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(71) Applicant(s)
Fujitsu Limited

(72) Inventor(s)
Otonari, Akihide;Shinohara, Chiaki;Shimizu, Hirotoshi;Soejima, Yoshinori;Yamasaki, Miki;Okamoto, Shinya;Obuchi, Kazuhisa

(74) Agent / Attorney
Spruson & Ferguson, L 35 St Martins Tower 31 Market St, Sydney, NSW, 2000

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A WIRELESS COMMUNICATION APPARATUS, WIRELESS COMMUNICATION CONTROL APPARATUS, WIRELESS COMMUNICATION METHOD, WIRELESS COMMUNICATION PROGRAM, WIRELESS COMMUNICATION CONTROL METHOD, AND WIRELESS COMMUNICATION CONTROL PROGRAM.

ABSTRACT

A wireless communication apparatus, wherein the wireless communication apparatus uses a communication protocol to transmit and receive MAC PDU with a check bit, and the wireless communication apparatus comprises: a receiving section that receives the MAC PDU from other wireless communication apparatus; a first determining section that performs a data check for the received MAC PDU by using the check bit and performs a determination whether or not the MAC PDU is an error; a transmitting section that generates a first message indicating that the MAC PDU is error when a result of the determination is an error, and generates a second message indicating that the MAC PDU is normal when a result of the determination is not an error; and a second determining section that determines whether an identity of MAC control information is out of designation, and that discards the MAC PDU when the identity of MAC control information is determined to be out of designation.

20 Feb 2013 2013200946

DESCRIPTION

WIRELESS COMMUNICATION APPARATUS, WIRELESS COMMUNICATION CONTROL APPARATUS, WIRELESS COMMUNICATION METHOD, WIRELESS COMMUNICATION PROGRAM, WIRELESS COMMUNICATION CONTROL METHOD, AND WIRELESS COMMUNICATION CONTROL PROGRAM

Technical Field

[0001] The embodiment discussed herein is related to a wireless communication apparatus that uses a communication protocol to transmit and receive data with a data check bit, a wireless communication control apparatus that is used in the wireless communication apparatus to control communication, a wireless communication method that uses the wireless communication apparatus, a wireless communication program that causes the wireless communication apparatus to perform data reception processing, a wireless communication control method that uses the wireless communication control apparatus used in the wireless communication apparatus to control communication, and a wireless communication control program that uses the wireless communication control apparatus which is used in the wireless communication apparatus to control communication.

Background Art

[0002] Recently, a protocol of wireless communication system referred to as 3G (3rd generation) is widely employed.

[0003] There are some development stages in this 3G, and in addition to the original 3G employed in FOMA and the like, there appears a cellular telephone employing a protocol referred to as 3.5G or HSDPA in which speed of communication is more enhanced. Moreover, now a protocol referred to as Super3G or 3.9G is examined.

[0004] A protocol in a wireless communication system of this 3G group is divided into plural layers. A layer 1 among them is a layer referred to as a physical layer and handles actual communication.

[0005] FIG. 1 is a protocol block diagram of a layer 2.

[0006] The layer 2 positioned on the layer 1 includes three sub layers of a MAC (Medium Access Control), a RLC (Radio Link Control), and a PDCP (Packet Data Convergence Protocol).

[0007] Here, a whole of one processing function arranged in one layer or one sub layer is called an entity. PDCP entity or RLC entity exists as many as LCH (Logical Channel) to be used (n pieces of #1 ~#n in the example illustrated in FIG. 1). Each PDCP and each RLC correspond to each LCH and transfer a PDU (Protocol Data Unit). Here, the PDCP entity processes concealment of data and the like in 3.9G (Super3G), and the RLC entity processes retransmission control of data and the like.

[0008] A MAC entity integrates PDU's transferred from each RLC entity via each LCH into one PDU and transmits the PDU to a HARQ (Hybrid Automatic Repeat reQuest). The HARQ transfers the PDU to the lower layer 1 via a TRCH (Transport Channel).

[0009] On a receiving side, the MAC entity divides the PDU transferred from the layer 1 via the TRCH into one PDU or plural PDU's, and transfers the divided PDU's (PDU) to each RLC entity via each LCH.

[0010] Incidentally, although there is a layer 3 on the layer 2, the layer 3 is not directly related here so that its illustration and explanation are omitted.

[0011] Here, for each PDU, a mechanism capable of exchanging information with a counterpart side by adding not only user data but also control information necessary for an entity on the counterpart side is examined in 3GPP (3rd Generation Partnership Project).

[0012] FIG. 2 illustrates an example of a data flow of a PDU with control information added thereto.

[0013] In the RLC entity, a header H is added to a RLC-SDU (Source Data Unit) received from the PDCP entity of the same LCH to be transmitted to the MAC entity as a PDU in a RLC sub layer (RLC-PDU). In the MAC entity, RLC-PDU's transmitted from RLC entities of plural LCH's are received as SDU's

(MAC-SDU's) in the MAC sub layers. The plural MAC-SDU's are integrated, added with MAC control information and further added with a header H, and transmitted to the layer 1 as one single MAC-PDU. In the layer 1, the MAC-PDU transmitted from the MAC sub layer is transmitted by wireless.

[0014] On the other hand, on the receiving side, the MAC-PDU received in the layer 1 is passed to the MAC entity, and in the MAC entity, the received MAC-PDU is divided into MAC-SDU's for each LCH and passed to the RLC entities of each LCH.

[0015] Incidentally, in this FIG. 2, a case of normally being transmitted and received is exemplified. Incidentally, the HARQ (see FIG. 1) included in the MAC entity checks whether reception is normal or abnormal by a CRC (Cyclic Redundancy Check), and transmits an ACK (Acknowledgment) toward a transmitting origin if reception is normal (CRC-OK) or transmits a NACK (Negative Acknowledgment) when reception is abnormal (CRC-NG), so that a retransmission request is performed.

[0016] FIG. 3 illustrates a data flow including returning of the ACK and NACK by the HARQ on the receiving side.

[0017] Here, a case is illustrated in which a HARQ transmission controlling section on the transmitting side operates, and two MAC-PDU's of a MAC-PDU #1 and a MAC-PDU #2 are transmitted toward the receiving side. On the receiving side, these two MAC-PDU's are received, and a HARQ reception controlling section on the receiving side performs a CRC check for each of the received MAC-PDU's. As a result of the CRC check, it is determined that the MAC-PDU #1 is abnormal in receiving (CRC-NG), and a NACK is transmitted toward the transmitting side at this time. When the HARQ transmission controlling section on the transmitting side receives the NACK, the HARQ transmission controlling section performs retransmission control of the same MAC-PDU #1. On the transmitting side, a time when the MAC-PDU #1 is transmitted is managed, and when the NACK is received, it is possible to identify retransmission of which particular MAC-PDU the NACK requests, from a received time of the NACK. Therefore, on the

receiving side of the MAC-PDU, simply by transmitting the NACK, without transmitting an identifier of a MAC-PDU in which an abnormality in receiving occurs on the receiving side, it is possible to recognize in which particular MAC-PDU the abnormality in receiving occurs on the transmitting side.

[0018] As for the MAC-PDU #2 that is transmitted following the MAC-PDU #1 from the transmitting side, when reception is normal (CRC-OK), the HARQ reception controlling section passes the MAC-PDU #2 to the MAC-PDU determination processing section and also transmits an ACK toward the transmitting side. The transmitting side which receives the ACK recognizes that retransmission control for the MAC-PDU #2 is unnecessary and transmits a MAC-PDU (here, MAC-PDU #n) to be transmitted next.

[0019] In the MAC-PDU determination processing section, it is determined whether the MAC-PDU #2 received from the HARQ reception controlling section is a PDU in a normal format or a PDU in an incorrect format.

[0020] FIG. 4 is a schematic diagram illustrating a determination processing whether a PDU is in a normal format or an incorrect format in the MAC-PDU determination processing section.

[0021] As described above, when the HARQ reception controlling section determines that the reception is normal as a result of the CRC check, the HARQ reception controlling section transmits an ACK toward the transmitting side and also passes the MAC-PDU to the MAC-PDU determination processing section. When the MAC-PDU determination processing section receives the MAC-PDU from the HARQ reception controlling section, it is determined whether the format of the MAC-PDU is normal or incorrect.

[0022] For example, the following cases are considered as an incorrect format.

[0023] (1) An identifier of a LCH is out of range.

(2) More headers than specified in exist (E (Extension) flag in a header is ON).

(3) A sum of Length information in a header is longer than a received MAC-PDU.

(4) An identifier of the MAC control information is out of range.

(5) An identifier of the MAC control information is different from the Length.

[0024] In the MAC-PDU determination processing section, it is determined whether the MAC-PDU is in a normal format or an incorrect format, and when it is determined to be the normal format, the MAC-PDU is divided into MAC-SDU's for each LCH to be passed to a RLC entity of each LCH (see FIG. 2), and when it is determined to be the incorrect format, the MAC-PDU is discarded. In this case, the retransmission control is not performed in the MAC entity. As described above, since the retransmission control is performed in the RLC entity, if the RLC-PDU to be received by the RLC entity is not received, the retransmission request is performed from the RLC entity. However, since there is a condition for performing the retransmission control in the RLC entity, the retransmission control is not performed immediately.

[0025] Subsequently, as a technique related to the present invention, an outline of MINO (Multiple-Input Multiple-Output) to perform communication by using plural antennas will be explained.

[0026] FIG. 5 is a block diagram illustrating an outline of a transmitting apparatus and a receiving apparatus employing the MIMO, and FIG. 6 illustrates a data flow when the MIMO is employed.

[0027] In a MAC-PDU generation processing section 11 on the transmitting side, RLC-PDU's (MAC-SDU's) received from each RLC are integrated to generate a MAC-PDU as illustrated in FIG. 2. Although this MAC-PDU is generated in multiple numbers depending on generation of data to be transmitted, in FIG. 5 and FIG. 6, two MAC-PDU's of the MAC-PDU #1 and the MAC-PDU #2 are typically illustrated. The MAC-PDU's generated in the MAC-PDU generation processing section 11 are inputted into a layer 1 transmission processing section 13 via the HARQ transmission controlling section 12, the MAC-PDU's are allocated to plural antennas 14a, 14b (here,

two antennas as one example), respectively, and transmitted while being shared by these two antennas 14a, 14b.

[0028] On the receiving side, the MAC-PDU's transmitted from these two antennas 14a, 14b on the transmitting side are received by two antennas 24a, 24b, and passed to a layer 1 reception processing section 23. In FIG. 6, a pair of the antennas for transmitting and receiving is referred to as a MIMO antenna while identifying each as a MIMO antenna &1 and a MIMO antenna &2.

[0029] The MAC-PDU's received via the plural antennas 24a, 24b in the layer 1 reception processing section 22 on the receiving side are, after a CRC check is performed and a NACK and an ACK are transmitted by the HARQ reception controlling section 22, to be transmitted to the MAC-PDU determination processing section 21. In the MAC-PDU determination processing section 21, the normality or incorrectness of the format is determined, and when determined to be the normal format, the MAC-PDU's are divided into MAC-PDU's for each LCH to be passed to each RLC entity. A MAC-PDU in the incorrect format is discarded in the MAC-PDU determination processing section 21.

[0030] Thus, the MIMO is a technique of transmitting and receiving in parallel by using plural antennas, and enables high speed communication since the plural antennas are used so that the bandwidth is widened.

[0031] In the above-described communication algorithm, the MAC-PDU determination processing section on the receiving side determines whether a format of the received MAC-PDU is normal or incorrect and when determined to be the incorrect format, the MAC-PDU determination processing section discards the MAC-PDU. Although the acquisition of the discarded data is handled by the retransmission control in the RLC entity, as described above, the retransmission control in the RLC entity is not immediately performed, but it takes some time before the request of retransmission so that a throughput as a whole may decrease.

[0032] In view of the above circumstances,

a need exists to provide a wireless communication apparatus which obtains an improved throughput, a wireless communication control apparatus, a wireless communication method, a wireless communication program, a wireless communication control method, and a wireless communication control program.

Related Applications

This application is a divisional application of Australian Patent Application No. 2011211385, which is in turn a divisional application of Australian Patent Application No. 2007359820, both of which are incorporated herein in their entirety as if expressly set forth herein.

Disclosure

An aspect of the present invention provides a wireless communication apparatus, wherein the wireless communication apparatus uses a communication protocol to transmit and receive MAC PDU with a check bit, and the wireless communication apparatus comprises: a receiving section that receives the MAC PDU from other wireless communication apparatus;
a first determining section that performs a data check for the received MAC PDU by using the check bit and performs a determination whether or not the MAC PDU is an error; a transmitting section that generates a first message indicating that the MAC PDU is error when a result of the determination is an error, and generates a second message indicating that the MAC PDU is normal when a result of the determination is not an error; and a second determining section that determines whether an identity of MAC control information is out of designation, and that discards the MAC PDU when the identity of MAC control information is determined to be out of designation.

[NEXT PAGE IS PAGE 19]

[0055] Here, main aspects are described about the wireless communication control apparatus, the wireless communication control method, the wireless communication program, the wireless communication control method, and the wireless communication control program. However, all modes that correspond to the aspects described about the wireless communication apparatus are also included in the wireless communication control apparatus, the wireless communication control method, the wireless communication program, the wireless communication control method, and the wireless communication control program, as long as the modes are appropriate to the scope of embodiments of the present invention.

Brief Description of Drawings

[0056] FIG. 1 is a protocol block diagram of a layer 2.

FIG. 2 illustrates an example of a data flow of a PDU with control information added thereto.

FIG. 3 illustrates a data flow including returning of ACK and NACK by a HARQ on a receiving side.

FIG. 4 is a schematic diagram illustrating a determination processing whether a PDU is in a normal format or an incorrect format in a MAC-PDU determination processing section.

FIG. 5 is a block diagram illustrating an outline of a transmitting apparatus and a receiving apparatus employing MIMO.

FIG. 6 illustrates a data flow when the MIMO is employed.

FIG. 7 is a schematic diagram illustrating one example of a communication system to which one embodiment of the present invention is applied.

FIG. 8 is a block diagram illustrating a HARQ reception controlling section and a MAC-PDU determination processing

section in a first embodiment of the present invention.

FIG. 9 illustrates a data flow in the embodiment illustrated in FIG. 8.

FIG. 10 is a block diagram illustrating a configuration in a MAC sub layer on the receiving side in a second embodiment of the present invention.

FIG. 11 illustrates a data flow in the embodiment illustrated in FIG. 10.

The Best Mode for Carrying out the Invention

[0057] Embodiments of the present invention will be described with reference to the drawings.

[0058] FIG. 7 is a schematic diagram illustrating one example of a communication system to which one embodiment of the present invention is applied.

[0059] FIG. 7 illustrates a cellular telephone 100 and a base station 200 that performs wireless communication with the cellular telephone 100. Incidentally, although many cellular telephones and many base stations exist, and furthermore many switchboards exist in a real communication system, here, only a minimum configuration necessary to explain the present embodiment is illustrated.

[0060] Wireless communication is performed between the cellular telephone 100 and the base station 200, such that when the cellular telephone 100 becomes the transmitting side, the base station 200 becomes the receiving side, whereas when the base station 200 becomes the transmitting side, the cellular telephone 100 becomes the receiving side. In other words, in either one of the cellular telephone 100 and the base station 200, a configuration of the transmitting side and a configuration of the receiving side are provided as described in the following.

[0061] In the above-described conventional technique, when a format of the received MAC-PDU is incorrect, the MAC-PDU is discarded and a request of retransmission is handled by the RLC. However, in the present embodiment, when a format of the received MAC-PDU is incorrect, as illustrated in the

following two examples, a request of retransmission is made in the MAC sub layer, thereby improving the throughput of the communication. The present embodiment is different from the above-mentioned conventional technique only in a point that a request of retransmission is made in the MAC sub layer, so that the explanation made about the above-mentioned conventional technique is applied for the other points other than the point as they are.

[0062] That is, the wireless communication apparatus of the present invention includes, as a block configuration, both the configurations of the transmitting side and the receiving side illustrated in the previously described FIG. 5 as one example, and only the point to be described in the following is different from the above-mentioned conventional technique.

[0063] FIG. 8 is a block diagram illustrating the HARQ reception controlling section and the MAC-PDU determination processing section in a first embodiment of the present invention.

[0064] When a MAC-PDU transmitted from the transmitting side is received, a received data determining section 221 of the HARQ reception controlling section 22 on the receiving side performs a CRC check for the received MAC-PDU. If it is a normal receiving (CRC-OK), the MAC-PDU is transmitted to the MAC-PDU determination processing section 21 and also a request of transmitting an ACK is made for an ACK-NACK transmitting section 222, and the ACK is transmitted from the ACK-NACK transmitting section 222 via the layer 1. However, in spite of the request of transmitting the ACK made from the received data determining section 221 toward the ACK-NACK transmitting section 222, there is a case in which the ACK is not transmitted but a NACK is transmitted from the ACK-NACK transmitting section 222 as will be explained below.

[0065] When the received data determining section 221 determines that the reception is abnormal (CRC-NG), a request of transmitting a NACK is made from the received data determining section 221 toward the ACK-NACK transmitting section 222, and the NACK is transmitted from the ACK-NACK

transmitting section 222 toward the transmitting side via the layer 1. As already explained, the transmitting side manages a transmission time of a MAC-PDU and it is possible to identify, if an ACK or a NACK is received, which PDU the ACK or the NACK corresponds to, from a reception time of the ACK or the NACK. Also in the MIMO, since an ACK and a NACK is transmitted from the same antenna as that having received the ACK and the NACK on the receiving side, it is possible to identify, on the transmitting side of the PDU, which MAC-PDU the ACK and the NACK corresponds to, from the transmission time and the antenna having received the ACK and the NACK.

[0066] Here, the MAC-PDU that is determined as a normal reception (CRC-OK) in the received data determining section 221 and passed to the MAC-PDU determination processing section 21 is determined, this time, whether it is a PDU in a normal format or an incorrect format in the MAC-PDU determination processing section 21. If it is a PDU in the normal format, the MAC-PDU is divided into SDU's for each LCH to be passed to a RLC entity of each LCH (see FIG. 2).

[0067] On the other hand, when determined to be a PDU in the incorrect format in the MAC-PDU determination processing section 21, the PDU is discarded. What described hitherto is similar to the above-described conventional technique, however in the present embodiment, when the MAC-PDU determination processing section 21 determines that the PDU is in the incorrect format, discards the PDU and requests the ACK-NACK transmitting section 222 of the HARQ reception controlling section 22 to transmit a NACK, and causes the ACK-NACK transmitting section 222 to renew the request of transmitting the ACK which is transmitted from the received data determining section 221. Then, upon receipt of the request from the MAC-PDU determination processing section 21, the ACK-NACK transmitting section 222 transmits a NACK toward the transmitting side via the layer 1.

[0068] FIG. 9 illustrates a data flow in the embodiment illustrated in FIG. 8.

[0069] In the example illustrated here, a base station is

the transmitting side, and two MAC-PDU's of the MAC-PDU #1 and the MAC-PDU #2 are representatively transmitted from the transmitting side and received by a cellular telephone that is the receiving side. On the receiving side, a determination is made in a MAC sub layer further in the layer 2 whether it is a normal reception (CRC-OK) or an abnormal reception (CRC-NG).

[0070] Here, firstly, the determination is made for the MAC-PDU #1, and since it is a normal reception (CRC-OK), an ACK is to be transmitted toward the transmitting side here. However, in the meantime while the ACK is not yet transmitted, whether a format of the MAC-PDU #1 is normal or incorrect is determined, and if the format of the MAC-PDU #1 is incorrect, the ACK which is to be transmitted because of the normal reception (CRC-OK) is renewed with a NACK to be transmitted toward the transmitting side. Then, on the transmitting side, since the NACK is received, the MAC-PDU #1 corresponding to the NACK is retransmitted toward the receiving side.

[0071] As for the MAC-PDU #2, since the reception is normal and the format is normal as well, an ACK is transmitted toward the transmitting side, and on the transmitting side, a MAC-PDU #n that has not yet been transmitted is transmitted without retransmitting the MAC-PDU #2.

[0072] With this, not only when the reception is abnormal (CRC-NG), but also when the PDU is in an incorrect format even if the reception is normal (CRC-OK), a retransmission request is made in a MAC sub layer. As such, the retransmission request is made without waiting for the retransmission request from a RLC sub layer, so that a time until the retransmission request is reduced and thereby a throughput as the entire system is improved.

[0073] Incidentally, here, although the explanation is made by assuming the base station is the transmitting side and the cellular telephone is the receiving side, same is also applied to a case where the cellular telephone is the transmitting side and the base station is the receiving side.

[0074] In the layer 1 on the transmitting side, the MAC-PDU

which is transmitted once is stored for a while, and the stored MAC-PDU is retransmitted when a NACK corresponding to the once transmitted MAC-PDU is received. Thus, although the first embodiment is effective for an error that occurs between the layer 1 on the transmitting side and the MAC-PDU determination processing on the receiving side including the layer 1 on the transmitting side, it is impossible to cope with a case in which an error occurs in the MAC-PDU in the step of generating the MAC-PDU on the transmitting side or in the step of passing the generated MAC-PDU to the layer 1 on the transmitting side, even if retransmission is repeatedly tried. Because of this, in the MAC-PDU determination processing on the receiving side, when the format of the MAC-PDU that is retransmitted due to reception of the NACK is the same incorrect format as that of the MAC-PDU before the retransmission, retransmission request is not performed anymore. This prevents useless retransmission from being repeated and may allocate communication resources to another PDU.

[0075] Subsequently, a second embodiment of the present invention will be explained.

[0076] FIG. 10 is a block diagram illustrating a configuration in a MAC sub layer on the receiving side in the second embodiment of the present invention.

[0077] In the HARQ reception controlling section 22 on the receiving side (here, cellular telephone), a CRC check is performed for a received MAC-PDU similarly as described above, and according to a normal reception (CRC-OK) or an abnormal reception (CRC-NG), an ACK or a NACK is transmitted toward the transmitting side (base station). An ACK or a NACK at this time is transmitted depending on either the normal reception (CRC-OK) or the abnormal reception (CRC-NG), and whether the format is normal or incorrect is not taken into consideration.

[0078] When determined to be the normal reception (CRC-OK) in the HARQ reception controlling section 22, the MAC-PDU is transmitted to the MAC-PDU determination processing section 21. At this time, from the HARQ reception controlling section 22, reception information including time information

indicating a time when the MAC-PDU is received and MIMO antenna information to identify an antenna having received the MAC-PDU when MIMO is used is also passed to the MAC-PDU determination processing section 21 together with the MAC-PDU. In the MAC-PDU determination processing section 21, a format of the received MAC-PDU is examined to determine whether it is a normal format or an incorrect format. When it is the normal format, the MAC-PDU is divided into MAC-SDU = RLC-PDU for each LCH to be passed to a RLC entity of each LCH.

[0079] On the other hand, when determined to be the incorrect format in the MAC-PDU determination processing section 21, the MAC-PDU determined to be the incorrect format is discarded, and a retransmission request accompanied with the reception information (time information and MIMO antenna information) is passed to a MAC control information creation processing section 31. Although the MAC control information creation processing section 31 is not explicitly illustrated in FIG. 5, it is a constituent element in a MAC sub layer to handle the creation of the MAC control information of the MAC-PDU that is transmitted from the cellular telephone toward the base station.

[0080] Here, various kinds of MAC control information are created according to demands on occasions. The present embodiment is characterized in that the MAC control information creation processing section 31 creates the MAC control information in which the retransmission request received from the MAC-PDU determination processing section 21 is embedded. The retransmission request that is embedded in the MAC control information includes the reception information (time information and MIMO antenna information). The MAC control information created in the MAC control information creation processing section 31 is passed to the MAC-PDU generation processing section 11 in the same cellular telephone. The MAC-PDU generation processing section 11 integrates the RLC-PDU's (MAC-SDU's) received from the RLC entities and further adds the MAC control information received from the MAC control information creation processing section 31 and a header to

generate a MAC-PDU. The MAC-PDU generated in the MAC-PDU generation processing section 11 is passed to the HARQ transmission controlling section 12 and further transmitted toward a base station via the layer 1 of the cellular telephone. The base station side refers to the control information of the received MAC-PDU and recognizes the retransmission request included in the control information and further identifies a particular MAC-PDU to be retransmitted by the reception information (time information and MIMO antenna information) added to the retransmission request, and retransmits the MAC-PDU. At this time, on the base station side, the MAC-PDU which is stored until the ACK or the NACK is received no longer exists, and the base station side again receives the RLC-PDU's (MAC-SDU's) necessary for building the MAC-PDU to be retransmitted from the RLC of each LCH on the base station side, to regenerate and retransmit the MAC-PDU.

[0081] As such, in the second embodiment, an error occurred in the process of generating the MAC-PDU on the transmitting side or in the process of passing the generated MAC-PDU to the layer 1 on the transmitting side may be coped with. However, also in this embodiment, when the retransmitted MAC-PDU is of the incorrect format same as that of the MAC-PDU before the retransmission, it is desirable not to request retransmission anymore.

[0082] FIG. 11 illustrates a data flow in the embodiment illustrated in FIG. 10.

[0083] Here, the drawing representatively illustrates that two MAC-PDU's of the MAC-PDU # D1 and the MAC-PDU # D2 are transmitted from the base station that is the transmitting side to the cellular telephone that is the receiving side. Although in the MAC sub layer on the receiving side, the CRC check and the transmission of an ACK and a NACK are performed, they are similar to the conventional technique (see FIG. 3) and illustration is omitted here.

[0084] In the MAC sub layer on the receiving side, when it is a normal reception (CRC-OK) after a CRC check, a format of the received MAC-PDU is subsequently examined to determine

whether the format is normal or incorrect. When determined to be normal, the same procedure as the conventional technique or the above-mentioned first embodiment takes place.

[0085] On the other hand, when it is determined that the received MAC-PDU is a PDU of an incorrect format, the MAC-PDU is discarded, and this time, a retransmission request in which reception information including the time information indicating a time when the MAC-PDU of the incorrect format is received and the MIMO antenna information for identifying an antenna having received the MAC-PDU are added, is embedded in the MAC control information of a MAC-PDU that is built in a case where the same cellular telephone becomes the transmitting side, and the MAC-PDU (MAC-PDU #U1 in FIG. 11) is transmitted toward the base station.

[0086] The base station analyzes the MAC control information of the received MAC-PDU #U1, recognizes that the MAC-PDU #D1 needs to be retransmitted, regenerates and retransmits the MAC-PDU #D1 to the cellular telephone.

[0087] Also in the second embodiment, in the event of an incorrect format, a request of retransmission is made in the MAC sub layer so that the throughput of the entire system is improved.

2013200946 20 Feb 2013

CLAIMS

1. A wireless communication apparatus, wherein the wireless communication apparatus uses a communication protocol to transmit and receive MAC PDU with a check bit, and

the wireless communication apparatus comprises:

a receiving section that receives the MAC PDU from other wireless communication apparatus;

a first determining section that performs a data check for the received MAC PDU by using the check bit and performs a determination whether or not the MAC PDU is an error;

a transmitting section that generates a first message indicating that the MAC PDU is error when a result of the determination is an error, and generates a second message indicating that the MAC PDU is normal when a result of the determination is not an error; and

a second determining section that determines whether an identity of MAC control information is out of designation, and that discards the MAC PDU when the identity of MAC control information is determined to be out of designation.

2. The wireless communication apparatus according to claim 1, wherein the communication protocol of the wireless apparatus includes a MAC (Medium Access Control) protocol and the data check is a CRC (Cyclic Redundancy Check).

Dated 17 January, 2013
Fujitsu Limited
Patent Attorneys for the Applicant/Nominated Person
SPRUSON & FERGUSON

FIG. 1

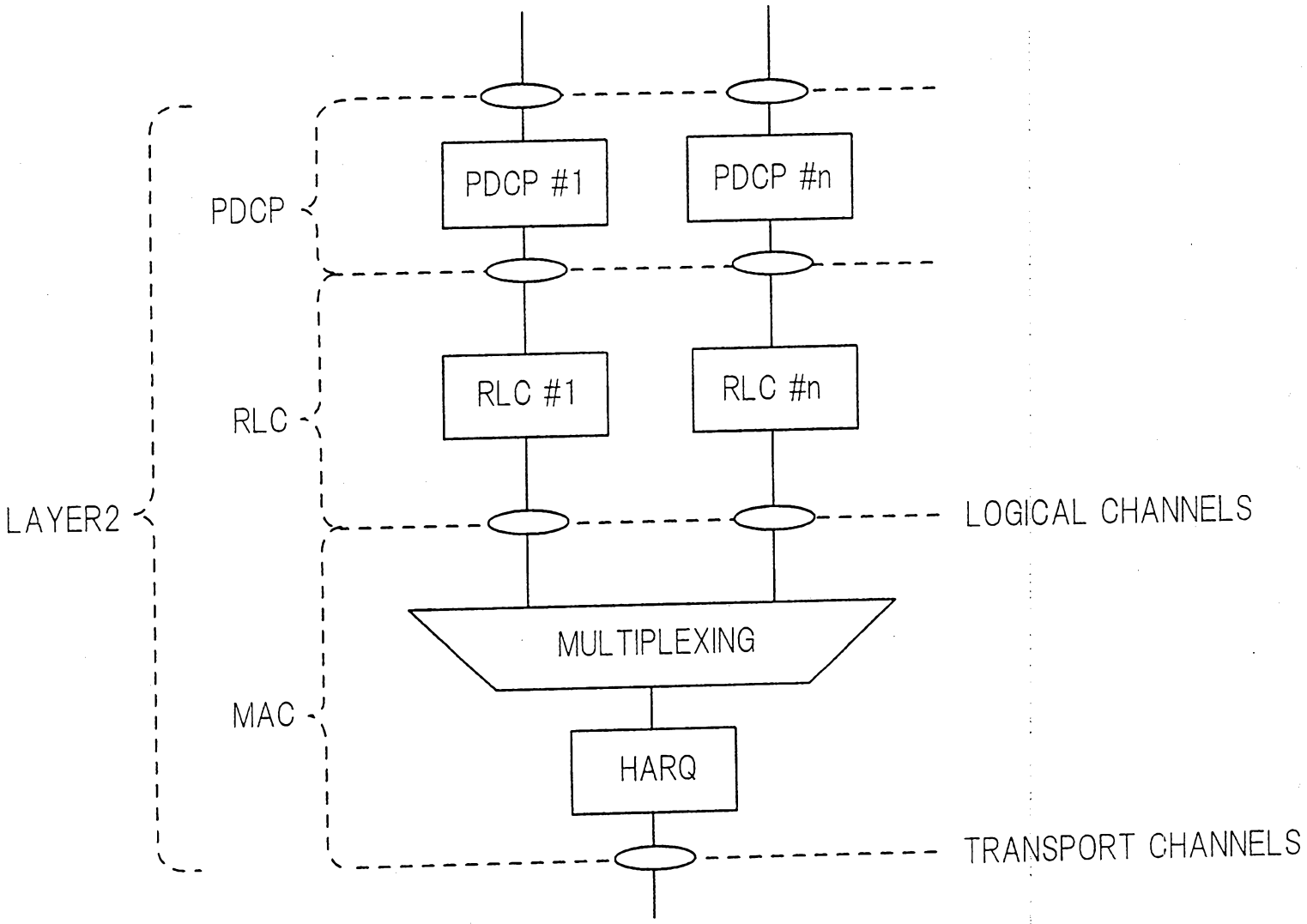

PDCP #1
PDCP #n
PDCP
RLC #1
RLC #n
RLC
LAYER2
LOGICAL CHANNELS
MULTIPLEXING
MAC
HARQ
TRANSPORT CHANNELS

FIG. 2

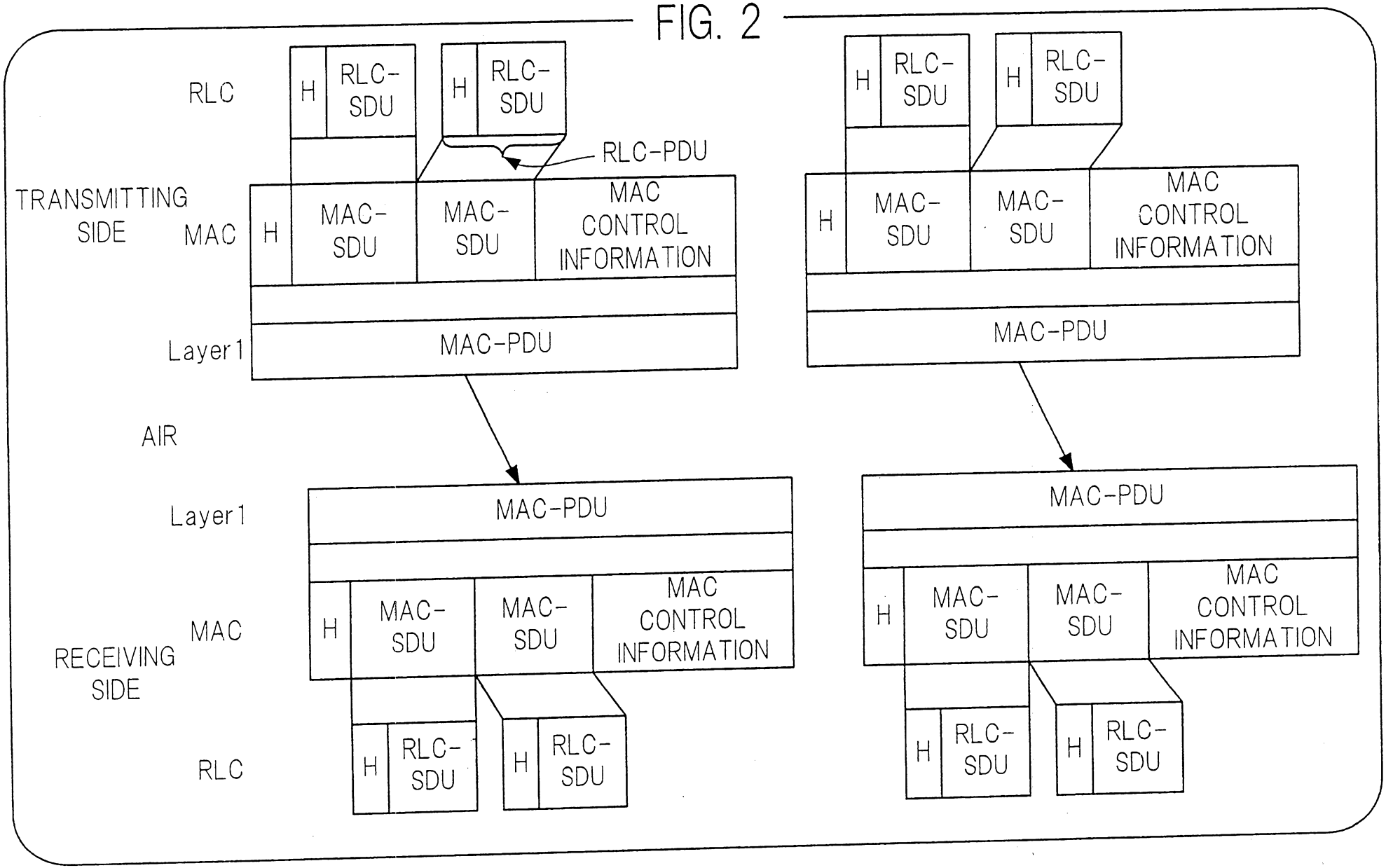

RLC
H
RLC-SDU
H
RLC-SDU
RLC-PDU
TRANSMITTING SIDE
MAC
H
MAC-SDU
MAC-SDU
MAC CONTROL INFORMATION
Layer1
MAC-PDU
AIR
Layer1
MAC-PDU
MAC
RECEIVING SIDE
RLC
H
RLC-SDU
H
RLC-SDU
MAC-PDU

FIG. 3

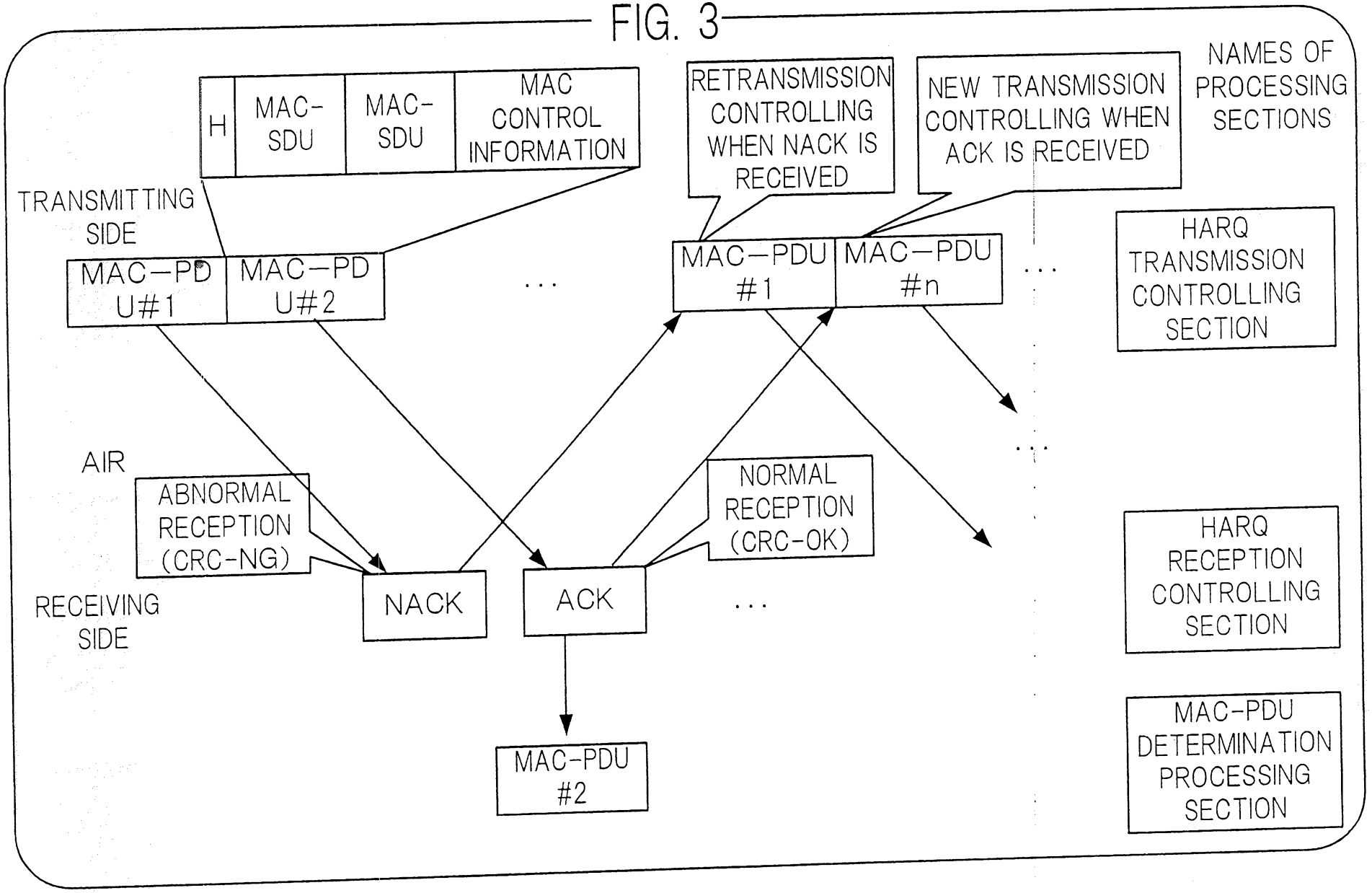

H
MAC-SDU
MAC-SDU
MAC CONTROL INFORMATION
RETRANSMISSION CONTROLLING WHEN NACK IS RECEIVED
NEW TRANSMISSION CONTROLLING WHEN ACK IS RECEIVED
NAMES OF PROCESSING SECTIONS
TRANSMITTING SIDE
MAC-PD U#1
MAC-PD U#2
MAC-PDU #1
MAC-PDU #n
HARQ TRANSMISSION CONTROLLING SECTION
AIR
ABNORMAL RECEPTION (CRC-NG)
NORMAL RECEPTION (CRC-OK)
RECEIVING SIDE
NACK
ACK
HARQ RECEPTION CONTROLLING SECTION
MAC-PDU #2
MAC-PDU DETERMINATION PROCESSING SECTION

FIG. 4

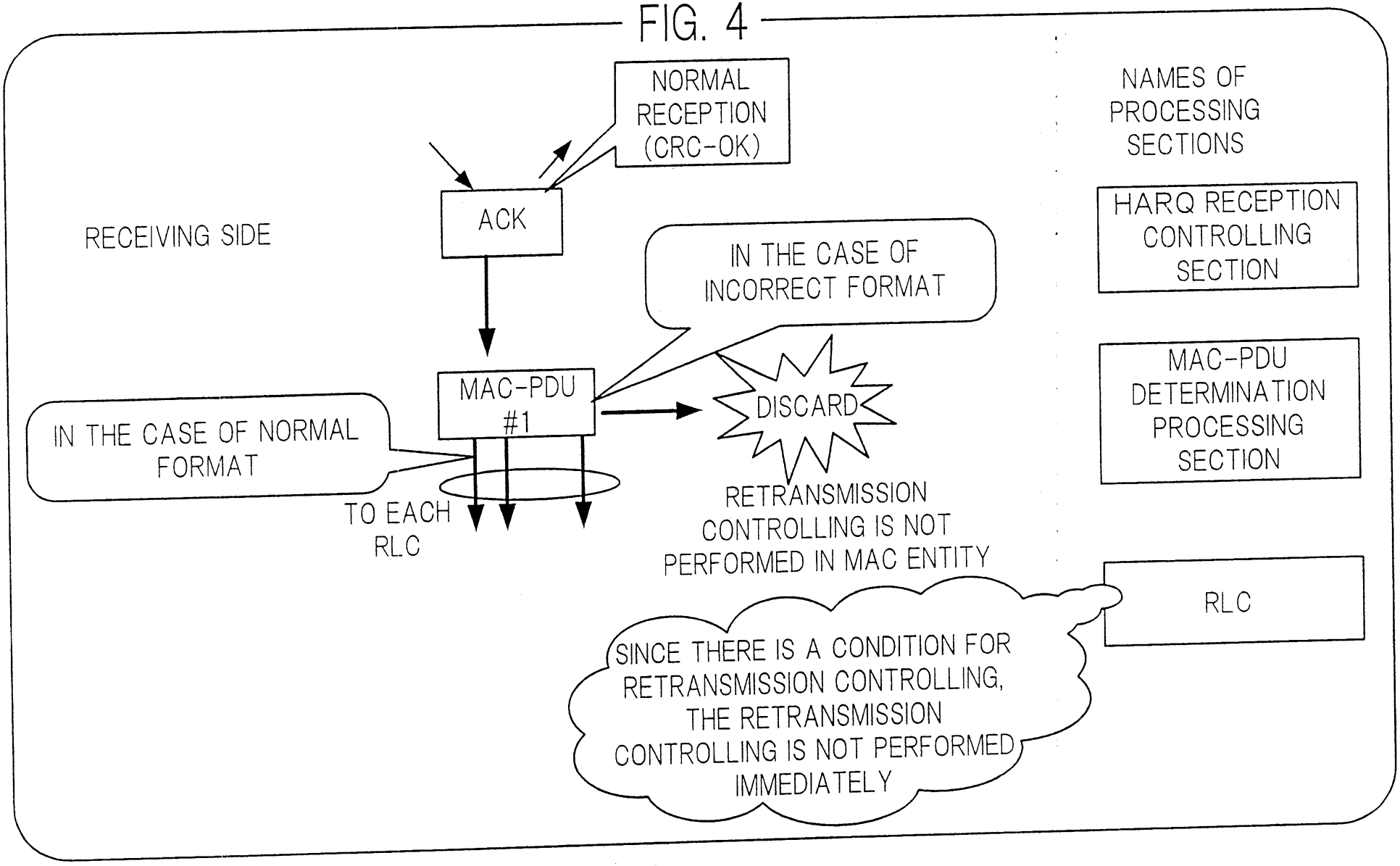

NORMAL RECEPTION (CRC-OK)
ACK
RECEIVING SIDE
IN THE CASE OF INCORRECT FORMAT
MAC-PDU #1
DISCARD
IN THE CASE OF NORMAL FORMAT
TO EACH RLC
RETRANSMISSION CONTROLLING IS NOT PERFORMED IN MAC ENTITY
SINCE THERE IS A CONDITION FOR RETRANSMISSION CONTROLLING, THE RETRANSMISSION CONTROLLING IS NOT PERFORMED IMMEDIATELY
NAMES OF PROCESSING SECTIONS
HARQ RECEPTION CONTROLLING SECTION
MAC-PDU DETERMINATION PROCESSING SECTION
RLC

FIG. 5

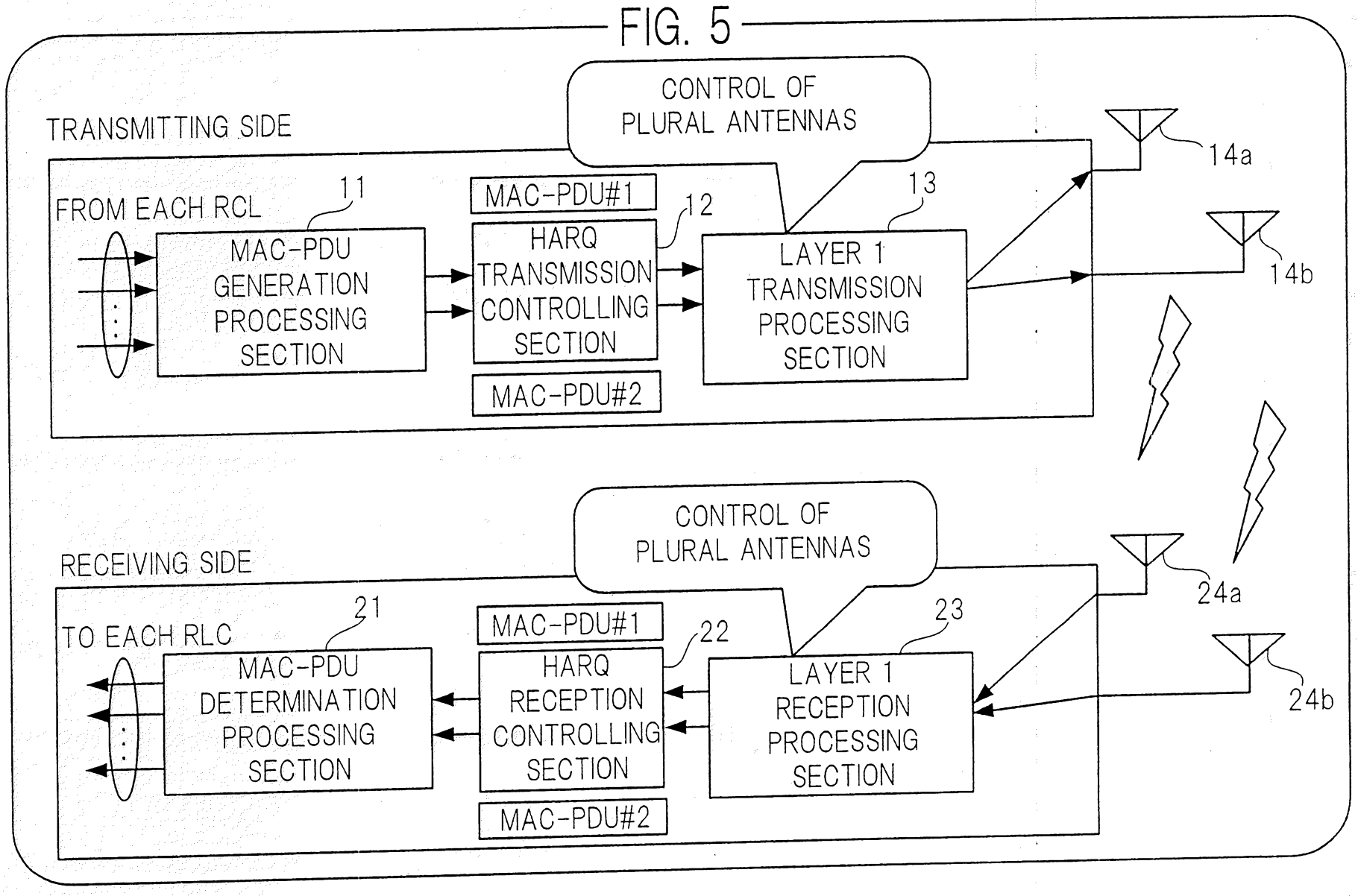

TRANSMITTING SIDE
CONTROL OF PLURAL ANTENNAS
FROM EACH RCL
11
MAC-PDU GENERATION PROCESSING SECTION
MAC-PDU#1
12
HARQ TRANSMISSION CONTROLLING SECTION
MAC-PDU#2
13
LAYER 1 TRANSMISSION PROCESSING SECTION
14a
14b
RECEIVING SIDE
CONTROL OF PLURAL ANTENNAS
TO EACH RLC
21
MAC-PDU DETERMINATION PROCESSING SECTION
MAC-PDU#1
22
HARQ RECEPTION CONTROLLING SECTION
MAC-PDU#2
23
LAYER 1 RECEPTION PROCESSING SECTION
24a
24b

FIG. 6

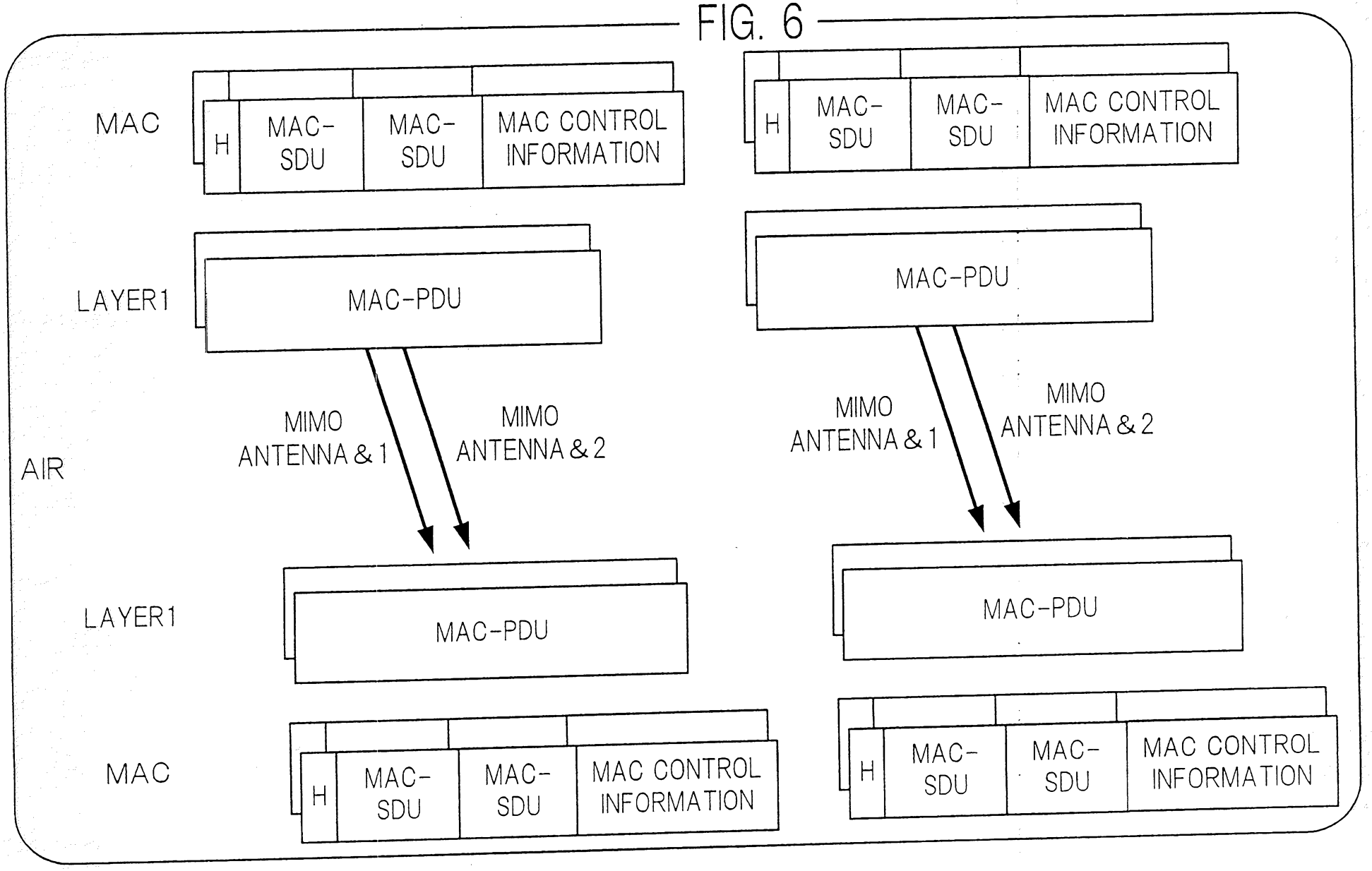

MAC
H
MAC-SDU
MAC-SDU
MAC CONTROL INFORMATION
LAYER1
MAC-PDU
AIR
MIMO ANTENNA & 1
MIMO ANTENNA & 2
LAYER1
MAC-PDU
MAC
H
MAC-SDU
MAC-SDU
MAC CONTROL INFORMATION
H
MAC-SDU
MAC-SDU
MAC CONTROL INFORMATION
MAC-PDU
MIMO ANTENNA & 1
MIMO ANTENNA & 2
MAC-PDU
H
MAC-SDU
MAC-SDU
MAC CONTROL INFORMATION

FIG. 7

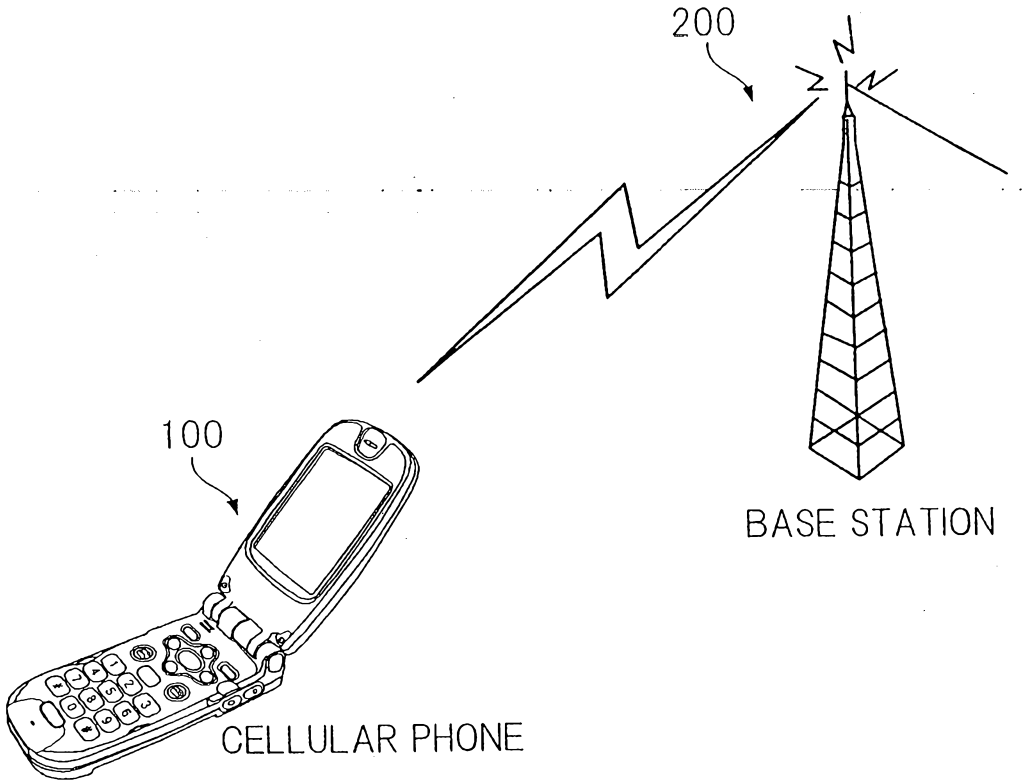
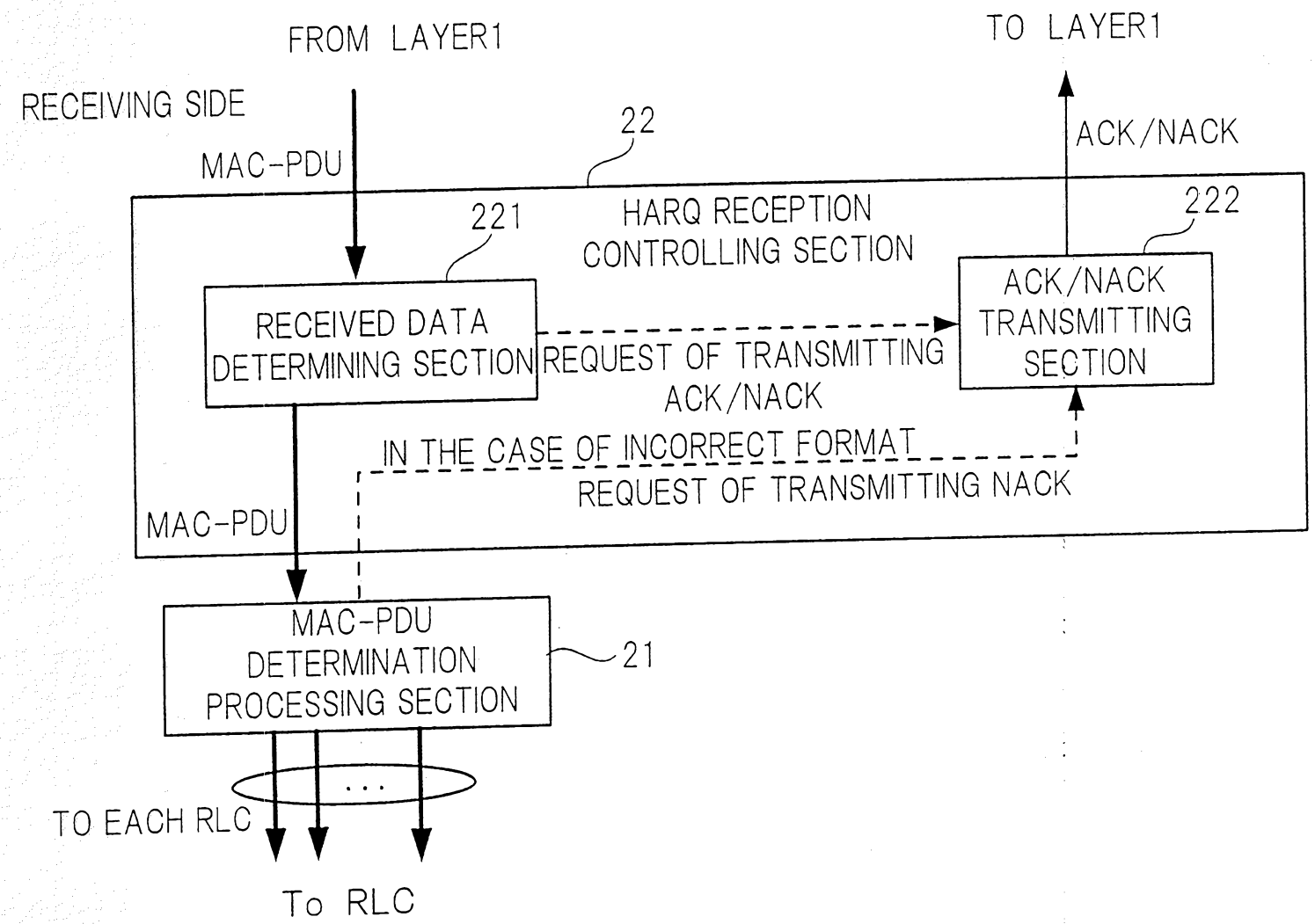


FIG. 8


FROM LAYER1
TO LAYER1
RECEIVING SIDE
MAC-PDU
22
ACK/NACK
221
HARQ RECEPTION CONTROLLING SECTION
222
RECEIVED DATA DETERMINING SECTION
REQUEST OF TRANSMITTING ACK/NACK
ACK/NACK TRANSMITTING SECTION
IN THE CASE OF INCORRECT FORMAT
REQUEST OF TRANSMITTING NACK
MAC-PDU
MAC-PDU DETERMINATION PROCESSING SECTION
21
...
TO EACH RLC
To RLC

9/11 FIG. 9

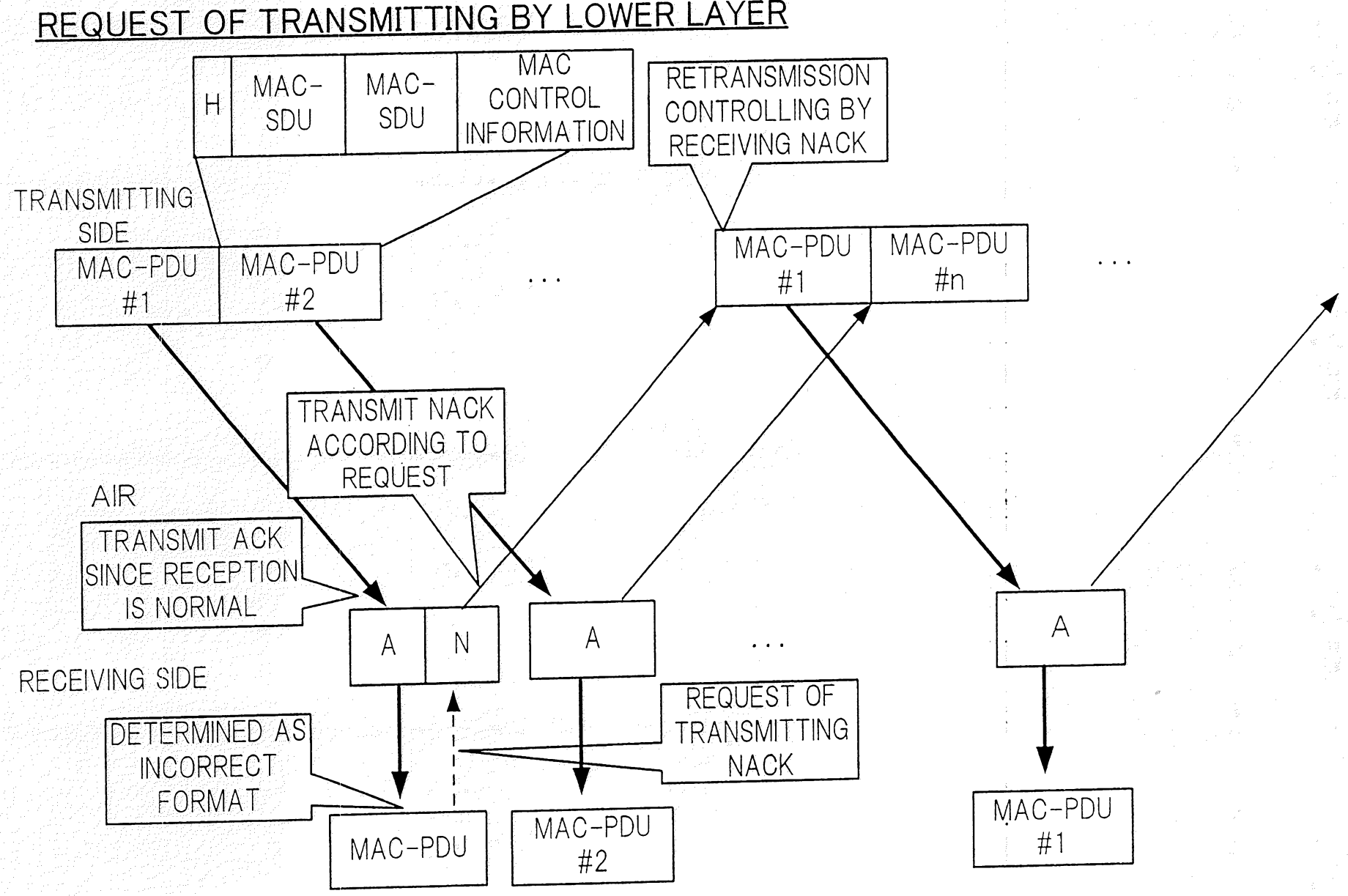

REQUEST OF TRANSMITTING BY LOWER LAYER
H
MAC-SDU
MAC-SDU
MAC CONTROL INFORMATION
RETRANSMISSION CONTROLLING BY RECEIVING NACK
TRANSMITTING SIDE
MAC-PDU #1
MAC-PDU #2
MAC-PDU #1
MAC-PDU #n
TRANSMIT NACK ACCORDING TO REQUEST
AIR
TRANSMIT ACK SINCE RECEPTION IS NORMAL
A
N
A
A
RECEIVING SIDE
REQUEST OF TRANSMITTING NACK
DETERMINED AS INCORRECT FORMAT
MAC-PDU
MAC-PDU #2
MAC-PDU #1

FIG. 10

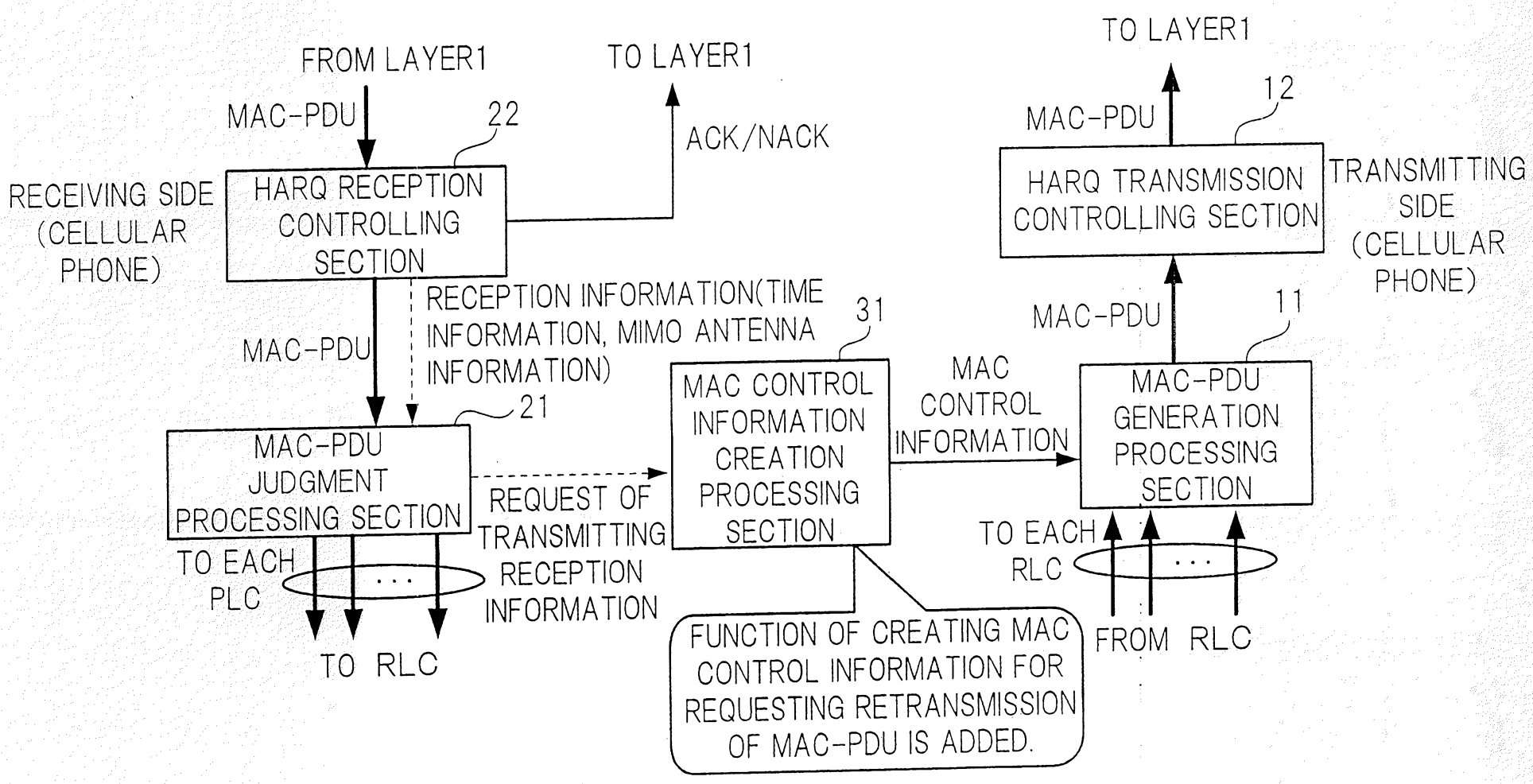
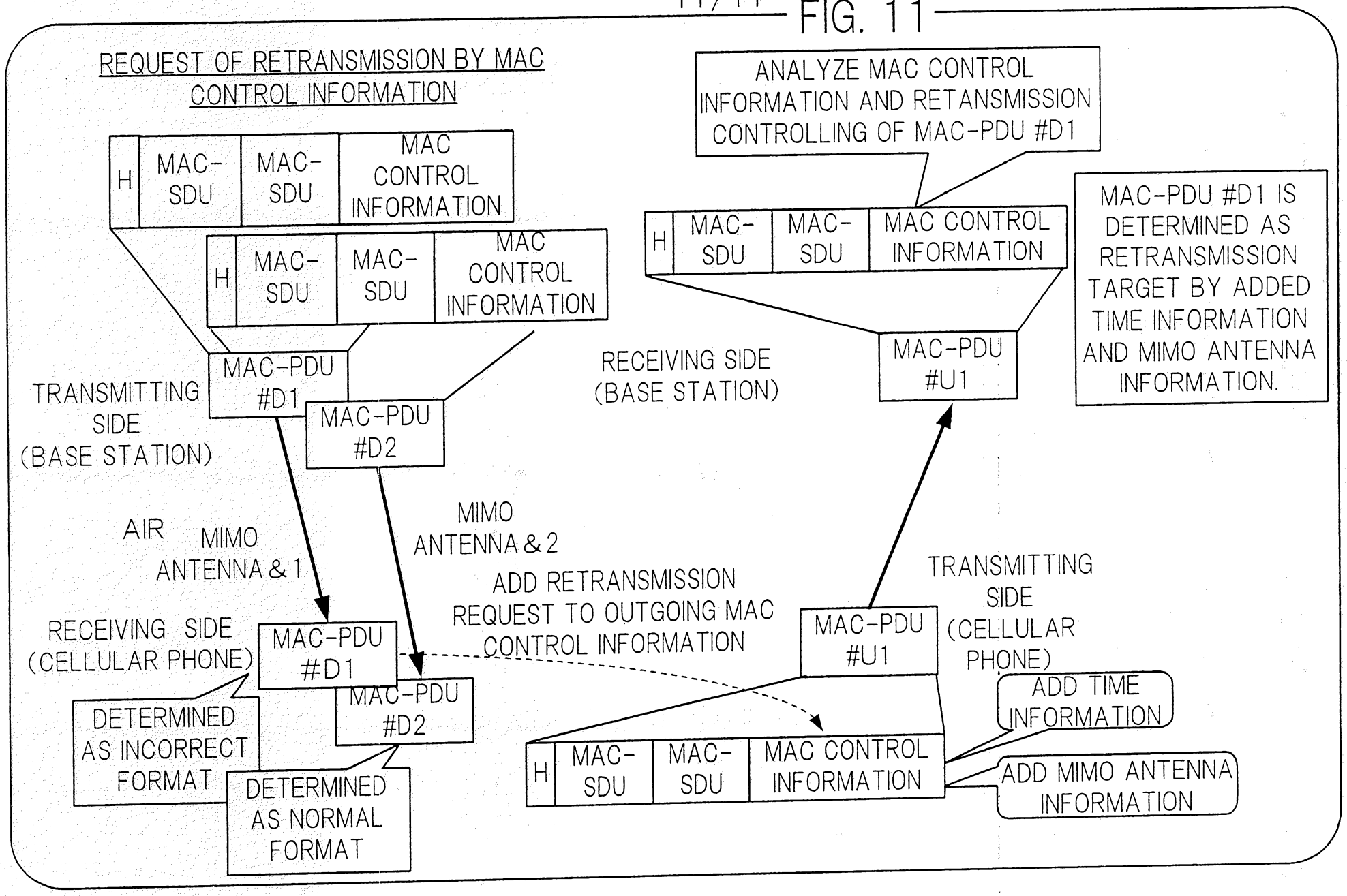

FROM LAYER1
TO LAYER1
MAC-PDU
22
ACK/NACK
RECEIVING SIDE (CELLULAR PHONE)
HARQ RECEPTION CONTROLLING SECTION
RECEPTION INFORMATION(TIME INFORMATION, MIMO ANTENNA INFORMATION)
MAC-PDU
21
31
MAC CONTROL INFORMATION CREATION PROCESSING SECTION
MAC-PDU JUDGMENT PROCESSING SECTION
REQUEST OF TRANSMITTING RECEPTION INFORMATION
TO EACH PLC
TO RLC
FUNCTION OF CREATING MAC CONTROL INFORMATION FOR REQUESTING RETRANSMISSION OF MAC-PDU IS ADDED.
MAC CONTROL INFORMATION
TO LAYER1
MAC-PDU
12
HARQ TRANSMISSION CONTROLLING SECTION
TRANSMITTING SIDE (CELLULAR PHONE)
MAC-PDU
11
MAC-PDU GENERATION PROCESSING SECTION
TO EACH RLC
FROM RLC

FIG. 11


REQUEST OF RETRANSMISSION BY MAC CONTROL INFORMATION
H
MAC-SDU
MAC-SDU
MAC CONTROL INFORMATION
MAC-PDU #D1
MAC-PDU #D2
TRANSMITTING SIDE (BASE STATION)
AIR
MIMO ANTENNA & 1
MIMO ANTENNA & 2
RECEIVING SIDE (CELLULAR PHONE)
DETERMINED AS INCORRECT FORMAT
DETERMINED AS NORMAL FORMAT
ADD RETRANSMISSION REQUEST TO OUTGOING MAC CONTROL INFORMATION
ANALYZE MAC CONTROL INFORMATION AND RETANSMISSION CONTROLLING OF MAC-PDU #D1
MAC-PDU #U1
RECEIVING SIDE (BASE STATION)
TRANSMITTING SIDE (CELLULAR PHONE)
ADD TIME INFORMATION
ADD MIMO ANTENNA INFORMATION
MAC-PDU #D1 IS DETERMINED AS RETRANSMISSION TARGET BY ADDED TIME INFORMATION AND MIMO ANTENNA INFORMATION.