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- (71) Applicant: ALCATEL LUCENT [FR/FR]; 148/152 Route de la Reine, F-92100 Boulogne-billancourt (FR).
- (72) Inventors: WEN, Pingping; 388# Ningqiao RD, Shanghai, Shanghai 201206 (CN). WORRALL, Chandrika; 11A Balfour Crescent, Newbury Berkshire RG14 6SN (GB).
- (74) Agent: THERIAS, Philippe; Alcatel-lucent International, 148/152 Route de la Reine, F-92100 Boulogne-billancourt (FR).

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(54) Title: METHOD AND APPARATUS FOR CONFIGURING DRX FOR A USER EQUIPMENT IN A DUAL/PLURAL CONNECTIVITY WIRELESS COMMUNICATION SYSTEM

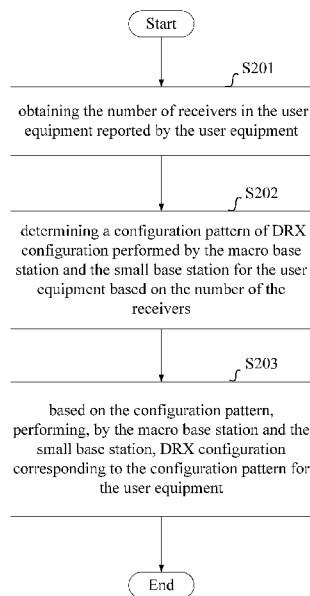


Fig.2

(57) Abstract: An objective of the present invention is to provide a method and apparatus for configuring DRX for a user equipment in a dual/plural connectivity wireless communication system. In the current 3GPP standard, the user equipment is not supported to perform a serving connection simultaneously to a plurality of cells at different nodes. Although there are a plurality of serving cells in the case of carrier aggregation, there is no significant gain for configuring DRX separately on respective carriers because there is only one common MAC layer and the upper layer data are multiplexed by carriers. However, for the dual/plural connectivity, different traffics will be transmitted over different base stations (even the same traffic may be transmitted in different base stations, it is likely that different base stations transmit multiple kinds of traffics; therefore, different base stations will transmit different traffics), such that configuring DRX separately will have a significant gain. The present invention determines a configuration pattern for DRX configuration for the user equipment based on the characteristics of dual/plural connectivity to perform DRX configuration to the user equipment better, which satisfies QoS demands of dif-

ferent traffics and meanwhile meets the objective of saving power.



METHOD AND APPARATUS FOR CONFIGURING DRX FOR A USER
EQUIPMENT IN A DUAL/PLURAL CONNECTIVITY WIRELESS
COMMUNICATION SYSTEM

5 **FIELD OF THE INVENTION**

The present invention relates to the field of communication technologies, and more specifically, to a technique for configuring DRX for a user equipment in a dual/plural connectivity wireless communication system.

10 **BACKGROUND OF THE INVENTION**

At present, since a low power node can bring gains in aspects such as capacity improvement and blind coverage, more and more studies focus on deployment and enhancement of small cells covered by the low power node. Here, the low power node may be a small eNB (shortly referred to as SeNB), examples of which include, but not
15 limited to, low power base stations such as Pico, Femto, etc. In 3GPP R12, a new study item "Small Cell Enhancements for E-UTRA and E-UTRAN Higher-layer aspects" has been approved, and a key issue thereof is to support a dual/plural connectivity to macro cell layer (a cell covered by a macro base station) and a small cell layer.

20 The dual/plural connectivity refers to respective connections to one or two/more macro cells and one or two/more small cells, wherein each cell in these macro cells and small cells has different functions, e.g., a macro cell connected to an MME (Mobility Management Entity) is used as an anchor cell providing a good coverage, and the small cell may implement data load sharing/ diversion from the macro cell.

25 In current stage, for dual/plural connectivity, a user equipment only has one RRC (Radio Resource Control) state, e.g., RRC idle state or RRC connected state. In the RRC connected state, DRX (Discontinuous Reception) is a good mechanism for saving UE batter power. The DRX configuration is a tradeoff between power consumption and traffic quality of service QoS of the user equipment. The longer the
30 duration of a long/short DRX cycle is, the better is the achieved power savings. However, such power savings is at the expense of traffic delay, which will bring a rather large time delay. Since different traffics have different time delay demands, just from the perspective of traffic characteristics, it would be better to configure DRX separately for different kinds of traffics. For the dual/plural connectivity, it may
35 support different kinds of services to run in different modes, e.g., macro base station (MeNB) and small base station (SeNB).

Therefore, for a user equipment having a dual/plural connectivity to a macro base station and a small base station, it is crucial how to configure DRX of the user
40 equipment.

SUMMARY OF THE INVENTION

An objective of the present invention is to provide a method and apparatus for configuring DRX for a user equipment in a dual/plural connectivity wireless communication system.

According to one aspect of the present invention, there is provided a method for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the method comprises:

- performing, by the macro base station and the small base station, DRX configuration for the user equipment, respectively;

- performing, by the user equipment, a separate DRX program for a connection to the macro base station and a connection to the small base station, respectively.

According to another aspect of the present invention, there is also provided a method for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the method comprises:

A. cooperatively performing, by the macro base station and the small base station, DRX configuration for the user equipment;

wherein a manner of cooperative configuration comprises:

- performing, by the macro base station, DRX configuration for the user equipment based on configuration related information corresponding to the small base station in conjunction with radio bearer information and connection related information transmitted by the macro base station.

According to a further aspect of the present invention, there is also provided a method for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the method comprises:

a. obtaining the number of receivers in the user equipment reported by the user equipment;

b. determining a configuration pattern of DRX configuration performed by the macro base station and the small base station for the user equipment based on the number of the receivers;

c. based on the configuration pattern, performing, by the macro base station and the small base station, DRX configuration corresponding to the configuration pattern for the user equipment.

According to a further aspect of the present invention, there is also provided a macro base station for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the macro base station comprises:

a first configuration device configured to perform DRX configuration for the user equipment, wherein the user equipment is dual/plural connected to the macro base station and a small base station corresponding to the macro base station.

5 According to a further aspect of the present invention, there is also provided a small base station for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the small base station
10 comprises:

a second configuration device configured to perform DRX configuration for the user equipment, wherein the user equipment is dual/plural connected to the small base station and a macro base station corresponding to the small base station.

15 According to a further aspect of the present invention, there is also provided a user equipment for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the user equipment
20 comprises:

a second transmitting device configured to report the number of receivers in the user equipment to a corresponding macro base station and/or small base station, wherein the user equipment is dual/plural connected to the macro base station and the small base station.

25 According to a further aspect of the present invention, there is also provided a wireless communication system for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, comprising at least one macro base station above, at least one small base station above, and a user equipment above, wherein the user equipment is dual/plural connected to the at least one macro base station and the at least one small base station.
30

Compared with the prior art, the present invention performs DRX configuration for a user equipment in a wireless communication system having a dual/plural connectivity based on characteristics of the dual/plural connectivity, wherein the wireless communication system comprises a user equipment and at least two base
35 stations connected to the user equipment, which at least two base stations comprise at least one macro base station and at least one small base station. In the current 3GPP standard, the user equipment is not supported to perform a serving connection simultaneously to a plurality of cells at different nodes. Although there are a plurality of serving cells in the case of CA (carrier aggregation), there is no significant gain for configuring DRX separately on respective carriers because there is only one common
40 MAC layer and the upper layer data are multiplexed by carriers. However, for the dual/plural connectivity, different traffics will be transmitted over different base stations (even the same traffic may be transmitted in different base stations, it is likely that different base stations transmit multiple kinds of traffics; therefore, different base

stations will transmit different traffics), such that configuring DRX separately will have a significant gain. The present invention determines a configuration pattern for DRX configuration for the user equipment based on the characteristics of dual/plural connectivity. Based on this configuration pattern, performing DRX configuration to the user equipment better satisfies QoS demands of different traffics and meanwhile meets the objective of saving power.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

Through reading the detailed depiction of the non-limiting embodiments with reference to the following drawings, other features, objectives and advantages of the present invention will become more apparent:

Fig. 1 shows a flow diagram of a method for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system according to one aspect of the present invention;

Fig. 2 shows a flow diagram of a method for performing DRX configuration for a user equipment in a dual/ plural connectivity wireless communication system according to another aspect of the present invention.

The same or like reference numerals in the drawings represent the same or corresponding components.

DETAILED DESCRIPTION OF THE ACCOMPANYING DRAWINGS

Hereinafter, the present invention is described in further detail with reference to the accompanying drawings.

Fig. 1 shows a flow diagram of a method for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system according to one aspect of the present invention, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station.

In step S101, the macro base station and the small base station perform DRX configuration for the user equipment, respectively; in step S102, the user equipment performs a separate DRX program for a connection to the macro base station and a connection to the small base station, respectively.

Here, the wireless communication system does not need to consider the number of receivers in the user equipment; instead, the macro base station and the small base station directly perform DRX configuration for the user equipment, respectively.

According to another aspect of the present invention, there is further provided a method for performing DRX configuration for a user equipment in a dual/ plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station.

Specifically, the macro base station and the small base station cooperatively perform DRX configuration for the user equipment;

wherein, the manner of cooperative configuration comprises:

- the macro base station performs DRX configuration for the user equipment based on configuration related information corresponding to the small base station in conjunction with radio bearer information and connection related information transmitted by the macro base station.

Preferably, configuration related information corresponding to the small base station includes any one of the following:

- DRX candidate configuration information obtained from the small base station performing candidate configuration of the user equipment;

- radio bearer information and connection related information transmitted by the small base station.

Here, the wireless communication system does not need to consider the number of receivers in the user equipment yet; instead, the macro base station and the small base station directly cooperate to perform DRX configuration for the user equipment.

Specifically, the manner in which the macro base station and the small base station cooperate to perform DRX configuration for the user equipment includes, but not limited to:

1) the small base station voluntarily transmits, to the macro base station, radio bearer information and connection related information transmitted by the small base station; after receiving the radio bearer information and connection related information transmitted by the small base station, the macro base station comprehensively performs DRX configuration for the user equipment in further conjunction with the radio bearer information and connection related information transmitted by the macro base station itself.

2) the macro base station transmits a configuration request to the small base station; the small base station returns, to the macro base station, the radio bearer information and connection related information transmitted by the small base station based on the configuration request; after receiving the radio bearer information and connection related information transmitted by the small base station, the macro base station comprehensively performs DRX configuration for the user equipment in further conjunction with the radio bearer information and connection related information transmitted by the macro base station itself.

3) upon establishment of the dual/plural connectivity, the macro base station will immediately obtains the radio bearer information and connection related information transmitted by the small base station; then, based on the radio bearer information and connection related information transmitted by the small base station, the macro base station comprehensively performs DRX configuration for the user equipment in further conjunction with the radio bearer information and connection related information transmitted by the macro base station itself.

4) the small base station first performs candidate DRX configuration for the user equipment based on the radio bearer information and connection related information transmitted by the small base station itself, then obtains DRX candidate configuration information and voluntarily transmits to the macro base station; the macro base station receives the DRX candidate configuration information and then comprehensively

performs DRX configuration for the user equipment in further conjunction with the radio bearer information and connection related information transmitted by the macro base station itself.

5 5) the small base station first performs candidate DRX configuration for the user equipment based on the radio bearer information and connection related information transmitted by the small base station itself and obtains DRX configuration information; the macro base station transmits a configuration request to the small base station; the small base station returns the DRX candidate configuration information obtained from configuration by the small base station to the macro base station based on the
10 configuration request; the macro base station receives the DRX candidate configuration information, and then comprehensively performs DRX configuration for the user equipment in further conjunction with the radio bearer information and connection related information transmitted by the macro base station itself.

15 Here, the interaction between the macro base station and the small base station, e.g., via an Xn interface, transmits the information required to transmit (e.g., DRX candidate configuration information, configuration request, radio bearer information, and connection related information, etc.). The connection related information includes information about the connection, such as the power capacity of the user equipment, the power saving intention, etc.

20 Fig. 2 shows a flow diagram of a method for performing DRX configuration for a user equipment in a dual/ plural connectivity wireless communication system according to another aspect of the present invention, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one
25 macro base station and at least one small base station.

Wherein, in step S201, the macro base station and/or small base station obtains the number of receivers in the user equipment, which is reported by the user equipment;

30 In step S202, a configuration pattern of a DRX configuration performed by the macro base station and the small base station for the user equipment based on the number of receivers is determined;

In step S203, the macro base station and the small base station perform DRX configuration corresponding to the configuration pattern for the user equipment based on the configuration pattern.

35 Herein, the radio communication system needs to consider the number of receivers in the user equipment, and determines a configuration pattern of performing DRX configuration for the user equipment based on the number of receivers.

40 For example, the user equipment reports the number of receivers thereon to the macro base station; the macro base station then transmits the number of the receivers, e.g., via an Xn interface, to a corresponding small base station; or, the user equipment reports the number of receivers thereon to the small base station, the small base station then transmits the number of receivers, e.g., via an Xn interface, to a corresponding macro base station; or, the user equipment directly reports the number of receivers simultaneously to the macro base station and the small base station.

Preferably, when the number of receivers in the user equipment is greater than a first predetermined number threshold, the configuration pattern is determined that the macro base station and the small base station perform DRX configuration for the user equipment, respectively; afterwards, the user equipment performs a separate DRX program for a connection to the macro base station and a connection to the small base station, respectively.

For example, suppose the first predetermined number threshold is 0, then when the number of receivers in the user equipment is greater than the first predetermined number threshold, i.e., as long as the user equipment comprises a receiver, then the macro base station and the small base station perform DRX configuration for the user equipment, respectively.

For another example, suppose the first predetermined number threshold is 1, then when the number of receivers in the user equipment is greater than the first predetermined number threshold, if the user equipment has two or more receivers, then the macro base station and the small base station perform DRX configuration for the user equipment, respectively.

Preferably, when the number of the receivers is less than a second predetermined number threshold, the configuration pattern is determined that the macro base station and the small base station cooperatively perform DRX configuration for the user equipment.

For example, suppose the second predetermined number threshold is 2, then when the number of receivers in the user equipment is less than the second predetermined number threshold, if the user equipment only has one receiver, then the macro base station and the small base station cooperatively perform DRX configuration for the user equipment.

Here, the first predetermined number threshold and the second predetermined number threshold are preset for example by the wireless communication system.

More preferably, when the wireless communication system determines that the configuration pattern is that the macro base station and the small base station cooperatively perform DRX configuration for the user equipment, the macro base station and the small base station cooperatively perform DRX configuration for the user equipment. Specifically, the macro base station obtains the DRX candidate configuration information from the small base station based on the configuration pattern, wherein the DRX candidate configuration information is obtained from the small base station performing candidate configuration for the user equipment; afterwards, the macro base station performs DRX configuration for the user equipment based on the DRX candidate configuration information in conjunction with the radio bearer information and connection related information transmitted by the macro base station. Meanwhile, the macro base station and the small base station maintain synchronization.

Wherein, the manner in which the macro base station obtains DRX candidate configuration information from the small base station includes, but not limited to:

1) after performing candidate DRX configuration for the user equipment and obtain the DRX candidate configuration information, the small base station

voluntarily transmits the DRX candidate configuration information to the macro base station. For example, the small base station obtains the number of the receivers in the user equipment; for example, it is directly transmitted by the user equipment to the small base station, or it is forwarded to the small base station after the macro base station obtains the number. Moreover, the small base station obtains that the configuration pattern is that the macro base station and the small base station cooperatively perform DRX configuration for the user equipment, then the small base station first performs the candidate DRX configuration for the user equipment, obtains DRX candidate configuration information, and voluntarily transmits the DRX candidate configuration information to the macro base station.

2) the macro base station transmits a configuration request to the small base station. Based on the configuration request, the small base station returns, to the macro base station, the DRX candidate configuration information obtained from the small base station performing candidate configuration for the user equipment. For example, the user equipment only transmits the number of receivers thereon to the macro base station; the macro base station, after obtaining the number of the receivers, obtains that the configuration pattern is that the macro base station and the small base station cooperatively perform DRX configuration for the user equipment, therefore, the macro base station transmits the configuration request to the small base station so as to request the DRX candidate configuration information of the small base station.

More preferably, based on the configuration pattern, the macro base station may also perform DRX configuration for the user equipment based on radio bearer information and connection related information transmitted by the small base station obtained upon establishment of the dual/plural connection in conjunction with radio bearer information and connection related information transmitted by the macro base station.

More preferably, based on the configuration pattern, the macro base station may also obtain radio bearer information and connection related information transmitted by the small base station from the small base station; afterwards, the macro base station performs DRX configuration for the user equipment based on radio bearer information and connection related information transmitted by the small base station in conjunction with radio bearer information and connection related information transmitted by the macro base station.

Similarly, the manner in which the macro base station obtains radio bearer information and connection related information transmitted by the small base station includes, but not limited to:

1) the small base station voluntarily sends radio bearer information and connection related information transmitted by itself to the macro base station.

2) the macro base station transmits a configuration request to the small base station, which small base station returns radio bearer information and connection related information transmitted by itself to the macro base station based on the configuration request.

Here, the interaction between the macro base station and the small base station, e.g., via an Xn interface, transmits the information required to transmit (e.g., DRX

candidate configuration information, configuration request, radio bearer information, and connection related information, etc.). The connection related information includes information about the connection, such as the power capacity of the user equipment, the power saving intention, etc.

5 For user plane, there are three options below for partitioning user plane data:

Option 1: S1-U is terminated in SeNB (i.e., the small base station is connected to the serving gateway S-GW and performs data transmission thereto);

10 Option 2: S1-U is terminated in MeNB (i.e., the macro base station is connected to the serving gateway S-GW and performs data transmission thereto), and no bearer partition occurs in RAN (radio access network); and

Option 3: S1-U is terminated in MeNB, and there is bearer partition in RAN.

With one embodiment in option 1 and option 2 of the user plane as an example, regarding dual/plural connectivity, there are different QoS requirements on different traffics transmitted over MeNB and SeNB. Suppose there is only one carrier, and there is only one receiver in the user equipment end, the two connections to the MeNB and the SeNB will be operated in a TDM (time-division multiplexing) manner. If the time interval cycle of the TDM is greater than the DRX cycle, there would be no problem; however, if the time cycle of the TDM is less than or close to the DRX cycle, the user's connection to the MeNB and the SeNB alternatively switches in time. When the connection to the MeNB is switched to the connection to the SeNB, suppose the target connection will be in an "on" state, while the source connection is in an "off" state, the user will be forced to switch from the "off" state to the "on" state. Vice versa. Therefore, the gain obtained from separately configuring DRX will not be apparent. In the above scenario, the gain change from the manner of configuring an identical DRX to the manner of separately configuring the DRX is very minor, such that the macro base station and the small base station may configure the DRX separately, or they may configure the same DRX.

Specifically, suppose the wireless communication system does not consider the number of receivers at the user equipment end; then the macro base station and the small base station perform DRX configuration for the user equipment, respectively.

Suppose the wireless communication system needs to consider the number of receivers at the user equipment end, then a configuration pattern is determined based on the number of receivers in the user equipment, in further conjunction with the first or second predetermined number threshold. For example, at this point, the user equipment only has one receiver, while the second predetermined number threshold is 2; then the number of the receiver is less than the second predetermined number threshold; then the configuration pattern is determined that the macro base station and the small base station cooperatively perform DRX configuration for the user equipment. The specific implementation manner of the cooperative configuration here is identical to the above embodiment, which is thus not detailed here, but is incorporated here by reference.

Or, suppose the wireless communication system does not consider the number of receivers at the user equipment end, the macro base station and the small base station cooperatively perform DRX configuration for the user equipment, i.e., configuring an

identical DRX.

With another embodiment in option 1 and option 2 of the user plane as an example, regarding the dual/ plural connectivity, there are different QoS requirements on different traffics transmitted over MeNB and SeNB. Suppose there are two or more carriers, and the user equipment only has one receiver, this scenario is similar to the scenario of having CA of a single receiver. If there is no or few overlapping for the duration of “on” on the connections between the user equipment and the macro base station and between the user equipment and the small base station, the user equipment has to be in an “on” state in most time. Therefore, the manner of separately configuring the DRX does not have a better gain than the common manner of configuring the DRX. Therefore, the macro base station and the small base station may configure the DRX separately or configure the same DRX.

Specifically, suppose the wireless communication system does not consider the number of receivers at the user equipment end, then the macro base station and the small base station perform DRX configuration for the user equipment, respectively.

Suppose the wireless communication system needs to consider the number of receivers at the user equipment end, then a configuration pattern is determined based on the number of receivers in the user equipment in further conjunction with the first or second predetermined threshold. For example, at this point, the user equipment only has one receiver, while the second predetermined number threshold is 2; then the number of the receiver is less than the second predetermined number threshold, and the configuration pattern is determined that the macro base station and the small base station cooperatively perform DRX configuration for the user equipment. The specific implementation manner of the cooperative configuration here is identical to the above embodiment, which is thus not detailed here, but is incorporated here by reference.

Or, suppose the wireless communication system does not consider the number of receivers at the user equipment end, the macro base station and the small base station cooperatively perform DRX configuration for the user equipment, i.e., configuring the same DRX.

With another embodiment in option 1 and option 2 of the user plane as an example, regarding the dual/ plural connectivity,, there are different QoS requirements on different traffics transmitted over MeNB and SeNB. Suppose the user equipment has a plurality of receivers, separately configuring the DRX by the macro base station and the small base station will have an apparent gain; thus, the macro base station and the small base station perform DRX configuration for the user equipment, respectively.

Specifically, suppose the wireless communication system does not consider the number of receivers at the user equipment end, then the macro base station and the small base station perform DRX configuration for the user equipment, respectively.

Suppose the wireless communication system needs to consider the number of receivers at the user equipment end, a configuration pattern is determined based on the number of receivers in the user equipment in further conjunction with the first or second predetermined number threshold. For example, at this point, the user equipment has a plurality of receivers, while the first predetermined number threshold

is 1; then the number of the receiver is greater than the first predetermined number threshold; the configuration pattern is determined that the macro base station and the small base station perform DRX configuration for the user equipment, respectively. Here, the specific implementation manner in which the macro base station and the small base station perform DRX configuration for the user equipment, respectively, is identical to the above embodiment, which is thus not detailed here, but is incorporated here by reference.

With another embodiment in option 3 of the user plane as an example, suppose there are a plurality of radio bearers being transmitted on the macro base station, while on the macro base station and the small base station, there are one or more radio bearers being transmitted simultaneously. It is similar to scenarios of option 1 and option 2 of the user plane; the gain of separately configuring the DRX likewise depends on the number of receivers in the user equipment. Suppose there is only one receiver, then the gain of separately configuring the DRX is limited; even there will be no gain. However, suppose the user equipment has a plurality of receivers, since the DRX configurations are performed separately based on the characteristics of the traffic transmitted on each base station, the gain will be very significant. Here, the specific implementation manner of the macro base station and the small base station cooperatively or separately performing DRX configuration for the user equipment is identical to the above embodiment, which is thus not detailed here, but is incorporated here by reference.

The present invention also provides a macro base station for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the macro base station comprises:

a first configuration device configured to perform DRX configuration for the user equipment, wherein the user equipment is dual/plural connected to the macro base station and a small base station corresponding to the macro base station.

Preferably, the base station further comprises a first obtaining device configured to obtain the number of receivers in the user equipment reported by the user equipment; a second obtaining device configured to obtain, from the small base station, DRX candidate configuration information or radio bearer information and connection related information transmitted by the small base station, wherein the DRX candidate configuration information is obtained from the small base station performing candidate configuration for the user equipment; a cooperative configuration device configured to perform DRX configuration for the user equipment based on the DRX candidate configuration information or radio bearer information and connection related information transmitted by the small base station in conjunction with the radio bearer information and connection related information transmitted by the macro base station.

The present invention also provides a small base station for performing DRX configuration for a user equipment in a dual/plural connectivity wireless

communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the small base station comprises a second configuration device
5 configured to perform DRX configuration for the user equipment, wherein the user equipment is dual/plural connected to the small base station and a macro base station corresponding to the small base station.

Preferably, the small base station further comprises a second obtaining device configured to obtain the number of receivers in the user equipment reported by the
10 user equipment; a first transmitting device configured to transmit, to the macro base station, DRX candidate configuration information or radio bearer information and connection related information transmitted by the small base station, wherein the DRX candidate configuration information is obtained from the small base station performing candidate configuration for the user equipment.

The present invention also provides a user equipment for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base
15 station, wherein the user equipment comprises a second transmitting device configured to report the number of receivers in the user equipment to a corresponding macro base station and/or small base station, wherein the user equipment is dual/plural connected to the macro base station and the small base station.

It should be noted that the present invention may be implemented in software and/or a combination of software and hardware, for example, it may be implemented
25 by an application-specific integrated circuit ASIC, a general purpose computer or any other similar hardware device. In one embodiment, the software program of the present invention may be executed through a processor to implement the steps or functions as mentioned above. Likewise, the software program of the present invention (including relevant data structure) may be stored in the computer-readable recording medium, for example, RAM memory, magnetic or optic driver or floppy
30 disk or similar devices. Besides, some steps or functions of the present invention may be implemented by hardware, for example, as a circuit cooperating with the processor to execute various steps or functions.

Besides, a part of the present invention may be applied as a computer program product, for example, a computer program instruction, which, when executed by a computer, through the operation of the computer, may invoke or provide the method and/or technical solution of the present invention. However, the program instruction invoking the method of the present invention may be stored in a fixed or mobile
35 recording medium, and/or transmitted through a data stream in broadcast or other signal carrier medium, and/or stored in a working memory of a computer device running according to the program instruction. Here, one embodiment according to the present invention comprises an apparatus that includes a memory for storing computer program instructions and a processor for executing program instructions, wherein
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when the computer program instructions are executed by the processor, the apparatus is triggered to run the methods and/or technical solutions based on the previously mentioned multiple embodiments of the present invention.

5 To those skilled in the art, it is apparent that the present invention is not limited to the details of above exemplary embodiments, and the present invention can be implemented with other specific embodiments without departing the spirit or basic features of the present invention. Thus, from any perspective, the embodiments should be regarded as illustrative and non-limiting. The scope of the present invention is limited by the appended claims, instead of the above description. Thus, meanings of
10 equivalent elements falling within the claims and all variations within the scope are intended to be included within the present invention. Any reference numerals in the claims should be regarded as limiting the involved claims. Besides, it is apparent that such terms as “comprise” and “include” do not exclude other units or steps, and a single form does not exclude a plural form. The multiple units or modules as stated in
15 apparatus claims can also be implemented by a single unit or module through software or hardware. Terms such as first and second are used to represent names, not representing any specific sequence.

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CLAIMS

1. A method for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the method comprises:

- performing, by the macro base station and the small base station, DRX configuration for the user equipment, respectively;
- performing, by the user equipment, a separate DRX program for a connection to the macro base station and a connection to the small base station, respectively.

2. A method for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the method comprises:

A. cooperatively performing, by the macro base station and the small base station, DRX configuration for the user equipment;

wherein a manner of cooperative configuration comprises:

- performing, by the macro base station, DRX configuration for the user equipment based on configuration related information corresponding to the small base station in conjunction with radio bearer information and connection related information transmitted by the macro base station.

3. The method according to claim 2, wherein configuration related information corresponding to the small base station includes any one of the following:

- DRX candidate configuration information obtained from the small base station performing candidate configuration for the user equipment;
- radio bearer information and connection related information transmitted by the small base station.

4. A method for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the method comprises:

a. obtaining the number of receivers in the user equipment reported by the user equipment;

b. determining a configuration pattern of DRX configuration performed by the macro base station and the small base station for the user equipment based on the number of the receivers;

c. based on the configuration pattern, performing, by the macro base station and the small base station, DRX configuration corresponding to the configuration pattern for the user equipment.

5. The method according to claim 4, wherein the step b comprises:

- when the number of receivers is greater than a first predetermined number

threshold, determining the configuration pattern that the macro base station and the small base station perform DRX configuration for the user equipment, respectively;

wherein the method further comprises:

- performing, by the user equipment, a separate DRX program for a connection to the macro base station and a connection to the small base station, respectively.

6. The method according to claim 4, wherein the step b comprises:

- when the number of the receivers is less than a second predetermined number threshold, determining the configuration pattern that the macro base station and the small base station cooperatively perform DRX configuration for the user equipment.

7. The method according to claim 6, wherein the step c comprises:

c1. based on the configuration pattern, obtaining, by the macro base station, DRX candidate configuration information from the small base station, wherein the DRX candidate configuration information is obtained from the small base station performing candidate configuration for the user equipment;

c2. performing, by the macro base station, DRX configuration for the user equipment based on the DRX candidate configuration information in conjunction with radio bearer information and connection related information transmitted by the macro base station.

8. The method according to claim 6, wherein the step c comprises:

- based on the configuration pattern, performing, by the macro base station, DRX configuration for the user equipment based on radio bearer information and connection related information transmitted by the small base station obtained upon establishment of the dual/plural connection in conjunction with radio bearer information and connection related information transmitted by the macro base station.

9. The method according to claim 6, wherein the step c comprises:

- based on the configuration pattern, obtaining, by the macro base station, radio bearer information and connection related information transmitted by the small base station from the small base station;

- performing, by the macro base station, DRX configuration for the user equipment based on radio bearer information and connection related information transmitted by the small base station in conjunction with radio bearer information and connection related information transmitted by the macro base station.

10. A macro base station for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the macro base station comprises:

a first configuration device configured to perform DRX configuration for the user equipment, wherein the user equipment is dual/plural connected to the macro base station and a small base station corresponding to the macro base station.

11. The macro base station according to claim 10, wherein the base station further comprises:

a first obtaining device configured to obtain the number of receivers in the user

equipment reported by the user equipment;

a second obtaining device configured to obtain, from the small base station, DRX candidate configuration information or radio bearer information and connection related information transmitted by the small base station, wherein the DRX candidate configuration information is obtained from the small base station performing candidate configuration for the user equipment;

a cooperative configuration device configured to perform DRX configuration for the user equipment based on the DRX candidate configuration information or radio bearer information and connection related information transmitted by the small base station in conjunction with the radio bearer information and connection related information transmitted by the macro base station.

12. A small base station for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the small base station comprises:

a second configuration device configured to perform DRX configuration for the user equipment, wherein the user equipment is dual/plural connected to the small base station and a macro base station corresponding to the small base station.

13. The small base station according to claim 12, wherein the base station further comprises:

a second obtaining device configured to obtain the number of receivers in the user equipment reported by the user equipment;

a first transmitting device configured to transmit, to the macro base station, DRX candidate configuration information or radio bearer information and connection related information transmitted by the small base station, wherein the DRX candidate configuration information is obtained from the small base station performing candidate configuration for the user equipment.

14. A user equipment for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, wherein the wireless communication system comprises a user equipment and at least two base stations connected to the user equipment, the at least two base stations including at least one macro base station and at least one small base station, wherein the user equipment comprises:

a second transmitting device configured to report the number of receivers in the user equipment to a corresponding macro base station and/or small base station, wherein the user equipment is dual/plural connected to the macro base station and the small base station.

15. A wireless communication system for performing DRX configuration for a user equipment in a dual/plural connectivity wireless communication system, comprising at least one macro base station according to claim 10 or 11, at least one small base station according to claim 12 or 13, and a user equipment according to claim 14, wherein the user equipment is dual/plural connected to the at least one

macro base station and the at least one small base station.

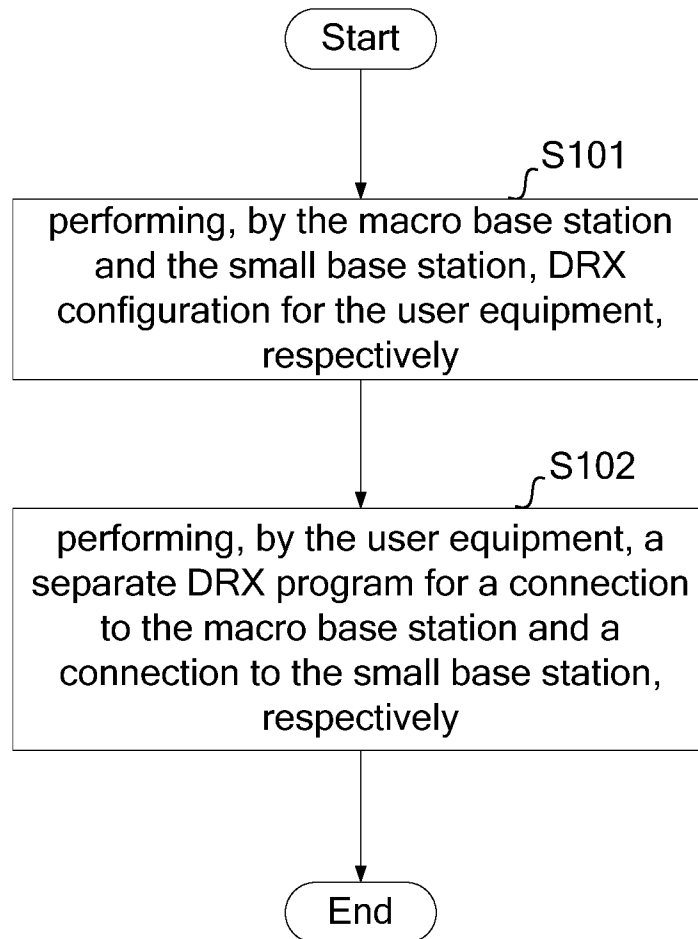


Fig.1

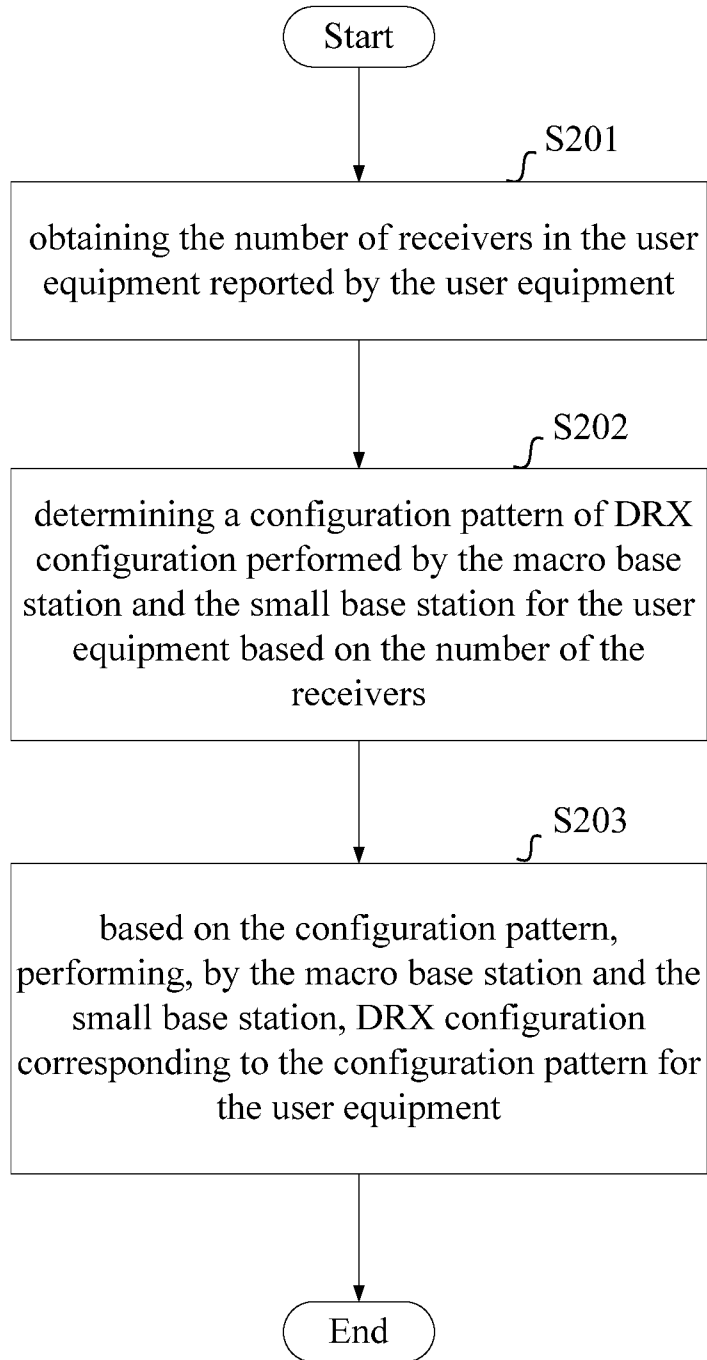


Fig.2