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(54) **Title**: UPLINK TRANSMISSION METHOD, UPLINK TRANSMISSION DEVICE, AND TERMINAL

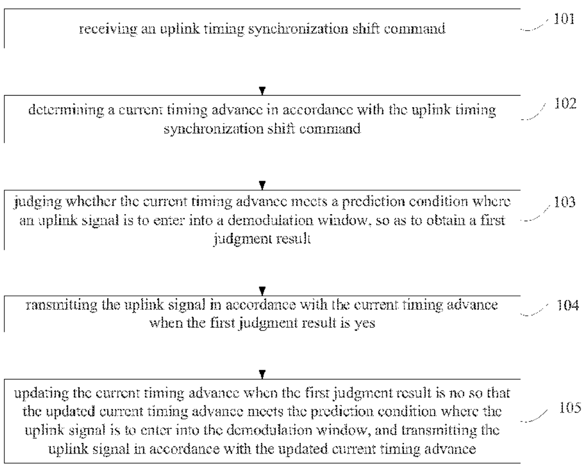

Fig. 1

(57) **Abstract**: The present invention provides an uplink transmission method, an uplink transmission device, and a terminal. The method comprises: receiving an uplink timing synchronization shift command; determining a current timing advance in accordance with the uplink timing synchronization shift command; judging whether the current timing advance meets a prediction condition where the uplink signal is to enter into a demodulation window, so as to obtain a first judgment result; transmitting the uplink signal in accordance with the current timing advance when the first judgment result is yes; and updating the current timing advance when the first judgment result is no so that the updated current timing advance meets the prediction condition where the uplink signal is to enter into a demodulation window, and transmitting the uplink signal in accordance with the updated current timing advance. The present invention provides a prediction and prevention way when an uplink signal goes beyond the range of a base station demodulation window, thereby to reduce the possibility of the uplink signal going beyond the base station demodulation window and enhance reliability of the uplink.

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Uplink Transmission Method, Uplink Transmission Device, and Terminal

TECHNICAL FIELD

[0001] The present invention relates to the field of telecommunication network, in particular to an uplink transmission method, an uplink transmission device, and a terminal.

BACKGROUND

[0002] In a real network environment, the distance between a terminal and a base station is random. The terminal cannot accurately calculate the actual time delay when a signal from the base station arrives at the position where the terminal is located, so it cannot acquire a correct timing advance. As a result, the uplink signals from multiple terminals will not arrive at the base station at the same time. For a CDMA system, this inconsistence will introduce non-orthogonality between spreading codes, lead to multiuser interference, and decrease the system capacity. However, the above-mentioned problems may be solved by an uplink synchronization technology.

[0003] In a closed-loop state, when a terminal moves away from or near a base station, the time when an uplink signal arrives at the base station will be delayed or advanced correspondingly. At this time, it is necessary to adjust the timing advance for the uplink transmission, and to ensure that the time when the uplink signal arrives at the terminals will not change along with the positions of the terminals, i.e., to adjust the uplink closed-loop timing synchronization. The adjustment procedure is shown as follows.

[0004] The base station detects the time when the uplink signal arrives at the terminal, compares it with a reference time to produce an uplink timing synchronization shift command, and transmits the command to the terminal via downlink physical layer signaling. The terminal adjusts the timing advance in accordance with the received command, so as to realize the adjustment of the uplink closed-loop timing synchronization.

[0005] In the closed-loop adjustment, demodulation performance of the base station and the terminal determines the correctness of the generation and reception of the uplink timing synchronization shift command. When the demodulation performance of the base station or the terminal is abnormal due to a wireless environment or the other causes, the uplink signal transmitted by the terminal in accordance with the received uplink timing synchronization shift command may go beyond a range of a base station demodulation window, and as a result, the uplink demodulation will be failed and even the link will be interrupted.

SUMMARY

[0006] An object of the present invention is to provide an uplink transmission method, an uplink transmission device, and a terminal, so as to provide a prediction and prevention way when an uplink signal goes beyond a range of a base station demodulation window, thereby to reduce the possibility of the uplink signal going beyond the base station demodulation window and enhance reliability of the uplink.

[0007] To solve the above-mentioned technical problems, the present invention provides an uplink transmission method for use in a TDD mode CDMA system, comprising:

receiving an uplink timing synchronization shift command;

determining a current timing advance in accordance with the uplink timing synchronization shift command;

judging whether the current timing advance meets a prediction condition where the uplink signal is to enter into a demodulation window, so as to obtain a first judgment result;

transmitting the uplink signal in accordance with the current timing advance when the first judgment result is yes; and

updating the current timing advance when the first judgment result is no, so that the updated current timing advance meets the prediction condition where the uplink signal is to enter into the demodulation window, and transmitting the uplink signal in accordance with the updated current timing advance.

[0008] Preferably, prior to receiving an uplink timing synchronization shift command, the method further comprises:

determining a prediction reference time.

[0009] The prediction condition where an uplink signal is to enter into a demodulation window includes: a difference between a first timing advance variation and a first reference downlink timing variation falls within a prediction range where an uplink signal is to enter into the demodulation window.

[0010] The first timing advance variation is a variation of the current timing advance relative to an initial timing advance, and the initial timing advance is a timing advance for the prediction reference time.

[0011] The first reference downlink timing variation is double a first variation of a distance D from a current base station to a terminal relative to an initial D, or a difference between the first variation doubled and a first correction value. The initial D is that of the prediction reference time, and the first correction value is a downlink timing synchronization error.

[0012] Updating the current timing advance so that the updated current timing advance meets the prediction condition where the uplink signal is to enter into a demodulation window includes:

updating the current timing advance so that a difference between a second timing advance variation and the first reference downlink timing variation falls within the prediction range where the uplink signal is to enter into the demodulation window. The second timing advance variation is a variation of the updated current timing advance relative to the initial timing advance.

[0013] Preferably, the prediction range where the uplink signal is to enter into the demodulation window is $(n-n_o, n)$, wherein n_o is a number of chips in the base station demodulation window, and the uplink timing synchronization position in the base station demodulation window is at the n^{th} chip of the base station demodulation window from left.

[0014] Preferably, updating the current timing advance so that a difference between a second timing advance variation and the first reference downlink timing variation falls within the prediction range where the uplink signal is to enter into the demodulation window includes:

adding the initial timing advance to the first reference downlink timing variation, so as to obtain the updated current timing advance.

[0015] Preferably, the step of determining a prediction reference time includes:

judging whether an entry condition is met, so as to obtain a second judgment result; and

determining the prediction reference time when the second judgment result is yes.

[0016] Preferably, the uplink timing synchronization shift command is a synchronization shift SS symbol carried on a downlink Dedicated Channel (DCH). The entry condition includes a first condition where a protocol stack indicates that the dedicated channel DCH is in a closed-loop state, a second condition where the protocol stack indicates that the SS symbol is carried on a downlink DCH, a third condition where the protocol stack indicates that the downlink DCH is in a synchronization state, and a fourth condition where a difference between a third timing advance variation and a second reference downlink timing variation falls within the range of $[-\gamma, \gamma]$.

[0017] The third timing advance variation is a timing advance variation determined based on all of the SS symbols carried on the downlink DCH and received by the terminal in accordance with the latest adjusting and matching period for the uplink and downlink closed-loop timing synchronization.

[0018] The second reference downlink timing variation is double a second variation of D within the latest adjusting and matching period for the uplink and downlink closed-loop timing synchronization, or a difference between the second variation doubled and a second correction value. The second correction value is a downlink timing synchronization error within the latest adjusting and matching period for the uplink and downlink closed-loop timing synchronization.

[0019] γ is a maximum value of the downlink timing synchronization error within the latest adjusting and matching period for the uplink and downlink closed-loop timing synchronization in a channel model.

[0020] Preferably, after determining the prediction reference time, the method further comprises:

returning to the step of determining a prediction reference time when an entry condition is met.

[0021] The present invention further provides an uplink transmission device for use in a TDD mode CDMA, comprising:

a receiving module, configured to receive an uplink timing synchronization shift command;

a first determining module, configured to determine a current timing advance in accordance with the uplink timing synchronization shift command;

a judging module, configured to judge whether the current timing advance meets a prediction condition where an uplink signal is to enter into a demodulation window, so as to obtain a first judgment result;

a transmitting module, configured to transmit the uplink signal in accordance with the current timing advance when the first judgment result is yes; and

an updating and transmitting module, configured to update the current timing advance when the first judgment result is no, so that the updated current timing advance meets the prediction condition where the uplink signal is to enter into the demodulation window, and transmit the uplink signal in accordance with the updated current timing advance.

[0022] Preferably, the device further comprises:

a second determining module, configured to determine a prediction reference time before the receiving module receives the uplink timing synchronization shift command.

[0023] The prediction condition where an uplink signal is to enter into a demodulation window includes that a difference between a first timing advance variation and a first reference downlink timing variation falls within a prediction range where an uplink signal is to enter into the demodulation window.

[0024] The first timing advance variation is a variation of the current timing advance relative to an initial timing advance, and the initial timing advance is a timing advance for the prediction reference time.

[0025] The first reference downlink timing variation is double a first variation of a distance D from a current base station to a terminal relative to an initial D, or a difference between the first variation doubled and a first correction value. The initial D is that of the prediction reference time, and the first correction value is a downlink timing synchronization error.

[0026] The updating and transmitting module includes:

an updating unit, configured to update the current timing advance so that a difference between a second timing advance variation and the first reference downlink timing variation falls within the prediction range where the uplink signal is to enter into the demodulation window, wherein the second timing advance variation is a variation of the updated current timing advance relative to the initial timing advance; and

a transmitting unit, configured to transmit the uplink signal in accordance with the updated current timing advance.

[0027] Preferably, the second determining module includes:

a judging unit configured to, before the receiving module receives the uplink timing synchronization shift command, judge whether an entry condition is met, so as to obtain a second judgment result; and

a determining unit, configured to, before the receiving module receives the uplink timing synchronization shift command, determine the prediction reference time when the second judgment result is yes.

[0028] Preferably, the device further comprises:

a returning module, configured to, after the second determining module determines the prediction reference value, returns to the second determining module when an entry condition is met.

[0029] The present invention further provides a terminal comprising the above-mentioned uplink transmission device.

[0030] As can be seen from the above, the present invention at least has the following beneficial effects.

[0031] When the current timing advance determined based on an uplink timing synchronization shift command does not meet a prediction condition where an uplink signal is to enter into a demodulation window, the current timing advance is updated so as to meet the prediction condition, and the uplink signal is transmitted in accordance with the updated current timing advance. As a result, the present invention provides a prediction and prevention way when the uplink signal goes beyond the range of a base station demodulation window, so as to reduce the possibility of the uplink signal going beyond the base station demodulation window and enhance reliability of the uplink.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] Fig.1 is a flow chart of an uplink transmission method according to embodiments of the present invention;

[0033] Fig.2 is a block diagram showing the uplink signal out-of-window detection modules according to embodiments of the present invention;

[0034] Fig.3 is a flow chart of uplink signal out-of-window detection according to embodiments of the present invention;

[0035] Fig 4 is a block diagram showing an uplink transmission device according to embodiments of the present invention.

DETAILED DESCRIPTION

[0036] In order to make the purposes, the technical solutions and the advantages of the present invention more apparent, the present invention will be described hereinafter in conjunction with the drawings and embodiments.

[0037] Referring to Fig.1, which is a flow chart of an uplink transmission method according to embodiments of the present invention, the present invention provides an uplink transmission method for use in a TDD mode CDMA system, comprising:

Step 101: receiving an uplink timing synchronization shift command;

Step 102: determining a current timing advance in accordance with the uplink timing synchronization shift command;

Step 103: judging whether the current timing advance meets a prediction condition where an uplink signal is to enter into a demodulation window, so as to obtain a first judgment result;

Step 104: transmitting the uplink signal in accordance with the current timing advance when the first judgment result is yes; and

Step 105: updating the current timing advance when the first judgment result is no, so that the updated current timing advance meets the prediction condition where the uplink signal is to enter into the demodulation window, and transmitting the uplink signal in accordance with the updated current timing advance.

[0038] It can be seen that, when the current timing advance determined in accordance with the uplink timing synchronization shift command does not meet the prediction condition where the uplink is to enter into the demodulation window, the current timing advance is updated so as to meet the prediction condition, and then the uplink signal is transmitted in accordance with the updated current timing advance. As a result, the present invention provides a prediction and prevention way when the uplink signal goes beyond the range of the base station demodulation window, so as to reduce the possibility of the uplink signal going beyond the base station demodulation window and enhance reliability of the uplink.

[0039] The TDD mode CDMA system may adopt a TD-SCDMA or WCDMA-TDD standard.

[0040] According to the embodiment of the present invention, considering that the uplink and downlink in the TDD mode CDMA system share the same carrier frequency, it is deemed that the uplink and downlink signals have the same transmission path. In order to enable the UL signals from the terminal arrive at an antenna port of the base station at the same time, the terminal shall transmit the UL signals in accordance with the following equation:

$$Tadv = 2 \times D \qquad (1)$$

wherein, Tadv is a timing advance, D is a distance between the base state and the terminal in chips.

[0041] The relation between Tadv and D is linear, thus it can be inferred that the relation between a variation of the timing advance and a variation of D is also linear as shown in the following equation:

$$\delta Tadv = 2 \times \delta D \quad (2).$$

[0042] Considering the downlink timing synchronization accuracy in actual situations, a downlink timing synchronization error may also be taken into account for the relation between $\delta Tadv$ and δD. Presumed that the error is $err(dlsc)$, the relation between $\delta Tadv$ and δD may be expressed as the following equation:

$$\delta Tadv = 2 \times \delta D - err(dlsc).$$

[0043] Based on the above fact, the terminal can predict whether the UL signal is out of the base station demodulation window using the relation between the variation of timing advance and the variation of D during the observation time. If the prediction result is yes, the terminal may restore $\delta Tadv$ with δD, so as to maintain the normal communication between the terminal and the base station.

[0044] Based on the above, prior to receiving an uplink timing synchronization shift command, the method further comprises:

determining a prediction reference time;

[0045] The prediction condition where an uplink signal is to enter into a demodulation window includes: a difference between a first timing advance variation and a first reference downlink timing variation falls within a prediction range where the uplink signal is to enter into the demodulation window.

[0046] The first timing advance variation is a variation of the current timing advance relative to an initial timing advance, and the initial timing advance is a timing advance for the prediction reference time.

[0047] The first reference downlink timing variation is double a first variation of a distance D from a current base station to a terminal relative to an initial D, or a difference between the first variation doubled and a first correction value. The initial D is that of the prediction reference time, and the first correction value is a downlink timing synchronization error.

[0048] The step of updating the current timing advance so that the updated current timing advance meets the prediction condition where the uplink signal is to enter into the demodulation window includes:

updating the current timing advance so that a difference between a second timing advance variation and the first reference downlink timing variation falls within the prediction range where the uplink signal is to enter into the demodulation window. The second timing advance variation is a variation of the updated current timing advance relative to the initial timing advance.

[0049] The downlink timing synchronization error may be an error obtained in accordance with the terminal capability, or an error actually obtained by the terminal during the period from the prediction reference time to the current time.

[0050] The prediction range where the uplink signal enters the demodulation range may be $(n - n_o, n)$, wherein n_o is a number of chips in the base station demodulation window, and the uplink timing synchronization position in the base station demodulation window is at the n^{th} chip of the base station demodulation window from left. Preferably, n_o is 16 and n is 6.

[0051] In order to prevent the uplink signal from being out of window more effectively when it is predicted that the uplink signal is to be out of window, the step of updating the current timing advance so that a difference between a second timing advance variation and the first reference downlink timing variation falls within the prediction range where the uplink signal is to enter into the demodulation window may include:

adding the initial timing advance to the first reference downlink timing variation, so as to obtain the updated current timing advance.

[0052] According to embodiments of the present invention, the step of determining a predicted reference time may include:

judging whether an entry condition is met, so as to obtain a second judgment result; and

determining the prediction reference time when the second judgment result is yes.

[0053] For example, the entry condition including: the terminal determines the open-loop UL timing synchronization adjustment is completed in accordance with the relevant information from the base station, the terminal receives information indicating that the closed-loop uplink timing synchronization is completed from the base station, and the terminal receives information indicating that the closed-loop uplink timing synchronization is to be maintained from the base station.

[0054] In addition, the uplink timing synchronization shift command is a synchronization shift SS symbol carried on a downlink DCH. The entry condition may include a first condition where a protocol stack indicates that the dedicated channel DCH is in a closed-loop state, a second condition where the protocol stack indicates that the SS symbol is carried on a downlink DCH, and a third condition where the protocol stack indicates that the downlink DCH is in a synchronization state. In other words, the entry condition is met only when the first, second and third conditions are fulfilled.

[0055] Further, in order to predict the actual situation of the uplink signal demodulated by the base station more accurately through the uplink signal out-of-window prediction and/or to prevent the uplink signal from being out of window more effectively when it is predicted that the uplink is to be out of window, besides the first, second and third conditions, the entry condition may further include a fourth condition where a difference between a third timing advance variation and a second reference downlink timing variation falls within the range of $[-\gamma, \gamma]$.

[0056] The third timing advance variation is a timing advance variation determined based on all of the SS symbols carried on the downlink DCH and received by the terminal in accordance with the latest adjusting and matching period for the uplink and downlink closed-loop timing synchronization.

[0057] The second reference downlink timing variation is double a second variation of D within the latest adjusting and matching period for the uplink and downlink closed-loop timing synchronization, or a difference between the second variation doubled and a second correction value. The second correction value is a downlink timing synchronization error within the latest adjusting and matching period for the uplink and downlink closed-loop timing synchronization.

[0058] γ is a maximum value of the downlink timing synchronization error within the latest adjusting and matching period for the uplink and downlink closed-loop timing synchronization in a channel model.

[0059] In other words, the entry condition is met when the first, second, third and fourth conditions are fulfilled.

[0060] Here, the adjusting and matching period δt for the uplink and downlink closed-loop timing synchronization means that in an ideal circumstance, under the condition where the demodulation success rate for the base station and the demodulation success rate for the terminal are both 100% and the downlink timing synchronization error is 0, the timing advance variation obtained by the terminal in accordance with all of the SS symbols received within this period is the equivalent double the downlink timing synchronization variation within this period. For example, δt may be the least integer common multiple of $2 * P_{ul} * S_{dl}$ and $P_{dl} * S_{ul}$, wherein P_{ul} is an adjusting period for the network uplink timing synchronization, S_{ul} is an adjusting step size for the uplink timing synchronization, P_{dl} is an adjusting period for the terminal downlink timing synchronization, S_{dl} is an adjusting step size for the downlink timing synchronization, and the unit of δt is subframe. Of course, δt may also be a positive integral multiple of the least integer common multiple of $2 * P_{ul} * S_{dl}$ and $P_{dl} * S_{ul}$.

[0061] According to the embodiment of the present invention, it may not need to perform the uplink signal out-of-window prediction and prevention in some situations. In order to prevent unnecessary resource utilization during the uplink signal out-of-window prediction and prevention, after determining a predicted reference time, the method further comprises:

returning to the step of determining a prediction reference time when an entry condition is met.

[0062] The entry condition may be any one of a fifth condition where the protocol stack indicates that the downlink dedicated channel is out of synchronization, a sixth condition where the protocol stack indicates that the current downlink channel is reconfigured; and a seventh condition where the protocol stack indicates that the current link is to be released.

[0063] A preferred embodiment is given hereinafter so as to make the present invention more apparent.

[0064] The modules according to the preferred embodiment may be implemented as shown in Fig.2, which is a block diagram showing the uplink signal out-of-window detection modules. Referring to Fig.2, the modules include an uplink timing synchronization module 201, a downlink timing synchronization module 202 and an uplink timing synchronization out-of-window detection module 203.

[0065] The uplink timing synchronization module 201 is configured to determine an adjustment value of the timing advance and transmit the adjustment value of the timing advance to the uplink timing synchronization out-of-window detection module 203, perform real-time maintenance on the current timing advance for transmitting the Uplink (UL) signal by User Equipment (UE), receive a variation of the timing advance from the uplink timing synchronization out-of-window detection module 203, and update the current timing advance in accordance with the variation of the timing advance.

[0066] The downlink timing synchronization module 202 is configured to control the downlink timing synchronization, estimate an adjustment value of a distance between the base station and the terminal, and output the adjustment value to the uplink timing synchronization out-of-window detection module 203.

[0067] The uplink timing synchronization out-of-window detection module 203 is configured to judge the entry and exit conditions and the prediction conditions where the uplink signal enters the demodulation window, receive from the protocol stack information related to the entry and exit conditions and the prediction conditions, periodically count a variation of the timing advance and a variation of D, judge whether the prediction condition is met in accordance with the variations, if yes, determine an updated variation of the timing advance in accordance with the counted variation of D, and output the updated variation of the timing advance to the uplink timing synchronization module 201 so as to update the current timing advance.

[0068] In this preferred embodiment, the TDD mode CDMA system adopts a TD-SCDMA standard, and the uplink timing synchronization shift command is an SS symbol carried on the downlink DCH.

[0069] The entry condition is met when the above first, second, third and fourth conditions are fulfilled, and the exit condition is met when any one of the above fifth, sixth and seventh conditions is fulfilled. The adjusting and matching period δt for the uplink and downlink closed-loop timing synchronization is the least integer common multiple of $2 * P_{ul} * S_{dl}$ and $P_{dl} * S_{ul}$.

[0070] Fig.3 is a flow chart of the uplink signal out-of-window detection according to the preferred embodiment of the present invention. Referring to Fig.3, the detection comprises the following steps.

[0071] Step 301: judging whether the entry condition is met, if yes, turning to Step 302, and otherwise returning to Step 301.

[0072] To be specific, after the UE is turned on and enters into a DCH mode, it periodically judge whether the entry condition is met, and determine a timing advance and D of the prediction reference time as an initial timing advance and an initial D when the entry condition is met.

[0073] Here, the fourth condition is met when the equation $\left|\delta Tadv1'' - 2 * \delta D1'' + err1(dlsc)\right| \le \gamma$ is fulfilled, wherein $\delta Tadv1''$ is a variation of the timing advance counted by the UE within the latest δt subframes, $\delta D1''$ is a variation of D counted by the UE within the latest δt subframes, and $err1(dlsc)$ is a downlink timing synchronization error within the latest δt subframes.

[0074] Step 302: calculating a variation of the timing advance and a variation of a distance between the base station and the terminal.

[0075] To be specific, the uplink timing synchronization out-of-window detection module 203 determines a prediction reference time, takes m frames as a prediction period starting from the prediction reference time (m is preferably 1), receives an adjustment value of the timing advance from the uplink timing synchronization module 201 and an adjustment value of D from the downlink timing synchronization module 202, and counts the variation of the timing advance and the variation of D corresponding to each prediction period, i.e., the variation of the timing advance and the variation of D during the period from the prediction reference time to the time when each prediction period is ended.

[0076] For the first prediction period, the adjustment values of the timing advance received within the first prediction period are added when the first prediction period is ended so as to obtain the variation of the timing advance corresponding to the first prediction period, and the adjustment values of D received within the first prediction period are added so as to obtain the variation of D corresponding to the first prediction period.

[0077] For each one of the subsequent prediction periods, the variation of the timing advance corresponding to a previous prediction period is added to accumulated values of the adjustment values of the timing advance received within the prediction period to obtain a variation of the timing advance corresponding to the prediction period, and the variation of D corresponding to a previous prediction period is added to accumulated values of the adjustment values of D received within the prediction period to obtain a variation of D corresponding to the prediction period.

[0078] Preferably, the adjustment value of the timing advance close to the base station is positive and that away from the base station is negative, the adjustment value of D away from the base station is positive and that close to the base station is negative.

[0079] Step 303: judging whether the exit condition is met, if yes returning to Step 301 and otherwise turning to Step 304.

[0080] To be specific, before each prediction period expires, the uplink timing synchronization out-of-window detection module 203 judges whether the exit condition is met when the variation of the timing advance and the variation of D corresponding to the prediction period has been counted.

[0081] Step 304: predicting whether the uplink signal is to exit or enter the demodulation window, if it is to enter into the demodulation window, returning to Step 302, and if it is to exit the demodulation window, turning to Step 305.

[0082] To be specific, before each prediction period expires, the uplink timing synchronization out-of-window detection module 203 judges whether a difference between the variation of the timing advance corresponding to the prediction period and a reference downlink timing variation falls within the range of $(n - n_o, n)$, if yes, determines that the signal is to enter into the demodulation window and otherwise the signal is to exit the demodulation window. The reference downlink timing variation is a difference between the variation of D doubled corresponding to the prediction period and $err2(dlsc)$, wherein $err2(dlsc)$ is a downlink timing synchronization error within the prediction period.

[0083] The uplink timing synchronization out-of-window detection module 203 may also judge whether a difference between the variation of the timing advance corresponding to the prediction period and the reference downlink timing variation meets any one of $\geq n$ and $\leq n - n_o$, if yes, determine that the signal is to exit demodulation window and otherwise the signal is to enter into the demodulation window. When the condition $\geq n$ is met, the UL signal is predicted to be forward-out-of-window at the base station demodulation window, and when the condition $\leq n - n_o$ is met, the UL signal is predicted to be backward-out-of-window at the base station demodulation window.

[0084] Step 305: updating the current timing advance, and returning to Step 302.

[0085] To be specific, the uplink timing synchronization out-of-window detection module 203 transmits a variation of the timing advance to the uplink timing synchronization module 201. The uplink timing synchronization module 201 uses the variation of the timing advance as the variation of the timing advance corresponding to the just-ended prediction period, so as to count in Step 302 the variation of the timing advance corresponding to a prediction period next to the just-ended prediction period, and updates the current timing advance in according with the variation of the timing advance, i.e., adds the timing advance of the prediction reference time to the variation of the timing advance so as to obtain the updated current timing advance.

The UL signal may be transmitted by the UE in accordance with the current timing advance updated in the uplink timing synchronization module 201.

[0086] Through the preferred embodiment, it is able to ensure the uplink timing synchronization in a better manner and to overcome the problems when the base station adjusts the timing advance toward one direction, thereby to increase reliability of the uplink and to improve the call quality accordingly.

[0087] The present invention further provides an uplink transmission device for use in a TDD mode CDMA system, comprising:

a receiving module 401, configured to receive an uplink timing synchronization shift command;

a first determining module 402, configured to determine a current timing advance in accordance with the uplink timing synchronization shift command;

a judging module 403, configured to judge whether the current timing advance meets a prediction condition where an uplink signal is to enter into a demodulation window, so as to obtain a first judgment result;

a transmitting module 404, configured to, when the first judgment result is yes, transmit the uplink signal in accordance with the current timing advance; and

an updating and transmitting module 405, configured to, when the first judgment result is no, update the current timing advance so that the updated current timing advance meets the prediction condition where the uplink signal is to enter into the demodulation, and transmit the uplink signal in accordance with the updated current timing advance.

[0088] It can be seen that, when the current timing advance determined based on an uplink timing synchronization shift command does not meet a prediction condition where an uplink signal is to enter into a demodulation window, the current timing advance is updated so as to meet the prediction condition, and the uplink signal is transmitted in accordance with the updated current timing advance. As a result, the present invention provides a prediction and prevention way when the uplink signal goes beyond the range of a base station demodulation window, so as to reduce the possibility of the uplink signal going beyond the base station demodulation window and enhance reliability of the uplink.

[0089] The device may further comprise:

a second determining module 406, configured to determine a prediction reference time before the receiving module 401 receives the uplink timing synchronization shift command.

[0090] The prediction condition where the uplink signal is to enter into the demodulation window includes: a difference between a first timing advance variation and a first reference downlink timing variation falls within a prediction range where an uplink signal is to enter into the demodulation window.

[0091] The first timing advance variation is a variation of the current timing advance relative to an initial timing advance, and the initial timing advance is a timing advance for the prediction reference time.

[0092] The first reference downlink timing variation is double a first variation of a distance D from a current base station to a terminal relative to an initial D, or a difference between the first variation double and a first correction value. The initial D is that of the prediction reference time, and the first correction value is a downlink timing synchronization error.

[0093] The updating and transmitting module 405 may comprise:

an updating unit 4051, configured to update the current timing advance so that a difference between a second timing advance variation and the first reference downlink timing variation falls within the prediction range where the uplink signal is to enter into the demodulation window, wherein the second timing advance variation is a variation of the updated current timing advance relative to the initial timing advance; and

a transmitting unit 4052, configured to transmit the uplink signal in accordance with the updated current timing advance.

[0094] The second determining module 406 may comprise:

a judging unit 4061, configured to, before the receiving module 401 receives the uplink timing synchronization shift command, judge whether an entry condition is met, so as to obtain a second judgment result; and

a determining unit 4062, configured to, before the receiving module 401receives the uplink timing synchronization shift command, determine the prediction reference time when the second judgment result is yes.

[0095] In addition, the device may further comprise:

a returning module 407, configured to, after the second determining module 406 determines a prediction reference value, returns to the second determining module 406 when an entry condition is met.

[0096] The present invention further provides a terminal which comprises the above-mentioned uplink transmission device.

[0097] The above are merely the embodiments of the present invention. It shall be noted that, a person skilled in the may make alterations and modifications without departing from the principle of the present invention. These alterations and modifications shall also be regarded as the protection scope of the present invention.

What is claimed is:

1. An uplink transmission method, comprising:

receiving an uplink timing synchronization shift command;

determining a current timing advance in accordance with the uplink timing synchronization shift command;

judging whether the current timing advance meets a prediction condition where the uplink signal is to enter into a demodulation window, so as to obtain a first judgment result;

transmitting the uplink signal in accordance with the current timing advance when the first judgment result is yes; and

updating the current timing advance when the first judgment result is no so that the updated current timing advance meets the prediction condition where the uplink signal is to enter into a demodulation window, and transmitting the uplink signal in accordance with the updated current timing advance.

2. The method according to claim 1, wherein prior to receiving an uplink timing synchronization shift command, the method further comprises:

determining a prediction reference time,

wherein the prediction condition where an uplink signal is to enter into the demodulation window includes:

a difference between a first timing advance variation and a first reference downlink timing variation falls within a prediction range where an uplink signal is to enter into the demodulation window,

wherein, the first timing advance variation is an variation of the current timing advance relative to an initial timing advance, and the initial timing advance is a timing advance for the prediction reference time,

the first reference downlink timing variation is double a first variation of a distance D from a current base station to a terminal relative to an initial D, or a difference between the first variation double and a first correction value, and the initial D is the D of the prediction reference time, and the first correction value is a downlink timing synchronization error,

updating the current timing advance so that the updated current timing advance meets the prediction condition where the uplink signal is to enter into a demodulation window includes:

updating the current timing advance so that a difference between a second timing advance variation and the first reference downlink timing variation falls within the prediction range where the uplink signal is to enter into the demodulation window, wherein the second timing advance variation is a variation of the updated current timing advance relative to the initial timing advance.

3. The method according to claim 2, wherein the prediction range where the uplink signal is to enter into the demodulation window is $(n - n_o, n)$,

wherein n_o is a number of chips in the base station demodulation window, and the uplink timing synchronization position in the base station demodulation window is at the n^{th} chip of the base station demodulation window from left.

4. The method according to claim 3, wherein updating the current timing advance so that a difference between a second timing advance variation and the first reference downlink timing variation falls within the prediction range where the uplink signal is to enter into the demodulation window includes:

adding the initial timing advance to the first reference downlink timing variation, so as to obtain the updated current timing advance.

5. The method according to claim 2, wherein the step of determining a prediction reference time includes:

judging whether an entry condition is met, so as to obtain a second judgment result; and

determining the prediction reference time when the second judgment result is yes.

6. The method according to claim 5, wherein

the uplink timing synchronization shift command is a synchronization shift SS symbol carried on a downlink Dedicated Channel DCH, and the entry condition includes:

a first condition where a protocol stack indicates that the dedicated channel DCH is in a closed-loop state,

a second condition where the protocol stack indicates that the SS symbol is carried on a downlink DCH,

a third condition where the protocol stack indicates that the downlink DCH is in a synchronization state, and

a fourth condition where a difference between a third timing advance variation and a second reference downlink timing variation falls within the range of [$-\gamma$, γ],

wherein the third timing advance variation is a timing advance variation determined based on all of the SS symbols carried on the downlink DCH and received by the terminal in accordance with the latest adjusting and matching period for the uplink and downlink closed-loop timing synchronization,

the second reference downlink timing variation is double a second variation of D within the latest adjusting and matching period for the uplink and downlink closed-loop timing synchronization, or a difference between the second variation doubled and a second correction value, and the second correction value is a downlink timing synchronization error within the latest adjusting and matching period for the uplink and downlink closed-loop timing synchronization, and

γ is a maximum value of the downlink timing synchronization error within the latest adjusting and matching period for the uplink and downlink closed-loop timing synchronization in a channel model.

7. The method according to claim 2, wherein after determining a prediction reference time, the method further comprises:

returning to the step of determining a prediction reference time when an entry condition is met.

8. An uplink transmission device, comprising:

a receiving module, configured to receive an uplink timing synchronization shift command;

a first determining module, configured to determine a current timing advance in accordance with the uplink timing synchronization shift command;

a judging module, configured to judge whether the current timing advance meets a prediction condition where the uplink signal is to enter into a demodulation window, so as to obtain a first judgment result;

a transmitting module, configured to transmit the uplink signal in accordance with the current timing advance when the first judgment result is yes; and

an updating and transmitting module, configured to update the current timing advance when the first judgment result is no so that the updated current timing advance meets the prediction condition where the uplink signal is to enter into a demodulation window, and transmit the uplink signal in accordance with the updated current timing advance.

9. The device according to claim 8, wherein the device further comprises:

a second determining module, configured to determine a prediction reference time before the receiving module receives the uplink timing synchronization shift command,

wherein the prediction condition where an uplink signal is to enter into the demodulation window includes that a difference between a first timing advance variation and a first reference downlink timing variation falls within a prediction range where an uplink signal is to enter into the demodulation window,

the first timing advance variation is an variation of the current timing advance relative to an initial timing advance, and the initial timing advance is a timing advance for the prediction reference time,

the first reference downlink timing variation is double a first variation of a distance D from a current base station to a terminal relative to an initial D, or a difference between the first variation doubled and a first correction value, and the initial D is the D of the prediction reference time, and the first correction value is a downlink timing synchronization error,

wherein the updating and transmitting module includes:

an updating unit, configured to update the current timing advance so that a difference between a second timing advance variation and the first reference downlink timing variation falls within the prediction range where the uplink signal is to enter into the demodulation window, wherein the second timing advance variation is a variation of the updated current timing advance relative to the initial timing advance; and a transmitting unit, configured to transmit the uplink signal in accordance with the updated current timing advance.

10. The device according to claim 9, wherein the second determining module comprises:

a judging unit, configured to, before the receiving module receives the uplink timing synchronization shift command, judge whether an entry condition is met, so as to obtain a second judgment result; and

a determining unit, configured to, before the receiving module receives the uplink timing synchronization shift command, determine the prediction reference time when the second judgment result is yes.

11. The device according to claim 9, wherein the device further comprises:

a returning module, configured to, after the second determining module determines a prediction reference value, returns to the second determining module when an entry condition is met.

12. A terminal comprising the uplink transmission device according to any one of claims 8 to 11.

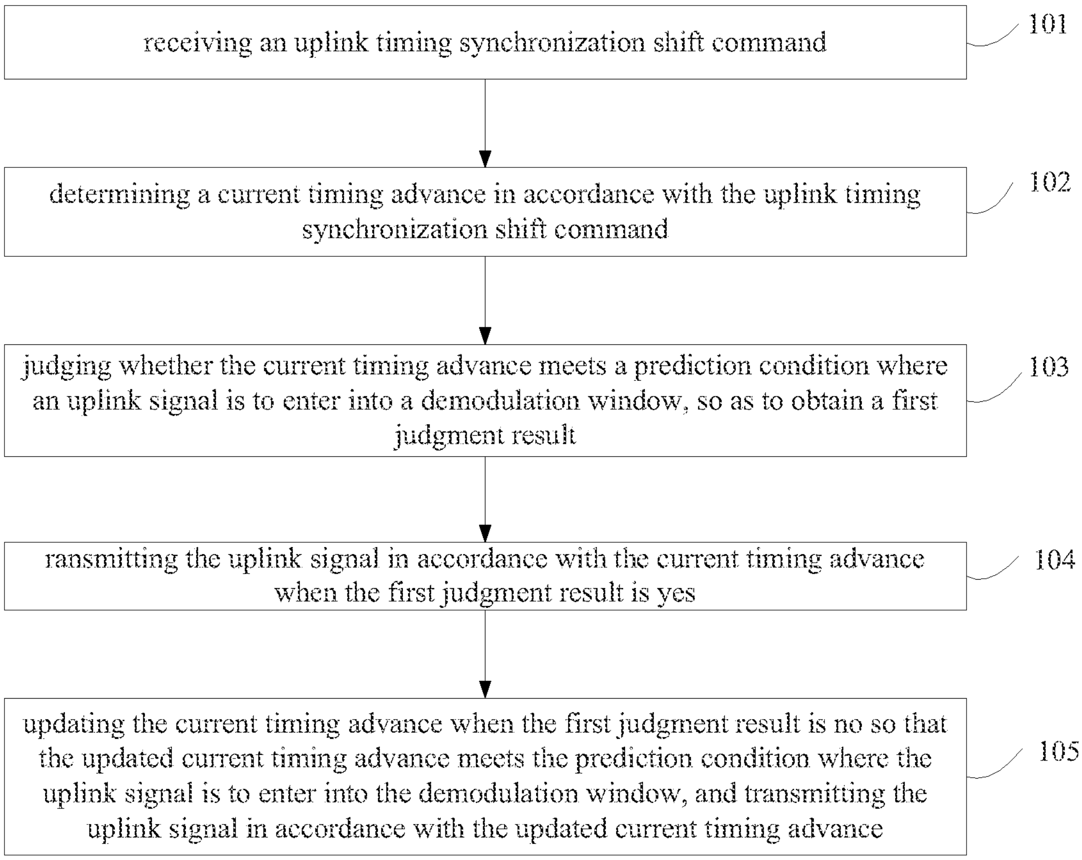
receiving an uplink timing synchronization shift command
101
determining a current timing advance in accordance with the uplink timing synchronization shift command
102
judging whether the current timing advance meets a prediction condition where an uplink signal is to enter into a demodulation window, so as to obtain a first judgment result
103
ransmitting the uplink signal in accordance with the current timing advance when the first judgment result is yes
104
updating the current timing advance when the first judgment result is no so that the updated current timing advance meets the prediction condition where the uplink signal is to enter into the demodulation window, and transmitting the uplink signal in accordance with the updated current timing advance
105

Fig. 1

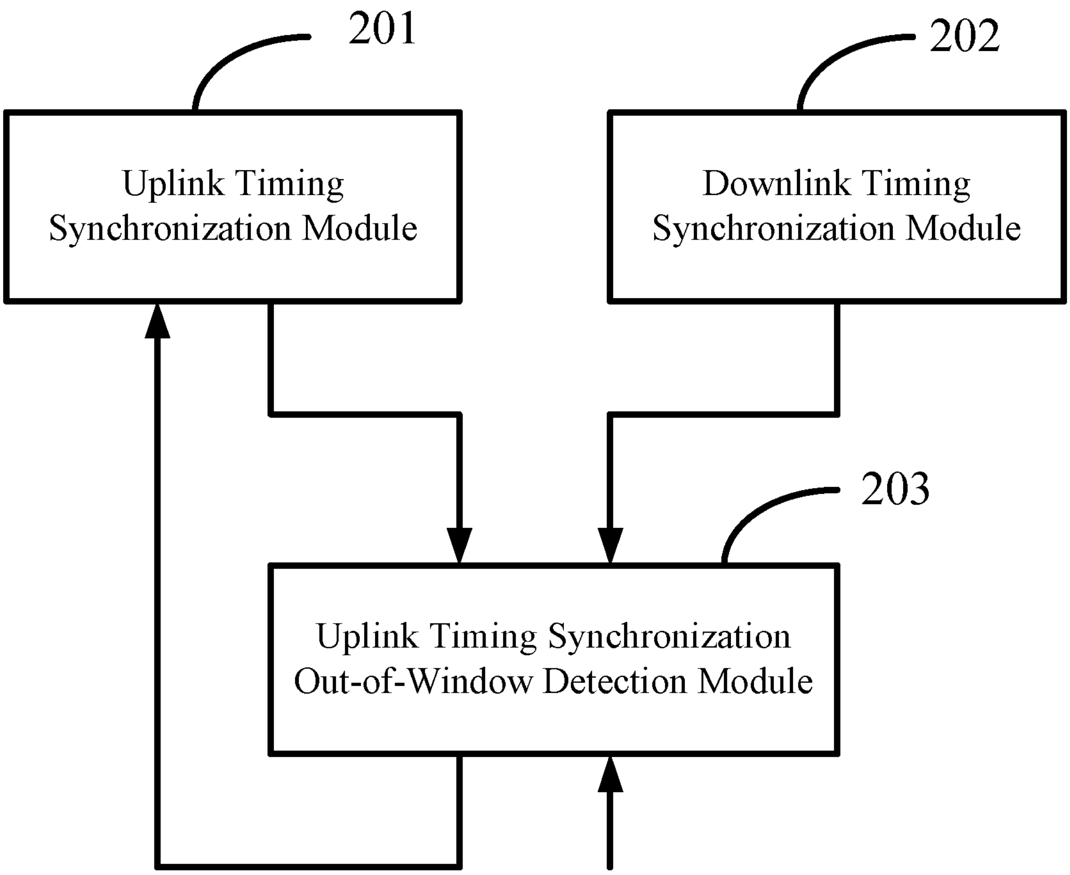
201
202
Uplink Timing Synchronization Module
Downlink Timing Synchronization Module
203
Uplink Timing Synchronization Out-of-Window Detection Module

Fig. 2

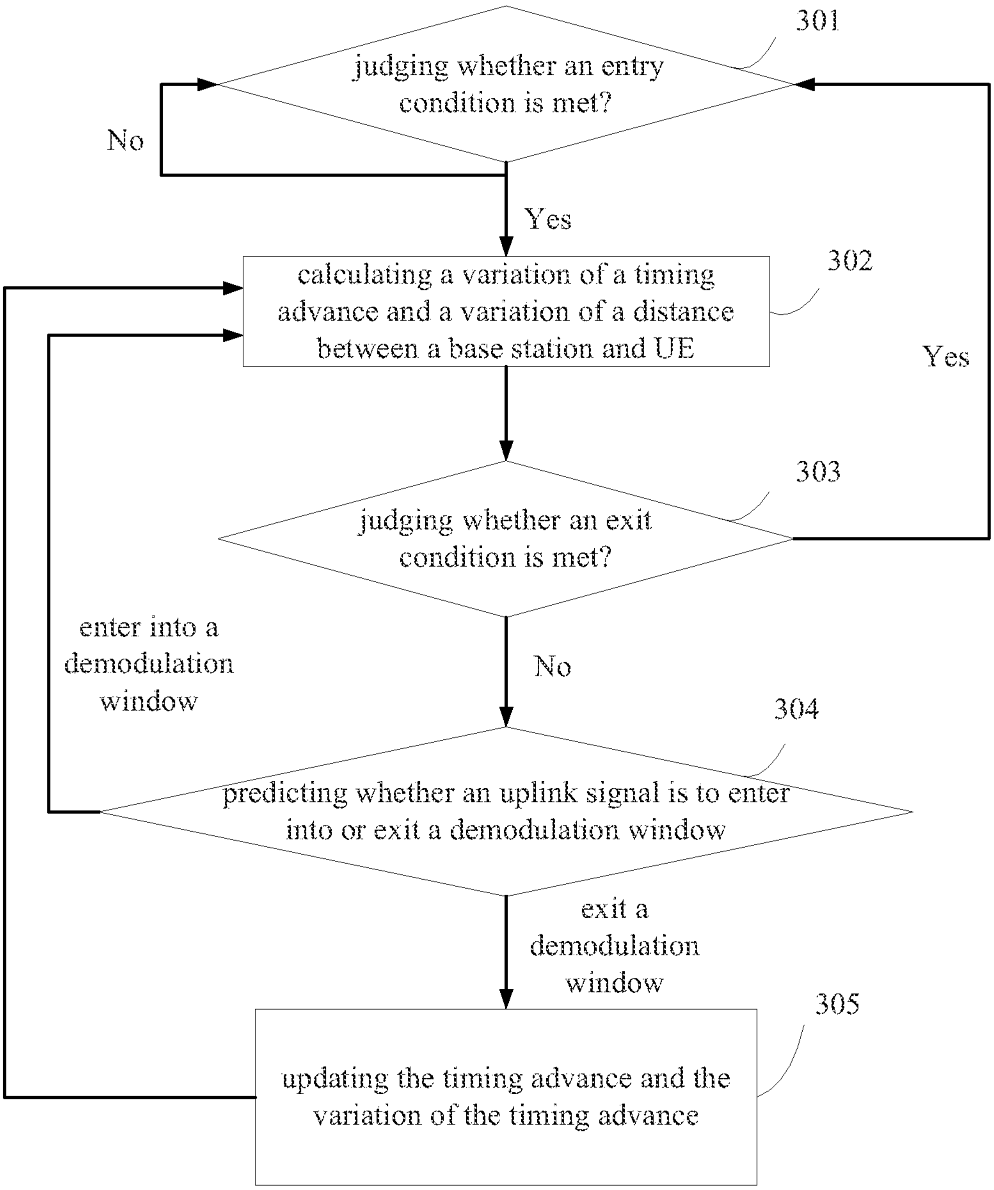
301
judging whether an entry condition is met?
No
Yes
302
calculating a variation of a timing advance and a variation of a distance between a base station and UE
Yes
303
judging whether an exit condition is met?
enter into a demodulation window
No
304
predicting whether an uplink signal is to enter into or exit a demodulation window
exit a demodulation window
305
updating the timing advance and the variation of the timing advance

Fig. 3

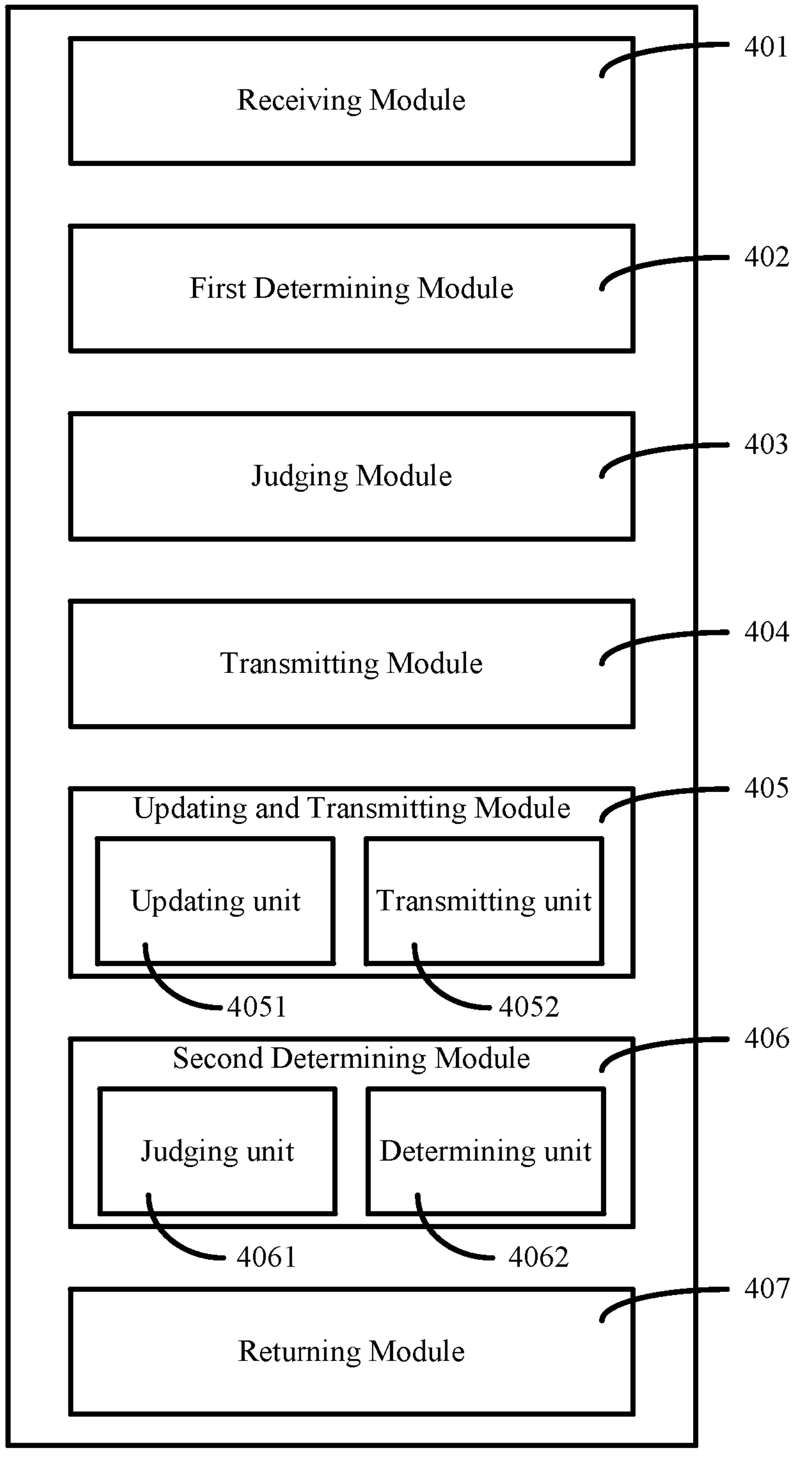
Receiving Module
401
First Determining Module
402
Judging Module
403
Transmitting Module
404
Updating and Transmitting Module
405
Updating unit
Transmitting unit
4051
4052
Second Determining Module
406
Judging unit
Determining unit
4061
4062
Returning Module
407

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2013/071222

A. CLASSIFICATION OF SUBJECT MATTER

H04W 56/00 (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)

IPC: H04W, H04L

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)

VEN, USTXT, CNABS, CNTXT, CNKI: uplink, synchronization, transmission, transmit, demodulation, update, timing advance, TA, closed loop, node, nodeb, basestation, base station, BS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 101631010 A (SHANGHAI HUAWEI TECHNOLOGIES CO LTD) 20 January 2010 (20.01.2010) the whole document	1-12
A	CN 102076077 A (ZTE CORP) 25 May 2011 (25.05.2011) the whole document	1-12
A	US 2012300752 A1 (PANTECH CO., LTD.) 29 November 2012 (29.11.2012) the whole document	1-12
A	WO 2012134071 A2 (LG ELECTRONICS INC.) 04 October 2012 (04.10.2012) the whole document	1-12

☐ 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

"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)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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

"&"document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 October 2013 (29.10.2013)	**07 Nov. 2013 (07.11.2013)**

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2013/071222

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 101631010 A	20.01.2010	CN 101631010 B	02.01.2013
CN 102076077 A	25.05.2011	None	
US 2012300752 A1	29.11.2012	WO 2012165821 A1	06.12.2012
		KR 2012132284 A	05.12.2012
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		KR 2012132311 A	05.12.2012
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		KR 20120111982 A	11.10.2012
		WO 2012134072 A2	04.10.2012
		WO 2012134072 A3	03.01.2013
		KR 20120111983 A	11.10.2012