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(54) **Title:** METHOD OF TRANSMITTING RLC DATA

[Fig 5]
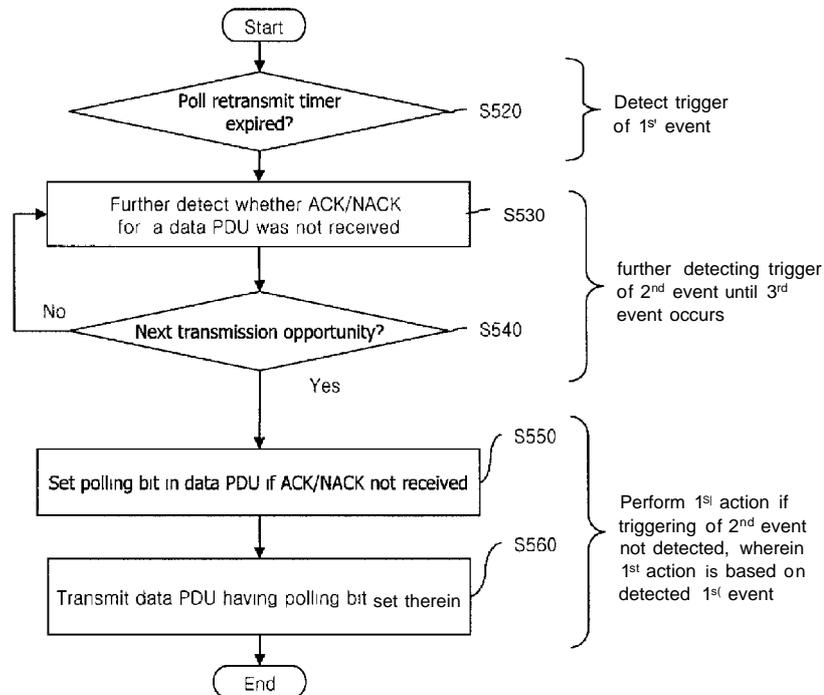
(57) **Abstract:** A method of transmitting data is performed by detecting a triggering of a first event, further detecting a triggering of a second event until a third event occurs, and performing a first action if the triggering of the second event is not detected, wherein the first action is based on the detected first event. The first event may be the expiry of a poll retransmit timer, the second event may be a detecting whether a ACK or NACK is not received, the third event may be a next transmission opportunity, and the first action may be setting a polling bit of a data PDU to be transmitted.

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

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Description

METHOD OF TRANSMITTING RLC DATA

Technical Field

[I]   The present invention relates to a method of transmitting RLC data.

Background Art

[2]   In the related art, RLC data transmission was performed, but radio resources were unnecessarily wasted. As such, the related art technologies do not sufficiently address such issues, and thus do not offer appropriate solutions.

Disclosure of Invention

Technical Solution

[3]   The present inventors recognized at least the above-identified drawbacks of the related art. Based upon such recognition, the various features described hereafter have been conceived such that a method of transmitting RLC data is provided, which results in more efficient use of radio resources.

Brief Description of Drawings

[4]   Figure 1 shows an exemplary network architecture of a LTE system.

[5]   Figure 2 shows an exemplary protocol stack for peer entities in the UE and E-UTRAN for the control plane.

[6]   Figure 3 shows an exemplary protocol stack for peer entities in the UE and E-UTRAN for the user plane.

[7]   Figure 4 shows an exemplary AM RLC entity structure.

[8]   Figure 5 shows an exemplary flow chart of the procedures for an improved method of transmitting RLC data.

Mode for the Invention

[9]   The inventive concepts and features herein related to a method of transmitting RLC data are explained in terms of a Long Term evolution (LTE) system or other so-called 4G communication systems, which is an enhancement to current 3GPP technologies. However, such details are not meant to limit the various features described herein, which are applicable to other types of mobile and/or wireless communication systems and methods.

[10]   Hereafter, the term "mobile terminal" will be used to refer to various types of user devices, such as mobile communication terminals, user equipment (UE), mobile equipment (ME), and other devices that support various types of wireless communication technologies.

[II]   The present invention relates to an LTE system in which an RLC layer of a transmitting side transmits a status report to an RLC layer of a receiving side. In

particular, when the transmitting side sends a polling message, after polling is triggered, the transmission of the polling message is determined according to a message received from the receiving side.

[12]   Figure 1 shows an exemplary network architecture of an LTE system. The LTE system is a system that has evolved from the UMTS system, and its basic stan-dardization work is being performed at the 3GPP organization.

[13]   The LTE network 100 can be largely divided into the E- UTRAN (Evolved UMTS Terrestrial Radio Access Network) 110 the CN (Core Network) 120. The E-UTRAN 110 may be comprised of UE (user equipment) 112 and at least one evolved Node B (eNB) 114, 116. An access gateway (aGW) 60 that allows connection with an external network may be located at an end of the E-UTRAN. The aGW may be divided into a section that handles the processing of user traffic and a section that handles the processing of control traffic. Here, between an aGW that processes new user traffic and an aGW that processed control traffic, a new interface can be used to allow com-munication therebetween. A single eNB can have one or more cells. The CN may be comprised of nodes (possible the aGW) that are used for UE user registration and other procedures. An interface may be used to differentiate between the E-UTRAN and the CN.

[14]   Figure 2 and 3 show an exemplary structure of the radio interface protocol between the mobile terminal and the E-UTRAN based on the 3GPP standard.

[15]   The radio interface protocol is divided horizontally into the Physical Layer, the Data Link Layer, and the Network Layer, and is divided vertically into the User Plane (U-Plane) for transmitting data and information and the Control Plane (C-Plane) used to transfer control signaling. The protocol layers of Figures 2 and 3 are based on the Open System Interconnection (OSI) standard model well-known in communication systems, and can thus be divided into L1 (Layer 1), L2 (Layer 2), and L3 (Layer 3). Such radio protocol layers exist in both the mobile terminal and in the E-UTRAN as pair (or peer) entities to handle data transfers over the radio interface.

[16]   Hereafter, the control plane of the radio protocol in Figure 2 and the user plane of the radio protocol in Figure 3 will be described respectively.

[17]   In Layer 1, the physical layer uses one or more physical channels to provide an in-formation transfer service. The physical layer is connected to the MAC (Medium Access Control) layer located above via one or more transport channels, and data is transferred between the MAC layer and the physical layer through these transport channels. Here, the transport channels can be divided into dedicated transport channel and common transport channels based on whether the transport channels are shared or not. Also, between respectively different physical layers, such as the physical layer in the transmitter (transmitting side) and the physical layer in the receiver (receiving

side), data is transferred via one or more physical channels.

[18]   In Layer 2, there are many layers. The MAC layer provides service to a RLC (Radio Link Control) layer, which is an upper layer, via one or more logical channels which are mapped to various transport channels. Also, logical channel multiplexing is performed for mapping many logical channels to one transport channel. The MAC layer is connected to the RLC layer via logical channels, which are comprised of control channels used to transport control plane information and traffic channels used to transport user plane information.

[19]   The RLC layer supports the transmission of data with reliability, by performing segmentation and concatenation of data received from an upper layer and to adjust the data size to be appropriate for transmission from the lower layer over the radio interface. Also, in order to guarantee the various quality of service (QoS) requirement for each radio bearer (RB), three modes of operation are provided: TM (Transparent Mode), UM (Unacknowledged mode), and AM (Acknowledged mode). In particular, the AM RLC uses an Automatic Repeat and Request (ARQ) function to perform retransmissions in order to achieve reliable data transmissions.

[20]   The PDCP (Packet Data Convergence Protocol) layer in Layer 2 performs a header compression function to reduce the header size for Internet Protocol (IP) packets that contain relatively large and unnecessary control information such that IP packets (such as for IPv4, IPv6, etc.) may be effectively transmitted over the radio interface having relatively small bandwidth. Also, the PDCP layer is used for performing coding of control plane (C-plane) data, such as RRC messages. The PDCP layer can also perform coding of user plane (U-plane) data. In the LTE system, the PDCP layer performs a security function by performing ciphering to prevent third parties from eavesdropping on data transmissions and performing integrity protection to prevent undesired data manipulation by third parties.

[21]   Located at the uppermost portion of Layer 3, the RRC (Radio Resource Control) layer is only defined in the control plane and is responsible for the control of logical channels, transport channels and physical channels with relation to the configuration, re-configuration and release of radio bearers (RBs). Here, a radio bearer is a service or logical path provided by Layers 1 and 2 for transferring data between the mobile terminal and E-UTRAN. The establishment of an RB refers to managing the characteristics of the radio protocol layers and channels needed for providing a particular service, and the process of setting the specific parameters and operation methods thereof. The radio bearers can be divided into signaling radio bearers (Signaling RBs: SRB) and data radio bearers (Data RBs: DRB), whereby the SRB is used to transport RRC messages in the C-plane, and the DRB is used to transport user data in the U-plane.

[22]   Hereafter, the RLC layer will be considered in more detail.

[23]   The RLC layer has three modes: TM, UM and AM. For TM, because the RLC need not perform any functions, only the UM and AM will be considered.

[24]   For each PDU, the UM RLC sends a PDU header that contains a sequence number (SN) and transmits the same, such that the receiving side can know what PDUs were lost (missing) during transmission. Due to such functions, the UM RLC in the user plane handles the transmission of broadcast/multicast data and the transmission of real time data of the packet service (PS) domain such as voice (VoIP) and streaming, while the UM RLC in the control plane handles the transmission of certain RRC messages (that do not require reception response messages among the RRC messages) to a particular mobile terminal within a cell or a particular mobile terminal group.

[25]   Like the UM RLC, the AM RLC generates a PDU by adding a PDU header that includes a sequence number (SN), but unlike UM RLC, the receiving side provides an acknowledgement for the PDU transmitted from the transmitting side. The reason for this is for the receiving side to request the transmitting side to retransmit the PDUs that were not received properly. Such retransmission function is the biggest characteristic of the AM RLC. As a result, the AM RLC has the purpose of guaranteeing error-free data transmissions by using retransmissions, and due to such purpose, the AM RLC usually handles non-real time packet data transmissions such as TCP/IP of the PS domain, and in the control plane, also handles the transmission of certain RRC messages (that require reception acknowledgements among the RRC messages) to particular mobile terminal within a cell.

[26]   With respect to directions, the UM RLC is used in uni-direction communications, while the AM RLC is used in bi-directional communications because there is feedback. There are also differences in structural aspects, as the UM RLC has separate RLC entities respectively having a structure that only performs either transmissions or re-ceptions, while the AM RLC has one RLC entity that includes both a transmitting side and receiving side therein.

[27]   The AM RLC entity is complicated due to its retransmission function. To manage re-transmissions, the AM RLC also has a retransmission buffer in addition to a transmission/reception buffer. For flow control, a transmission/reception window is used. Between peer RLC entities in the transmitting side and receiving side, various types of functions including polling (whereby the transmitting side requesting the receiving side for state information), status report (whereby. the receiving side reporting its buffer status to the transmitting side), generating a Status PDU (used for carrying the status report), and the like are performed. Also, in order to support all of these functions, the AM RLC requires many kinds of protocol parameters, state variables, timers and the like. For the status report, Status PDU, and the like, the AM

RLC uses PDUs to control data transmissions (called Control PDUs) and uses PDUs to transfer user data (called Data PDUs).

[28]   In AM RLC, the RLC Data PDUs can be divided into AMD PDUs and AMD PDU Segments. An AMD PDU Segment has a portion of the data for the AMD PDU. In the LTE system, the maximum size of the data block(s) that the mobile terminal transmits can be changed or varied. Thus, for example, assuming that at a certain point in time, after the transmitting side AM RLC entity generates and transmits a 200 byte AMD PDU, a NACK is received from the receiving side AM RLC, and when the transmitting AM RLC wishes to retransmit such AMD PDU. Then, if the maximum size of the data block that can be transmitted has changed to 100 bytes, the AMD PDU cannot be retransmitted because it is too large. The AMD PDU segments, which are smaller units of the corresponding AMD PDU, can be used in such situations. Thus, in the above procedures, the AM RLC entity of the transmitting side can divide the AMD PDU into AMD PDU segments for transmission at different times, and the AM RLC entity of the receiving side can reconstruct the entire AMD PDU from the AMD PDU segments.

[29]   As described above, the AM RLC operates based on retransmissions using the status report. Namely, the AM RLC entity at the transmitting side sends a RLC Data PDU to the receiving side, and based on the status report from the receiving side, the transmitting side retransmits any RLC Data PDUs that were not properly received.

[30]   However, just as the RLC Data PDUs can be lost over the radio interface, the status report itself can also be lost (or become erroneous) over the radio interface. Also, if only the receiving side determines when the status report will be sent, the transmitting side may sometime not be able to receive the status report when it desires to. To solve these problems, a polling procedure is used.

[31]   The polling procedure refers to when the transmitting side sends a RLC Data PDU, upon setting the polling bit existing in the header of the RLC Data PDU. The receiving side that received such RLC Data PDU, checks the polling bit in the header, and if the polling bit was set, a status report is transmitted.

[32]   However, in such procedure, the RLC Data PDU including the set polling bit may be lost over the radio interface (or some type of error may occur). Thus, the transmitting side uses a specific timer called a T-poll-retransmit, which operates in the following manner:

[33]

- Expiry of poll retransmit timer:

    - The transmitting side of an AM RLC entity shall:

        - start T_poll_retransmit upon setting the P field for a RLC data PDU to "1", and store the SN of the corresponding RLC data PDU in memory;

        - stop T_poll_retransmit when it receives either a positive or negative acknowledgement for the corresponding RLC data PDU with the SN it stored in memory;

        - when T_poll_retransmit expires:

            - if both the transmission buffer and the retransmission buffer are empty (excluding transmitted RLC data PDU awaiting for acknowledgements):

                - consider the AMD PDU with SN = VR(S) - 1 for retransmission;

                - set the P field of the RLC data PDU to be transmitted in the next transmission opportunity to "1";

            - else:

                - set the P field of the RLC data PDU to be transmitted in the next transmission opportunity to "1".

[34]   However, the above procedure has some problems. In LTE, the mobile terminal is not able to perform transmissions on the uplink whenever it wishes to do so. Namely, in LTE, when the mobile terminal has some data to be transmitted on the uplink, the needed amount of buffer resources is informed to the base station (eNB), then, uplink transmission is performed by using the radio resources allocated from the base station (eNB). The time from when the mobile terminal generates certain data that should be transmitted until the time of actually transmission may take between about 10 ms to about 100 ms.

[35]   Accordingly, in the above procedure, even when a poll has been triggered, such poll may be transmitted some time later after triggering. Also, while waiting to transmit the poll that was triggered, a status report from the receiving side may arrive. In such case, sending of the poll that was triggered may have become useless due to the newly received status report, and thus radio resources are wasted.

[36]   Accordingly, the present invention improved the polling procedure for AM RLC, such that unnecessary polling and unnecessary RLC Data PDU transmission can be minimized.

[37]   To achieve this, according to the present invention, after a poll is triggered and until the transmitting side AM RLC entity can actually perform transmissions, it is checked to see whether a status report has been received from the receiving side. Only if it is determined that a status report was not received, then the RLC Data PDU related to the

triggered poll is transmitted.

[38]   The following shows an example of this operation.

[39]

- Expiry of poll retransmit timer:

  - The transmitting side of an AM RLC entity shall:

    - start T_poll_retransmit upon setting the P field for a RLC data PDU to "1", and store the SN of the corresponding RLC data PDU in memory;

    - stop T_poll_retransmit when it receives either a positive or negative acknowledgement for the corresponding RLC data PDU with the SN it stored in memory;

    - when T_poll_retransmit expires:

      - if either a positive or negative acknowledgement for the corresponding RLC data PDU with the SN it stored in memory was not received until the next transmission opportunity:

        - if both the transmission buffer and the retransmission buffer are empty (excluding transmitted RLC data PDU awaiting for acknowledgements):

          - consider the AMD PDU with SN = VR(S) - 1 for retransmission;

          - set the P field of the RLC data PDU to be transmitted in the next transmission opportunity to "1";

        - else:

          - set the P field of the RLC data PDU to be transmitted in the next transmission opportunity to "1".

[40]   Thus, in the present invention, when the T_Poll_Retransmit timer expires, then the AM RLC entity of the transmitting side considers that a poll was triggered. Also, the transmitting side RLC entity waits until the next transmission opportunity that is informed from a lower layer indicating the RLC Data PDU transmission is possible. During this wait time, if a status report (that includes ACK-NACK information with respect to sequence numbers of PDUs stored upon receipt from the receiving side) is received, the triggered poll is canceled. But is a status report is not received, the poll bit of the RLC Data PDU is set to 1 and then transmitted.

[41]   The above described operations can be implemented in various ways. For example, when a poll is triggered, the mobile terminal can immediately generate the RLC Data PDU having its poll bit set to 1. Then, if a status report is received before the RLCE Data PDU can be actually transmitted (i.e., before the lower layer informs about the transmission opportunity), then the RLC Data PDU can be deleted or discarded. In contrast, if a status report is not received until the transmission opportunity is informed

from the lower layer, the RLC Data PDU is transferred to the lower layer from transmission thereof.

[42]   Figure 4 shows an exemplary AM RLC entity structure.

[43]   An AM RLC entity can be configured to deliver/receive RLC PDUs through the following logical channels: DL/UL DCCH or DL/UL DTCH. An AM RLC entity delivers/receives the following RLC data PDUs: AMD PDU; AMD PDU segment. An AM RLC entity delivers/receives the following RLC control PDU: STATUS PDU.

[44]   Figure 5 shows an example flow chart of how the improved RLC data transmission method is performed.

[45]   First, it is detected whether the poll retransmit timer has expired or not (S520). If so, a checking step to see whether a ACK signal or a NACK signal was not received with respect to a data PDU (S530). This checking step is performed unit the next transmission opportunity occurs (S540).

[46]   If in the checking step, it is found that a ACK or NACK has not been received, then the polling bit is set (S550), and the data PDU having the set polling bit is transmitted (S560).

[47]   The features and aspects of the present invention can also be considered in the following manner. Namely, the step of checking whether a ACK or NACK signal is received may be performed either before or after the expiry of the poll retransmit timer. As a result, if the ACK or NACK is not received as a result of the checking step, then the polling bit is set and the RLC Data PDU is transmitted.

[48]   As such, it can be said that the present invention provides an "additional con-firmation period" during which the possible reception of a ACK or NACK signal from the receiving side is double-checked to ensure that the polling bit should really be set. The duration of this additional confirmation period can be pre-set or varied as necessary. For example, the checking step is performed until a next transmission op-portunity occurs.

[49]   The present invention specifies the E-UTRA Radio Link Control (RLC) protocol for the UE - E-UTRAN radio interface. The features herein are related to E-UTRA RLC sublayer architecture; E-UTRA RLC entities; services expected from lower layers by E-UTRA RLC; services provided to upper layers by E-UTRA RLC; E-UTRA RLC functions; elements for peer-to-peer E-UTRA RLC communication including protocol data units, formats and parameters; and handling of unknown, unforeseen and erroneous protocol data at E-UTRA RLC.

[50]   The following definitions should be noted: byte segment: A byte of the Data field of an AMD PDU. Specifically, byte segment number 0 corresponds to the first byte of the Data field of an AMD PDU; Data field element: An RLC SDU or an RLC SDU segment that is mapped to the Data field; and RLC SDU segment: A segment of an

RLC SDU.

[51]   Regarding retransmissions, the transmitting side of an AM RLC entity can receive a negative acknowledgement (notification of reception failure by its peer AM RLC entity) for an AMD PDU or a portion of an AMD PDU by the following:

[52]   - STATUS PDU from its peer AM RLC entity;

[53]   - HARQ delivery failure from the transmitting MAC entity.

[54]   When receiving a negative acknowledgement for an AMD PDU or a portion of an AMD PDU by a STATUS PDU from its peer AM RLC entity, the transmitting side of the AM RLC entity shall:

[55]   - if the SN of the corresponding AMD PDU falls within the STATUS receiving window:

[56]   - consider the AMD PDU or the portion of the AMD PDU for which a negative ac-knowledgement was received for retransmission.

[57]   When receiving a negative acknowledgement for an AMD PDU or a portion of an AMD PDU by HARQ delivery failure notification from the transmitting MAC entity, the transmitting side of the AM RLC entity may:

[58]   - if the SN of the corresponding AMD PDU falls within the STATUS receiving window:

[59]   - consider the AMD PDU or the portion of the AMD PDU for which a negative ac-knowledgement was received for retransmission.

[60]   When retransmitting an AMD PDU, the transmitting side of an AM RLC entity shall:

[61]   - if the AMD PDU can entirely fit into the TB of the particular transmission op-portunity, deliver the AMD PDU as it is except for the P field (the P field should be set accordingly);

[62]   - otherwise, segment the AMD PDU and form a new AMD PDU segment which will fit into the TB of the particular transmission opportunity, in which case:

[63]   When retransmitting a portion of an AMD PDU, the transmitting side of an AM RLC entity shall:

[64]   - segment the portion of the AMD PDU as necessary and form a new AMD PDU segment which will fit into the TB of the particular transmission opportunity, in which case:

[65]   When forming a new AMD PDU segment, the transmitting side of an AM RLC entity shall:

[66]   - only map the Data field of the original AMD PDU to the Data field of the new AMD PDU segment;

[67]   - set the header of the new AMD PDU segment accordingly.

[68]   With respect to polling, an AM RLC entity can poll its peer AM RLC entity in order to trigger STATUS reporting at the peer AM RLC entity.

[69]   Triggers to initiate polling include:

[70]   - Transmission of last data in the buffer:

[71]   - The transmitting side of an AM RLC entity shall set the P field of an RLC data PDU to "1" if both the transmission buffer and the retransmission buffer becomes empty (excluding transmitted RLC data PDU awaiting for acknowledgements) after the transmission of the RLC data PDU;

[72]   - Expiry of poll retransmit timer:

[73]   - The transmitting side of an AM RLC entity shall:

[74]   - start T_poll_retransmit upon setting the P field for a RLC data PDU to "1", and store the SN of the corresponding RLC data PDU in memory;

[75]   - stop T_poll_retransmit when it receives either a positive or negative acknowledgement for the corresponding RLC data PDU with the SN it stored in memory;

[76]   - when T_poll_retransmit expires:

[77]   - if both the transmission buffer and the retransmission buffer are empty (excluding transmitted RLC data PDU awaiting for acknowledgements):

[78]   - consider the AMD PDU with SN = VR(S) ? 1 for retransmission;

[79]   - set the P field of the RLC data PDU to be transmitted in the next transmission opportunity to "1";

[80]   - else:

[81]   - set the P field of the RLC data PDU to be transmitted in the next transmission opportunity to "1".

[82]   - Every Poll_PDU PDUs:

[83]   - The transmitting side of an AM RLC entity shall:

[84]   - maintain a counter PDU_WITHOUT_POLL, which is initially set to 0;

[85]   - increment PDU_WITHOUT_POLL by one for every new AMD PDU that it forms;

[86]   - reset PDU_WITHOUT_POLL to 0 when it delivers to lower layer a RLC data PDU whose P field is set to "1";

[87]   - set the P field of an AMD PDU that it forms to "1" when PDU_WITHOUT_POLL = PoILPDU.

[88]   - Every Poll_Byte bytes:

[89]   - The transmitting side of an AM RLC entity shall:

[90]   - maintain a counter BYTE_WITHOUT_POLL, which is initially set to 0;

[91]   - increment BYTE_WITHOUT_POLL for every new byte of Data field element that it maps to the Data field of an AMD PDU;

[92]   - reset BYTE_WITHOUT_POLL to 0 when it delivers to lower layer a RLC data PDU whose P field is set to "1";

[93]   - set the P field of an AMD PDU that it forms to "1" when PDU_WITHOUT_POLL >= Poll_Byte.

[94]   With respect to status reporting,. an AM RLC entity sends STATUS PDUs to its peer AM RLC entity in order to provide positive and/or negative acknowledgements of RLC PDUs (or portions of them).

[95]   RRC configures whether or not the status prohibit function is to be used an AM RLC entity.

[96]   Triggers to initiate STATUS reporting include:

[97]   Polling from its peer AM RLC entity:

[98]   The receiving side of an AM RLC entity shall trigger a STATUS report when it receives a RLC data PDU with the P field set to "1" and the HARQ reordering of the corresponding RLC data PDU is completed.

[99]   Detection of reception failure of an RLC data PDU:

[100]   The receiving side of an AM RLC entity shall trigger a STATUS report when T_reordering expires.

[101]   NOTE: The expiry of T_reordering triggers both VR(MS) to be updated and a STATUS report to be triggered, but the STATUS report shall be triggered after VR(MS) is updated.

[102]   When STATUS reporting has been triggered, the receiving side of an AM RLC entity shall:

[103]   if T_status_prohibit is not running:

[104]   at the first transmission opportunity indicated by lower layer, construct a STATUS PDU and deliver it to lower layer;

[105]   else:

[106]   at the first transmission opportunity indicated by lower layer after T_status_prohibit expires, construct a STATUS PDU and deliver it to lower layer;

[107]   NOTE: If T_status_prohibit is not running at the time STATUS reporting was triggered, the STATUS PDU size shall be accounted for in the Buffer Status Report [3] from the time STATUS reporting was triggered. If T_status_prohibit is running at the time STATUS reporting was triggered, the STATUS PDU size shall be accounted for in the Buffer Status Report [3] from the time T_reordering expires.

[108]   When a STATUS PDU has been delivered to lower layer, the receiving side of an AM RLC entity shall:

[109]   start T_status_prohibit.

[110]   When constructing a STATUS PDU, the AM RLC entity shall:

[111]   set ACK_SN to VR(MS);

[112]   for each AMD PDU with SN such that $VR(R) <= SN < VR(MS)$ that has not been completely received yet:

[113]   if no byte segments have been received yet for an AMD PDU:

[114]   include in the STATUS PDU a NACK_SN which is set to the SN of the AMD PDU;

[115]   else

[116]   include in the STATUS PDU a set of NACK_SN, SOstart and SOend for each con-
secutive byte segments of the AMD PDU that has not been received yet.

[117]   Meanwhile, RLC re-establishment is performed upon request by RRC, and the
function is applicable for AM and UM RLC entities.

[118]   When RRC indicates that an RLC entity should be re-established, the RLC entity
shall:

[119]   if it is a receiving UM RLC entity:

[120]   when possible, reassemble RLC SDUs from UMD PDUs with SN < VR(UMR),
remove RLC headers when doing so and deliver the reassembled RLC SDUs to upper
layer;

[121]   discard all remaining UMD PDUs;

[122]   if it is a transmitting UM RLC entity:

[123]   discard all RLC SDUs;

[124]   if it is an AM RLC entity:

[125]   when possible, reassemble RLC SDUs from any byte segments of AMD PDUs with
SN < VR(MR) in the receiving side, remove RLC headers when doing so and deliver
the reassembled RLC SDUs to upper layer;

[126]   discard the remaining AMD PDUs and byte segments of AMD PDUs in the
receiving side;

[127]   discard all RLC SDUs and AMD PDUs in the transmitting side;

[128]   discard all RLC control PDUs.

[129]   stop and reset all timers;

[130]   reset all state variables to their initial values.

[131]   The RLC polling procedure will be discussed further.

[132]   There are several triggers for polling. "Transmission of last data in the buffer",
"Expiry of poll retransmit timer", "Every Poll_PDU PDUs" and "Every Poll_Byte
bytes" is used for poll trigger.

[133]   Regarding the UE procedure when a Poll is sent, following text applies:

[134]   start T_poll_retransmit upon setting the P field for a RLC data PDU to "1", and store
the SN of the corresponding RLC data PDU in memory.

[135]   Namely, whenever a Poll is sent, AM RLC entity memorizes the SN that included the
Poll and starts T_poll_retransmit. These actions are used to check whether the Poll is
successfully transmitted, and to retransmit a Poll if the previous transmission of Poll
was not successful.

[136]   But as stated above, Polls can be triggered by several occasions. So, in some cases,
another Poll can be triggered while the AM RLC entity waits for the reception of
Status Report for the previous Poll. In this situation, following is not clear:

[137]   T_poll_retransmit is configured per Poll and SN is stored per Poll?

[138]   Or, the stored SN is updated and T_poll_retransmit is restarted whenever a Poll is sent?

[139]   The purpose of T_poll_retransmit is to ensure that a AM RLC transmitter receives a Status Report from a AM RLC receiver. As long as the transmitter runs at least one one T_poll_retransmit timer and restarts it for the newly-sent Poll, the transmitter will eventually receive an intended Status Report. Furthermore, running several T_poll_retransmit timers simultaneously will just cause additional transmission of Poll and Status Report, leading to waste of radio resources. Thus, only one T_poll_retransmit should be used regardless of how many poll is triggered.

[140]   Proposal 1: Only one T_poll_retransmit timer is used and restarted whenever a new Poll is sent.

[141]   When a AM RLC receiver sends Status Reports, later Status Report includes more up-to-date information than the earlier Status Report. And the later Poll is normally sent with a higher SN than the previous Poll. To ensure that AM transmitter will receive a Status Report regarding up to the PDU with highest SN, the stored SN related to a Poll should be updated whenever a Poll is sent.

[142]   Proposal 2: A SN stored for a Poll is updated whenever a new Poll is sent.

[143]   When a Poll was triggered for a last data in the buffer and if a Status Report is not received for that data, another poll is trigged and the last PDU itself is sent again. Regarding this scenario, following text applies:

[144]   when T_poll_retransmit expires:

[145]   if both the transmission buffer and the retransmission buffer are empty (excluding transmitted RLC data PDU awaiting for acknowledgements):

[146]   consider the AMD PDU with SN = VR(S) ? 1 for retransmission;

[147]   set the P field of the RLC data PDU to be transmitted in the next transmission opportunity to "1".

[148]   Here, "consider for retransmission" means that the concerned AMD PDU (segment) should be retransmitted at the earliest transmission opportunity.

[149]   The problem is that the time of Poll trigger is not always same as the time of next transmission opportunity. Depending on the time when UL GRANT is received or depending on the result of Logical Channel Prioritization, the time difference between Poll trigger and actual Poll transmission will be quite long.

[150]   In this case, the question is what if Status Report that acknowledges the reception of the last AMD PDU is received during the time that the transmitter waits for the transmission opportunity? The most logical procedure is to transmit neither a Poll nor the last AMD PDU. But, according to the current specification, the transmitter should re-transmit the last AMD PDU that will be eventually discarded due to the function of

"duplicate detection". Furthermore, the radio resource is also wasted. Thus, the triggered Poll and the AMD PDU should not be retransmitted.

[151]   In addition, the time of starting of T_poll_retransmit should be changed to the moment when the actual RLC data PDU with Poll is delivered to lower layer.

[152]   Proposal 3: An AMD PDU which is considered for retransmission is not transmitted if acknowledgement for the AMD PDU is received before the next transmission opportunity.

[153]   Proposal 4: A Poll triggered by T_poll_retransmit is cancelled if a Status Report which includes ACK or NACK for the AMD PDU with equal SN to the Stored SN is received before the next transmission opportunity.

[154]   Proposal 5: T_poll_retransmit is started when RLC data PDU with poll is delivered to lower layer.

[155]   Hereafter, the polling procedure can be summarized as follows:

[156]   An AM RLC entity can poll its peer AM RLC entity in order to trigger STATUS reporting at the peer AM RLC entity.

[157]   Triggers to initiate polling include:

[158]   - Transmission of last data in the buffer:

[159]   - The transmitting side of an AM RLC entity shall set the P field of an RLC data PDU to "1" if both the transmission buffer and the retransmission buffer becomes empty (excluding transmitted RLC data PDU awaiting for acknowledgements) after the transmission of the RLC data PDU;

[160]   - Expiry of poll retransmit timer:

[161]   - The transmitting side of an AM RLC entity shall:

[162]   - upon delivering a new RLC data PDU with the P field set to "1" to lower layer;

[163]   - if T_poll_retransmit is not running:

[164]   - start T_poll_retransmit;

[165]   - store the SN of the corresponding RLC data PDU in memory;

[166]   - else:

[167]   - restart T_poll_retransmit;

[168]   - replace the stored SN in memory with the SN of the corresponding RLC data;

[169]   - stop T_poll_retransmit when it receives either a positive or negative acknowledgement for the corresponding RLC data PDU with the SN it stored in memory;

[170]   - when T_poll_retransmit expires, if either a positive or negative acknowledgement for the corresponding RLC data PDU with the SN it stored in memory was not received until the next transmission opportunity:

[171]   - if both the transmission buffer and the retransmission buffer are empty (excluding transmitted RLC data PDU awaiting for acknowledgements):

[172]   - consider the AMD PDU with SN = VR(S) ? 1 for retransmission;

[173]   - set the P field of the RLC data PDU to be transmitted in the next transmission op-
          portunity to "1";

[174]   - else:

[175]   - set the P field of the RLC data PDU to be transmitted in the next transmission op-
          portunity to "1".

[176]   - Every PoILPDU PDUs:

[177]   - The transmitting side of an AM RLC entity shall:

[178]   - maintain a counter PDU_WITHOUT_POLL, which is initially set to 0;

[179]   - increment PDU_WITHOUT_POLL by one for every new AMD PDU that it forms;

[180]   - reset PDU_WITHOUT_POLL to 0 when it delivers to lower layer a RLC data PDU
          whose P field is set to "1";

[181]   - set the P field of an AMD PDU that it forms to "1" when PDU_WITHOUT_POLL
          = PoILPDU.

[182]   - Every Poll_Byte bytes:

[183]   - The transmitting side of an AM RLC entity shall:

[184]   - maintain a counter BYTE_WITHOUT_POLL, which is initially set to 0;

[185]   - increment BYTE_WITHOUT_POLL for every new byte of Data field element that
          it maps to the Data field of an AMD PDU;

[186]   - reset BYTE_WITHOUT_POLL to 0 when it delivers to lower layer a RLC data
          PDU whose P field is set to "1";

[187]   - set the P field of an AMD PDU that it forms to "1" when PDU_WITHOUT_POLL
          >= Poll_Byte.

[188]   As for the effects of the present invention, unnecessary setting of the polling bit can
          be minimized such that RLC data PDU transmissions are reduced, which results in
          more efficient use of radio resources.

[189]   The present invention provides a method of transmitting data, the method
          comprising: detecting a triggering of a first event; further detecting a triggering of a
          second event until a third event occurs; and performing a first action if the triggering of
          the second event is not detected, wherein the first action is based on the detected first
          event.

[190]   If the triggering of the second even is detected, canceling the first event. The first
          event is an expiry of a poll retransmit timer, the second event is detecting whether a
          ACK or NACK signal is not received, and the third event is a next transmission op-
          portunity. The first action may be setting a polling bit of a data PDU (protocol data
          unit) to be transmitted.

[191]   Also, the present invention provides a method of transmitting data, the method
          comprising: detecting an expiry of a poll retransmit timer; further detecting whether a
          positive or negative acknowledgement for a (RLC) data PDU was not received, the

further detecting step being performed until the next transmission opportunity; if the positive or negative acknowledgement was not detected or received, setting a polling bit in the data PDU; and transmitting the data PDU having the polling bit set therein.

[192]   The next transmission opportunity occurs when an instruction is received from the MAC layer indicating that transmission is possible because radio resources are available. The radio resources are used for supporting OFDM. The further detecting step is performed during a further confirmation period defined as a fixed or variable time duration. Also, the further detecting step may be timer-based.

[193]   The various features and concepts described herein may be implemented in software, hardware, or a combination thereof. For example, a computer program (that is executed in a computer, a terminal or a network device) for a method and system for transmitting RLC data may comprise one or more program code sections for performing various tasks. Similarly, a software tool (that is executed in a computer, a terminal or a network device) for a method and system for processing a method of transmitting RLC data may comprise program code portions for performing various tasks.

[194]   The method and system for processing a method of transmitting RLC data according to the present invention are compatible with various types of technologies and standards. Certain concepts described herein are related to various types of standards, such as GSM, 3GPP, LTE, IEEE, 4G and the like. However, it can be understood that the above exemplary standards are not intended to be limited, as other related standards and technologies would also be applicable to the various features and concepts described herein.
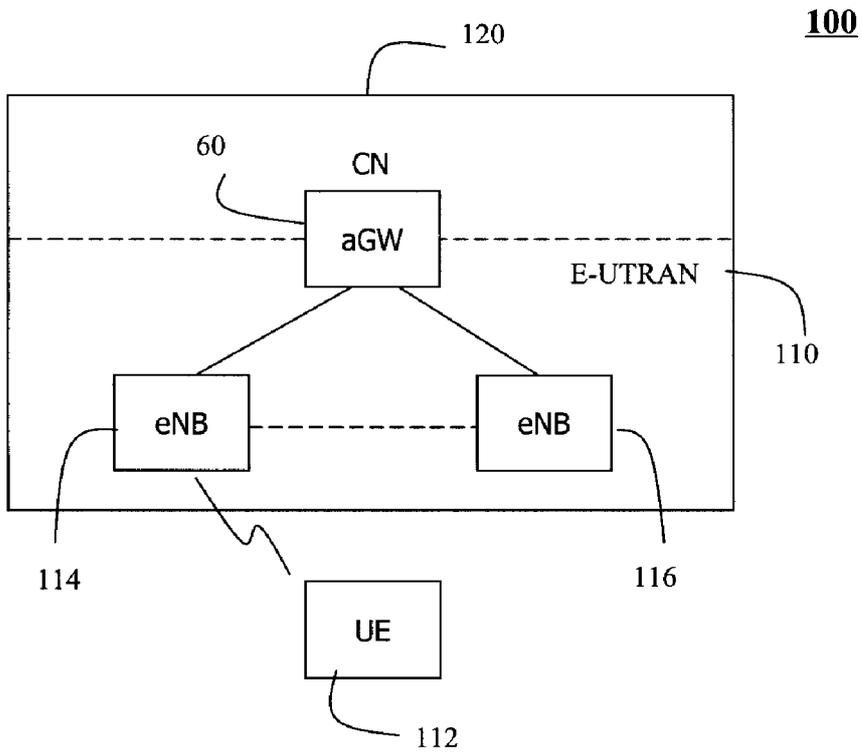
Industrial Applicability

[195]   The features and concepts herein are applicable to and can be implemented in various types of user devices (e.g., mobile terminals, handsets, wireless communication devices, etc.) and/or network entities that can be configured to support a method for transmitting RLC data.

[196]   As the various concepts and features described herein may be embodied in several forms without departing from the 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 scope as defined in the appended claims. Therefore, all changes and modifications that fall within such scope or equivalents thereof are therefore intended to be embraced by the appended claims.
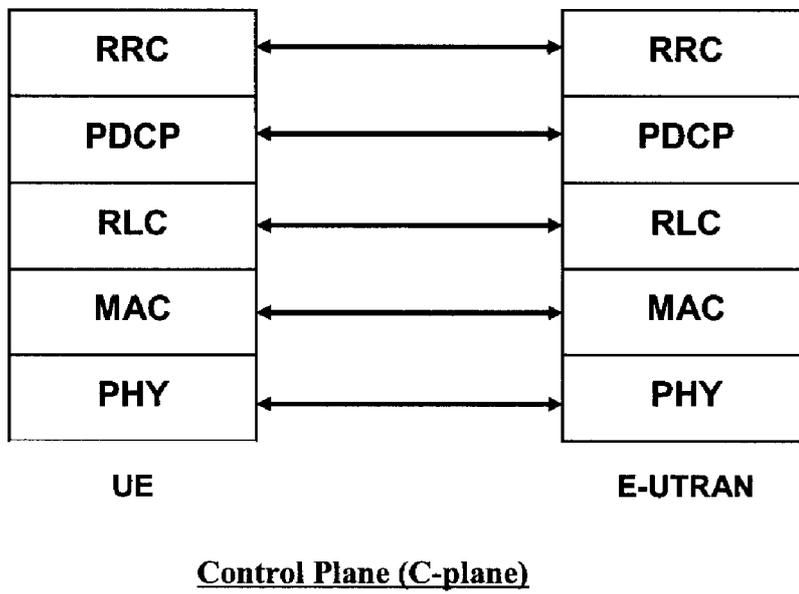
Claims

[1]   A method of transmitting data, the method comprising:

detecting a triggering of a first event;

further detecting a triggering of a second event until a third event occurs; and

performing a first action if the triggering of the second event is not detected, wherein the first action is based on the detected first event.

[2]   The method of claim 1, wherein if the triggering of the second even is detected, canceling the first event.

[3]   The method of claim 1, wherein the first event is an expiry of a poll retransmit timer, the second event is detecting whether a ACK or NACK signal is not received, and the third event is a next transmission opportunity,

[4]   The method of claim 3, wherein the first action may be setting a polling bit of a data PDU (protocol data unit) to be transmitted.

[5]   A method of transmitting data, the method comprising:

detecting an expiry of a poll retransmit timer;

further detecting whether a positive or negative acknowledgement for a (RLC) data PDU was not received, the further detecting step being performed until the next transmission opportunity;

if the positive or negative acknowledgement was not detected or received, setting a polling bit in the data PDU; and

transmitting the data PDU having the polling bit set therein.

[6]   The method of claim 5, wherein the next transmission opportunity occurs when an instruction is received from the MAC layer indicating that transmission is possible because radio resources are available.

[7]   The method of claim 6, wherein the radio resources are used for supporting OFDM.

[8]   The method of claim 5, wherein the further detecting step is performed during a further confirmation period defined as a fixed or variable time duration.

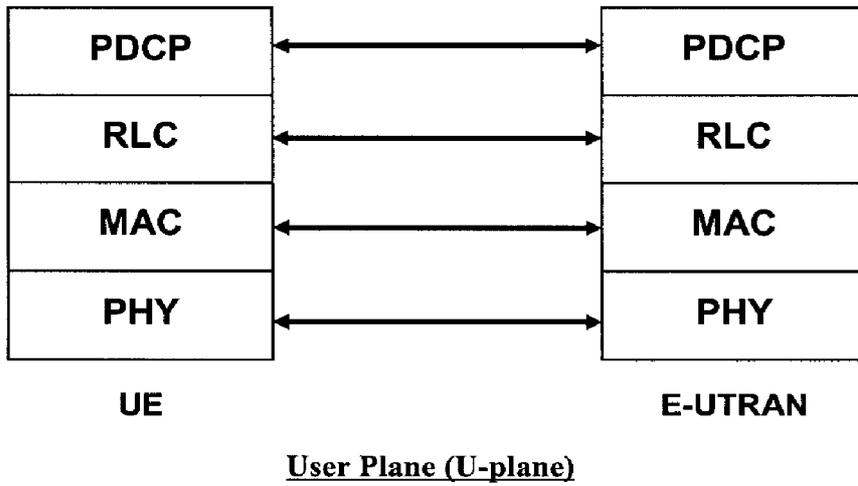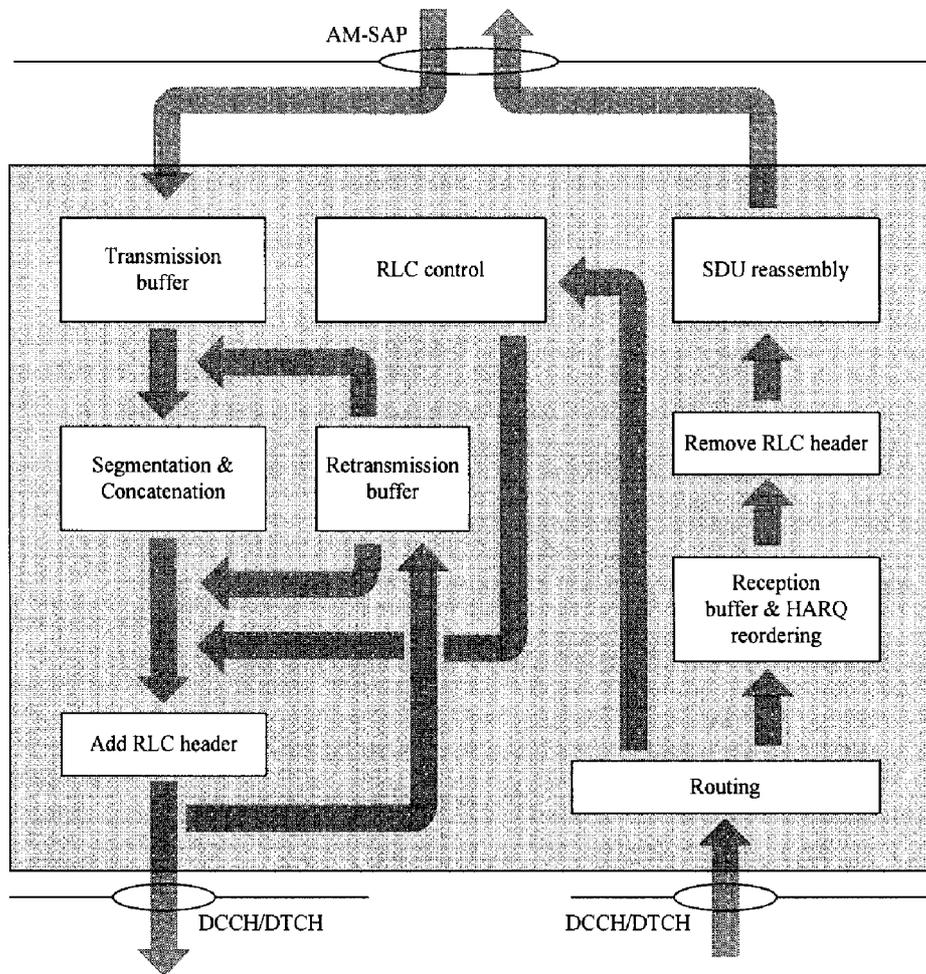[9]   The method of claim 5, wherein the further detecting step is timer-based.
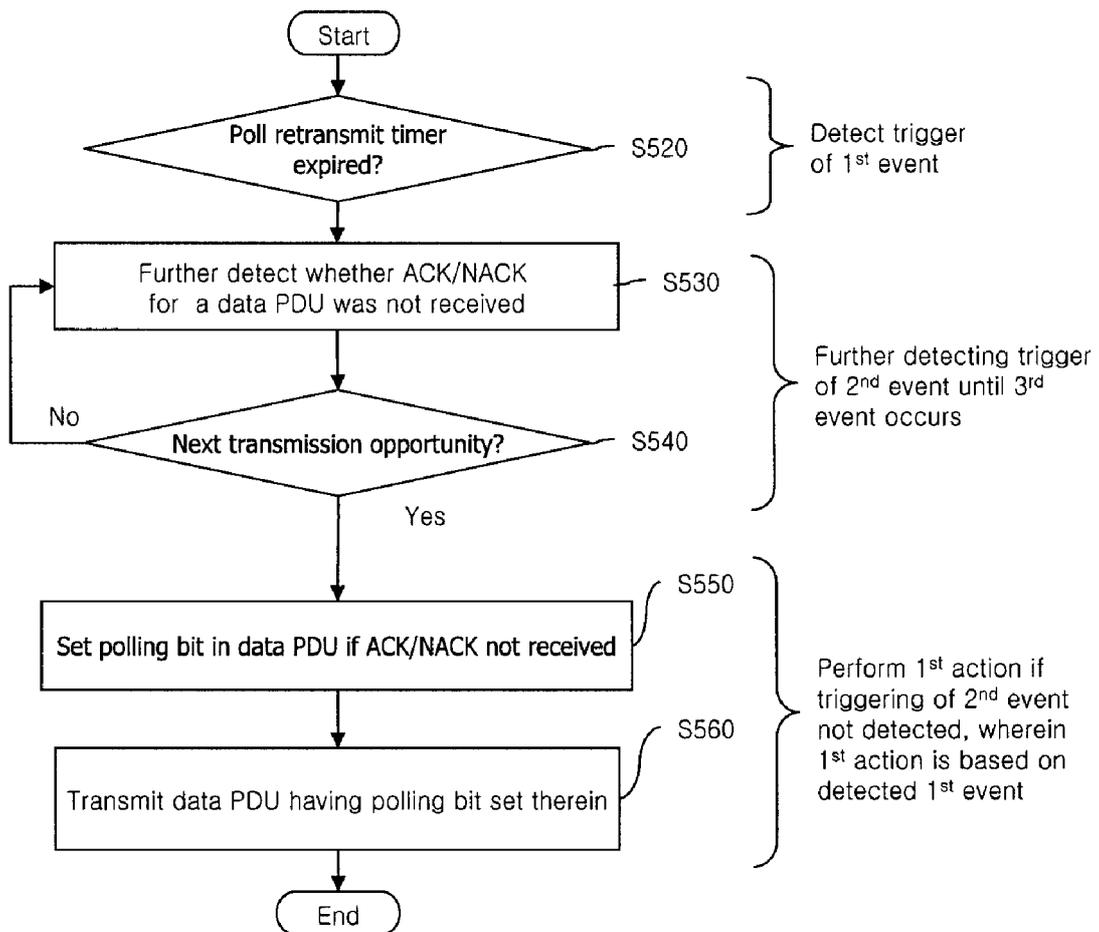
[Fig. 1]

[Fig. 2]

Control Plane (C-plane)

[Fig. 3]

User Plane (U-plane)

[Fig. 4]

[Fig. 5]

INTERNATIONAL SEARCH REPORT

International application No

PCT/KR2009/001342

A.   CLASSIFICATION OF SUBJECT MATTER

H04B 7/26(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B.   FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
  IPC H04B, H04J, H04L, H04Q, H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
  Korean Utility models and applications for Utility models since 1975
  Japanese Utility models and application for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
  EKIPASS(KIPO, internal), IEEE xplore "Keyword detecting, triggering and RLC "

C.   DOCUMENTS   CONSIDERED   TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
A	US 7181667 B2(YIANNIS ARGYROPOULOS et al) 20 February 2007 See the abstract, claims 3-5	1-9
A	US 7227856 B2(CHIH HSIANG WU) 05 June 2007 See the abstract, claims 2-3	1-9
A	US 2005/0287957 Al(LEE, YOUNG DAE et al) 29 December 2005 See the abstract, claims 9-10	1-9

☐ Further documents are listed in the continuation of Box C   ☒ See patent family annex

* Special categories of cited documents "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance, the claimed invention cannot he considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 JUNE 2009 (26 06 2009)	29 JUNE 2009 (29.06.2009)

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Form PCT/ISA/210 (second sheet) (My 2008)

| International application No |
| PCT/KR2009/001342 |

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		EP 1389886 A1	18.02.2004
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