

(51) International Patent Classification:
H04W 72/02 (2009.01)(21) International Application Number:
PCT/CN2013/084497(22) International Filing Date:
27 September 2013 (27.09.2013)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant (for all designated States except US): **MEDI-
ATEK SINGAPORE PTE. LTD.** [SG/SG]; No.1 Fu-
sionopolis Walk, #03-01 Solaris, Singapore 138628 (SG).

(72) Inventors; and

(71) Applicants (for US only): **ZHANG, Yuanyuan** [CN/CN];
1203, Unit 2, Building 13, Fuli Taoyuan, Jiancaicheng
Road, Xisanqi, Haidian District, Beijing 100096 (CN).
SUN, Feifei [CN/CN]; No.35 Beitaipingzhuang Road,
Room 1303, Haidian District, Beijing 100088 (CN). **HSU,
Chia-Chun** [CN/CN]; 6F., No.11, Baoqing St., Xindian
Dist., New Taipei City, Taiwan 231 (CN).(74) Agent: **BEIJING SANYOU INTELLECTUAL PROP-
ERTY AGENCY LTD.**; 16th Fl., Block A, Corporate
Square, No. 35 Jinrong Street, Beijing 100033 (CN).(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME,
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM,

[Continued on next page]

(54) Title: METHOD TO REPORT THE CHANNEL STATUS

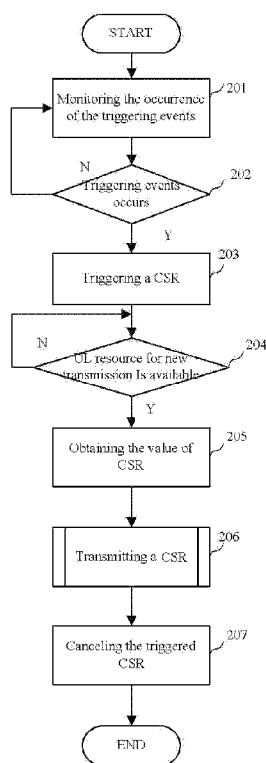


FIG.2

(57) Abstract: These disclosed embodiments describe a method for a mobile station to report the channel status to the network, the method comprising: triggering a CSR when certain event occurs; obtaining the value of the channel status from the physical layer when having UL resource for new transmission; transmitting a CSR with the allocated UL resource; and canceling the triggered CSR. In one embodiment, a method for a mobile station to report the channel status is that the report is transmitted in Msg3 during the initial random access. In one embodiment, a method for a mobile station to report the channel status after initial random access further comprising: monitoring the channel situation; triggering a CSR when the channel status has changed or has changed more than a threshold since the last transmission of a CSR; obtaining the value of the channel status from the physical layer when having UL resource for new transmission; transmitting a CSR; and canceling the triggered CSR. In another embodiment, a method for a mobile station to report the channel status further comprising if there is no UL radio resource available for CSR transmission, scheduling request will be triggered.



TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,

EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

METHOD TO REPORT THE CHANNEL STATUS

FIELD OF INVENTION

This disclosure relates generally to wireless communications and, more particularly, to
5 report the channel status.

BACKGROUND OF THE INVENTION

Machine-to-Machine (M2M) applications required low-cost devices and improved
coverage other than current cellular communication system. For example, some smart-metering
10 devices suffer a significantly larger path-loss (e.g., 20dB path loss) than that in the typical
operation condition of normal devices, which are often installed in the basements of residential
buildings or locations shielded by foil-backed insulation, metalized windows, or traditional
thick-walled building construction. In order to serve these devices, 3rd generation partnership
project (3GPP) RAN1 working group have studied for coverage improvement and cost
15 reduction for these MTC devices in coverage hole scenario. Some potential solutions have been
identified such as repetition of the physical channels to improve the coverage. In addition, cost
reduction techniques are studied, including reducing the data buffer size and operation
bandwidth, reducing receiving the antenna number and so on. In order to access and serve such
devices with proper allocation of radio resources i.e. the repetition number of each physical
20 channel as well as the corresponding transmission power, the channel status should be reported
by the devices. The CSR (CSR) can be used as assistant information and used by the network
for radio resource allocation. Therefore, it is important to have a method to report the CSR. The
benefit of reporting channel status is not limited to the examples above.

SUMMARY OF THE INVENTION

Methods and device for a mobile station to report channel status are provided.

In one novel aspect, the method comprising: triggering a CSR when certain event occurs;
transmitting a CSR with one of the at least one UL resource; and canceling the triggered CSR.
The events include but not limited to the following ones: 1) the mobile station is performing
30 initial access to the network or re-establishment through random access procedure; 2) the
channel status has changed since the last transmission of a CSR; 3) the channel status has
changed more than a threshold since the last transmission of a CSR, wherein the threshold is
configured by the network; 4) a request for CSR is received from the network; 5) the coverage

problem is detected.

In one example, wherein triggering a CSR when the mobile station is performing initial access or re-establishment to the network through random access procedure further comprising: obtaining the value of the channel status from the physical layer when an UL grant is received
5 in the random access response; transmitting the a CSR with the one of the at least one UL resource in Msg3; and canceling the triggered CSR.

In another example, wherein triggering a CSR upon the occurrence of the events further comprising: starting or re-starting a timer after a CSR is triggered; stopping the timer when the CSR is transmitted; triggering a scheduling request for UL radio resources when the timer
10 expires; and sending a scheduling request to the network.

In another example, wherein triggering a CSR upon the occurrence of the events further comprising: determining whether there is potential UL radio resource available for CSR after a CSR is triggered; starting or re-starting timer if there is no potential UL radio resource; stopping the timer when the CSR is transmitted; triggering a scheduling request for UL radio
15 resources when the timer expires; and sending a scheduling request to the network.

In one novel aspect, the method comprising: sending a NAS message to the network when certain events occur; obtaining the value of the channel status from the lower layer. The events include but not limited to the following ones: 1) the channel status has changed; 2) the channel status has changed more than a threshold; 3) the coverage problem is detected.

In one example, wherein sending a NAS message to the network further comprising: initiating the tracking area updating procedure, and sending the TRACKING AREA UPDATE REQUEST message containing the IE for channel status to the network.
20

Other embodiments and advantages are described in the detailed description below. This summary does not purport to define the invention. The invention is defined by the claims.
25

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, where like numerals indicate like components, illustrate embodiments of the invention.

Figure 1 illustrates a wireless communication system and exemplary block diagrams of UE
30 and eNB in accordance with embodiments of the invention.

Figure 2 illustrates a flowchart of an example for a mobile station to report the channel status in accordance with embodiments of the current invention.

Figure 3a illustrates an example of the MAC CE for CSR in accordance with embodiments of the current invention.

Figure 3b illustrated an example of the MAC CE for CSR transmitted through Msg 3 in accordance with embodiments of the current invention.

Figure 4 illustrates a flowchart of an example for a mobile station to transmit CSR in accordance with embodiments of the current invention.

5 Figure 5 illustrates a flowchart for a mobile station to report channel status during initial random access in accordance with embodiments of the current invention.

Figure 6 illustrates a flowchart of an example for a mobile station to report channel status after RRC connection is established in accordance with embodiments of the current invention.

10 Figure 7 illustrates a flowchart of an example for a mobile station to request UL resource for CSR through triggering and sending scheduling request in accordance with embodiments of the current invention.

Figure 8 illustrates a flowchart of another example for a mobile station to request UL resource for CSR through triggering and sending scheduling request in accordance with embodiments of the current invention.

15 Figure 9 illustrates a flowchart of an example for a mobile station to send scheduling request for CSR report in accordance with embodiments of the current invention.

Figure 10 illustrates a flowchart of an example for a mobile station to report channel status through NAS procedure in accordance with embodiments of the current invention.

20 DETAILED DESCRIPTION

Reference will now be made in detail to some embodiments of the invention, examples of which are illustrated in the accompanying drawings.

Figure 1 illustrates a wireless communication system and exemplary block diagrams of UE and eNB in accordance with embodiments of the invention.. In Figure 1, the wireless communication system 100 includes one or more fixed base infrastructure units forming a network distributed over a geographical region. The base unit may also be referred to as an access point, access terminal, base station, Node-B, eNode-B, or by other terminology used in the art. In Figure 1, the one or more base stations 101 and 102 serve a number of mobile stations 103 and 104 within a serving area, for example, a cell, or within a cell sector. In some systems, one or more base stations are communicably coupled to a controller forming an access network that is communicably coupled to one or more core networks. The disclosure however is not intended to be limited to any particular wireless communication system.

Generally, the serving base station 101 and 102 transmit downlink communication signals 112 and 113 to mobile station in the time and/or frequency domain. UE or Mobile station 103

and 104 communicate with one or more base units 101 and 102 via uplink communication signals 113 and 114. UE or the mobile station may also be referred to a mobile phone, laptop, and mobile work station and so on. In Figure 1, the mobile communication network 100 is an OFDM/OFDMA system comprising a base station eNB 101 eNB 102 and a plurality of mobile station 103 and mobile station 104. When there is a downlink packet to be sent from eNB to mobile station, each mobile station gets a downlink assignment, e.g., a set of radio resources in a physical downlink shared channel (PDSCH). When a UE needs to send a packet to eNB in the uplink, the mobile station gets a grant from the eNB that assigns a physical downlink uplink shared channel (PUSCH) consisting of a set of uplink radio resources. The mobile station gets the downlink or uplink scheduling information from a physical downlink control channel (PDCCH) or an enhanced physical downlink control channel (EPDCCH) that is targeted specifically to that mobile station. The downlink or uplink scheduling information and the other control information, carried by PDCCH, is referred to as downlink control information (DCI).

Figure 1 further shows exemplary block diagrams illustrating protocol stacks of UE 103, and eNB 101. UE 103 has a physical layer stack (PHY), Mac layer (MAC), Radio Link Control (RLC), Packet Data Control Protocol (PDCP) and Radio Resource Control (RRC). The peer protocol stacks terminated in eNB 101 on the network side, include PHY, MAC, RLC, PDCP and RRC. Figure 1 further shows exemplary block diagrams of UE 103 and eNB 101 that supports some embodiments of the present invention.

UE 103 has RF transceiver module 150, coupled with antenna 171 receives RF signals from antenna 171, converts them to baseband signals and sends them to processor 151. RF transceiver 150 also converts received baseband signals from the processor 151, converts them to RF signals, and sends out to antenna 171. Processor 151 processes the received baseband signals and invokes different functional modules to perform features in UE 103. Memory 152 stores program instructions and data to control the operations of UE 103. Figure 1 further illustrates seven functional modules 153 to 154, the MAC module could process the operation of MAC layer, and the lower layer module 154 process the operation of lower layer.

eNB 101 has RF transceiver module 160, coupled with antenna 172 receives RF signals from antenna 172, converts them to baseband signals and sends them to processor 161. RF transceiver 160 also converts received baseband signals from the processor 161, converts them to RF signals, and sends out to antenna 172. Processor 161 processes the received baseband signals and invokes different functional modules to perform features in eNB 101. Memory 162 stores program instructions and data to control the operations of eNB 101. Figure 1 further

illustrates six functional modules 163 to 164 in eNB 101 that carry out embodiments of the current invention. The MAC module 163 could process the operation of MAC layer, and the lower layer module 164 could process the operation of lower layer. And the other modules are omitted here. The other modules corresponding to UE are omitted here.

5 In one embodiment, the communication system utilizes MAC layer to control the upper layers' access to the communication medium. MAC layer decides how much radio resource should be allocated to data from which logical channel of which mobile station. To achieve this, the MAC layer performs assistant information reporting such as buffer status reporting(BSR) and power headroom reporting(PHR) for network scheduling, multiplexing and de-multiplexing
10 to combine and disassemble upper layer data unites into/out of lower layer data unites and HARQ to transfer data units over the radio interface. Exemplary of MAC layer includes the developing Long Term Evolution (LTE) of the 3GPP UMTS standard and IEEE 802.16 standard.

For coverage hole devices, PDCCH or EPDCCH may need repetitions across multiple
15 subframes. In the meanwhile, the PDSCH and/or PUSCH of the devices may also need across subframe (re)transmission (or repetitions). In order to determine the repetitions number (or the number of subframes occupied by data channel or control channel) for each physical channels in both DL and UL based on the channel situation, a method to report the channel status is necessary. The channel situation is evaluated by measuring the DL reference signals, through
20 which RSRP, RSRQ, RSSI, CQI as well as other metrics used for channel quality evaluation can be derived. These measurement results can be reported directly as channel status. Or the measurement results within a certain range can be quantified into different coverage levels and each level is assigned a channel status index. The reported channel status index and the corresponding coverage levels are defined in the specification.

25 In one embodiment of the disclosure, a method for a mobile station to report the channel status includes: triggering a CSR when certain event occurs; obtaining the value of the channel status from the lower layer when there is at least one UL resource for new transmission; transmitting a CSR with one of the at least one UL resource; and canceling the triggered CSR. The events include but not limited to the following ones: 1) the mobile station is performing
30 initial access or re-establishment to the network through random access procedure; 2) the channel status has changed since the last transmission of CSR; 3) the channel status has changed more than a threshold since the last transmission of CSR, wherein the threshold is configured by the network; 4) a request for CSR is received from the network; 5) the coverage problem is detected, e.g. the channel quality is worse than a predefined threshold. For example,

the threshold could be set to different value according with different situation. When the mobile station uses a special PRACH resource or when it can't detect normal mode downlink physical channel (e.g, PBCH, PDCCH, PDSCH, and PHICH) for a period of time or when the channel quality is worse than a predefined threshold, it can determine that a coverage problem occurs.

5 In one embodiment, a method for a mobile station to transmitting a CSR further comprising: instructing the Multiplexing and Assembly procedure to generate the CSR MAC control element(CE) if the allocated UL resources can accommodate a CSR MAC CE plus its subheader. In the embodiments of present invention, the UL resources used for CSR transmission should be allocated by the network, which can be assigned semi-persistently
10 through configuration or assigned dynamically through UL grants. One example of the MAC CE is that it has a fixed size of zero bits with two reserved bits in the subheader used to indicate four levels of channel status. Another example of the MAC CE is that it has a fixed size of one byte. Some bits are used as the fields of CSR, while others are reserved bits. A new LCID is assigned to the MAC CE for CSR.

15 In one embodiment of the present invention, when performing multiplexing and assembling to generate the CSR MAC CE, the mobile station takes into account the following relative priority in decreasing order: MAC CE for C-RNTI or data from UL-CCCH; MAC CE for BSR, with exception of BSR included for padding; MAC CE for CSR; other MAC CE and data from other logical channels except UL-CCCH. In other words, CRS MAC CE takes
20 precedence over other MAC CE and data from other logical channels, but has lower priority than MAC CE for C-RNTI or data from UL-CCCH as well as MAC CE for BSR, with exception of BSR included for padding.

In one embodiment, a method for a mobile station to report the channel status includes: triggering a CSR upon initiating random access procedure, e.g. upon transmission of random
25 access preamble; obtaining the value of the channel status from the physical layer when UL grant is received in the random access response; transmitting the a CSR with the allocated UL resources in the Message subsequent to random access response such as Msg3 and canceling the triggered CSR. In one embodiment, a method for a mobile station to transmit a CSR in Msg3 further comprising: instructing the Multiplexing and Assembly procedure to generate the
30 CSR MAC CE; and placing the MAC CE at the beginning of the MAC PDU. The MAC CE has a fixed size of one byte with any subheader. In one embodiment, a method for a mobile station to placing the MAC CE at the beginning of a MAC PDU further comprising: checking whether the allocated UL resources can accommodate other higher priority MAC SDUs/MAC CE as well as the corresponding subheaders together with the CSR MAC CE; placing the CSR

MAC CE at the beginning of the MAC PDU if the allocated UL resources can accommodate; otherwise waiting for another UL grant for CSR transmission.

After the communication between the mobile station and the network is established, i.e. the mobile station is in the RRC_CONNECTED state and performing data transfer to/from the network, the mobile station needs to monitor its channel situation and report the channel status timely upon detection that the channel status has changed or has changed more than a threshold since the last transmission of a CSR. The threshold can be configured by the network. If the channel status is reported during the initial random access through Msg3, the channel status is considered as the very first transmission.

In one embodiment, a method for a mobile station to report the channel status after initial random access further comprising: monitoring the channel situation; triggering a CSR when the channel status has changed or has changed more than a threshold since the last transmission of a CSR; obtaining the value of the channel status from the physical layer when there is at least one UL resource for new transmission; transmitting a CSR; and canceling the triggered CSR.

In one embodiment, a method for a mobile station to report the channel status after initial random access further comprising: monitoring the request for CSR sent from the network; triggering a CSR when the request is received; obtaining the value of the channel status from the physical layer when having UL resource for new transmission; transmitting a CSR; and canceling the triggered CSR.

It is possible that there is no UL resource available to transmit the CSR. One example of the case is that only DL traffic is transferred from the network to the mobile station and there are no UL services. Another example of the case is that the channel status of the mobile station becomes worse and the UL grant still can't be received after several repetitions. In both of the cases, even a CSR is triggered, there won't be UL resource available to transmit the CSR. The triggered CSR remains pending until it is transmitted. In order to transmit the CSR timely upon the triggering, scheduling request will be required to be sent to the network if there is no UL resource available.

In one embodiment, a method for a mobile station to report the channel status further comprising: starting or re-starting a timer after a CSR is triggered; stopping the timer when the CSR is transmitted; triggering a scheduling request for UL radio resources when the timer expires; and sending a scheduling request to the network.

In one embodiment, a method for a mobile station to report the channel status further comprising: determining whether there is potential UL radio resource available for CSR after a CSR is triggered; starting or re-starting timer if there is no potential UL radio resource;

stopping the timer when the CSR is transmitted; triggering a scheduling request for UL radio resources when the timer expires; and sending a scheduling request to the network. Determining whether there is potential UL radio resource available for CSR should consider the occurrence of the following conditions: whether there is pre-configured UL radio resources, such as
5 dedicated UL resources configured for semi-persistent scheduling; and whether there is any pending SR. If there is a pre-configured UL radio resource or there is SR pending, the mobile station will transmit the channel status with the configured UL resources or the UL resources requested from the network. Otherwise, the mobile station considers that there is no potential UL radio resource available.

10 There are two types of scheduling request taking use of dedicated access channels such as physical UL control channel (PUCCH) or contention channels such as random access channel (RACH), i.e. dedicated-SR (D-SR) or RA-SR respectively. The mobile station utilizes RA-SR to request UL resources through random access procedure, while utilizes D-SR to request UL resources through the configured dedicated resources. When SR is triggered, the mobile station
15 needs to determine which SR to utilize if both the RA-SR and D-SR are available.

In one embodiment, a method for a mobile station to send scheduling request comprising: utilizing RA-SR if there is no D-SR configured or the channel status becomes worse or it becomes worse than a pre-defined threshold; otherwise utilizing D-SR.

20 In one embodiment, the communication system utilizes NAS layer for mobility management and session management. NAS layer support the mobility of the mobile station and session management procedure to establish and maintain IP connectivity between the mobile station and the core network. Exemplary of NAS layer includes the developing Long Term Evolution (LTE) of the 3GPP UMTS standard.

25 In one embodiment of the disclosure, a method for a mobile station to report the channel status includes: sending a NAS message to the network when certain events occurs; obtaining the value of the channel status from the lower layer. The events include but not limited to the following ones: 1) the channel status has changed; 2) the channel status has changed more than a threshold; 3) the coverage problem is detected, e.g. the channel quality is worse than a predefined threshold.

30 In one embodiment, a method for a mobile station to sending a NAS message to the network further comprising: initiate the tracking area updating procedure, and sending the TRACKING AREA UPDATE REQUEST message containing the IE for channel status to the network.

Some further details are the above embodiments are given below.

Referring now to Figure 2, Figure 2 illustrates a flowchart of an example for a mobile station to report the channel status in accordance with embodiments of the current invention. The mobile station monitors the occurrence of at least one triggering event in step 201. If the at least one triggering event occur 202, the mobile station triggers a CSR in step 203. If the mobile station has UL resource available for new transmission 204, it will obtain the channel status value from the lower layer in step 205. Then the mobile station transmits the CSR with the allocated UL resources in step 206 and cancels all the triggered CSR in step 207.

Referring now to Figure 3a, Figure 3a illustrates an example of the MAC CE for CSR for the present invention in accordance with embodiments of the current invention. In one embodiment of the disclosure, the MAC CE 303 has a fixed size of zero bits with two reserved bits e.g. 301 in the subheader used to indicate four levels of channel status. A new LCID 302 is assigned to the MAC CE for CSR. Or the MAC CE 313 has a fixed size of one byte. Five bits 312 are the fields of CSR, while others are reserved bits.

Referring now to Figure 3b, Figure 3b illustrated an example of the MAC CE for CSR transmitted through Msg 3 in accordance with embodiments of the current invention. In one embodiment of the disclosure, the MAC CE 321 has a fixed size of eight bits placed at the beginning of a MAC PDU, i.e. MAC header 322 and MAC payload 323.

Referring now to Figure 4, Figure 4 illustrates a flowchart of an example for a mobile station to transmit CSR in step 206. If the allocated UL resource(s) can accommodate the CSR MAC CE in step 401, the mobile station will instruct the multiplexing and assembly procedure to generate the MAC CE in step 402. Otherwise, it continues monitoring the UL grant and go to step 204.

Referring now to Figure 5, Figure 5 illustrates a flowchart for a mobile station to report channel status during initial random access in accordance with embodiments of the current invention. When the mobile station performs initial random access to the network in step 501, such as transmitting preamble, it triggers a CSR in step 502. If random access response is received in step 503, the mobile station will obtain the value of channel status in step 504, indicate to the Multiplexing and assembly entity to include a CSR MAC CE in Msg3 in step 505, obtain the MAC PDU to transmit from the "Multiplexing and assembly" entity and store it in the Msg3 buffer in step 506.

Referring now to Figure 6, Figure 6 illustrates a flowchart of an example for a mobile station to report channel status after RRC connection is established in accordance with embodiments of the current invention. The CSR transmitted in Msg3 is considered as the very first transmission. When in RRC_CONNECTED state, the mobile station monitors the channel

status in step 601. If the channel status has changed more than a pre-defined threshold 602, a CSR is triggered in step 603. If there is UL resource available for new transmission 604, the mobile station will obtaining the CSR value from the physical layer and transmitting the CSR with the allocated resources, in step 605 and 606 respectively. Then all triggered CSR is cancelled in 607.

Referring now to Figure 7, Figure 7 illustrates a flowchart of an example for a mobile station to request UL resource for CSR through triggering and sending scheduling request in accordance with embodiments of the current invention. When the CSR triggering events occurs, the mobile station triggers a CSR in step 701. It starts or restarting a timer in step 702 and monitors UL grant continuously 703. If UL grant for new transmission is received in step 704, the mobile station transmits the CSR with the allocated resource in step 705 and stops the timer in step 706. Otherwise, the mobile station checks whether the timer expires or not. If the timer expires in step 707, it will trigger and send scheduling request to the network in step 708. Otherwise, it continues monitoring UL grants until the timer expires in step 703.

Referring now to Figure 8, Figure 8 illustrates a flowchart of another example for a mobile station to request UL resource for CSR through triggering and sending scheduling request in accordance with embodiments of the current invention. When the CSR triggering events occurs, the mobile station triggers a CSR in step 801. It determines whether there is at least one potential UL resource available in step 802, which considers two conditions, i.e. whether there is configured UL resource in step 820 and whether there is any pending scheduling request in step 821. If there is potential UL resource available in step 803, the mobile station would utilize the potential UL resource for CSR transmission in step 805. Otherwise, it starts or restarting a timer in step 804 and monitors UL grant continuously in step 806. If UL grant for new transmission is received in step 807, the mobile station transmits the CSR with the allocated resource in step 808 and stops the timer in step 809. Otherwise, the mobile station checks whether the timer expires or not in step 810. If the timer expires, it will trigger and send scheduling request to the network in step 811. Otherwise, it continues monitoring UL grants until the timer expires in step 806.

Referring now to Figure 9, Figure 9 illustrates a flowchart of an example for a mobile station to send scheduling request for CSR report in accordance with embodiments of the current invention. When the mobile station triggers a scheduling request for CSR report, it checks whether there is dedicated SR configured in step 901. If no dedicated SR is configured, it will utilize RA-SR in step 903. Otherwise, it checks further whether channel status becomes worse or worse than a predefined threshold in step 902. If the channel status becomes better or

doesn't become worse than a threshold, it will utilize D-SR in step 904.

Referring now to Figure 10, Figure 10 illustrates a flowchart of an example for a mobile station to report channel status through NAS procedure in accordance with embodiments of the current invention. The mobile station monitors the occurrence of the triggering events in step 1001. If the triggering events occur in step 1002, the mobile station initiates tracking area update procedure in step 1003. Then it obtains the channel status value from the lower layer in step 1004 and transmits TRACKING AREA UPDATE REQUEST message to network containing the CSR.

While the present disclosure and the best modes thereof have been described in a manner establishing possession and enabling those of ordinary skill to make and use the same, it will be understood and appreciated that there are equivalents to the exemplary embodiments disclosed herein and that modifications and variations may be made thereto without departing from the scope and spirit of the inventions, which are to be limited not by the exemplary embodiments but by the appended claims.

CLAIMS

1. A method for a mobile station to report the channel status by the MAC layer, comprising:

5 triggering a CSR when at least one triggering event occurs; and
transmitting the CSR to the network.

2. The method of claim 1, further comprising:

obtaining a value of the channel status from lower layer when there is at least one UL
10 resource for new transmission;
transmitting the CSR with the at least one UL resource; and
canceling the triggered CSR.

3. The method of claim 1, wherein the at least one triggering event comprises at least one
15 of the following terms:

the mobile station is performing initial access to the network or re-establishment through
random access procedure;

the channel status has changed since the last transmission of a CSR;

the channel status has changed more than a threshold since the last transmission of a CSR,
20 wherein the threshold is configured by the network;

a request for CSR is received from the network by the mobile station; and

a coverage problem is detected by the mobile station.

4. The method of claim 3, after triggering a CRS when the mobile station is performing
25 initial access to the network or re-establishment through random access procedure further
comprising:

obtaining the value of the channel status from the physical layer when an UL grant is
received in the random access response;

transmitting the CSR in Msg3; and

30 canceling the triggered CSR.

5. The method of claim 1, further comprising:

after triggering a CSR starting or re-starting a timer.

6. The method of claim 1, further comprising:
determining whether there is at least one potential UL radio resource available;
starting or re-starting a timer if there is no potential UL radio resource.

5 7. The method of claim 6, wherein determining whether there is potential UL radio resource available further comprising:

checking whether there is pre-configured UL radio resources and whether there is any pending SR.

10 8. The method of claim 6, wherein after starting or re-starting a timer, a mobile station to report the channel status further comprising:

stopping the timer when the CSR is transmitted;

triggering a scheduling request for the at least one UL radio resource when the timer expires; and

15 sending a scheduling request to the network.

9. The method of claim 8, wherein a method for a mobile station to send a scheduling request comprising:

20 utilizing RA-SR if there is no D-SR configured or the channel status becomes worse or the channel status becomes worse than a pre-defined threshold;
otherwise, utilizing D-SR.

10. The method of claim 6, wherein the length of the timer is configured by the network.

25 11. The method of claim 5, wherein after starting or re-starting a timer, a mobile station to report the channel status further comprising:

stopping the timer when the CSR is transmitted;

triggering a scheduling request for the at least one UL radio resource when the timer expires; and

30 sending a scheduling request to the network.

12. The method of claim 11, wherein a method for a mobile station to send a scheduling request comprising:

utilizing RA-SR if there is no D-SR configured or the channel status becomes worse or the

channel status becomes worse than a pre-defined threshold;
otherwise, utilizing D-SR.

13. The method of claim 5, wherein the length of the timer is configured by the network.

14. The method of claim 1, wherein transmitting a CSR with the at least one UL resource further comprising:

instructing the Multiplexing and Assembly procedure to generate the CSR MAC CE if the allocated UL resources can accommodate a CSR MAC CE plus its subheader.

15. The method of claim 14, wherein multiplexing and assembling to generate the CSR MAC CE further comprising: taking into account the following relative priority in decreasing order: MAC CE for C-RNTI or data from UL-CCCH; MAC CE for BSR, with exception of BSR included for padding; MAC CE for CSR; other MAC CE and data from other logical channels except UL-CCCH.

16. The method of claim 14, wherein instructing the multiplexing and assembly procedure to generate a CSR MAC CE, which is transmitted in Msg3 further comprising:
placing the CSR MAC CE at the beginning of the MAC PDU.

17. A method for a mobile station to report the channel status, the method comprising:
sending a NAS message to the network when at least one events occurs; and
obtaining the value of the channel status from the lower layer.

18. The method of claim 17, wherein a mobile station sending a NAS message to the network further comprising:
initiating the tracking area updating procedure; and
sending the TRACKING AREA UPDATE REQUEST message containing the IE for channel status to the network.

19. The method of claim 17, wherein the at least one event comprises at least one of the following terms:

the channel status has changed;
the channel status has changed more than a threshold; and

a coverage problem is detected.

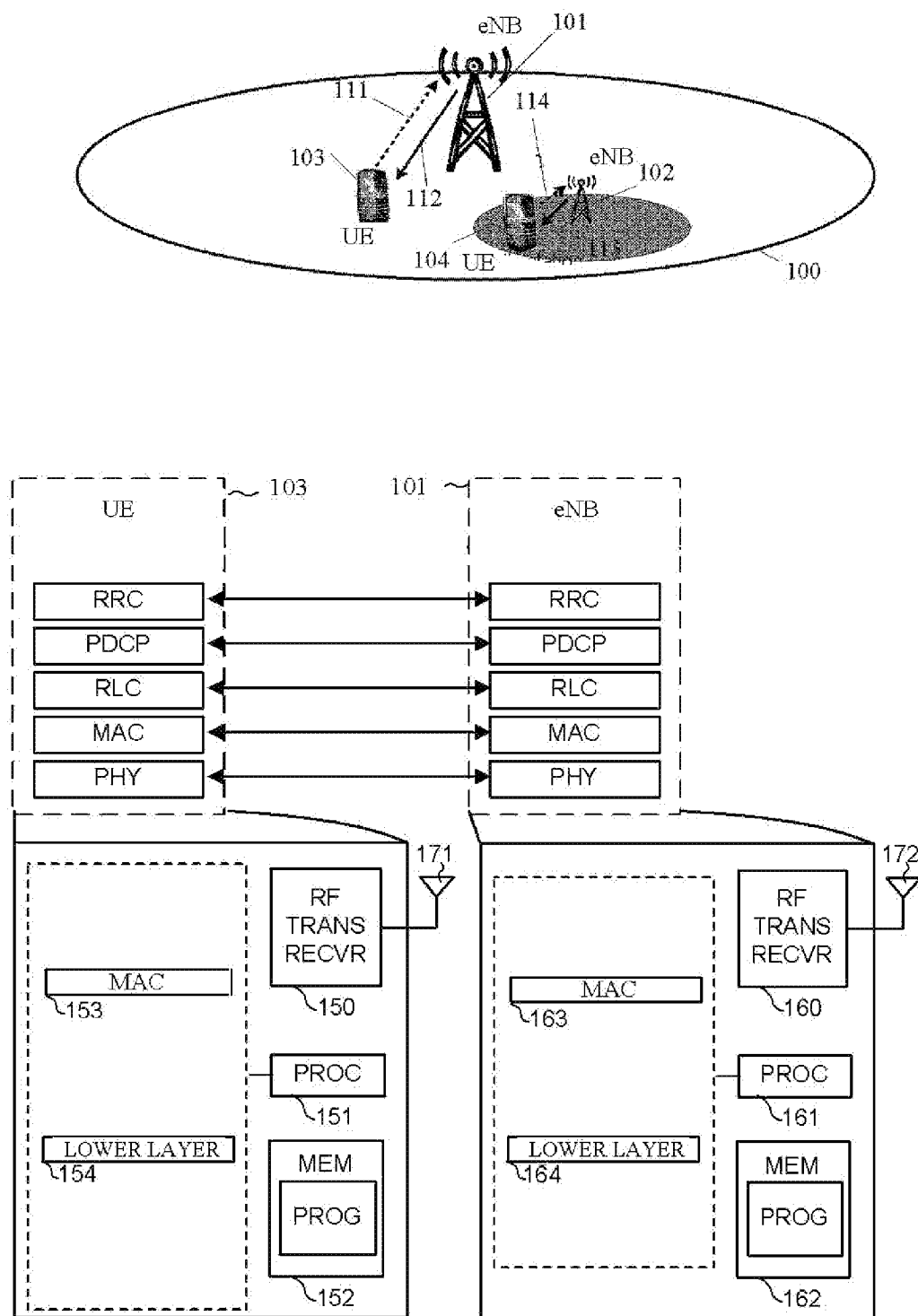


FIG.1

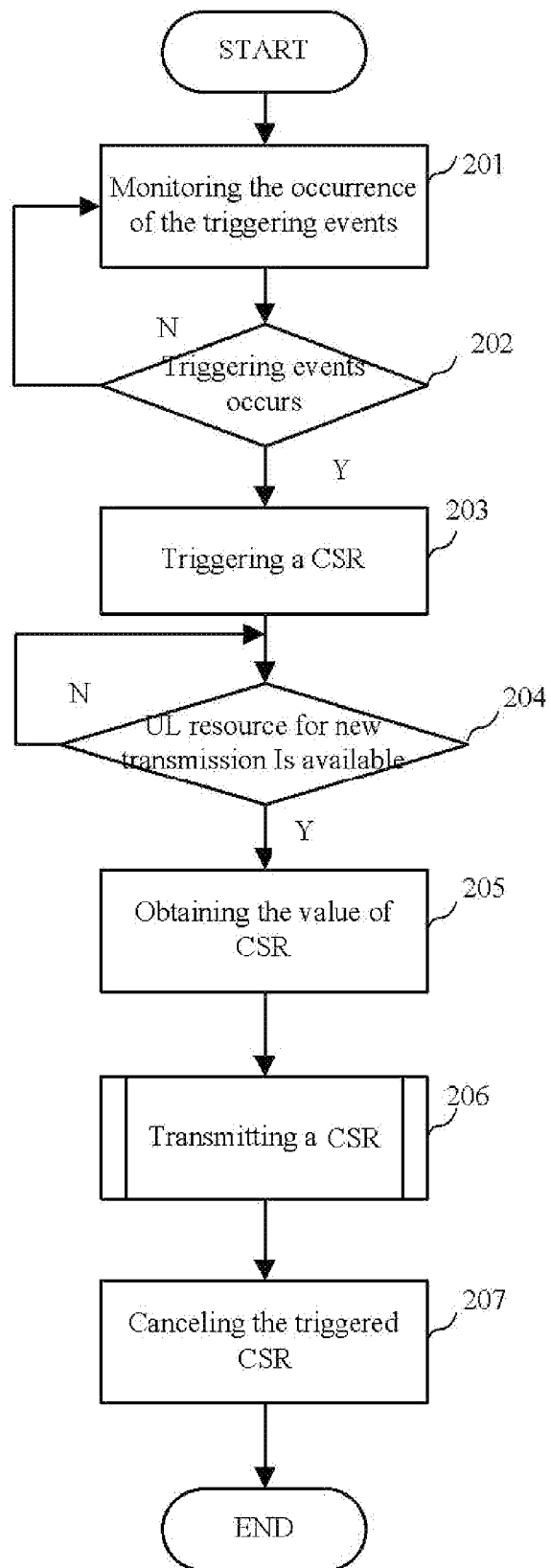


FIG.2

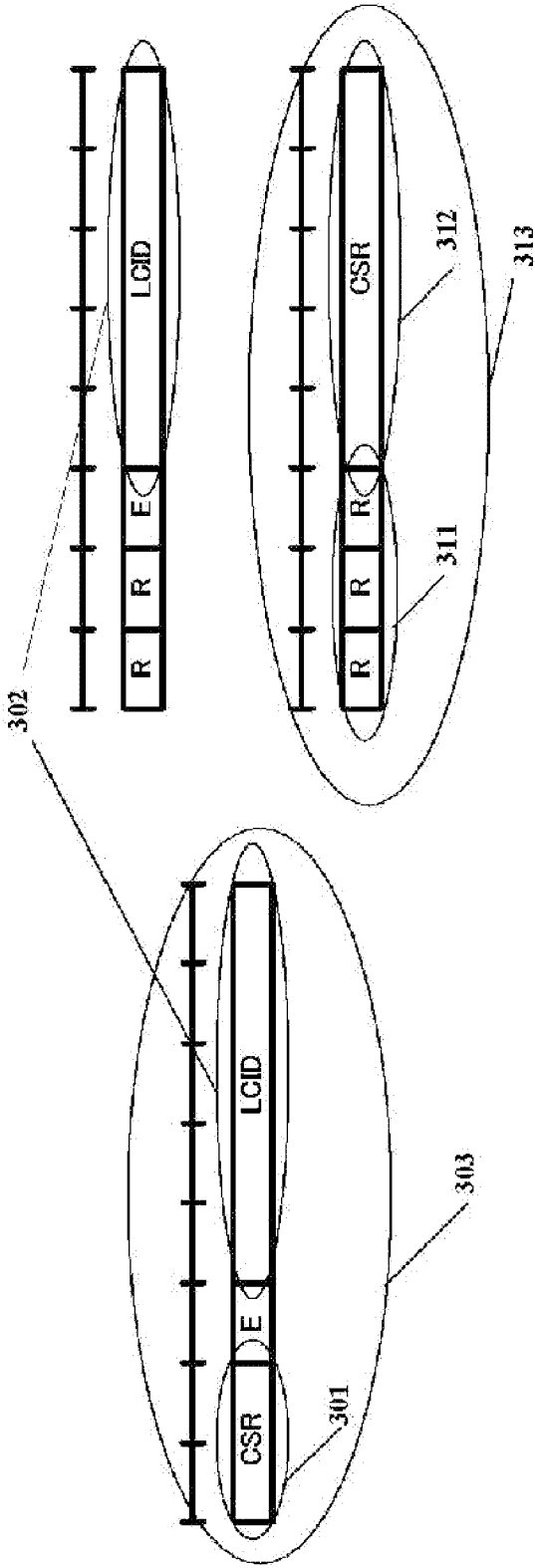


FIG.3a

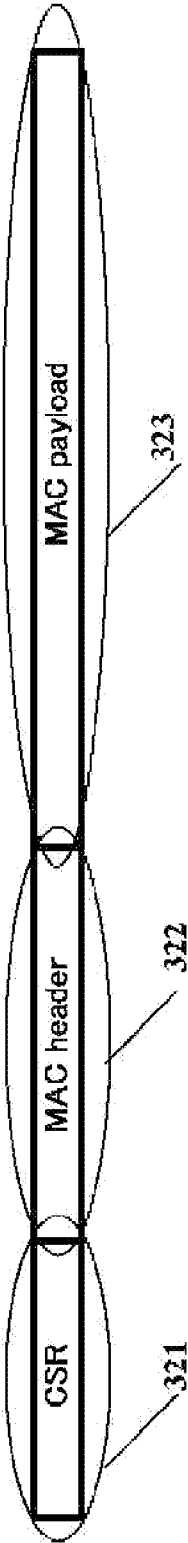


FIG.3b

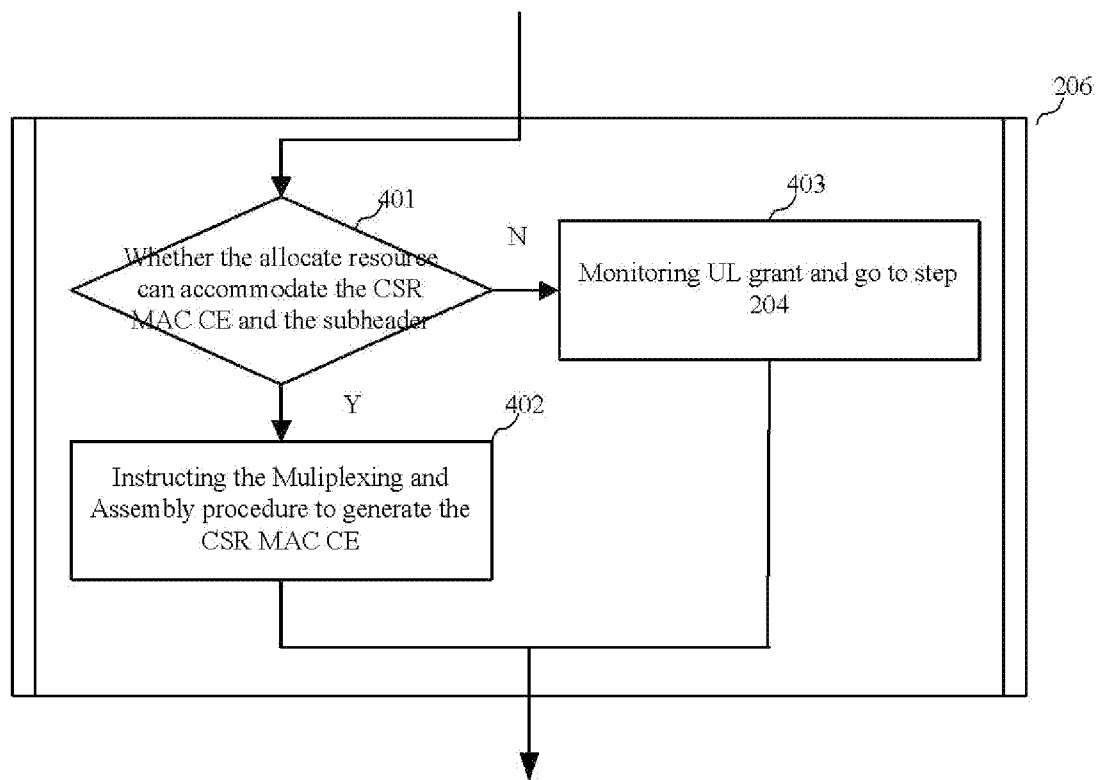


FIG.4

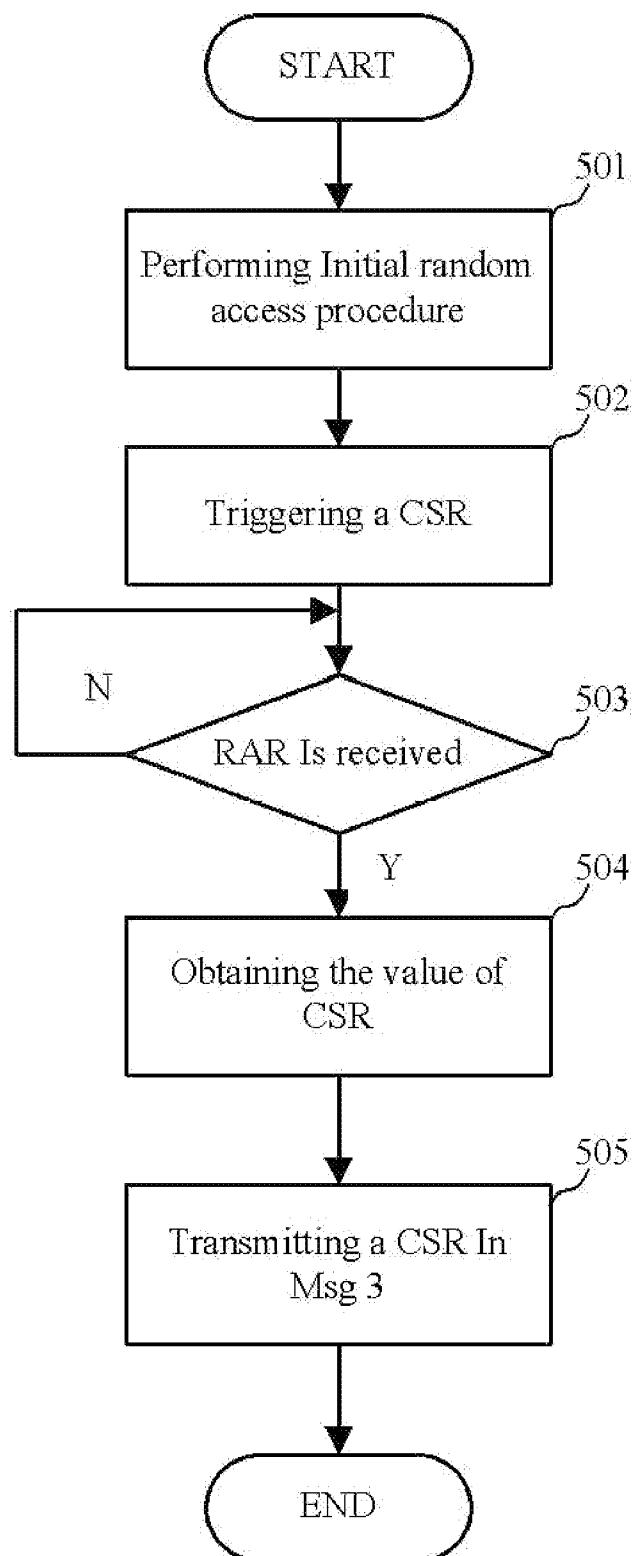


FIG.5

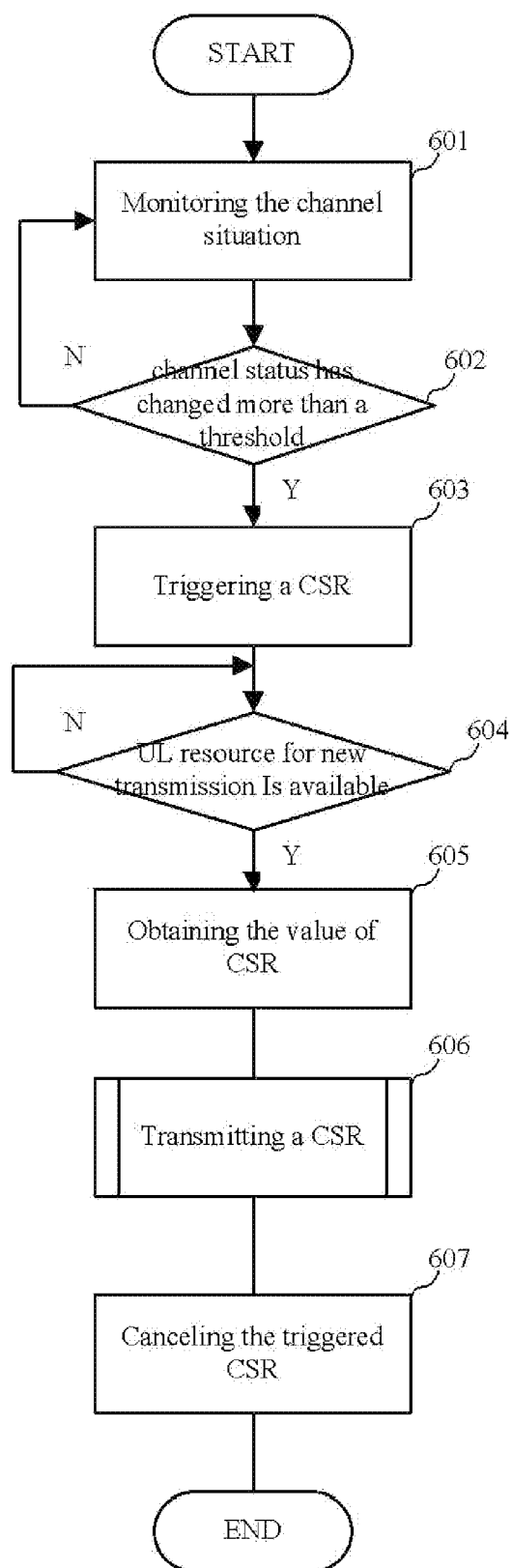


FIG.6

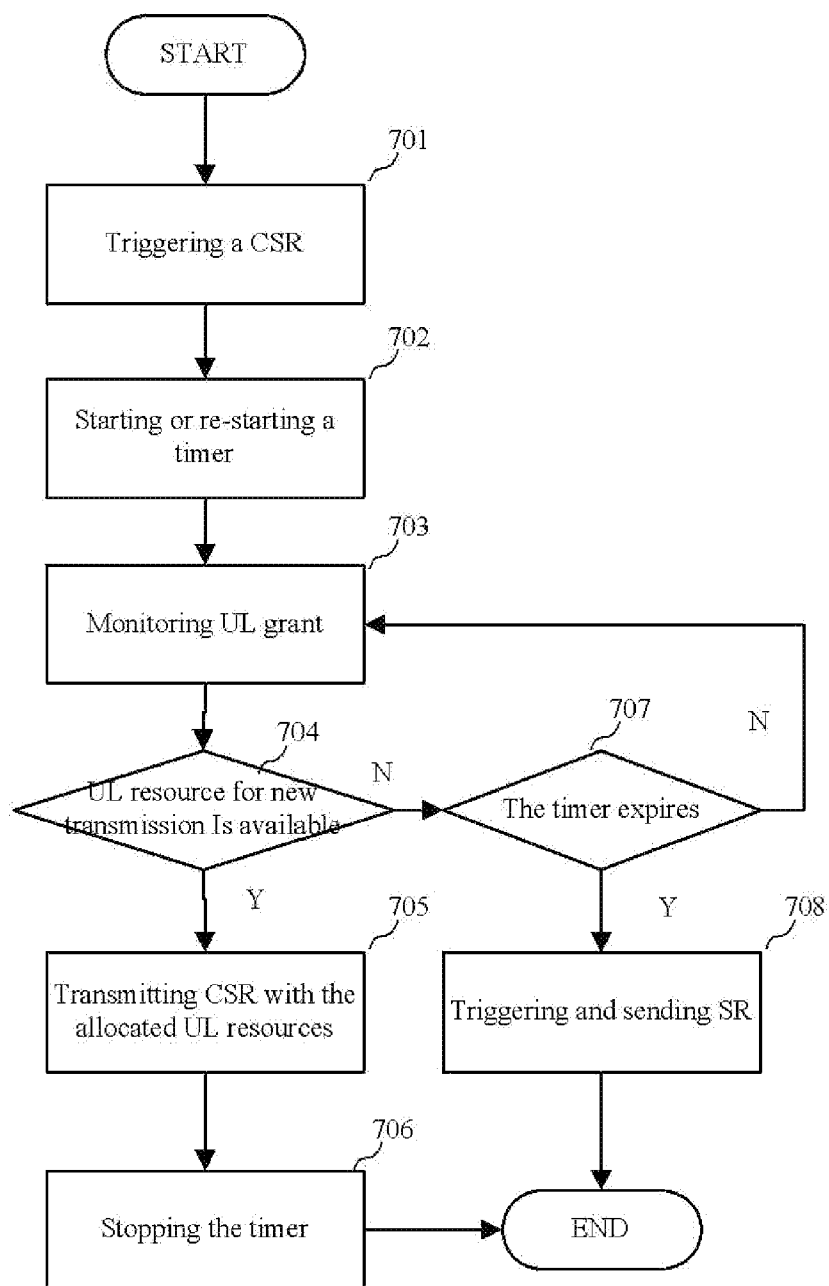


FIG.7

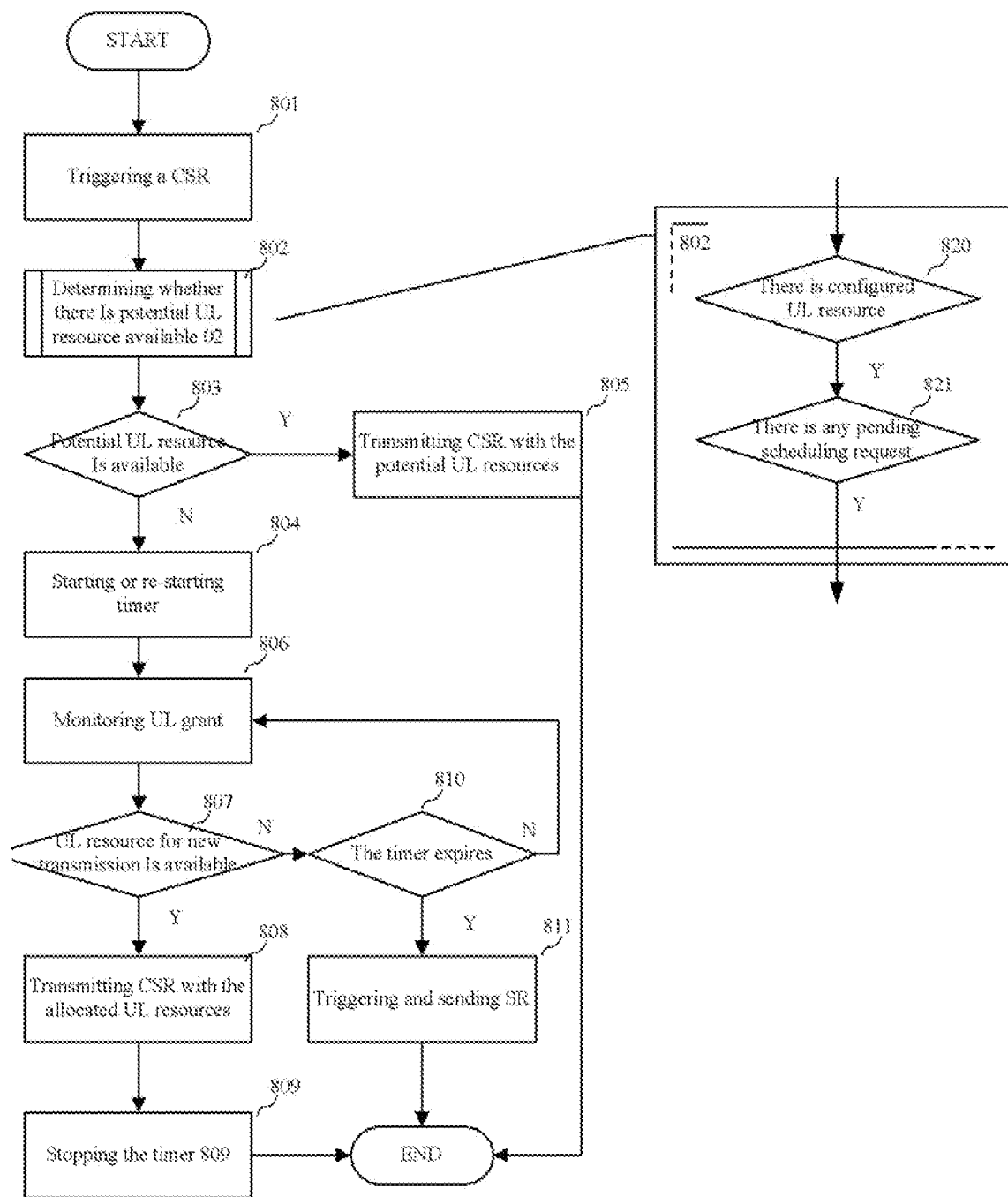


FIG.8

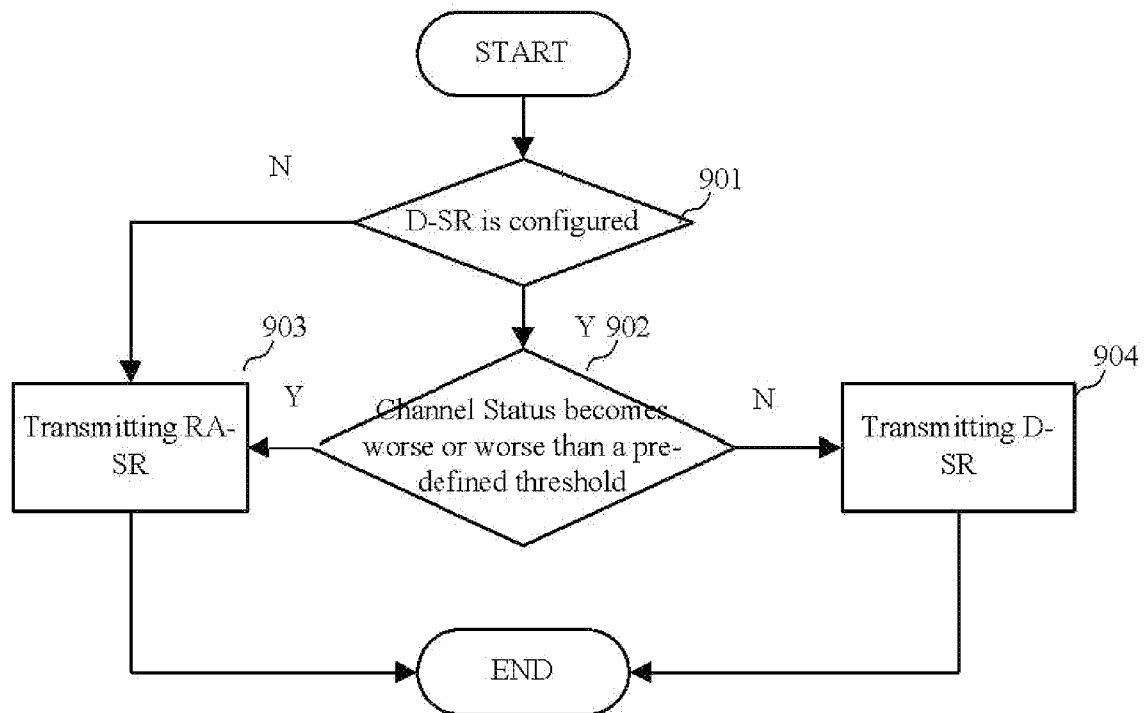


FIG.9

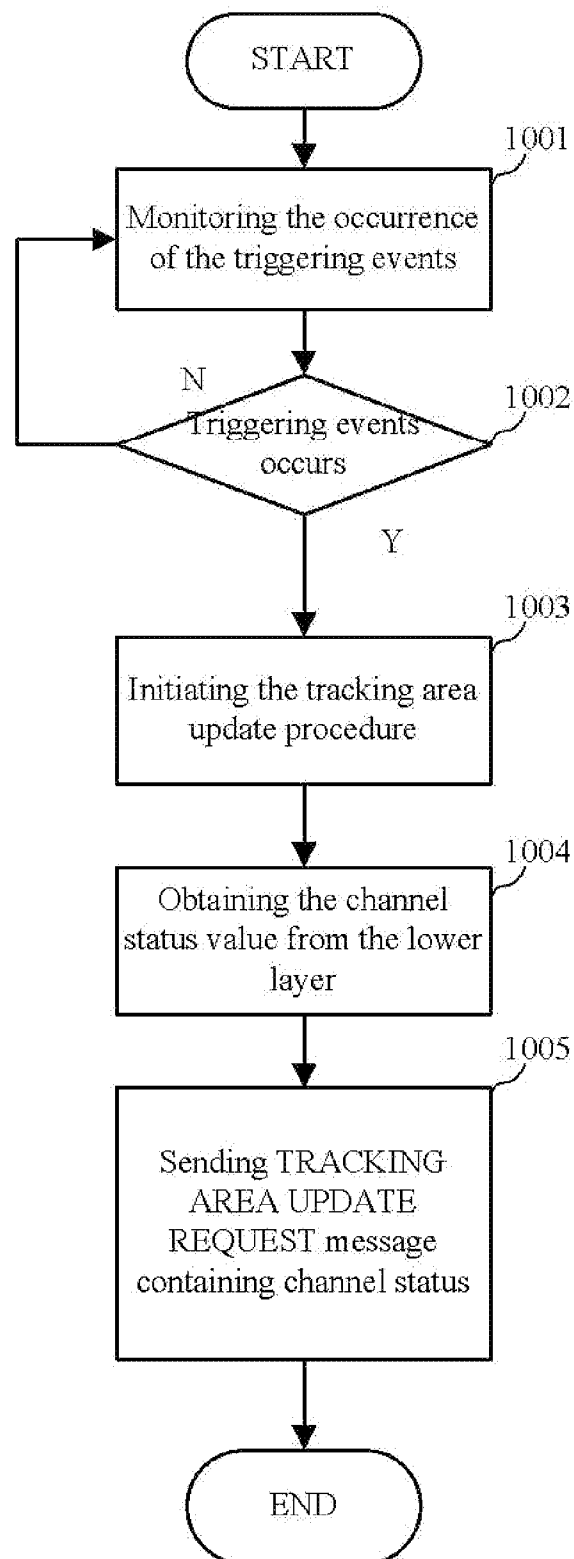


FIG.10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2013/084497

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/02(2009.01)i

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)

H04W; H04Q

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)

CNPAT,CNKI,WPI,EPODOC:channel,link,line,interface,radio,wireless,state,status,quality,monitor,measure,network,mobile,station,node w B,eNB,trigger,CSR,MSG3,NAS,MAC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 102123486A (CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY) 13 July 2011 (2011-07-13) description, paragraphs [0019] to [0034] and [0053]	1-13, 17, 19
A	CN 102123486A (CHINA ACADEMY OF TELECOMMUNICATIONS TECHNOLOGY) 13 July 2011 (2011-07-13) the whole document	14-16, 18
A	CN 102624494A (ZTE CORPORATION) 01 August 2012 (2012-08-01) the whole document	1-19
A	CN 102215591A (HUAWEI TECHNOLOGIES CO., LTD.) 12 October 2011 (2011-10-12) the whole document	1-19
A	US 2013163532A1 (RESEARCH IN MOTION LIMITED) 27 June 2013 (2013-06-27) the whole document	1-19

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

* Special categories of cited documents:

“A”	document defining the general state of the art which is not considered to be of particular relevance	“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
“E”	earlier application or patent but published on or after the international filing date	“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
“L”	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	“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
“O”	document referring to an oral disclosure, use, exhibition or other means	“&”	document member of the same patent family
“P”	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

13 June 2014

Date of mailing of the international search report

01 July 2014

Name and mailing address of the ISA/

STATE INTELLECTUAL PROPERTY OFFICE OF THE
P.R.CHINA(ISA/CN)
6,Xitucheng Rd., Jimen Bridge, Haidian District, Beijing
100088 China

Authorized officer

LU,Xia

Facsimile No. (86-10)62019451

Telephone No. (86-10)82245294

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/CN2013/084497

Patent document cited in search report		Publication date (day/month/year)	Patent family member(s)		Publication date (day/month/year)
CN	102123486A	13 July 2011	None		
CN	102624494A	01 August 2012	None		
CN	102215591A	12 October 2011	WO	2011140867A1	17 November 2011
			US	2012314685A1	13 December 2012
			EP	2523514A1	14 November 2012
US	2013163532A1	27 June 2013	WO	2013096555A1	27 June 2013
			TW	201334614A	16 August 2013