US008054777B2

(12) **United States Patent**
Jiang

(10) **Patent No.: US 8,054,777 B2**
(45) **Date of Patent: Nov. 8, 2011**

(54) **METHOD AND APPARATUS FOR HANDLING CONTROL PDUS DURING RE-ESTABLISHING RECEIVING SIDES IN A WIRELESS COMMUNICATIONS SYSTEM**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 579 days.

(21) Appl. No.: **11/524,486**

(22) Filed: **Sep. 21, 2006**

(65) **Prior Publication Data**

US 2007/0064600 A1 Mar. 22, 2007

Related U.S. Application Data

(60) Provisional application No. 60/596,402, filed on Sep. 21, 2005.

(51) **Int. Cl.**
H04W 4/00 (2009.01)

(52) **U.S. Cl.** **370/328**; 455/500; 455/69; 370/278; 370/394

(58) **Field of Classification Search** 714/748, 714/750; 455/36, 67.11, 69, 412.1, 414.1, 455/438, 501, 502, 68; 370/229, 280, 332–338, 370/349, 474, 469
See application file for complete search history.

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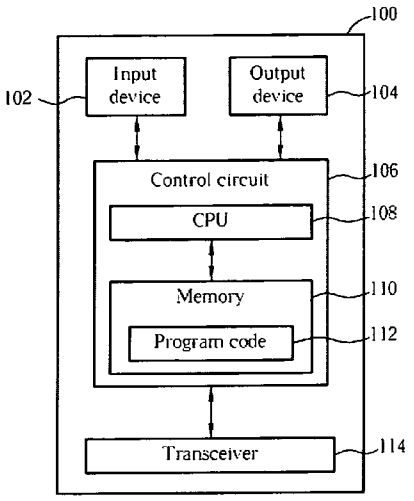
(57) **ABSTRACT**

A wireless communications system has a communications device, which has an RLC entity having a transmitting side and a receiving side. When re-establishing the receiving side, to handle control PDUs, only the receiving side in the RLC entity of the communications device is re-established, a first control PDU corresponding to the receiving side is discarded, and a second control PDU corresponding to the transmitting side is retained and not discarded.

16 Claims, 3 Drawing Sheets



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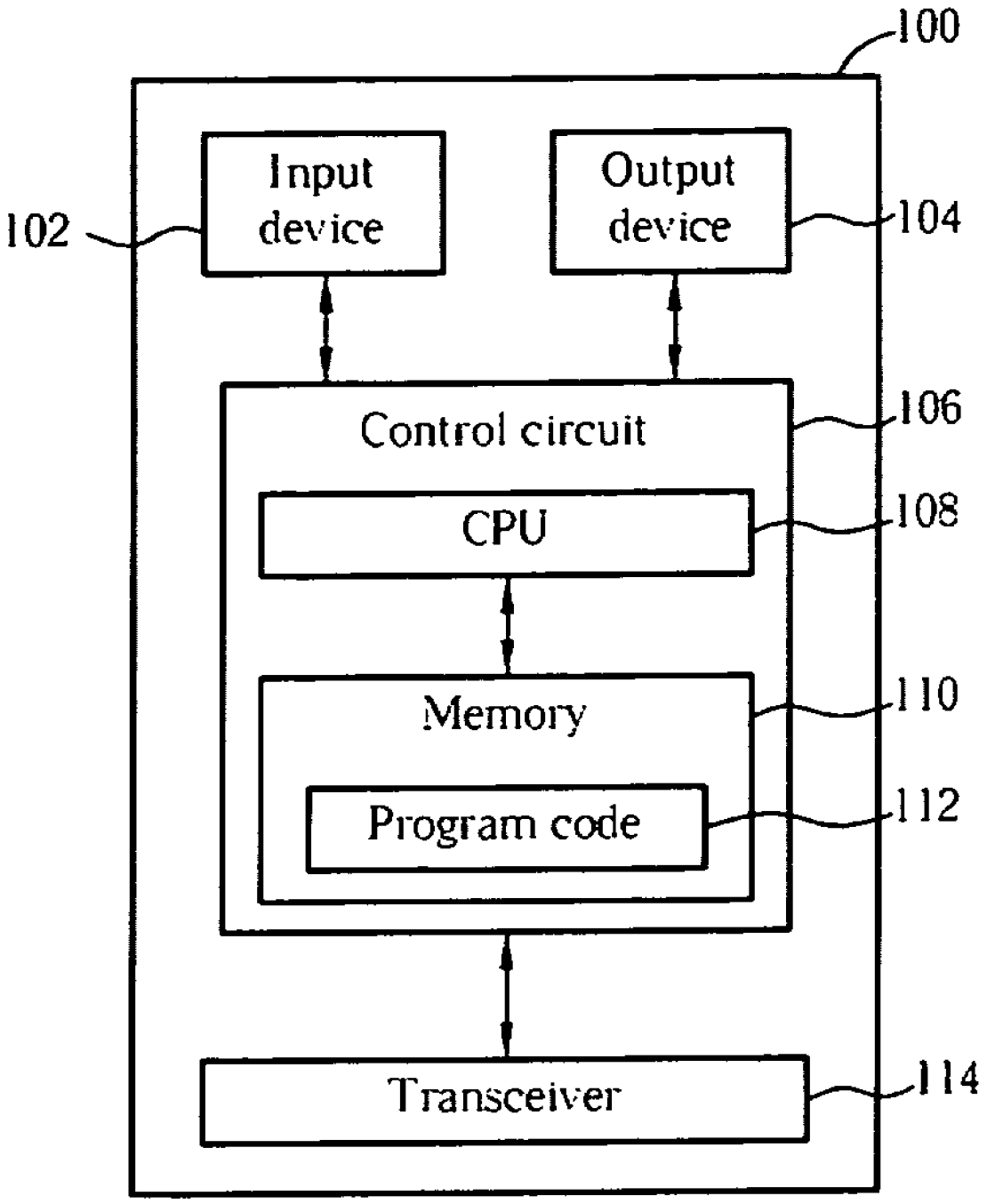
100
Input device
102
Output device
104
Control circuit
106
CPU
108
Memory
110
Program code
112
Transceiver
114

Fig. 1

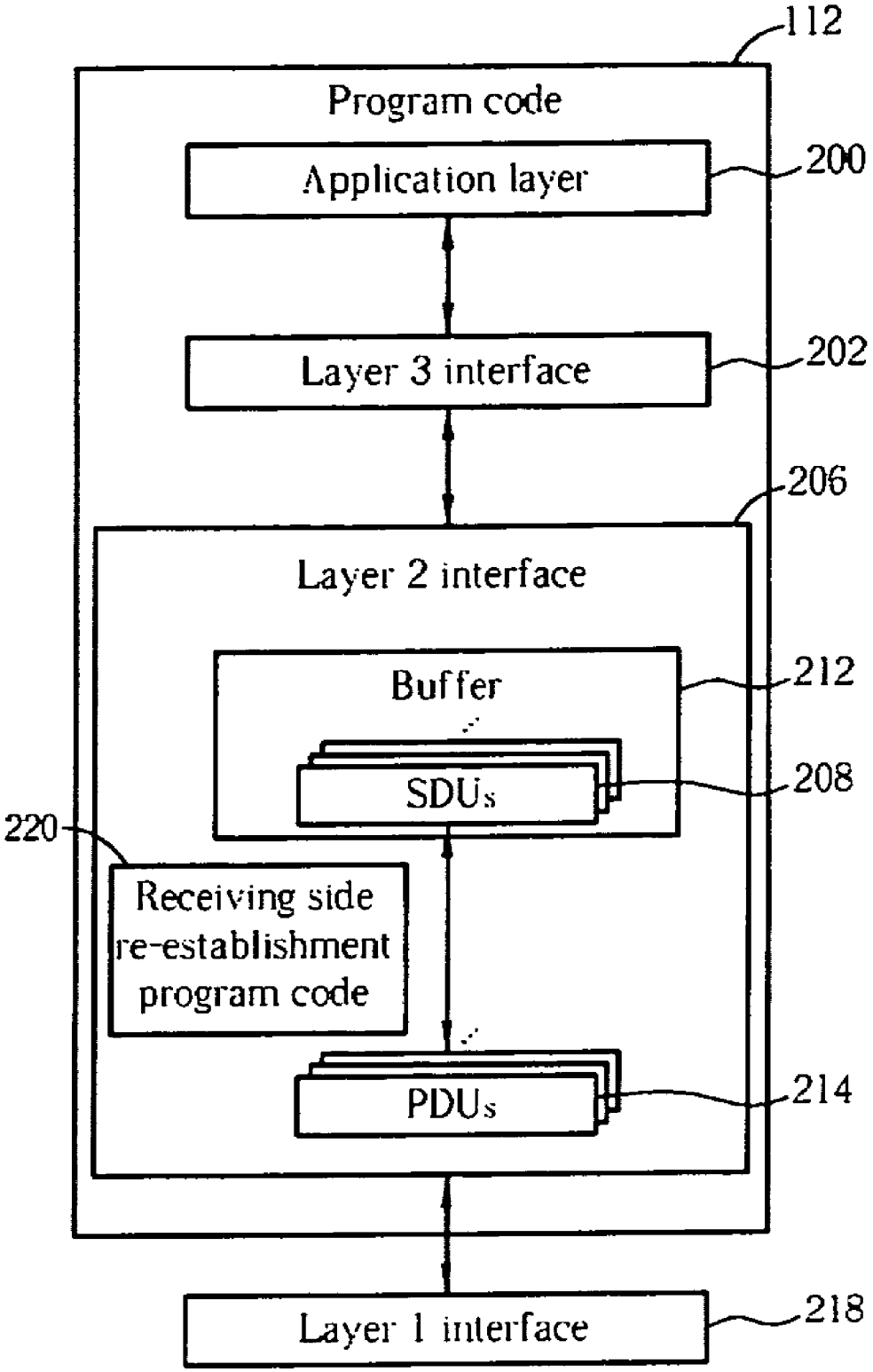
112
Program code
Application layer
200
Layer 3 interface
202
206
Layer 2 interface
Buffer
212
SDUs
208
220
Receiving side re-establishment program code
PDUs
214
Layer 1 interface
218

Fig. 2

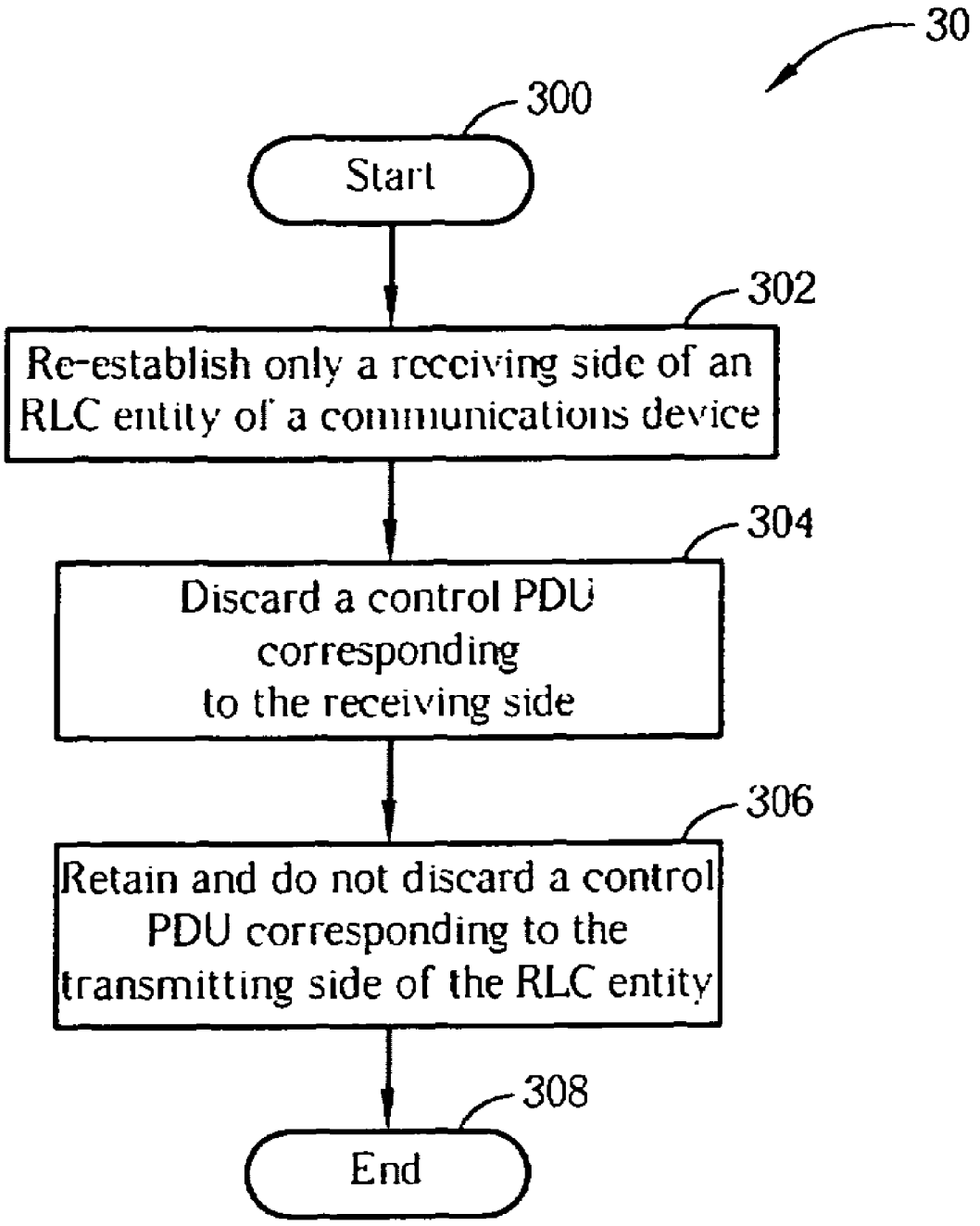
30
300
Start
302
Re-establish only a receiving side of an RLC entity of a communications device
304
Discard a control PDU corresponding to the receiving side
306
Retain and do not discard a control PDU corresponding to the transmitting side of the RLC entity
308
End

Fig. 3

METHOD AND APPARATUS FOR HANDLING CONTROL PDUS DURING RE-ESTABLISHING RECEIVING SIDES IN A WIRELESS COMMUNICATIONS SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 60/596,402, filed on Sep. 21, 2005 and entitled "Improved Single-Sided Re-establishment Method and Apparatus in a wireless communications system," the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to methods and related communications devices utilized in re-establishing a receiving side in a wireless communications system, and more particularly, to a method and related apparatus for handling control PDUs when only the receiving side of an RLC entity is re-established.

2. Description of the Prior Art

The third generation (3G) mobile communications system has adopted a Wideband Code Division Multiple Access (WCDMA) wireless air interface access method for a cellular network. WCDMA can provide high frequency spectrum utilization, universal coverage, and high quality, high speed multimedia data transmission. The WCDMA method also meets all kinds of QoS requirements simultaneously, providing diverse flexible two-way transmission services and better communication quality to reduce transmission interruption rates.

Taking a signal communications protocol standard set forth by the 3rd Generation Partnership Project (3GPP) as an example, targeting the Access Stratum (AS), the 3G mobile communications system defines various protocol stacks, such as Radio Resource Control (RRC), Radio Link Control (RLC), Media Access Control (MAC), Packet Data Convergence Protocol (PDCP), and Broadcast/Multicast Control (BMC). In addition, the 3G mobile communications system also provides different levels of transmission quality, and can operate in different corresponding modes according to different transmission quality requirements, such as: Transparent Mode (TM), Unacknowledged Mode (UM), and Acknowledged Mode (AM). TM is appropriate for use in services with high requirements for real-time transmission, UM is appropriate for use in services with requirements for real-time transmission and packet sequencing, and AM is appropriate for use in services with low requirements for real-time transmission, but high requirements for data accuracy.

In AM, the RLC layer combines a transmitting side and a receiving side. The transmitting side and the receiving side each process transmission and reception through the RLC layer, and both sides can share system resources. In some circumstances, the RLC layer must be reestablished, e.g. when changing the size of a protocol data unit. The prior art reestablishes the RLC layer by reestablishing the transmitting side or the receiving side.

Directed at operations corresponding to reestablishing the RLC layer, a communications protocol specification established by the 3GPP (3GPP TS 25.322 V6.4.0 (2005-06), "Radio Link Control (RLC) protocol specification (Release 6)") and a Change Request (R2-052168 "Single Sided RLC Re-establishment", Motorola, 3GPP RAN2 #48 meeting, August 2005) are already described in detail. The details of the communications protocol specification and the Change Request can be summarized as follows: When reestablishment of a transmitting side and/or a receiving side of an AM RLC entity is initiated by an upper layer, the RLC entity should execute the following two operations:

1. If the receiving side of the RLC entity is being reestablished, reset state variables (VR(R), VR(H), and VR(MR)) corresponding to a receiver; set configurable protocol parameters (Configured_Tx_Window_Size and Configured_Rx_Window_Size) corresponding to the receiver to accurate values; set a Hyper Frame Number of the receiving side (downlink of the receiver) to a value set by the upper layer; and discard all control PDUs of the receiving side and the transmitting side, and discard data PDUs of the receiving side. If only the receiving side is being reestablished, the prior arts described above have not yet disclosed a method of handling a timer.
2. If the transmitting side of the RLC entity is being reestablished, reset state variables (VT(S), VT(A), VT(DAT), VT(MS), VT(PDU), VT(SDU), VT(RST), VT(MRW), and VT(WS)) corresponding to a transmitter; set configurable protocol parameters (MaxDat, Poll_PDU, Poll_SDU, Poll_ Window, MaxRST, MaxMRW, OSD_Window_Size, and DAR_Window_Size) corresponding to the transmitter to accurate values; set a Hyper Frame Number of the transmitting side (uplink of the receiver) to a value set by the upper layer. In this operation, if only the transmitting side of the RLC entity is being reestablished, discard all control PDUs of both the receiving side and the transmitting side, and discard all already successfully transmitted SDUs of the transmitting end. Segment any not yet discarded SDUs into PDUs again based on a configured size of the PDU. If the transmitting side and the receiving side of the RLC entity are both being reestablished, discard the control PDUs of the receiving side and the transmitting side, and discard the data PDUs of the receiving side. If the transmitting side is being reestablished, regardless of whether or not the receiving side is being reestablished, stop all timers except for Timer_Poll_Periodic, Timer_Status_Periodic, and Timer_Discard, which corresponds to the SDUs that have not yet been discarded. Finally, if needed, inform the upper layer of the SDUs that have already been discarded.

When only the receiving side is being reestablished, the prior art discards all of the control PDUs of the receiving side and the transmitting side, which may cause an error in operation of the system. For example, a Move Receiving Window Super-Field (MRW SUFI) PDU of an SDU discard command has already been transmitted before the receiving side is reestablished, but has been lost in the transmission process, because the prior art discards all of the control PDUs when only the receiving side is being reestablished, the MRW SUFI PDU cannot be retransmitted, such that the SDU discard process cannot be accurately executed in the transmitting side. Likewise, if the RLC layer reset process has already been initiated in the transmitting side before the receiving side is reestablished, but the RESET PDU has been lost in a transmission process, because the prior art discards all of the control PDUs when only the receiving side is being reestablished, including the RESET PDU, the RESET PDU cannot be retransmitted, and the reset process cannot be executed smoothly.

SUMMARY OF THE INVENTION

According to the present invention, a method of handling control PDUs in a wireless communications system having a communications device having an RLC entity having a trans-

mitting side and a receiving side when reestablishing the receiving side comprises only reestablishing the receiving side in the RLC entity of the communications device, discarding a first control PDU corresponding to the receiving side, and retaining and not discarding a second control PDU corresponding to the transmitting side.

According to the present invention, a communications device utilized in a wireless communications system, an RLC entity of the communications device having a transmitting side and a receiving side, utilized for accurately reestablishing the receiving side, the communications device comprises a control circuit for realizing functions of the communications device, a central processing unit for executing a program code to operate the control circuit, and a memory for storing the program code. The program code comprises only reestablishing the receiving side in the RLC entity of the communications device, discarding a first control PDU corresponding to the receiving side, and retaining and not discarding a second control PDU corresponding to the transmitting side.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a functional block diagram of a communications device according to the present invention.

FIG. **2** is a diagram of program code of FIG. **1**.

FIG. **3** is a flow chart diagram of a process according to the present invention.

DETAILED DESCRIPTION

In the communications protocol specification (3GPP TS 25.322 V6.4.0 (2005-06), "Radio Link Control (RLC) protocol specification (Release 6)") established by the 3GPP, parameters, variables, timers, and control PDUs, etc. are defined according to different operating requirements. Based on the above-mentioned communications protocol specification, the parameters, variables, and timers can be defined as corresponding to the transmitting side or the receiving side of the RLC layer. Taking status variables for AM as an example, status variables corresponding to status of the receiving side comprise VR(R), VR(H), and VR(MR). Status variables corresponding to status of the transmitting side comprise VT(S), VT(A), VT(DAT), VT(MS), VT(PDU), VT(SDU), VT(RST), VT(MRW), and VT(WS). Timers corresponding to the receiving side comprise Timer_Status_Periodic and Timer_Status_Prohibit. Timers corresponding to the transmitting side comprise Timer_Poll, Timer_Poll_Periodic, Timer_Poll_Prohibit, Timer_Discard, Timer_RST, and Timer_MRT. Protocol parameters corresponding to the receiving side comprise Configured_Tx_Window_Size and Configured_Rx_Window_Size. Protocol parameters corresponding to the transmitting side comprise MaxDAT, Poll_PDU, Poll_SDU, Poll_Window, MaxRST, MaxMRW, OSD_Window_Size, and DAR_Window_Size. Definitions for the above-mentioned status variables, timers, and protocol variables can be found in the communications protocol specification, and are not repeated here.

However, regarding control PDUs, the above-mentioned communications protocol specification does not clearly define which control PDUs correspond to the receiving side of the RLC layer, and which control PDUs correspond to the transmitting side of the RLC layer. In order to clearly describe the spirit of the present invention, the following is a definition of which side each control PDU corresponds to. First, the above-mentioned communications protocol specification separates the control PDUs into three broad categories: 1) STATUS PDUs and Piggybacked STATUS PDUs, 2) RESET PDUs, and 3) RESET ACK PDUs. The first type of control PDU is primarily comprised of a header (for indicating the type of PDU), one or a plurality of super fields (SUFI), and a PAD. By setting information carried by the SUFIs, the STATUS PDU and the Piggybacked STATUS PDU can become one of the following types:

1. ACK/NACK: A receiving status report which the receiver reports back to the transmitter regarding information about received or lost PDUs.
2. Change Window Size: Information transmitted to the transmitter by the receiver requesting the transmitter change the size of the transmission window.
3. MRW: A request by the transmitter of the receiver to advance a position of the receiving window of the receiver.
4. MRW ACK: Report sent to the receiver from the transmitter to acknowledge that the transmitter has already received a STATUS PDU comprising an MRW.

On the other hand, the RESET PDU is transmitted to the receiver from the transmitter, and used to achieve synchronization by resetting all of the protocol parameters, status variables, and some of timers. Analogously, the RESET ACK PDU is a report sent by the receiver to the transmitter to acknowledge receipt of the RESET PDU.

The ACK/NACK, Change Window Size, and MRW ACK STATUS PDUs and the RESET ACK PDU all correspond to the receiving side of the RLC layer. The MRW STATUS PDU and the RESET PDU correspond to the transmitting side of the RLC layer.

Having clearly defined which control PDUs correspond to which side of the RLC layer, we can now move on to describe the embodiments of the present invention.

The present invention relates to a wireless communication system operating in Acknowledged Mode, and is utilized to re-establish the receiving side accurately, so as to improve wireless transmission efficiency and prevent system errors. The wireless communications system is preferably a 3G mobile communications system.

Please refer to FIG. **1**, which is a functional block diagram of a communications device **100**. For the sake of brevity, FIG. **1** only shows an input device **102**, an output device **104**, a control circuit **106**, a central processing unit (CPU) **108**, a memory **110**, a program code **112**, and a transceiver **114** of the communications device **100**. In the communications device **100**, the control circuit **106** executes the program code **112** in the memory **110** through the CPU **108**, thereby controlling an operation of the communications device **100**. The communications device **100** can receive signals input by a user through the input device **102**, such as a keyboard, and can output images and sounds through the output device **104**, such as a monitor or speakers. The transceiver **114** is used to receive and transmit wireless signals, delivering received signals to the control circuit **106**, and outputting signals generated by the control circuit **106** wirelessly. From a perspective of a communications protocol framework, the transceiver **114** can be seen as a portion of Layer 1, and the control circuit **106** can be utilized to realize functions of Layer 2 and Layer 3.

Please continue to refer to FIG. **2**. FIG. **2** is a diagram of the program code **112** shown in FIG. **1**. The program code **112** comprises an application layer **200**, a Layer 3 interface **202**, and a Layer 2 interface **206**, and is coupled to a Layer 1 interface **218**. When a signal is transmitted, the Layer 2 interface **206** forms a plurality of SDUs **208** according to data

submitted by the Layer 3 interface **202**, and stores the plurality of SDUs **208** in a buffer **212**. Then, based on the SDUs **208** stored in the buffer **212**, the Layer 2 interface **206** generates a plurality of PDUs **214**, and sends the plurality of PDUs **214** to a destination terminal through the Layer 1 interface **218**. In contrast, when a wireless signal is received, the signal is received through the Layer 1 interface **218**, then delivered as PDUs **214** to the Layer 2 interface **206**. The Layer 2 interface **206** restores the PDUs **214** to SDUs **208** and stores the SDUs **208** in the buffer **212**. Last, the Layer 2 interface **206** delivers the SDUs **208** stored in the buffer **212** to the Layer 3 interface **202**.

When the communications device **100** operates in AM, the Layer 2 interface **206** is a combination of the transmitting side and the receiving side. The transmitting side and the receiving side respectively represent the transmitting and receiving portions of the RLC layer. In some circumstances, the program code **112** must re-establish the Layer 2 interface **206**. The present invention can re-establish the Layer 2 interface **206** through re-establishing the receiving side based on receiving side re-establishment program code **220**.

Please refer to FIG. **3**, which is a diagram of a process **30** according to the present invention. The process **30** is utilized to re-establish the receiving side of the wireless communications system, and can be seen as the receiving side re-establishment program code **220**. The process **30** comprises steps of:

Step **300**: Start.

Step **302**: Re-establishing only a receiving side of an RLC entity of a communications device.

Step **304**: Discarding a control PDU corresponding to the receiving side.

Step **306**: Retaining and not discarding a control PDU corresponding to the transmitting side of the RLC entity.

Step **308**: End.

According to the process **30**, when the RLC entity only re-establishes the receiving side, the present invention discards the control PDU corresponding to the receiving side, and retains and does not discard the control PDU corresponding to the transmitting side. As mentioned previously, the control PDUs corresponding to the receiving side comprise the ACK/NACK, Change Window Size, and MRW ACK STATUS PDUs, and the RESET ACK PDU, of which at least one is discarded in Step **304**. On the other hand, the process **30** does not discard the control PDU corresponding to the transmitting side, such as the MRW STATUS PDU and the REST PDU, of which at least one will be retained, and not discarded, in Step **306**.

Thus, when the RLC entity only re-establishes the receiving side, the preferred embodiment of the present invention discards the control PDU (ACK/NACK, Change Window Size, and MRW ACK STATUS PDU and RESET ACK PDU) corresponding to the receiving side, and does not discard the MRW PDU corresponding to the transmitting side. Thus, after re-establishing only the receiving side, the system can accurately execute an MRW process. Likewise, in another embodiment of the present invention, the RESET PDU is not discarded, such that after the receiving side has been re-established, the system can accurately execute a RESET process to improve system efficiency.

Simply speaking, through the process **30**, when the RLC entity only re-establishes the receiving side, the control PDU corresponding to the receiving side can be discarded and the control PDU corresponding to the transmitting side can be retained to improve the system efficiency.

Thus, the present invention provides the process of only re-establishing the receiving side of the RLC layer, which not only increases the efficiency of wireless resource use, but also makes related processes (such as RESET and discard SDU processes) execute more accurately.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A method of handling control Protocol Data Units (PDU's) in a wireless communications system having a communications device having an Radio Link Control (RLC) entity having a transmitting side and a receiving side when reestablishing the receiving side comprising:

only reestablishing the receiving side in the RLC entity of the communications device;

discarding a first control PDU corresponding to the receiving side; and

retaining and not discarding a second control PDU corresponding to the transmitting side

wherein the first control PDU corresponding to the receiving side is a Move Receiving Window (MRW) Acknowledgment (ACK) Status PDU.

2. A communications device utilized in a wireless communications system, and Radio Link Control (RLC) entity of the communications device having a transmitting side and a receiving side, utilized for accurately reestablishing the receiving side, the wireless communications device comprising:

a control circuit for realizing functions of the wireless communications device;

a central processing unit for executing a program code to operate the control circuit; and

a memory for storing the program code;

wherein the program code comprises:

only reestablishing the receiving side in the RLC entity of the communications device;

discarding a first control Protocol Data Unit (PDU) corresponding to the receiving side; and

retaining and not discarding a second control PDU corresponding to the transmitting side

wherein the first control PDU corresponding to the receiving side is a Move Receiving Window (MRW) Acknowledgment (ACK) Status PDU.

3. The method of claim **1**, wherein the first control PDU corresponding to the receiving side is an ACK/Negative Acknowledgement (NACK) Status PDU.

4. The method of claim **1**, wherein the first control PDU corresponding to the receiving side is a Change Window Size Status PDU.

5. The method of claim **1**, wherein the first control PDU corresponding to the receiving side is a RESET ACK PDU.

6. The method of claim **1**, wherein the second control PDU corresponding to the transmitting side is a Move Receiving Window (MRW) Status PDU.

7. The method of claim 1, wherein the second control PDU corresponding to the transmitting side is a RESET PDU.

8. The method of claim 1, wherein the wireless communications system operates in Acknowledged Mode.

9. The method of claim 1, wherein the communications device is a mobile phone, a wireless mobile communications device, or a networking device.

10. The wireless communications device of claim 2, wherein the first control PDU corresponding to the receiving side is an ACK/Negative Acknowledgement (NACK) Status PDU.

11. The wireless communications device of claim 2, wherein the first control PDU corresponding to the receiving side is a Change Window Size Status PDU.

12. The wireless communications device of claim 2, wherein the first control PDU corresponding to the receiving side is a RESET ACK PDU.

13. The wireless communications device of claim 2, wherein the second control PDU corresponding to the transmitting side is a Move Receiving Window (MRW) Status PDU.

14. The wireless communications device of claim 2, wherein the second control PDU corresponding to the transmitting side is a RESET PDU.

15. The wireless communications device of claim 2, wherein the wireless communications system operates in Acknowledged Mode.

16. The wireless communications device of claim 2, wherein the communications device is a mobile phone, a wireless mobile communications device, or a networking device.

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