



- (51) **International Patent Classification:**
H04W 74/08 (2009.01)
- (21) **International Application Number:**
PCT/IB2013/000539
- (22) **International Filing Date:**
4 March 2013 (04.03.2013)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
201210065469.4 13 March 2012 (13.03.2012) CN
- (71) **Applicant:** ALCATEL LUCENT [FR/FR]; 3 avenue Octave Gréard, F-75007 Paris (FR).
- (72) **Inventors:** YANG, Tao; Alcatel-Lucent Shanghai Bell, 388 Ningqiao Road, Pudong Jinqiao, Shanghai, 201206 (CN). LIM, Seau Sian; Alcatel-lucent Telecom Ltd, The Quadrant Stonehill Green, Westlea, Swindon WI SN5 7DJ (GB).
- (74) **Agent:** THERIAS, Philippe; Alcatel-Lucent International, 32 avenue Kléber, F-92700 Colombes (FR).
- (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, KM, 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, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, 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,

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(54) **Title:** METHOD AND USER EQUIPMENT FOR SUPPORTING CARRIER AGGREGATION

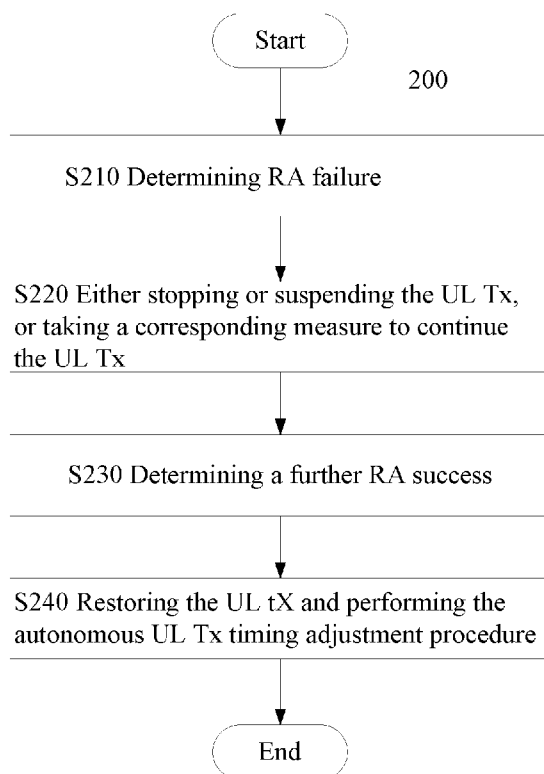


Fig.2

(57) **Abstract:** The present invention provides a method and a corresponding user equipment for supporting carrier aggregation. According to the present invention, the method comprises determining a random access RA on a secondary cell Scell of a secondary timing advance group sTAG fails so that confusion on uplink UL transmission Tx timing reference of the sTAG is caused; and either stopping or suspending UL Tx on all Scells of the sTAG, or taking a corresponding measure to continue the UL Tx on all Scells of the sTAG.

WO 2013/136173 A1



TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, **Published:**
ML, MR, NE, SN, TD, TG).

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

Method and User Equipment for Supporting Carrier Aggregation

Field of the Invention

The present invention relates to communications, and particularly to a method
5 and user equipment for supporting carrier aggregation.

Background of the Invention

According to current standardization work, random access RA on a Scell
(secondary cell) is supported in long term evolution-advanced (LTE-A) scheme R11,
10 and following agreements are achieved in 3GPP till now:

--secondary timing advance group (sTAG) is supported with only Scell involved

--uplink UL transmission Tx timing reference for a sTAG is one Scell belonging
to the sTAG and primary cell Pcell can only be UL Tx timing reference for primary
timing advance group (pTAG);

15 --For a sTAG, the UL Tx timing reference should be synchronized between an
evolved node B (eNB) and a user equipment (UE), which is determined by a RA
procedure. That means, if the eNB wants to indicate the UL Tx timing reference of the
sTAG, a RA procedure must be triggered on the corresponding Scell, and the related
downlink DL component carrier CC of this Scell will be regarded as the UL Tx timing
20 reference for this sTAG to guarantee correct UL Tx.

--If the Scell with RA on-going is de-activated, for example, due to de-activation
timer expires, the RA procedure will be aborted.

Hence there are at least two scenarios of failure of RA on a Scell:

Scenario 1: UE can not receive a random access response (RAR) during its
25 reception window;

Scenario 2: the Scell with RA on-going is de-activated.

Also, failure of RA on a Scell has been discussed according to the current
standardization work and following agreements are achieved:

--Media access control (MAC) layer will not inform Radio resource control
30 (RRC) layer of this RA failure, hence no radio link failure (RLF) will be triggered

--UE will not inform the eNB of the RA failure and the eNB will detect this RA failure by its own. This means the eNB will detect the RA failure some time later after the UE recognizes this RA failure.

Another related issue is UE UL Tx timing adjustment.

5 At UE side, there are two situations for UL Tx timing adjustment of one sTAG:

Situation 1: UL Tx timing adjustment with regard to the sTAG is performed according to a received TAC (timing advance command).

Situation 2: autonomous UL Tx timing adjustment procedure with regard to the sTAG is performed according to the DL reception Rx time of the Scell as the UL Tx
10 timing reference of the sTAG, for example, between two TAC.

The situation 2 means the UL Tx timing reference is very important for UE during its normal UL Tx. The RA failure will make the UE confused and unclear about which Scell of the sTAG is the UL Tx timing reference of the sTAG.

Currently, there is a need to solve the problem about how the UE processes the
15 UL Tx of the corresponding sTAG in the event of the RA failure.

Summary of the Invention

According to one aspect of the present invention, there is provided a method for supporting carrier aggregation, comprising: determining a random access RA on a
20 secondary cell Scell of a secondary timing advance group sTAG fails so that confusion on UL Tx timing reference of the sTAG is caused; and

either stopping or suspending UL Tx on all Scells of the sTAG, or taking a corresponding measure to continue the UL Tx on all Scells of the sTAG.

According to another aspect of the present invention, there is provided a user
25 equipment UE for supporting carrier aggregation, comprising: a determining module configured to determine a random access RA on a secondary cell Scell of a secondary timing advance group sTAG fails so that confusion on UL Tx timing reference of the sTAG is caused; and a controlling module configured to either stop or suspend UL Tx on all Scells of the sTAG or to take a corresponding measure to continue the UL Tx
30 on all Scells of the sTAG.

Brief Description of Drawings

Other objects and effects of the present invention will be made more apparent and comprehensible by the following description taken with reference to figures, and
5 as the present invention is understood more fully.

Fig.1 illustrates a wireless communication system in which the present invention may be implemented;

Fig.2 illustrates a flow chart of a method of supporting carrier aggregation according to an embodiment of the present invention;

10 Fig.3 illustrates a block diagram of a user equipment supporting carrier aggregation according to an embodiment of the present invention.

In all of the above figures, identical reference numbers represent parts having identical, similar or corresponding features or functions.

Detailed Description of Preferred Embodiments

15 Embodiments of the present invention will be described in detail with reference to figures.

Fig.1 illustrates a wireless communication system 100 in which the present invention may be implemented. For example, carrier aggregation CA property is
20 introduced in the wireless communication system 100.

In the system in which the CA property is introduced, a UE may communicate with an eNB in uplink UL and in downlink DL via a plurality of component carriers CC, respectively. With regard to one UE, if the eNB believes that these CCs may share one timing advance TA value, i.e., so long as the eNB adjusts the TA value with
25 reference to uplink transmission signal of any one of theses CCs, and the TA value may be used by these CCs, it is believed that these CCs belong to one timing advance group TAG.

When the UE establishes RRC connection for the first time, the eNB only configures one service cell, namely, primary cell (Pcell), for the UE. The carrier of
30 the Pcell is called primary component carrier (PCC).

According to conditions such as load and QoS, the eNB may configure one or more extra service cells, namely, secondary cells (Scells) for the UE. The carrier of a Scell is called secondary component carrier (SCC).

That is to say, the UE only has one Pcell. In a frequency division duplex (FDD) system, the Pcell only has one UL CC and one DL CC. One UE may have one or more Scells, each Scell only has one UL CC and/or one DL CC. Certainly, in a time division duplex (TDD) system, the Pcell and a Scell both have only one carrier for use in uplink and in downlink.

In addition, the UE only has one pTAG which comprises the Pcell, zero or one or more Scells. Furthermore, the UE may have zero or one or more sTAGs, and one sTAG may have one or more Scells.

That is to say, the TAG to which the CC(s) of the Pcell belong is pTAG, and other TAGs are sTAGs.

In the example as shown in Fig.1, the wireless communication system 100 comprises one eNB 110 and one UE 120. Certainly, those skilled in the art may understand that the system 100 may comprise more eNBs 110 and more UEs 120.

The UE 120 may be a mobile phone, a panel computer, a notebook computer, a desktop computer, a personal digital assistant (PDA) or the like. Besides, between the eNB110 and the UE 120, there are a Pcell 130 and four Scells 140-1, 140-2, 140-3 and 140-4. Certainly, those skilled in the art may understand that the number of Scells may be more or less, and different cells may have different paths.

Here, without the loss of generality, it is assumed that Scell 140-1, Scell 140-2 and Scell 140-3 belong to sTAG 1 and Scell 140-4 belongs to sTAG 2.

In the LTE-A R10, random access RA is only performed on the Pcell, and when RA on the Pcell fails, RRC re-establishment will be triggered. While for the LTE-A R11, RA on a Scell will be performed to support multiple TA scenarios.

According to current standardization work, for the pTAG, the Pcell will be the UL Tx timing reference. The RA on a Scell of the pTAG is only used to determine which TAG this Scell belongs to. Hence the failure of RA on the Scell of the pTAG will not impact UL operation of the pTAG. And this Scell of the pTAG is regarded as

still UL-synchronized with the eNB.

If the eNB thinks that current UL Tx timing reference of one sTAG is undesirable, for example, radio channel quality is poor, or the current UL Tx timing reference may be released or de-activated soon, RA on a new Scell of the sTAG may
5 be used to indicate a new UL Tx timing reference. If the RA on the new Scell of the sTAG fails, the UE will not know which Scell is the new UL Tx timing reference of the sTAG. This will impact UE autonomous UL Tx timing adjusting operation with regard to the sTAG, hence may lead to potential UL interference to other UEs.

Fig.2 illustrates a flow chart of a method of supporting carrier aggregation
10 according to an embodiment of the present invention.

As shown in Fig.2, the method 200 comprises a step S210 of determining that a random access RA on one secondary cell Scell of one secondary timing advance group sTAG fails so that confusion on UL Tx timing reference of the sTAG is caused; and a step S220 of either stopping or suspending UL Tx on all Scells of the sTAG, or
15 taking a corresponding measure to continue the UL Tx on all Scells of the sTAG.

Referring to Fig.1, without the loss of generality, it is assumed that the RA on Scell 1 of sTAG 1 fails.

As stated above, after the failure of RA on Scell 1 of sTAG 1 is determined, the UL Tx on all of Scell 1, Scell 2 and Scell 3 of sTAG 1 is stopped or suspended, or a
20 corresponding measure is taken to continue the UL Tx on all of Scell 1, Scell 2 and Scell 3 of sTAG 1.

RA failure comprises any one of the following:

The UE cannot receive a random access response RAR during a reception window;

25 The Scell with the RA on-going is de-activated.

That is to say, when the UE cannot receive a corresponding random access response RAR during a reception window or the Scell with the RA on-going is de-activated, failure of RA on Scell 1 of sTAG 1 is determined.

Under the circumstance that failure of RA on Scell 1 of sTAG 1 is determined,
30 potential interference to other UEs may be avoided by stopping or suspending the UL

Tx on all of Scell 1, Scell 2 and Scell 3 of sTAG 1. This can be realized by stopping/suspending the running of a corresponding timing advance timer (TAT: timeAlignmentTimer) by the UE. That means, when failure of RA on Scell 1 of sTAG 1 occurs, the UE has to suspend/stop the running of the TAT and then stop the
5 UL Tx on all of Scell 1, Scell 2, Scell 3 of this sTAG 1. Based on this solution, the UL Tx on all of Scell 1, Scell 2 and Scell 3 of sTAG 1 will not occur, so there is no potential interference to other UEs.

According to the current standardization work, failure of RA on a Scell will not trigger RRC connection re-establishment. RA failure means UL Tx timing reference
10 indication intention with regard to a sTAG is not successful. As stated above, a UE will track DL Rx time of a Scell, which is the UL Tx timing reference of a sTAG, so as to adjust its Tx timing during normal UL Tx. RA failure will make the UE not clear about which Scell of the sTAG is the UL Tx timing reference of the sTAG, and therefore affects the UE's UL Tx operation of the sTAG.

15 According to an embodiment of the present invention, the corresponding measure includes one of a first measure and a second measure.

The first measure includes stopping use of the UL Tx timing reference of the sTAG 1 to perform the UE autonomous UL Tx timing adjustment procedure with regard to sTAG 1.

20 As above stated, originally, the UE autonomous UL Tx timing adjustment procedure with regard to sTAG 1 is performed according to the DL Rx time of the UL Tx timing reference of sTAG 1. According to the first measure, the UE stops use of the UL Tx timing reference of sTAG 1 to perform the UE autonomous UL Tx timing adjustment procedure with regard to sTAG 1. This means that the UE performs the
25 UL Tx timing adjustment with regard to sTAG 1 only based on received TAC, and therefore may continue to perform the UL Tx of sTAG 1.

The second measure includes any one of the following:

A) using Scell 1 on which the RA fails as the UL Tx timing reference of sTAG 1, to perform the UE autonomous UL Tx timing adjustment procedure with regard to
30 sTAG 1;

B) Using the UL Tx timing reference (e.g., Scell 2) of sTAG 1 before the RA that fails, to perform the UE autonomous UL Tx timing adjustment procedure with regard to sTAG 1;

C) Using one Scell of sTAG 1 as the UL Tx timing reference of sTAG 1, to
5 perform the UE autonomous UL Tx timing adjustment procedure with regard to sTAG 1, e.g., using an activated Scell (e.g., Scell 3) of sTAG 1 as the UL Tx timing reference of sTAG 1, to perform the UE autonomous UL Tx timing adjustment procedure with regard to sTAG 1.

According to the second measure, the UE may continue to track the
10 corresponding UL Tx timing reference of sTAG 1 to perform the UE autonomous UL Tx timing adjustment procedure with regard to sTAG 1, and therefore, may continue to perform the UL Tx of sTAG 1.

Among the above second measures, measure A) is preferable because the UE and the eNB have the same UL Tx timing reference record of sTAG 1 according to the
15 measure A).

Further, in the case that sTAG 1 only has one Scell, the measure A) is substantively the same as the measure B).

Whether to stop or suspend the UL Tx on all Scells of the sTAG or to take a corresponding measure to continue the UL Tx on all Scells of the sTAG is determined
20 according to a degree of impact exerted to the system by the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG according to the UL Tx timing reference of the sTAG. If there is no correct UL Tx timing reference, serious UL interference will be caused to other UEs, it is determined to stop or suspend the UL Tx on all Scells of the sTAG. On the other hand, if the UE autonomous UL Tx timing
25 adjustment procedure with regard to the sTAG is not an important factor, particularly in the event of short time interval, then corresponding measure can be taken to continue the UL Tx on all Scells of the sTAG. The first measure enables the UE to stop tracking the reception time of the UL Tx timing reference of the sTAG in a short range of time during which confusion on the UL Tx timing reference of the sTAG is
30 caused. The second measure provides the UE with temporary UL Tx timing

reference of the sTAG to meet the UE autonomous UL Tx timing adjustment procedure so that the UE can continue the UL Tx of the sTAG.

According to an embodiment of the present invention, the method 200 further comprises a step S230 of determining that a further RA on Scell 1 of sTAG 1 is successful or a RA on another Scell (e.g., Scell 2) of sTAG 1 is successful; and a step S240 of restoring the UL Tx on all of Scell 1, Scell 2 and Scell 3 of sTAG 1, and using the Scell on which the RA is successful as the UL Tx timing reference of sTAG 1 to perform the UE autonomous UL Tx timing adjustment procedure with regard to sTAG 1.

Under the circumstance that the eNB also notices the failure of RA on Scell 1 of sTAG 1, RA is performed again on Scell 1 of sTAG 1 or on another Scell (e.g., Scell 2) of sTAG 1.

Fig.3 illustrates a block diagram of user equipment UE supporting carrier aggregation according to an embodiment of the present invention.

As shown in Fig.3, the UE 300 comprises: a determining module 310 configured to determine that a random access RA on one secondary cell Scell of a secondary timing advance group sTAG fails so that confusion on the UL Tx timing reference of the sTAG is caused; and a controlling module 320 configured to either stop or suspend the UL Tx on all Scells of the sTAG or to take a corresponding measure to continue the UL Tx on all Scells of the sTAG.

According to an embodiment of the present invention, the corresponding measure includes one of a first measure and a second measure.

The first measure includes stopping use of the UL Tx timing reference of the sTAG to perform the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG.

The second measure includes any one of the following:

Using the Scell on which the RA fails as the UL Tx timing reference of the sTAG, to perform the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG;

Using UL Tx timing reference of the sTAG before the RA that fails, to perform

the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG;

Using one Scell of the sTAG as the UL Tx timing reference of the sTAG, to perform the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG.

5 According to an embodiment of the present invention, the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG is performed according to DL Rx time of the UL Tx timing reference of the sTAG.

 According to an embodiment of the present invention, the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG is performed using an
10 activated Scell of the sTAG as the UL Tx timing reference of the sTAG.

 According to an embodiment of the present invention, the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG is performed between two timing advance commands, wherein the timing advance commands are used to adjust the UE UL Tx timing with regard to the sTAG.

15 According to an embodiment of the present invention, the determining module 310 is further configured to determine that a further RA on the Scell of the sTAG is successful or a RA on another Scell of the sTAG is successful; and the controlling module 320 is further configured to restore the UL Tx on all Scells of the sTAG, and use the Scell on which the RA is successful as the UL Tx timing reference of the
20 sTAG to perform the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG.

 According to an embodiment of the present invention, RA failure comprises any one of the following:

 The UE cannot receive a random access response RAR during a reception
25 window;

 The Scell with RA on-going is de-activated.

 According to an embodiment of the present invention, the UL Tx on all Scells of the sTAG is stopped or suspended by stopping or suspending the running of the timing advance timer TAT of the sTAG.

30 It should be noted that in order to make the present invention more

comprehensible, the above description omits some more specific technical details which are known to the skilled in the art and may be essential to implement the present invention.

Those skilled in the art should further understand that the present invention is
5 not limited to the above described steps, and the present invention further covers a combination of the above described steps, or changed order thereof, etc. The final scope of the present invention is defined by the appended claims.

Thus, selecting and describing the preferred embodiments is to better illustrate the principle and practical application of the present invention and to enable a person
10 of normal skill in the art to understand that without departing the spirit of the present invention, all modifications and alterations fall within the protection scope of the present invention as limited by the appending claims.

WHAT IS CLAIMED IS:

1. A method for supporting carrier aggregation, comprising:

5 determining that a random access RA on a secondary cell Scell of a secondary timing advance group sTAG fails so that confusion on uplink UL transmission Tx timing reference of the sTAG is caused; and

either stopping or suspending UL Tx on all Scells of the sTAG, or taking a corresponding measure to continue the UL Tx on all Scells of the sTAG.

10

2. The method according to claim 1, wherein the corresponding measure includes one of a first measure and a second measure,

the first measure includes stopping use of the UL Tx timing reference of the sTAG to perform user equipment UE autonomous UL Tx timing adjustment procedure
15 with regard to the sTAG;

the second measure includes any one of the following:

using the Scell on which the RA fails as the UL Tx timing reference of the sTAG, to perform the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG;

20 using UL Tx timing reference of the sTAG before the RA that fails, to perform the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG;

using one Scell of the sTAG as the UL Tx timing reference of the sTAG, to perform the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG.

25

3. The method according to claim 2, wherein the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG is performed according to downlink DL reception Rx time of the UL Tx timing reference of the sTAG.

30 4. The method according to claim 2, wherein the UE autonomous UL Tx timing

adjustment procedure with regard to the sTAG is performed using an activated Scell of the sTAG as the UL Tx timing reference of the sTAG.

5 5. The method according to claim 2, wherein the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG is performed between two timing advance commands, wherein the timing advance commands are used to adjust UE UL Tx timing with regard to the sTAG.

10 6. The method according to claim 1, further comprising:
determining a further RA on the Scell of the sTAG is successful or a RA on another Scell of the sTAG is successful; and
restoring the UL Tx on all Scells of the sTAG, and using the Scell on which the RA is successful as the UL Tx timing reference of the sTAG to perform the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG.

15 7. The method according to claim 1, wherein RA failure comprises any one of the following:
a UE cannot receive a random access response RAR during a reception window;
the Scell with the RA on-going is de-activated.

20 8. The method according to claim 1, wherein the UL Tx on all Scells of the sTAG is stopped or suspended by stopping or suspending the running of a timing advance timer TAT of the sTAG.

25 9. User equipment UE for supporting carrier aggregation, comprising:
a determining module configured to determine that a random access RA on a secondary cell Scell of a secondary timing advance group sTAG fails so that confusion on uplink UL transmission Tx timing reference of the sTAG is caused; and
a controlling module configured to either stop or suspend UL Tx on all Scells of
30 the sTAG or to take a corresponding measure to continue the UL Tx on all Scells of

the sTAG.

10. The UE according to claim 9, wherein the corresponding measure includes one of a first measure and a second measure,

5 the first measure includes stopping use of the UL Tx timing reference of the sTAG to perform UE autonomous UL Tx timing adjustment procedure with regard to the sTAG;

 the second measure includes any one of the following:

 using the Scell on which the RA fails as the UL Tx timing reference of the sTAG,
10 to perform the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG;

 using UL Tx timing reference of the sTAG before the RA that fails, to perform the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG;

 using one Scell of the sTAG as the UL Tx timing reference of the sTAG, to
15 perform the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG.

11. The UE according to claim 10, wherein the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG is performed according to downlink
20 DL reception Rx time of the UL Tx timing reference of the sTAG.

12. The UE according to claim 10, wherein the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG is performed using an activated Scell of the sTAG as the UL Tx timing reference of the sTAG.

25

13. The UE according to claim 10, wherein the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG is performed between two timing advance commands, wherein the timing advance commands are used to adjust UE UL Tx timing with regard to the sTAG.

30

14. The UE according to claim 9, wherein:

the determining module is further configured to determine a further RA on the Scell of the sTAG is successful or a RA on another Scell of the sTAG is successful;
and

5 the controlling module is further configured to restore the UL Tx on all Scells of the sTAG, and use the Scell on which the RA is successful as the UL Tx timing reference of the sTAG to perform the UE autonomous UL Tx timing adjustment procedure with regard to the sTAG.

10 15. The UE according to claim 9, wherein RA failure comprises any one of the following:

the UE cannot receive a random access response RAR during a reception window;

the Scell with the RA on-going is de-activated.

15

16. The UE according to claim 9, wherein the UL Tx on all Scells of the sTAG is stopped or suspended by stopping or suspending the running of a timing advance timer TAT of the sTAG.

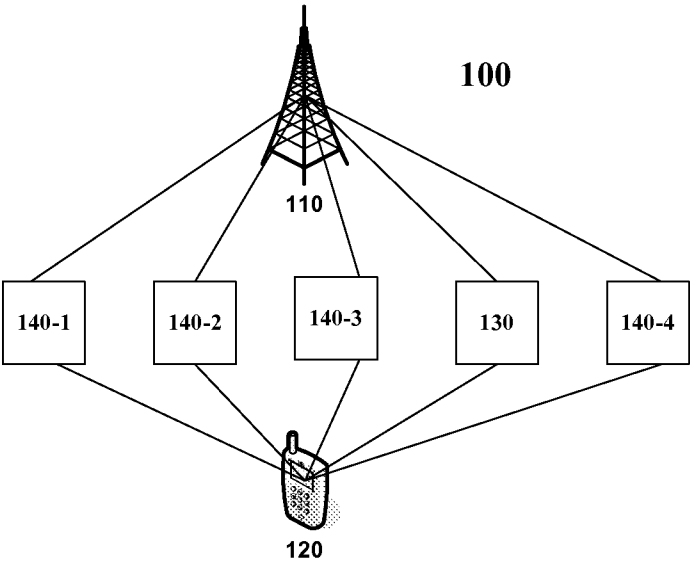
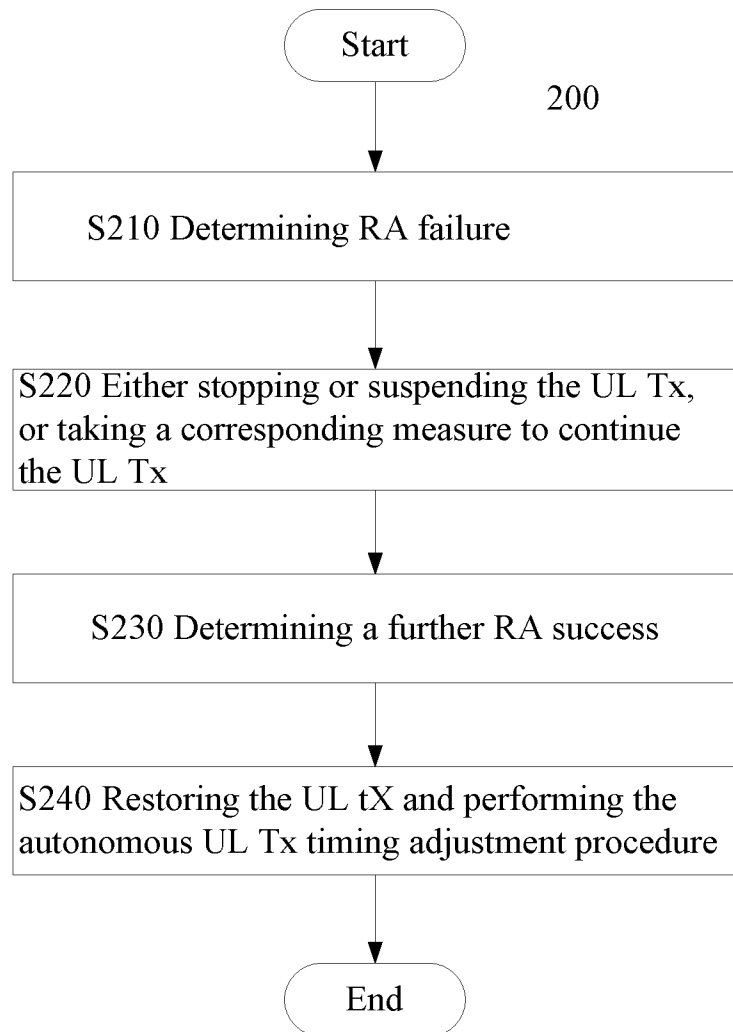


Fig.1

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**Fig.2**

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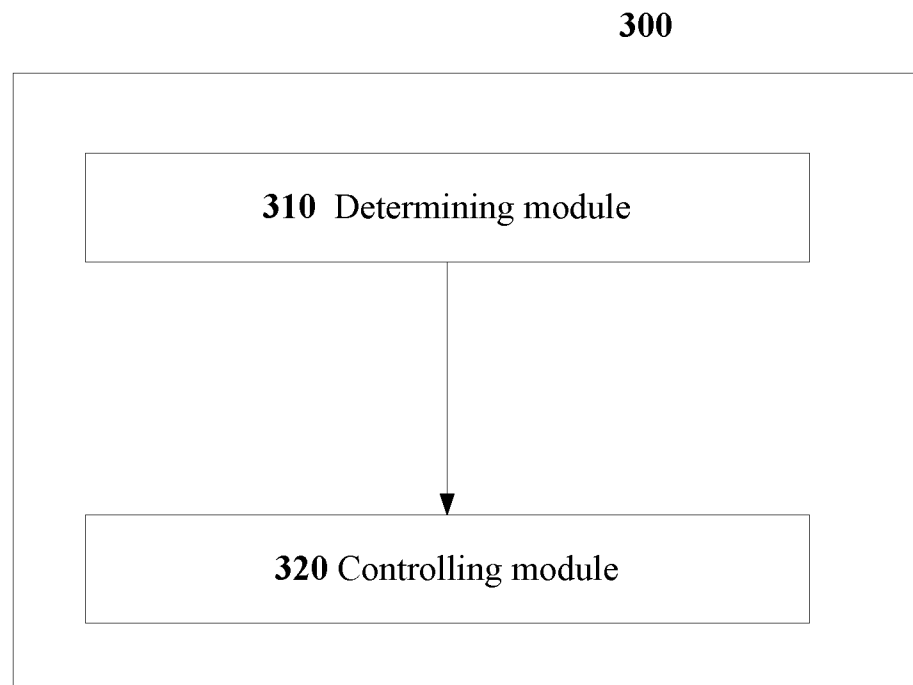


Fig.3

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2013/000539

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W74/08

ADD.

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

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)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/134774 A1 (PELLETIER GHYSLAIN [CA] ET AL) 9 June 2011 (2011-06-09)	1,9
Y	paragraph [0004] paragraph [0102] paragraph [0112] paragraphs [0162] - [0164] paragraphs [0175], [0176], [0177] paragraphs [0158], [0159] -----	2-8, 10-16
Y	US 2012/008600 A1 (MARINIER PAUL [CA] ET AL) 12 January 2012 (2012-01-12) paragraphs [0054] - [0060] ----- -/-	2-8, 10-16



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

"E" earlier application or patent but published on or after the international filing date

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Date of the actual completion of the international search

5 June 2013

Date of mailing of the international search report

12/06/2013

Name and mailing address of the ISA/

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NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

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INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2013/000539

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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