(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification:
H04B 1/00 (2006.01)   H04B 7/185 (2006.01)
H04B 7/00 (2006.01)

(21) International Application Number:
PCT/US2005/014489

(22) International Filing Date: 27 April 2005 (27.04.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/567,308   30 April 2004 (30.04.2004)   US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report
— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

(88) Date of publication of the international search report:
1 June 2006

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD AND SYSTEM FOR CONTROLLING TRANSMISSION POWER OF A DOWNLINK SIGNALING CHANNEL BASED ON ENHANCED UPLINK TRANSMISSION FAILURE STATISTICS
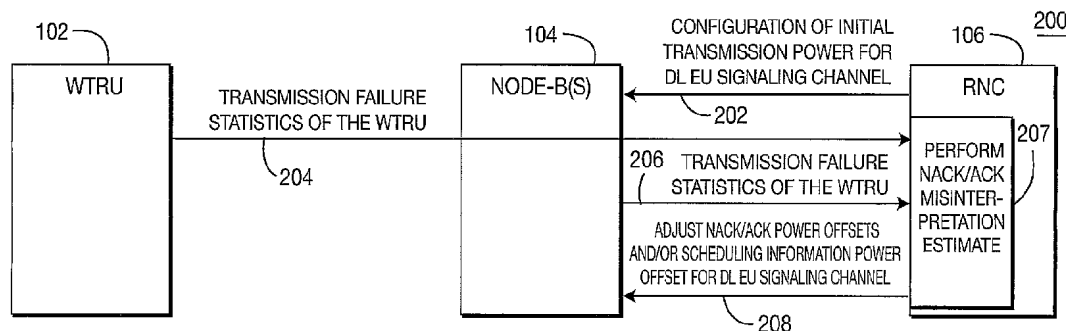
(57) Abstract: A method and system for controlling the transmission power of at least one downlink (DL) enhanced uplink (EU) signaling channel such that enhanced dedicated channel (E-DCH) DL signaling is delivered efficiently and reliably. The system includes at least one wireless transmit/receive unit (WTRU), at least one Node-B and a radio network controller (RNC). At least one of the WTRU and the Node-B compute EU transmission failure statistics on the DL EU signaling channel and report the EU transmission failure statistics to the RNC. The RNC then adjusts a transmission power offset of the DL EU signaling channel to be used in determining transmission power level of the DL EU signaling channel at the Node-B based on the EU transmission failure statistics.

[0001]   METHOD AND SYSTEM FOR CONTROLLING
              TRANSMISSION POWER OF A DOWNLINK
              SIGNALING CHANNEL BASED ON ENHANCED
              UPLINK TRANSMISSION FAILURE STATISTICS

[0002]   FIELD OF INVENTION

[0003]   The present invention is related to a wireless communication system including a wireless transmit/receive unit (WTRU), at least one Node-B and a radio network controller (RNC). More particularly, the present invention is a method and system for controlling transmission power of a downlink (DL) enhanced uplink (EU) signaling channel based on EU transmission and scheduling information reception failure statistics reported to the RNC by the WTRU and/or the Node-B such that enhanced dedicated channel (E-DCH) downlink signaling channels are more reliable.

[0004]   BACKGROUND

[0005]   Methods for improving uplink (UL) coverage, throughput, and transmission latency are currently being investigated in Release 6 of the Third Generation Partnership Project (3GPP). In order to achieve these goals, the Node-B will take over responsibility of scheduling and assigning uplink resources to WTRUs. The Node-B can make more efficient decisions and manage UL radio resources on a short-term basis better than the RNC, even if the RNC retains coarse overall control.

[0006]   A new media access control (MAC) function/entity for enhanced uplink (EU) called MAC-e is created in a WTRU and the Node-B to handle the transmission and reception of the E-DCH transmissions. To properly support EU, information such as channel allocations, transmission feedback, (i.e., acknowledge (ACK) or non-acknowledge (NACK)), and other feedback information, (such as power control command or channel quality), must be transmitted to the WTRU via a DL EU signaling channel efficiently and reliably.

[0007]   Power control on the shared DL EU signaling channel is essential to support proper operation of the DL EU signaling channel. Power control reduces

overall interference and therefore results in more efficient use of radio resources.

[0008]   SUMMARY

[0009]   The present invention is a method and system for controlling transmission power of at least one DL EU signaling channel such that E-DCH DL signaling is delivered to the WTRU efficiently and reliably. For DL signaling dedicated to specific WTRUs, the transmit power of DL EU signaling channels is based on the current DL dedicated control channel power plus a power offset. For DL signaling common to multiple WTRUs, the transmit power of DL EU signaling channels is based on a power set by the RNC plus a power offset. The RNC monitors EU transmission failure statistics reported from the Node-B and the WTRU to estimate the NACK to ACK misinterpretation statistics.

[0010]   The Node-B reports the statistics of EU transmission failures at the Node-B to the RNC and the WTRU reports the statistics of EU transmission failures at the WTRU to the RNC. The RNC then adjusts the NACK to ACK power ratio according to the estimated NACK to ACK misinterpretation statistics. The Node-B computes failed scheduling information, (i.e., channel allocation information), reception statistics by detecting when the WTRU does not initiate EU transmissions after the Node-B sends channel allocation information to the WTRU, or the data rate/frequency of E-DCH transmissions is not the same as specified in the channel allocation information.

[0011]   The WTRU may also compute failed scheduling information reception statistics by detecting when there is no response to EU channel allocation requests within a specified time period following the request. The RNC monitors failed scheduling information reception statistics reported by the WTRU and the Node-B to estimate statistics of scheduling information reception error. The RNC adjusts the power offset of the scheduling information field based on the statistics of scheduling information reception failure.

[0012]   BRIEF DESCRIPTION OF THE DRAWINGS

[0013]   A more detailed understanding of the invention may be had from the following description of a preferred embodiment, given by way of example and to be understood in conjunction with the accompanying drawing wherein:

[0014]   Figure 1 is a block diagram of a wireless communication system in accordance with the present invention;

[0015]   Figure 2 is a signaling diagram between components of the system of Figure 1 for implementing transmission power control on a DL EU signaling channel in accordance with the present invention;

[0016]   Figure 3 is a flow diagram of a process for implementing transmission power control on a DL EU signaling channel in accordance with one embodiment of the present invention; and

[0017]   Figure 4 is a flow diagram of a process for implementing transmission power control on a DL EU signaling channel in accordance with another embodiment of the present invention.

[0018] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019]   Hereafter, the terminology "WTRU" includes but is not limited to a user equipment (UE), a mobile station, a fixed or mobile subscriber unit, a pager, or any other type of device capable of operating in a wireless environment. When referred to hereafter, the terminology "Node-B" includes but is not limited to a base station, a site controller, an access point or any other type of interfacing device in a wireless environment.

[0020]   The features of the present invention may be incorporated into an integrated circuit (IC) or be configured in a circuit comprising a multitude of interconnecting components.

[0021]   Figure 1 is a block diagram of a wireless communication system 100 in accordance with the present invention. The system 100 comprises a WTRU 102, at least one Node-B 104 and an RNC 106. The RNC 106 controls overall EU operation by configuring EU parameters for the Node-B 104 and the WTRU 102 such as initial transmission power level, maximum allowed EU transmission

power or available channel resources per Node-B. Between the WTRU 102 and the Node-B 104, a dedicated physical control channel (DPCCH) 114, an E-DCH 108, a UL EU signaling channel 112 and DL EU signaling channel 110 are established.

[0022]   For E-DCH transmissions, the WTRU 102 sends an E-DCH allocation request to the Node-B 104 via either the E-DCH 108 or the UL EU signaling channel 112. In response, the Node-B 104 sends channel allocation information to the WTRU 102 via a DL EU signaling channel 110. After EU radio resources are allocated for the WTRU 102, the WTRU 102 transmits data via the E-DCH 108. In response to the E-DCH transmissions, the Node-B 104 sends an ACK or NACK for hybrid-automatic repeat request (H-ARQ) operation via the DL EU signaling channel 110.

[0023]   When the WTRU 102 is configured to operate on the E-DCH 108 by the RNC 106, the power offset of each information field, (e.g., ACK/NACK, scheduling information, etc.), transmitted via the DL EU signaling channel 110 is also configured by the RNC 106 and signaled to the Node-B 104 via Iub/Iur 118. Those initial power offsets are determined by the RNC 106 based on the required error probability of information fields. During the operation of the E-DCH 108, the power offsets of information fields in the DL EU signaling channel 110 need to be adjusted according to the actually experienced quality of service of the DL EU signaling channel 110.

[0024]   For DL signaling dedicated to specific WTRUs 102, the transmit power of the DL EU signaling channel(s) 110 is based on the current DL dedicated control channel power plus a power offset. For DL signaling common to multiple WTRUs 102, the transmit power of DL EU signaling channels 110 is based on a power level set by the RNC 106 plus a power offset.

[0025]   For each WTRU 102, the transmission power of the DL EU signaling channel 110 is controlled separately. The transmission power of the DL EU signaling channel 110 for a specific WTRU 102 is determined as the transmission power of the DL dedicated physical control channel (DPCCH) 114 of the WTRU 102 plus a power offset. In this sense, the power of DPCCH is used as

reference. The transmission power of the DPCCH of the WTRU 102 is controlled as in Release 99/4/5 of the universal mobile telecommunication services (UMTS).

[0026]   Different power offsets are used depending on the information, (i.e., ACK/NACK, channel quality feedback, scheduling information, etc.), to be sent by the Node-B 104. For the ACK/NACK information field, a higher power offset is used to transmit NACK than to transmit ACK, because NACK to ACK misinterpretation causes a more serious problem than ACK to NACK misinterpretation.

[0027]   Figure 2 is a signaling diagram of a process 200 implemented by the system 100 for implementing transmission power control on a DL EU signaling channel 110 in accordance with the present invention. The RNC 106 sends an initial configuration of power offsets for the DL EU signaling channel 110 to the Node-B 104 (step 202). The RNC 106 monitors failed MAC-e transmissions and/or failed channel allocation information reception statistics reported by the WTRU 102 and/or the Node-B 104 to estimate the error probability of the reception and transmission on the DL EU signaling channel 110 (steps 204, 206). In step 207, the RNC 106 estimates the statistics of NACK to ACK misinterpretation based on the reported failed MAC-e transmissions statistics. If the estimate of statistics of NACK to ACK misinterpretation is higher than a threshold, the RNC 106 adjusts the NACK to ACK power ratio, (i.e., the ratio of power offsets), for the DL EU signaling channel 110 accordingly. Based on failed channel allocation information reception statistics received from the WTRU 102 and the Node-B 104, the RNC 106 adjusts the power offset of the scheduling information field accordingly (step 208). In this way, proper operation of EU is maintained and radio resources are used efficiently.

[0028]   Figure 3 is a flow diagram of a process 300 for controlling the transmission power of a DL EU signaling channel in accordance with one embodiment of the present invention. The WTRU 102 is configured for EU operation (step 302). The WTRU 102 determines whether there is a data to be transmitted via the E-DCH 108 (step 304). If there is data to be transmitted, the

WTRU 102 sends a channel allocation request to the Node-B 104 via either the E-DCH 108 or the UL EU signaling channel 112 (step 306). The Node-B 104 receives the request and sends channel allocation information to the WTRU 102 via the DL EU signaling channel 110 (step 308).

[0029]   After sending the channel allocation request, the WTRU 102 monitors the DL EU signaling channel 110 for channel allocation information. The Node-B 104 also monitors E-DCH transmissions after sending the channel allocation information via the DL EU signaling channel 110 (step 310).

[0030]   The channel allocation information sent to the WTRU 102 may not be delivered successfully. The consequence of failed transmission of the channel allocation information depends on the way that the allocation is performed. For deterministic allocation, the WTRU 102 will not transmit at all. For statistical allocation, the WTRU 102 either may not transmit at all, or may transmit the data at a rate and/or persistence level which is not the same as specified in the channel allocation information.

[0031]   Deterministic allocation is the allocation in which the maximum allocated transmit power and/or data rate is specified and the WTRU 102 can transmit at any time as long as its transmit power and/or data rate does not exceed the maximum. Statistical allocation is the allocation in which in addition to the specified maximum allocated transmit power and/or data rate, persistence level (probability) is also specified. The WTRU 102 may transmit from time to time according to the persistence level or transmit at any time with transmit power and/or data rate determined by the persistence level.

[0032]   The Node-B 104 computes and reports failed scheduling information reception statistics by detecting when the WTRU 102 does not initiate EU transmissions after the Node-B 104 sends the channel allocation information, or the data rate/frequency of E-DCH transmissions is not the same as specified in the channel allocation information (step 312). This may be based on a received power threshold. The WTRU 102 may also compute and report failed scheduling information reception statistics by detecting when there is no response to EU

channel allocation requests within a specified time period following the transmission of the channel allocation request (step 312).

[0033]   If failed transmission statistics of channel allocation information is higher than a predetermined threshold, the RNC 106 increases the transmission power offset of scheduling information field on the DL EU signaling channel 110 (step 314). The RNC 106 signals the adjusted power offset to the Node-B 104 via the Iub/Iur 118.

[0034]   Figure 4 is a flow diagram of a process 400 for controlling transmission power of a DL EU signaling channel 110 in accordance with another embodiment of the present invention. After the WTRU 102 is configured for EU operation and receives channel allocation information at step 402, the WTRU 102 transmits data via the E-DCH 108 (step 404). The Node-B 104 receives and decodes the data. The Node-B 104 then sends feedback information, (i.e., ACK or NACK), to the WTRU 102 in accordance with the decoded data (step 406).

[0035]   The WTRU 102 and/or the Node-B 104 compute MAC-e failure statistics and report them to the RNC 106 to adjust NACK to ACK power ratio, (i.e., the ratio of power offsets), (step 408). In accordance with one embodiment, the WTRU 102 reports the number of MAC-e failures at the WTRU 102, which is the number of data blocks that are not transmitted successfully. A MAC-e failure occurs when a data block fails in transmission at the MAC-e due to reasons such as a maximum number of retransmissions or maximum delay of a data block is reached. The Node-B 104 reports the number of MAC-e failures of the WTRU 102 at the Node-B 104, which is the number of data blocks that are not received successfully at the MAC-e in the Node-B 104.

[0036]   Sometimes, a data block that the WTRU 102 interprets as being transmitted successfully may not actually be received successfully at the Node-B 104 because a NACK of the data block is misinterpreted as an ACK at the WTRU 102. The RNC 106 determines the number of NACK to ACK misinterpretations of the WTRU 102 as the number of MAC-e failures of the WTRU 102 reported by

the Node-B 104 minus the number of MAC-e failures of the WTRU 102 reported by the WTRU 102.

[0037] Alternatively, the RNC 106 may determine the number of NACK to ACK misinterpretations utilizing the number of radio link control (RLC) recovery requests of E-DCH data for the WTRU 102 at the RNC 106, which can be internally collected or computed by the RNC 106. A data block that the WTRU 102 interprets as being transmitted successfully may later have an RLC recovery request for the data due to NACK to ACK misinterpretation. The RNC 106 determines the number of NACK to ACK misinterpretations of the WTRU 102 as the number of RLC recovery requests of E-DCH data for the WTRU 102 at the RNC 106 minus the number of MAC-e failures of the WTRU 102 reported by the WTRU 102.

[0038] MAC-e failure statistics of the WTRU 102 at the WTRU 102 are reported to the RNC 106 via RRC procedures, and MAC-e failure statistics of the WTRU 102 at the Node-B 104 are reported to the RNC 106 via the Iub/Iur 118.

[0039] If the NACK to ACK misinterpretation probability is higher than a predetermined threshold, the RNC 106 increases the power ratio of the NACK to ACK power offsets (step 410). With higher power offsets, NACK will be delivered to the WTRU more reliably. The RNC 106 signals adjusted power offsets for ACK and NACK, (or power ratio between ACK and NACK), to the Node-B 104 via Iub/Iur 118, and the Node-B 104 uses the power offsets/ratio in setting the transmission power of EU DL signaling channel.

[0040] Although the features and elements of the present invention are described in the preferred embodiments in particular combinations, each feature or element can be used alone without the other features and elements of the preferred embodiments or in various combinations with or without other features and elements of the present invention.

*   *   *

CLAIMS

What is claimed is:

1.   In a wireless communication system including at least one wireless transmit/receive unit (WTRU), at least one Node-B and a radio network controller (RNC), where an enhanced uplink (EU) operation is supported so that the Node-B sends EU control information to the WTRU via a downlink (DL) EU signaling channel for EU operation, a method for controlling transmission power of the DL EU signaling channel, the method comprising:

(a) at least one of the WTRU and the Node-B computing EU transmission failure statistics and reporting the computed statistics to the RNC; and

(b) based on the EU transmission failure statistics, the RNC adjusting transmission power offset of the DL EU signaling channel to be used in determining transmission power level of the DL EU signaling channel at the Node-B.

2.   The method of claim 1 wherein the RNC adjusts a transmission power offset for at least one of an acknowledge (ACK) message or a non-acknowledge (NACK) message included in a signal sent by the Node-B to the WTRU via the DL EU signaling channel in response to the Node-B receiving EU dedicated channel (E-DCH) transmissions from the WTRU.

3.   The method of claim 2 wherein the EU transmission failure statistics are determined by subtracting the number of EU media access control (MAC-e) failures of the WTRU detected by the WTRU from the number of MAC-e failures of the WTRU detected by the Node-B.

4.   The method of claim 3 wherein the MAC-e failures of the WTRU occur when the number of retransmissions exceeds a predetermined retransmission limit.

5.   The method of claim 3 wherein the MAC-e failures of the WTRU occur when a EU transmission data expires before successfully transmitted.

6.   The method of claim 2 wherein the EU transmission failure statistics are determined by subtracting the number of MAC-e failures of the WTRU detected by the WTRU from the number of radio link control (RLC) recovery requests for the WTRU.

7   The method of claim 2 wherein transmission power for the NACK message is set higher than transmission power for the ACK message.

8.   The method of claim 1 wherein the Node-B adjusts transmission power for EU channel allocation information transmitted in response to receiving a channel allocation request from the WTRU.

9.   The method of claim 8 wherein the EU transmission failure statistics are determined as the number of times that the Node-B receives no E-DCH transmissions from the WTRU within a predetermined time period after the EU channel allocation information is transmitted.

10.   The method of claim 8 wherein the EU transmission failure statistics are determined based on the number of times that the Node-B receives EU transmissions which are not consistent to the EU channel allocation information.

11.   The method of claim 8 wherein the EU transmission failure statistics are determined based on the number of times that the WTRU fails to receive channel allocation information from the Node-B in response to the channel allocation request within a specified time period.

12.   The method of claim 1 wherein transmission power level of the DL EU signaling channel for a specific WTRU is determined with reference to transmission power for a DL dedicated physical control channel (DPCCH) for the specific WTRU.

13.   A wireless communication system for controlling transmission power of a downlink (DL) enhanced uplink (EU) signaling channel, the system comprising:

(a) a radio network controller (RNC);

(b) at least one wireless transmit/receive unit (WTRU) for computing and reporting EU transmission failure statistics and reporting the statistics to the RNC;

(c) at least one Node-B for computing EU transmission failure statistics and reporting the statistics to the RNC; and

(d) at least one DL EU signaling channel in communication with the WTRU and the Node-B, wherein the Node-B sends signals to the WTRU via the DL UE signaling channel, and the RNC adjusts a transmission power offset of the DL EU signaling channel to be used in determining transmission power level of the signals sent by the Node-B based on the EU transmission failure statistics reported in steps (b) and (c).

14.   The system of claim 13 wherein the RNC adjusts a transmission power offset for at least one of an acknowledge (ACK) message or a non-acknowledge (NACK) message included in a signal sent by the Node-B to the WTRU via the DL EU signaling channel in response to the Node-B receiving EU dedicated channel (E-DCH) transmissions from the WTRU.

15.   The system of claim 14 wherein the EU transmission failure statistics are determined by subtracting the number of EU media access control (MAC-e) failures of the WTRU detected by the WTRU from the number of MAC-e failures of the WTRU detected by the Node-B.

16.   The system of claim 15 wherein the MAC-e failures of the WTRU occur when the number of retransmissions exceeds a predetermined retransmission limit.

17.   The system of claim 15 wherein the MAC-e failures of the WTRU occur when EU transmission data expires before being successfully transmitted.

18.   The system of claim 14 wherein the EU transmission failure statistics are determined by subtracting the number of MAC-e failures of the WTRU detected by the WTRU from the number of radio link control (RLC) recovery requests for the WTRU.

19   The system of claim 14 wherein transmission power for the NACK message is set higher than transmission power of the ACK message.

20.   The system of claim 13 wherein the RNC adjusts a transmission power offset of EU channel allocation information signaled by the Node-B in response to a channel allocation request by the WTRU.

21.   The system of claim 20 wherein the EU transmission failure statistics are determined based on the number of times that the Node-B fails to receive EU transmissions from the WTRU after the EU channel allocation information is transmitted.

22.   The system of claim 20 wherein the EU transmission failure statistics are determined based on the number of times that the Node-B receives an EU transmission which is not consistent to the EU channel allocation information.

23.   The system of claim 20 wherein the EU transmission failure statistics are determined as the number of times that the WTRU fails to receive channel allocation information from the Node-B within a specified time period.

24.   The system of claim 13 wherein transmission power of the DL EU signaling channel for a specific WTRU is determined with reference to transmission power for a DL dedicated physical control channel (DPCCH) for the specific WTRU.

25.   A wireless communication system for controlling transmission power of a downlink (DL) enhanced uplink (EU) signaling channel, the system comprising:

(a) a radio network controller (RNC);

(b) at least one wireless transmit/receive unit (WTRU) for computing EU transmission failure statistics and reporting the statistics to the RNC;

(c) at least one Node-B; and

(d) at least one DL EU signaling channel in communication with the WTRU and the Node-B, wherein the Node-B sends signals to the WTRU via the DL UE signaling channel, and the RNC adjusts a transmission power offset of the DL EU signaling channel to be used in determining transmission power level of the signals sent by the Node-B based on the EU transmission failure statistics reported to the RNC by the WTRU.

26.   A wireless communication system for controlling transmission power of a downlink (DL) enhanced uplink (EU) signaling channel, the system comprising:

(a) a radio network controller (RNC);

(b) at least one wireless transmit/receive unit (WTRU);

(c) at least one Node-B for computing EU transmission failure statistics and reporting the statistics to the RNC; and

(d) at least one DL EU signaling channel in communication with the WTRU and the Node-B, wherein the Node-B sends signals to the WTRU via the DL UE signaling channel, and the RNC adjusts a transmission power offset of the DL EU signaling channel to be used in determining transmission power level of the signals sent by the Node-B based on the EU transmission failure statistics reported to the RNC by the Node-B.

27.   A wireless communication system comprising:

(a) a wireless transmit/receive unit (WTRU); and

(b) a downlink (DL) enhanced uplink (EU) signaling channel dedicated to communicate with the WTRU, wherein the power level of the DL EU signaling channel is based on the power level of a current DL dedicated control channel.

28.   The system of claim 27 wherein the power level of the DL EU signaling channel is based on the current DL dedicated control channel power level and an initial power offset.

29.   The system of claim 28 further comprising:

(c) a Node-B; and

(d) a radio network controller (RNC), wherein the RNC adjusts the power offset based on EU transmission failure statistics computed and reported to the RNC by at least one of the WTRU and the Node-B.

30.   A wireless communication system comprising:

(a) a plurality of wireless transmit/receive units (WTRUs);

(b) a radio network controller (RNC); and

(c) a downlink (DL) enhanced uplink (EU) signaling channel shared by the WTRUs, wherein the power level of the DL EU signaling channel is based on a common DL signaling power level initially set by the RNC.

31.   The system of claim 30 wherein the power level of the DL EU signaling channel is based on the common DL signaling power level initially set by the RNC and a power offset.

32.   The system of claim 31 wherein the system further comprises a Node-B, and the RNC adjusts the power offset based on EU transmission failure statistics computed and reported to the RNC by at least one of the plurality of WTRUs and the Node-B.
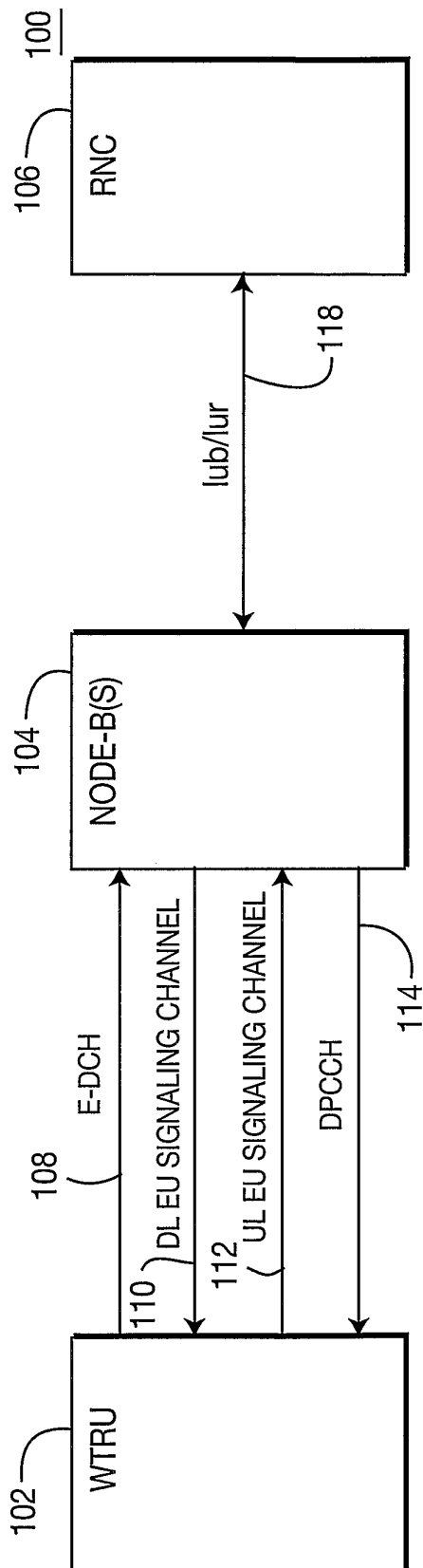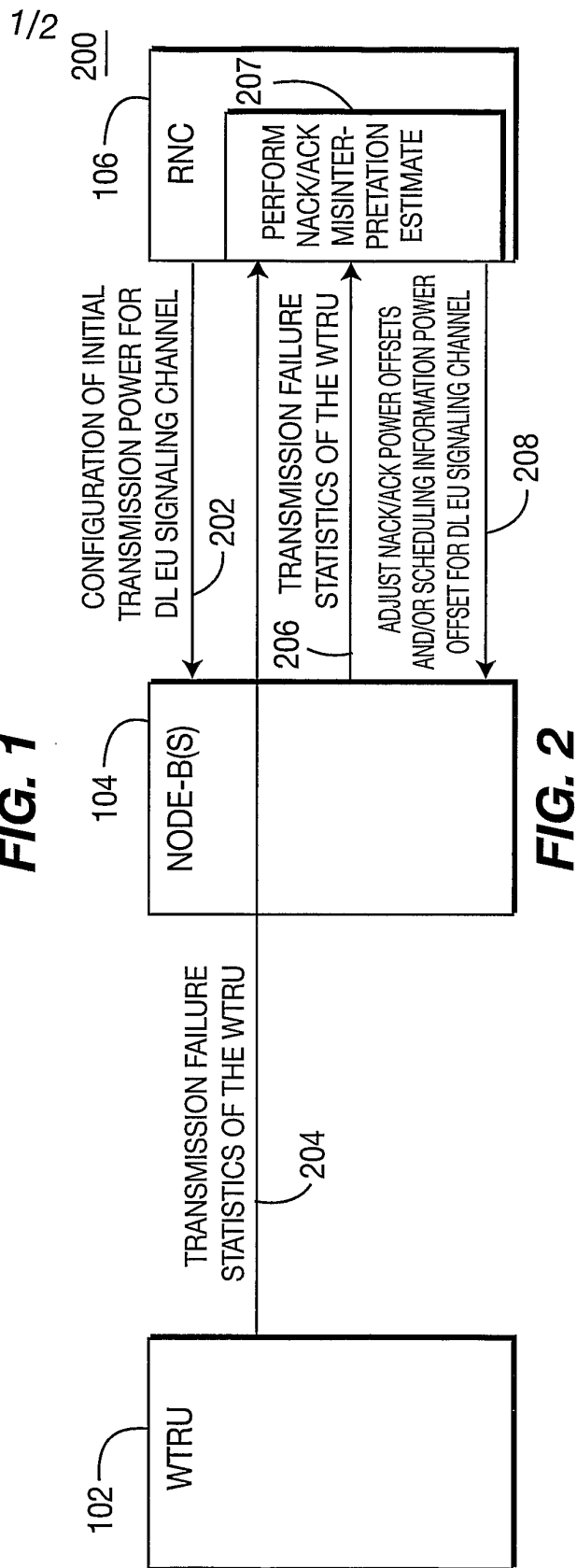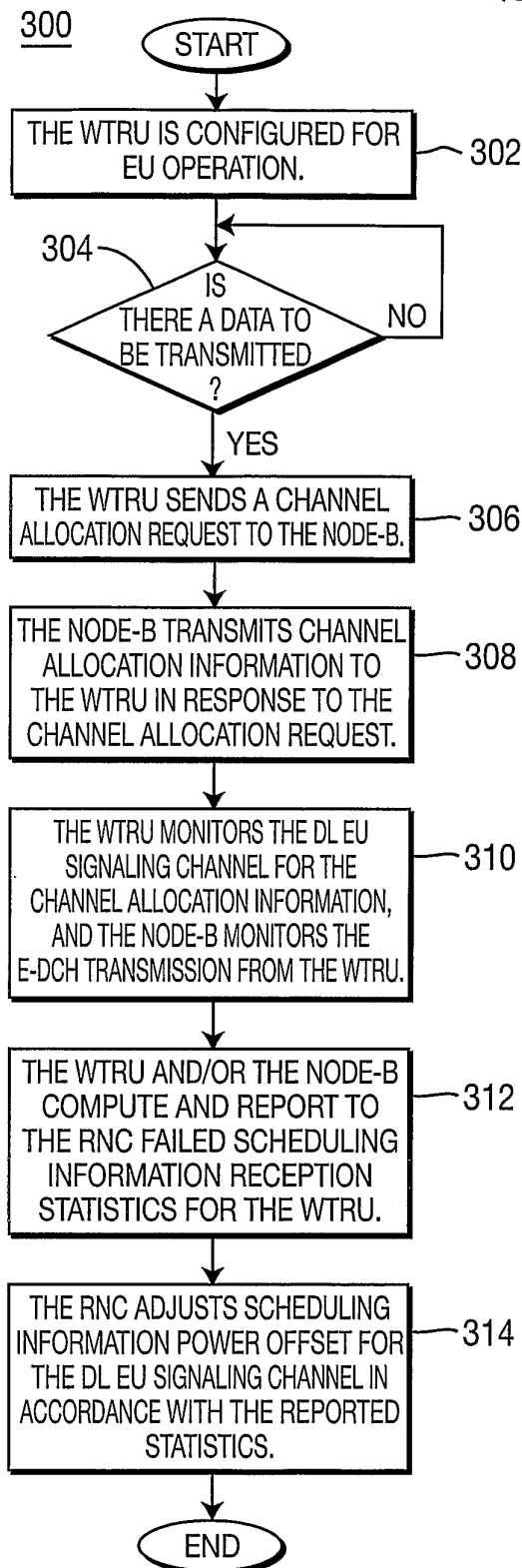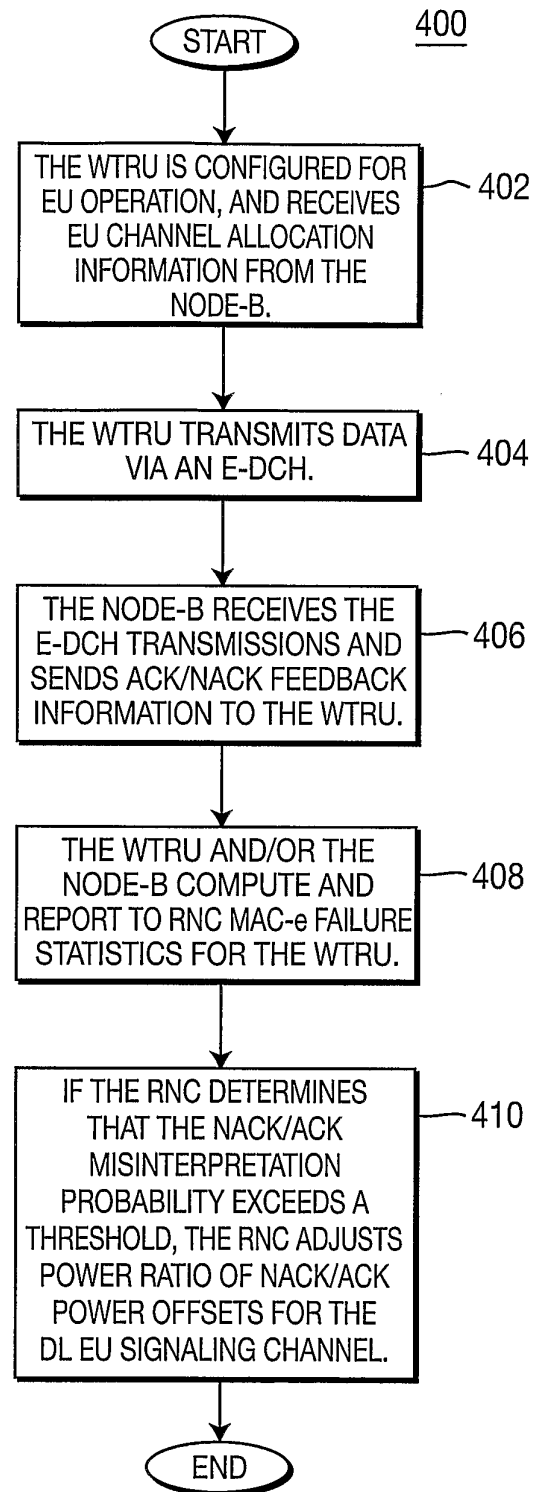
FIG. 1

FIG. 2

300

START

THE WTRU IS CONFIGURED FOR EU OPERATION. — 302

304 — IS THERE A DATA TO BE TRANSMITTED ? — NO

YES

THE WTRU SENDS A CHANNEL ALLOCATION REQUEST TO THE NODE-B. — 306

THE NODE-B TRANSMITS CHANNEL ALLOCATION INFORMATION TO THE WTRU IN RESPONSE TO THE CHANNEL ALLOCATION REQUEST. — 308

THE WTRU MONITORS THE DL EU SIGNALING CHANNEL FOR THE CHANNEL ALLOCATION INFORMATION, AND THE NODE-B MONITORS THE E-DCH TRANSMISSION FROM THE WTRU. — 310

THE WTRU AND/OR THE NODE-B COMPUTE AND REPORT TO THE RNC FAILED SCHEDULING INFORMATION RECEPTION STATISTICS FOR THE WTRU. — 312

THE RNC ADJUSTS SCHEDULING INFORMATION POWER OFFSET FOR THE DL EU SIGNALING CHANNEL IN ACCORDANCE WITH THE REPORTED STATISTICS. — 314

END

FIG. 3

400

START

THE WTRU IS CONFIGURED FOR EU OPERATION, AND RECEIVES EU CHANNEL ALLOCATION INFORMATION FROM THE NODE-B. — 402

THE WTRU TRANSMITS DATA VIA AN E-DCH. — 404

THE NODE-B RECEIVES THE E-DCH TRANSMISSIONS AND SENDS ACK/NACK FEEDBACK INFORMATION TO THE WTRU. — 406

THE WTRU AND/OR THE NODE-B COMPUTE AND REPORT TO RNC MAC-e FAILURE STATISTICS FOR THE WTRU. — 408

IF THE RNC DETERMINES THAT THE NACK/ACK MISINTERPRETATION PROBABILITY EXCEEDS A THRESHOLD, THE RNC ADJUSTS POWER RATIO OF NACK/ACK POWER OFFSETS FOR THE DL EU SIGNALING CHANNEL. — 410

END

FIG. 4