel in response to receiving the indication.

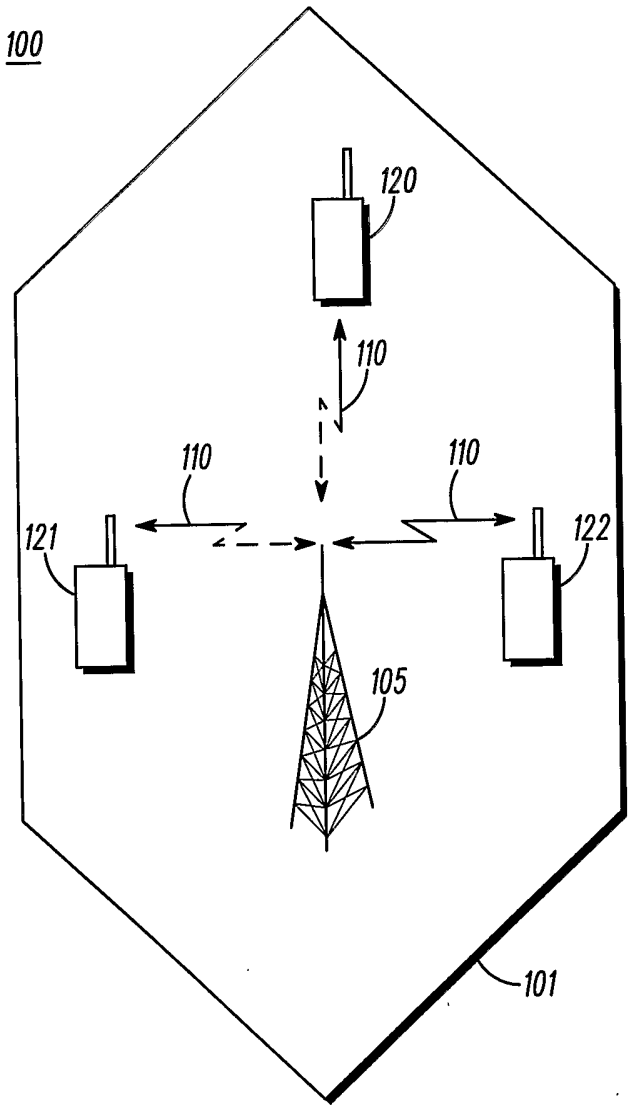


FIG. 1

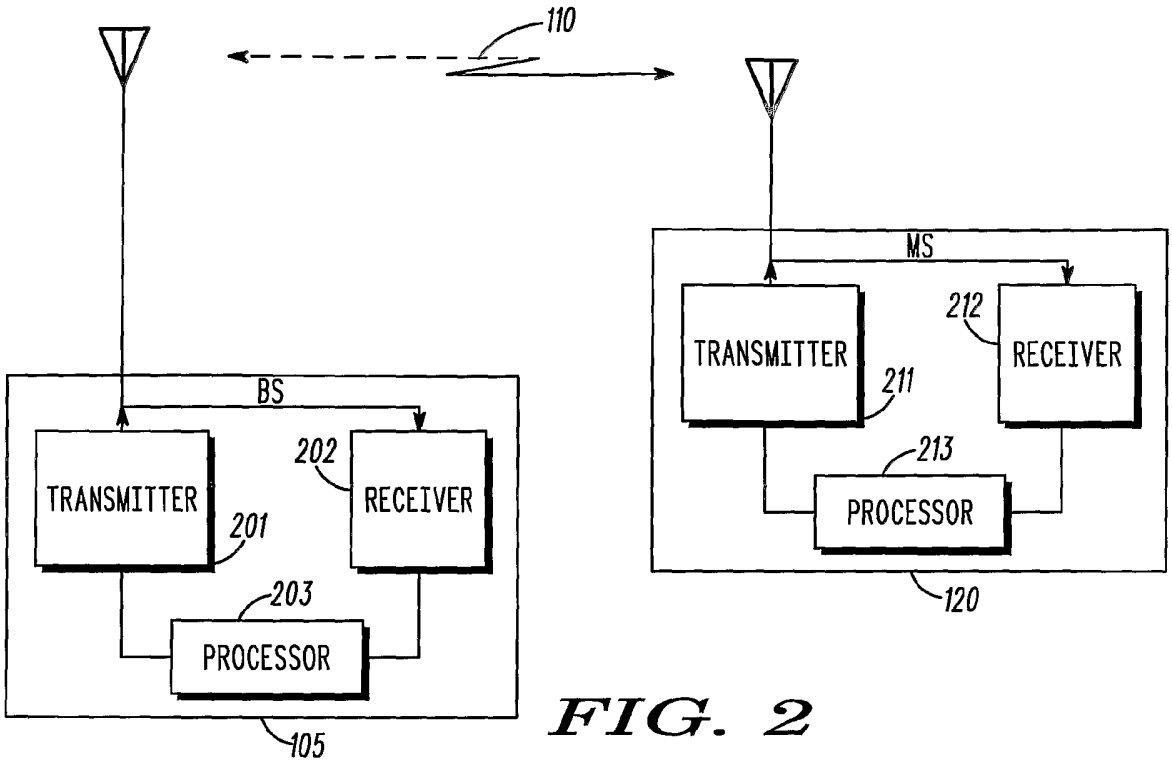

110
BS
TRANSMITTER
201
202
RECEIVER
203
PROCESSOR
105
MS
TRANSMITTER
211
212
RECEIVER
213
PROCESSOR
120

FIG. 2

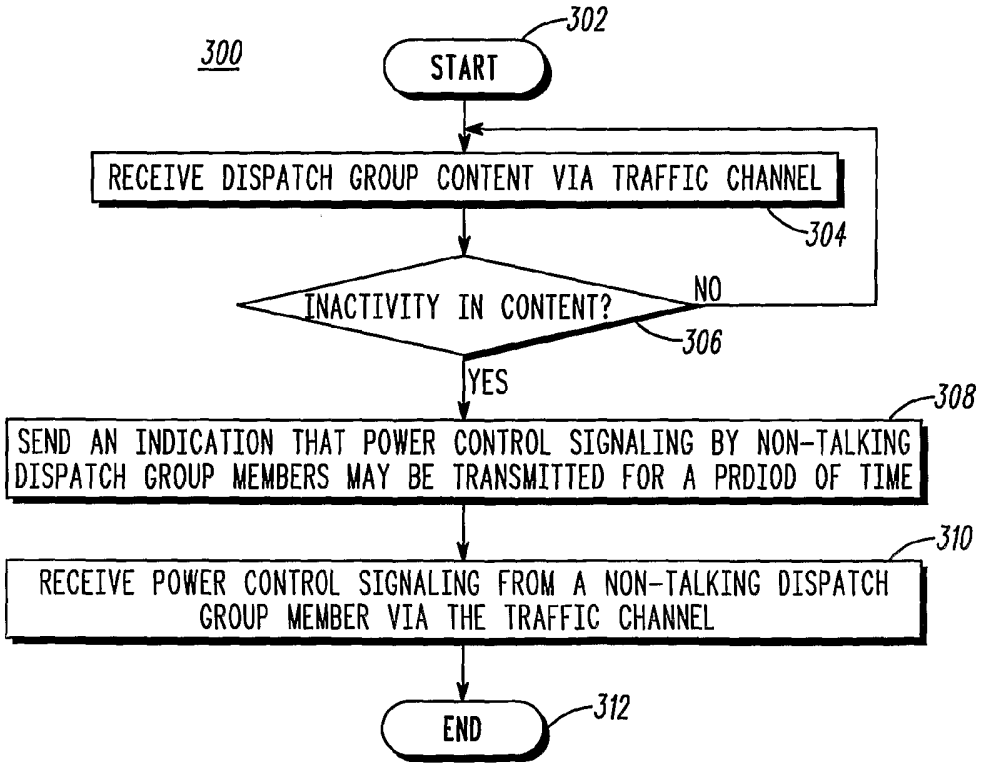

300
302
START
RECEIVE DISPATCH GROUP CONTENT VIA TRAFFIC CHANNEL
304
INACTIVITY IN CONTENT?
NO
306
YES
308
SEND AN INDICATION THAT POWER CONTROL SIGNALING BY NON-TALKING DISPATCH GROUP MEMBERS MAY BE TRANSMITTED FOR A PRDIOD OF TIME
310
RECEIVE POWER CONTROL SIGNALING FROM A NON-TALKING DISPATCH GROUP MEMBER VIA THE TRAFFIC CHANNEL
END
312

FIG. 3

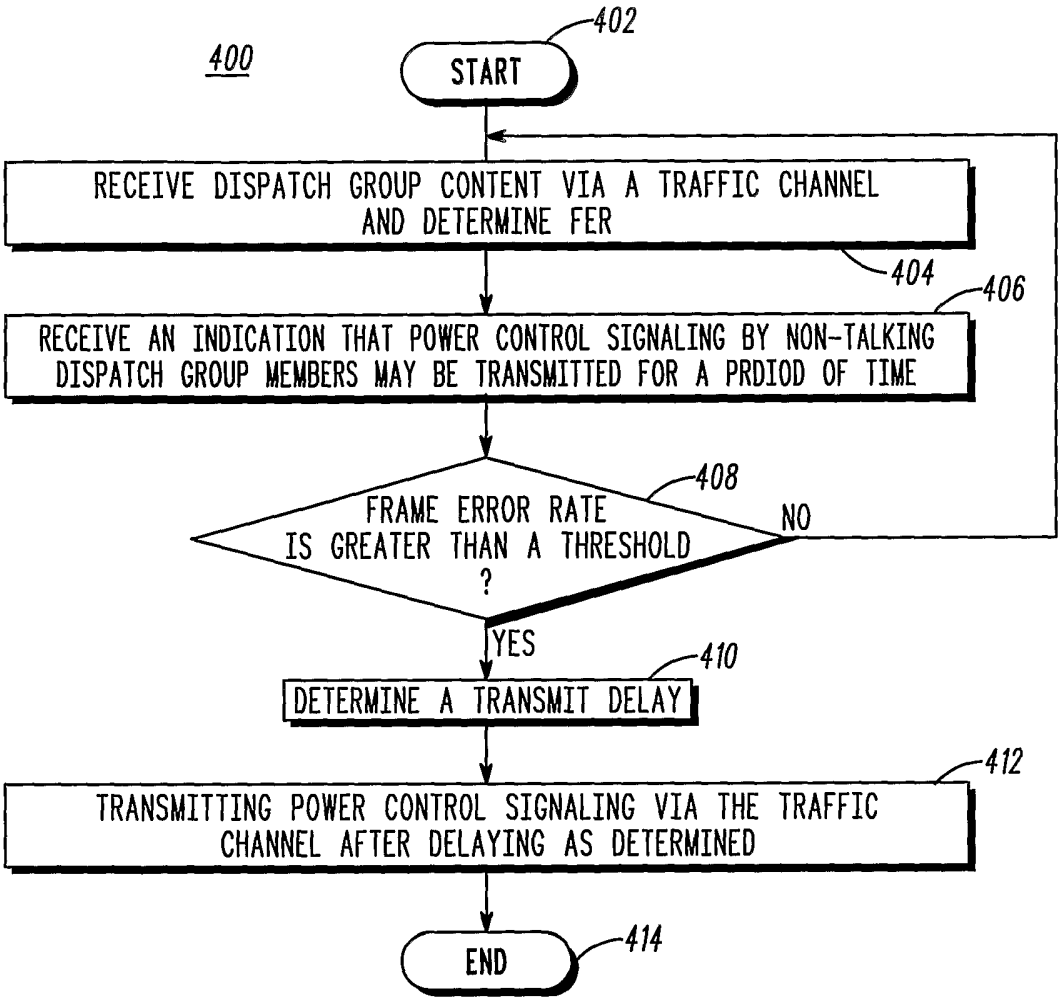

400
402
START
RECEIVE DISPATCH GROUP CONTENT VIA A TRAFFIC CHANNEL AND DETERMINE FER
404
406
RECEIVE AN INDICATION THAT POWER CONTROL SIGNALING BY NON-TALKING DISPATCH GROUP MEMBERS MAY BE TRANSMITTED FOR A PRDIOD OF TIME
408
FRAME ERROR RATE IS GREATER THAN A THRESHOLD ?
NO
YES
410
DETERMINE A TRANSMIT DELAY
412
TRANSMITTING POWER CONTROL SIGNALING VIA THE TRAFFIC CHANNEL AFTER DELAYING AS DETERMINED
414
END

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US04/10777

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : H 04 B 7/216
US CL : 370/335

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. : 370/335,310,311,320,328,332,342;455/13.4.

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,115,388 A (CHINITZ et al.) 05 September 2000 (05.09.2000), Abstract, Fig. 1-5, col. 7, lines 23-50.	1-10
A	US 5,881,368 A (GROB et al.) 09 March 1999 (09.03.1999), Abstract	1-10
A,E	US 6,748,231 B2 (PAN et al.) 08 June 2004 (08.06.2004), see abstract.	1-10

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

* Special categories of cited documents:

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"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

"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

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search	Date of mailing of the international search report
27 September 2004 (27.09.2004)	05 NOV 2004
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