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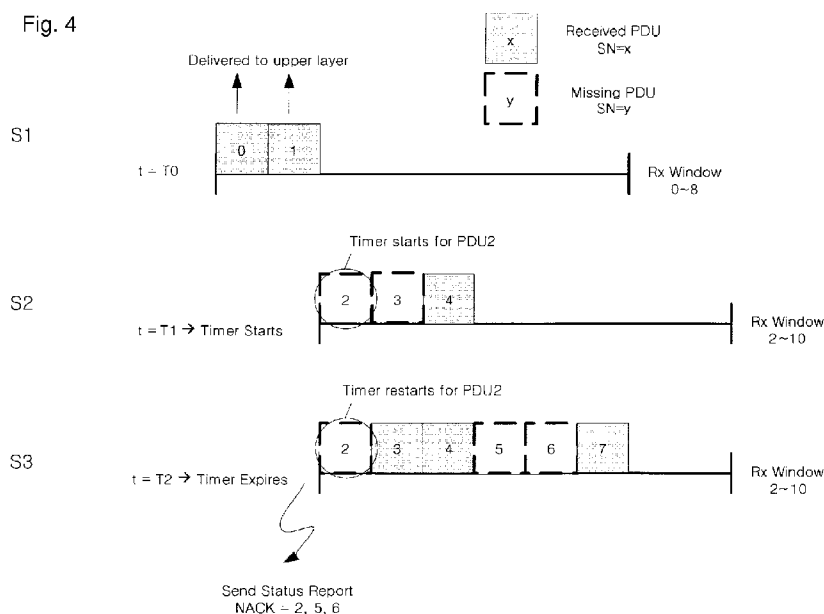
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(54) Title: METHOD FOR ENHANCING OF CONTROLLING RADIO RESOURCES, METHOD FOR TRANSMITTING STATUS REPORT, AND RECEIVER IN MOBILE COMMUNICATION SYSTEM

Fig. 4



(57) Abstract: A method for improving radio resources, a method for transmitting a status report, and a receiving apparatus (receiver) in a mobile communication system are disclosed. In transmitting a status report by a receiving side RLC, although data that has not been received (missing PDU) is discovered, the receiving side does not immediately request its retransmission but transmits the status report after the lapse of a certain time (namely, a time point at which a timer expires), to thus reduce radio resources consumed for transmission of the status report.

Description

METHOD FOR ENHANCING OF CONTROLLING RADIO RESOURCES, METHOD FOR TRANSMITTING STATUS REPORT, AND RECEIVER IN MOBILE COMMUNICATION SYSTEM

Technical Field

- [1] The present invention relates to a radio protocol of a mobile telecommunications system and, more particularly, to a method for enhancing of controlling radio resources, a method for transmitting a status report, and a receiving apparatus in an Evolved Universal Mobile Telecommunications System (E-UMTS) that has been evolved from a UMTS.

Background Art

- [2] FIG. 1 is a network structure of an LTE (Long Term Evolution) system, the related art mobile communication system. For the LTE system, which has evolved from the existing UMTS system, basic standardizations are ongoing in the 3GPP.
- [3] An LTE network can be divided into an E-UTRAN (Evolved UMTS Terrestrial Radio Access Network) and a CN (Core Network). The E-UTRAN includes a terminal (or UE (User Equipment)), a base station (eNB (Evolved Node B)), and an access gateway (aGW). The access gateway may be divided into a part that handles processing of user traffic and a part that handles control traffic. In this case, the access gateway part that processes the user traffic and the access gateway part that processes the control traffic may communicate with a new interface. One or more cells may exist in a single eNB. An interface may be used for transmitting user traffic or control traffic between eNBs. The CN may include the access gateway and a node or the like for user registration of the UE. An interface for discriminating the E-UTRAN and the CN may be used.
- [4] FIG. 2 shows an exemplary structure of a control plane of a radio interface protocol between the UE and the E-UTRAN based on the 3GPP radio access network standards. FIG. 3 shows an exemplary structure of a user plane of the radio interface protocol between the UE and the E-UTRAN based on the 3GPP radio access network standards.
- [5] The structure of the radio interface protocol between the UE and the E-UTRAN will now be described with reference to FIGs. 2 and 3.
- [6] The radio interface protocol has horizontal layers comprising a physical layer, a data link layer, and a network layer, and has vertical planes comprising a user plane (U-plane) for transmitting user data information and a control plane (C-plane) for

transmitting control signals. The protocol layers in FIGs. 2 and 3 can be classified into a first layer (L1), a second layer (L2), and a third layer (L3) based on three lower layers of an open system interconnection (OSI) standard model widely known in the communication system. The radio protocol layers exist as pairs between the UE and the E-UTRAN and handle a data transmission in a radio interface.

- [7] The layers of the radio protocol control plane of FIG. 2 and those of the radio protocol user plane of FIG. 3 will be described as follows.
- [8] The physical layer, the first layer, provides an information transfer service to an upper layer by using a physical channel. The physical layer is connected to an upper layer called a medium access control (MAC) layer via a transport channel. Data is transferred between the MAC layer and the physical layer via the transport channel. The transport channel is divided into a dedicated transport channel and a common channel according to whether or not a channel is shared. Between different physical layers, namely, between a physical layer of a transmitting side and that of a receiving side, data is transmitted via the physical channel.
- [9] The second layer includes various layers. First, a medium access control (MAC) layer performs mapping various logical channels to various transport channels and performs logical channel multiplexing by mapping several logical channels to a single transport channel. The MAC layer is connected an upper layer called a radio link control (RLC) layer by a logical channel. The logical channel is divided into a control channel that transmits information of the control plane and a traffic channel that transmits information of the user plane according to a type of transmitted information.
- [10] An RLC (Radio Resource Control) layer, the second layer, segments and/or concatenates data received from an upper layer to adjust the data size so as for a lower layer to suitably transmit the data to a radio interface. In addition, in order to guarantee various QoSs (Quality of services) required by each radio bearer RB, the RLC layer provides three operational modes: a TM (Transparent Mode); a UM (Unacknowledged Mode); and an AM (Acknowledged Mode). In particular, the RLC layer (referred to as an 'AM RLC layer', hereinafter) operating in the AM performs a retransmission function through an automatic repeat and request (ARQ) function for a reliable data transmission.
- [11] A packet data convergence protocol (PDCP) layer of the second layer performs a function called header compression that reduces the size of a header of an IP packet, which is relatively large and includes unnecessary control information, in order to effectively transmit the IP packet such as an IPv4 or IPv6 in a radio interface having a narrow bandwidth. The header compression increases a transmission efficiency between radio interfaces by allowing the head part of the data to transmit only the essential information.

- [12] The RRC layer located at the lowermost portion of the third layer is defined only in the control plane, and controls a logical channel, a transport channel and a physical channel in relation to configuration, reconfiguration, and the release of radio bearers (RBs). In this case, the RBs refer to a logical path provided by the first and second layers of the radio protocol for data transmission between the UE and the UTRAN. In general, configuration (or establishment) of the RB refers to the process of stipulating the characteristics of a radio protocol layer and a channel required for providing a particular data service, and setting the respective detailed parameters and operational methods.
- [13] Hereinafter, the RLC layer will be explained in more detail. As afore-mentioned, the RLC layer operates in three modes, TM, UM, and AM. Since the RLC layer performs a simple a function in the TM, only the UM and AM will be explained.
- [14] The UM RLC generates each PDU with a PDU header including a Sequence Number (SN), thereby allowing a receiving side to know which PDU has been lost while being transmitted. Accordingly, the UM RLC transmits broadcast/multicast data or transmits real-time packet data such as voice (e.g., VoIP) of a Packet Service domain (PS domain) or streaming on a user plane. Also, on a control plane, the UM RLC transmits, to a specific terminal or specific terminal group in a cell, an RRC message requiring no response for reception acknowledgement.
- [15] Like the UM RLC, the AM RLC generates each PDU with a PDU header including a Sequence Number (SN). Differently from the UM RLC, in the AM RLC, a receiving side performs acknowledgement for PDUs transmitted from a sending side. In the AM RLC, the reason why the receiving side performs acknowledgement is to request the sending side to retransmit a PDU if the receiving side fails to receive the PDU. The re-transmission function is the main characteristic part of the AM RLC. The AM RLC aims to guarantee error-free data transmission using the re-transmission function. To this end, the AM RLC handles transmission of non-real time packet data such as TCP/IP of PS domain in the user plane, and transmits an RRC message that necessarily requires a reception acknowledgement among RRC message transmitted to a specific terminal in a cell in the control plane.
- [16] In terms of directionality, the UM RLC is used for uni-directional communications, while the AM RLC is used for bi-directional communications due to feedback from the receiving side. The UM RLC is different from the AM RLC in the aspect of configuration. The UM RLC and the AM RLC are different in terms of structural aspect: the UM RLC is that a single RLC entity has only one structure of transmission or reception but the AM RLC is that both a sending side and a receiving side exist in a single RLC entity.
- [17] The AM RLC is complicated due to its re-transmission function for data. The AM

RLC is provided with a retransmission buffer as well as a transmission/reception buffer for retransmission management. The AM RLC performs many functions, e.g., usage of a transmission/reception window for flow control, polling to request a status information (status report) from a receiving side of a peer RLC entity by a sending side, a receiving side's status report informing about its buffer status to a sending side of a peer RLC entity, and generating of a status PDU to transmit status information, or the like.

- [18] In order to support those functions, the AM RLC requires various protocol parameters, status variables, and timers.
- [19] The PDUs used for controlling data transmission in the AM RLC such as the status report or a status PDU are called control PDUs, and PDUs used for transferring user data are called data PDUs.
- [20] A data loss may occur in a physical channel in all mobile telecommunications systems. Although the probability that data is not properly transferred from a sending side to a receiving side at a physical layer is much lower in an Evolved Universal Terrestrial Radio Access Network (E-UTRAN) than in the related art systems, but the probability of a data loss in the E-UTRAN is not completely 'zero'. Especially, as terminals become away from a base station, they have an increasing data loss rate. Thus, important signaling data or TCP data required to be transmitted without an error should be managed with a more special care. To this end, the afore-mentioned Acknowledged Mode (AM) is used.
- [21] In using the AM, if a receiving side fails to receive data, the receiving side should quickly inform a sending side accordingly. If time taken for the receiving side to recognize a data reception error and inform the sending side about the error is shortened, time taken for correcting the error would be shortened and also time taken for transmission failure of user data would be shortened, enhancing user's satisfaction. Thus, on an RLC layer, the receiving side informs the sending side about its buffer status and requests retransmission of data that has not been received through an RLC status report.
- [22] In this respect, however, if the RLC receiving side transmits the status report whenever it detects missing data, radio resources would be wasted. The RLC status report is transmitted through an RLC status PDU, so because the RLC status PDU is also an RLC PDU, the RLC status report consumes a certain amount of radio resources when transmitted.
- [23] Thus, a mechanism that may allow an RLC status report to be transmitted not too late and consume not too much radio resource is required.

Disclosure of Invention

Technical Solution

- [24] Therefore, it is an object of the present invention to provide a method for configuring a new L2 protocol in a Long Term Evolution (LTE) system that transmits a newly defined RLC status report.
- [25] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein,
- [26] there is provided a method for transmitting a status report in a mobile communication system, including: (A) when a receiving side receives a PDU (Protocol Data Units) from a sending side out of sequence, starting, by the receiving side, a timer at a lower edge of a reception window when the receiving side receives a PDU (Protocol Data Unit) from a sending side out of sequence,; and (B) if the timer expires in a state that a PDU corresponding to the lower edge of the reception window is not received yet, transmitting, by the receiving side, to the sending side, a status report including information about PDUs which have not been received until the expiration of the timer, to the sending side if the timer expires in a state that a PDU corresponding to the lower edge of the reception window is not received.
- [27] In step (A), if the PDU is received from the sending side out of sequence and no timer is active, the timer is start.
- [28] The method for transmitting a status report may further include: stopping timer if the PDU corresponding to the lower edge of the reception window is received before the timer expires; and delivering the received PDU and/or the following in-sequence PDU to an upper layer.
- [29] The method for transmitting a status report may further include: shifting, by the receiving side, the reception window such that the lower edge of the reception window corresponds to the first PDU which has not been received, after the received PDU and/or the following in-sequence PDU are delivered to the upper layer; checking whether there is any PDU stored in the shifted reception window; and re-starting the timer with respect to the lower edge of the shifted reception window if there is a PDU stored in the reception window.
- [30] The step (B) may further include: re-starting the timer with respect to the lower edge of the reception window after the status report is transmitted to the receiving side as the timer expires.
- [31] The receiving side may be a network, the receiving side may be a terminal, and the steps (A) and (B) may be performed by an RLC (Radio Link Control) entity of the terminal.
- [32] The value of time period of the timer is determined by the sending side and transmitted to the receiving side.

- [33] To achieve the above object, there is also provided an apparatus including: a reception buffer that stores PDUs transmitted by a sending side; a timer that operates during a pre-set time period if there is a PDU which has not been received at a lower edge of a reception window; and a processing unit that sets the reception window, determines whether there is a PDU which has not been received among the PDUs that have been received by the reception window, by using an SNs (Sequence Numbers) of the PDUs, and starts the timer for the lower edge of the reception window for which there exists the first PDU which has not been received.
- [34] If the corresponding PDU for which the timer was started has not been received at a time point when the timer expires, the processing unit transmits a status report including information about missing PDUs that have not been received at the time point when the timer expires, to the sending side.
- [35] The PDU that has not been received is a missing PDU.
- [36] The present invention is advantageous in that if certain data is not received, the data is not immediately requested to be re-transmitted but after a certain time lapses, several data that have not been received are collected and requested to be retransmitted, to thus reduce radio resources consumed for the request for retransmission.
- [37] The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

- [38] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description, and serve to explain the principles of the invention.
- [39] In the drawings:
- [40] FIG. 1 shows a network structure of a Long Term Evolution (LTE), the related art mobile communication system;
- [41] FIG. 2 shows the architecture of a control plane a radio interface protocol between a terminal and an Evolved-UMTS Terrestrial Radio Access Network (E-UTRAN) based on 3GPP radio access network standards;
- [42] FIG. 3 shows the architecture of a user plane of the radio interface protocol between a terminal and an Evolved-UMTS Terrestrial Radio Access Network (E-UTRAN) based on 3GPP radio access network standards;
- [43] FIG. 4 is a block diagram showing a method of transmitting a status report by a receiving side to a sending side as a timer expires according to an embodiment of the present invention; and

- [44] FIG. 5 is a block diagram showing a method of stopping a timer as a PDU, for which the timer has been started, is received according to an embodiment of the present invention.

Mode for the Invention

- [45] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.
- [46] The present invention is applied to a mobile telecommunications system and, more particularly, to an Evolved Universal Mobile Telecommunications System (E-UMTS) that has evolved from UMTS. However, without being limited thereto, the present invention may be also applied to any mobile telecommunications system and communication protocol to which technical features of the present invention is applicable.
- [47] Thus, a basic concept of the present invention is that 1) if data that has not been received (referred to as 'missing 'PDU', hereinafter) is detected by a receiving side (i.e., a terminal) RLC entity, 2) the missing data is not immediately requested to be re-transmitted but a status report with respect to status information about data that have not been received is transmitted after a certain period of time, 3) to thus reduce radio resources consumed for transmission of the status report.
- [48] In order to implement such concept of the present invention, the receiving side RLC includes a timer, and if particular conditions (i.e., timer starting conditions) are met, the timer is started, and then if particular conditions (i.e., timer stopping conditions) are met, the started (activated) timer is stopped. If the stopping conditions are not met until the timer expires, a status report is transmitted to a sending side (i.e., a network) RLC. Thereafter, if the particular conditions (i.e., the timer starting conditions) are met, the timer is re-started.
- [49] Here, the operation method of the RLC and the report transmission conditions vary depending on the starting conditions and stopping conditions of the timer, and the present invention proposes timer starting and stopping conditions as follows. Preferably, one timer is activated at a time.
- [50] The timer starting conditions will now be described.
- [51] First, a certain RLC PDU is received out of sequence.
- [52] Second, there should be no timer being currently active.
- [53] If the timer starting conditions are met and a timer is started, the timer is started for a PDU corresponding to a lower edge of the reception window.
- [54] The stopping conditions of the timer will now be described.
- [55] When a corresponding PDU, for which the timer has been started, namely, a PDU, which corresponds to a lower edge of the reception window, is received, the timer is stopped. When the timer is stopped, the PDU for which the timer was started and the

following PDU are delivered to an upper layer. The lower edge of the reception window is shifted to a PDU that has not been firstly received after the successive PDUs. If a PDU is not delivered to the upper layer but continuously stored in a reception buffer, a timer is re-started for the PDU corresponding to the lower edge of the shifted reception window.

- [56] The operation when the timer expires will now be described.
- [57] If the timer stopping conditions are not met until the timer expires, the receiving side RLC configures a status report including information about PDUs that have not been received and transmits the status report to the sending side RLC. And then, the receiving side RLC re-starts the timer for a PDU corresponding to the lower edge of the reception window.
- [58] The operation of the receiving side RLC according to the timer starting and stopping conditions and operations will now be described in detail.
- [59] - eNB RRC (network or sending side) decides the value of a missing PDU timer and informs a terminal RRC (i.e., UE RRC) accordingly. Here, the value of the missing PDU timer refers to a value of time period during which the timer operates for the PDU corresponding to the lower edge of the reception window (namely, the first missing PDU in the reception window). The eNB refers to an entity of a network, namely, a base station. The eNB RRC is an RRC layer of the base station, the sending side. The terminal RRC is an RRC layer of the terminal, the receiving side.
- [60] - The UE RRC configures a UE RLC with "Expiry of a missing PDU timer" trigger for status reporting, and informs UE RLC about the value of the missing PDU timer.
- [61] Upon reception of a RLC PDU, the receiving side RLC entity shall perform the following operations:
- [62] 1) If the RLC PDU is received in sequence, the RLC PDU is delivered to the upper layer, and then, all the following in-sequence RLC PDUs are delivered to the upper layer. If there is any remaining PDU in the reception buffer, the lower edge of the reception window is set to the first missing PDU in the reception buffer. If, however, there is no remaining PDU in the reception buffer, the lower edge of the reception window is set (shifted) to the next PDU expected to be received.
- [63] 2) If the RLC PDU is received out-of-sequence, the RLC PDU is stored in the reception buffer at the position indicated by its RLC sequence number. If there is no active missing PDU timer, a missing PDU timer is started for the lower edge of the reception buffer.
- [64] - Upon reception of an RLC PDU whose sequence number is the same as the lower edge of the reception window, the receiving side RLC entity performs the following operation:
- [65] 1) The missing PDU timer is stopped.

- [66] 2) The RLC PDU is delivered to the upper layer
- [67] 3) All the following in-sequence RLC PDUs are delivered to the upper layer.
- [68] 4) If there is any remaining PDU in the reception buffer, the lower edge of the reception window is set to the first missing PDU in the reception buffer. And, the missing PDU timer is re-started for the lower edge of the reception window.
- [69] 5) Meanwhile, if there is no remaining PDU in the reception buffer, the lower edge of the reception window is set (shifted) to the next PDU expected to be received.
- [70] - Upon expiry of the missing PDU timer, the receiving side RLC entity transmits a status report to the sending side RLC entity. In this case, the status report includes information about a missing PDU (namely, reception-failed PDU). And, the missing PDU timer is re-started for the lower edge of the reception window.
- [71] The operation of the timer will now be described in detail with reference to FIGs. 4 and 5.
- [72] FIG. 4 is a block diagram showing a method of transmitting a status report by a receiving side to a sending side as a timer expires according to an embodiment of the present invention.
- [73] With reference to FIG. 4, the size of the reception window is 8. At a time point of $t=T_0$, the lower edge of the reception window is positioned at 0 and an upper edge of the reception window is positioned at 8. The embodiment of FIG. 4 will be described according to divisional time points of $t=T_0$ (S1), $t=T_1$ (S2), and $t=T_2$ (S3).
- [74] First, at the time point $t=T_0$, the reception window is positioned from 0 to 8. In this case, when the receiving side receives PDU0 and PDU1 in sequence, they are delivered to the upper layer in sequence (S1). Thereafter, the reception window is shifted to 2~10.
- [75] Second, PDU4 is received at a time point of $t=T_1$. In this case, because PDU2 and PDU3 have not been received yet, PDU4 is not delivered to the upper layer but stored in the reception buffer. Because there is no active timer (namely, a missing PDU timer) at this time point, the receiving side RLC starts the timer for PDU2, the lower edge of the reception window (S2). In this case, the timer operates by a pre-set time period.
- [76] Third, the timer expires at the time point of $t=T_2$. PDU3 and PDU7 have been further received until the timer expires. Meanwhile, PDU2, PDU5 and PDU6 have not been received from the time point at which the timer was started to be driven (i.e., $t=T_1$) to the time point at which the timer has expired (i.e., $t=T_2$). Thus, the receiving side configures a status report based on the reception failure information with respect to the reception-failed data (namely, PDU2, PDU5 and PDU6) and transmits the status report to the sending side (S3). Namely, when the timer expires, the receiving side sends the status report including information (i.e., NACK information) about the reception-failed data (i.e., the missing PDUs) at the time point. And then, the receiving side re-starts the

timer for the PDU2, the lower edge of the reception window.

[77] FIG. 5 is a block diagram showing a method of stopping a timer as a PDU, for which the timer has been started, is received according to an embodiment of the present invention.

[78] With reference to FIG. 5, the size of the reception window is 8. Based on a time point of $t=T_0$, the lower edge of the reception window is positioned at 0 and an upper edge of the reception window is positioned at 8. The embodiment of FIG. 4 will be described by dividing time period into time points of $t=T_0$ (S10), $t=T_1$ (S20), $t=T_3$ (S30), and a time point (S40) following $t=T_3$.

[79] As shown in FIG. 5, PDU2 and PDU3 have not been received at the time point $t=T_1$, so the timer is started for the lower edge of the reception point, namely, for PDU2. And, PDU2, PDU3 and PDU7 are received at a particular time point ($t=T_3$ in FIG. 5) before the started timer expires. The operation of the receiving side RLC at each time point will now be described.

[80] 1) At the time point of $t=T_0$, the reception window is positioned at 0 to 8. In this case, if PDU0 and PDU1 are received by the receiving side in sequence, they are delivered to the upper layer in sequence (S10). Thereafter, the reception window is shifted to 2~10.

[81] 2) PDU4 is received at the time point of $t=T_1$. In this case, because PDU2 and PDU3 have not been received, the PDU4 is not delivered to the upper layer but stored in the reception buffer. At this point, because there is no active timer (namely, a missing PDU timer), the receiving side RLC starts the timer for PDU2, the lower edge of the reception window (S20). In this case, the timer operates by a pre-set time.

[82] 3) PDU2, PDU3 and PDU7 are received at the time point of $t=T_3$. Because PDU2 for which the timer was started has been received, the receiving side RLC stops the operation of the timer. The PDU2 is delivered as an in-sequence PDU to the upper layer, and the following PDU3 and PDU4 are also delivered to the upper layer (S30).

[83] 4) The reception window is shifted such that the lower edge is positioned at PDU5, which has not been firstly received. Because there is PDU (PDU7) stored in the reception buffer, the timer is re-started for the PDU5, the lower edge of the reception window (S40).

[84] A receiving apparatus (or a receiver) according to the present invention will now be described.

[85] The receiving apparatus according to the present invention includes hardware, software, a module having software, and the like that can implement the embodiments of FIGs. 4 and 5. The apparatus according to the present invention may be called an entity, and the apparatus according to the present invention may be a terminal.

[86] The apparatus according to the present invention includes: a reception buffer that

stores PDUs transmitted by a sending side; a timer that operates for a pre-set time if there is a missing PDU at a lower edge of a reception window; and a processing unit that sets the reception window, determines whether there is a missing PDU among the PDUs received by the reception window by using an SN of the PDU, and starts the timer for the lower edge of the reception window where there is a first missing PDU.

[87] If the PDU for which the timer was started is not received at a time point when the timer expires, the processing unit transmits a status report including information about missing PDUs which have not been received to the sending side at the expiry time.

[88] In addition, when the PDU for which the timer was started is received at the time point when the timer expires, the processing unit delivers the received PDU and the following in-sequence PDU to the upper layer.

[89] As described above, the receiving apparatus according to the present invention basically includes software, hardware required for implementing the technical idea of the present invention, in addition to the above-described elements, such as an output unit (display, speaker, or the like), an input unit (keypad, microphone, and the like), a memory, a transmission/reception unit (RF module, antenna, and the like). Such elements are obvious to the person in the art, so description for them will be omitted.

[90] The method described so far may be implemented by software, hardware or their combination. For example, the method according to the present invention may be stored in a storage medium (e.g., an internal memory of a mobile terminal, a flash memory, a hard disk, or the like), and may be implemented by codes or command languages in a software program that can be executed by a processor (e.g., an internal microprocessor of a mobile terminal).

[91] As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalence of such metes and bounds are therefore intended to be embraced by the appended claims.

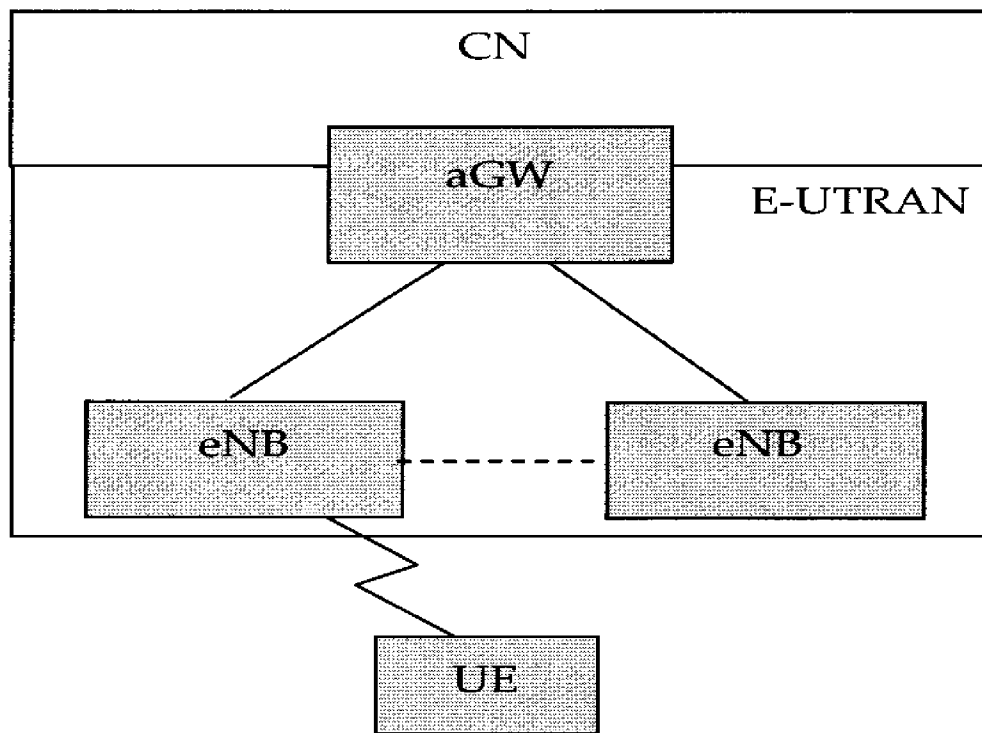
Claims

- [1] A method for transmitting a status report in a mobile communication system, comprising:
(A) starting, by a receiving side, a timer at a lower edge of a reception window when the receiving side receives a PDU (Protocol Data Unit) from a sending side out of sequence;; and
(B) transmitting, by the receiving side, to the sending side, a status report including information about PDUs which have not been received until the expiration of the timer, if the timer expires in a state that a PDU corresponding to the lower edge of the reception window is not received.
- [2] The method of claim 1, wherein, in step (A), if the PDU is received from the sending side out of sequence and no timer is active, the timer is started.
- [3] The method of claim 1, further comprising:
stopping the timer, if the PDU corresponding to the lower edge of the reception window is received before the timer expires; and
delivering the received PDU and/or the following in-sequence PDU to an upper layer.
- [4] The method of claim 3, further comprising:
shifting, by the receiving side, the reception window such that the lower edge of the reception window corresponds to the first PDU which has not been received, after the received PDU and/or the following in-sequence PDU are delivered to the upper layer;
checking whether there is any PDU stored in the shifted reception window; and
re-starting the timer with respect to the lower edge of the shifted reception window if there is a PDU stored in the reception window.
- [5] The method of claim 1, wherein the step (B) comprises:
re-starting the timer with respect to the lower edge of the reception window, after the status report is transmitted to the receiving side as the timer expires.
- [6] The method of claim 1, wherein the receiving side is a network, the receiving side is a terminal, and the steps (A) and (B) are performed by an RLC (Radio Link Control) entity of the terminal.
- [7] The method of claim 1, wherein the value of time period of the timer is determined by the sending side and transmitted to the receiving side.
- [8] An apparatus comprising:
a reception buffer that stores PDUs transmitted by a sending side;
a timer that operates during a pre-set time period if there is a PDU which has not been received at a lower edge of a reception window; and

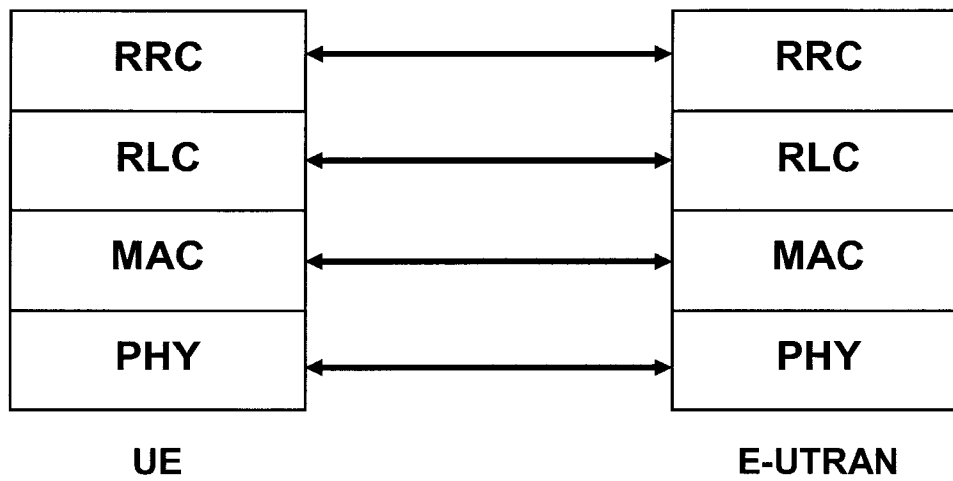
a processing unit that sets the reception window, determines whether there is a PDU which has not been received among the PDUs that have been received by the reception window, by using SNs (Sequence Numbers) of the PDUs, and starts the timer for the lower edge of the reception window for which there exists the first PDU which has not been received.

- [9] The apparatus of claim 8, wherein if the corresponding PDU for which the timer was started has not been received at a time point when the timer expires, the processing unit transmits a status report including information about missing PDUs that have not been received at the time point when the timer expires, to the sending side.
- [10] The apparatus of claim 8, wherein the PDU that has not been received is a missing PDU.

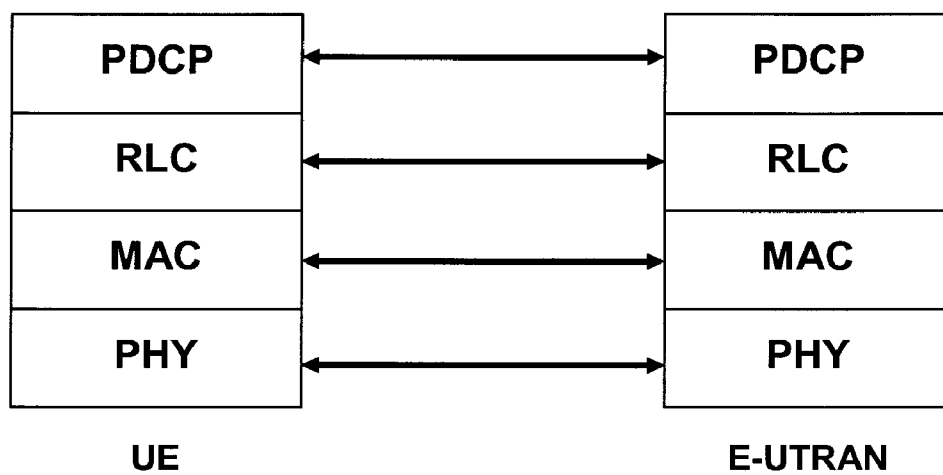
[Fig. 1]



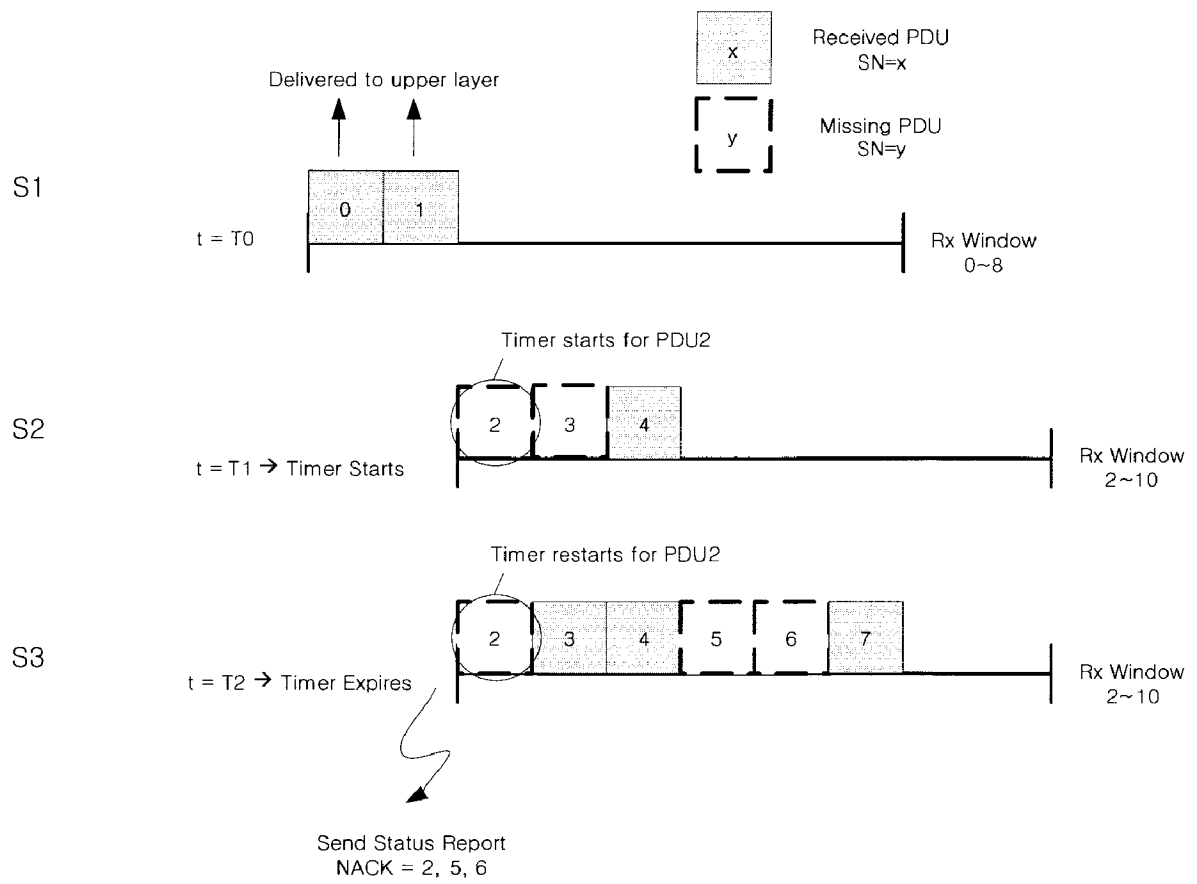
[Fig. 2]



[Fig. 3]



[Fig. 4]



[Fig. 5]

