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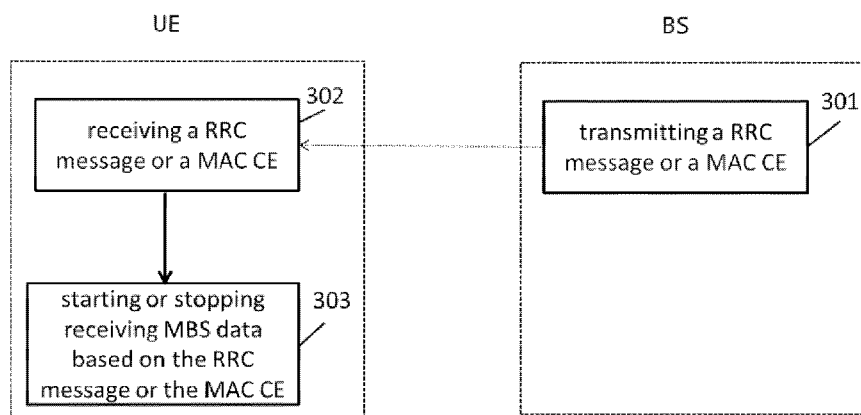


FIG. 3

(57) **Abstract:** Embodiments of the present application relate to methods and apparatuses for multicast and broadcast services (MBS). According to an embodiment of the present application, a method may include: receiving a radio resource control (RRC) message or a medium access control (MAC) control element (CE) indicating activation or deactivation of at least one MBS session configured to a user equipment (UE) in an RRC_CONNECTED state; and starting or stopping receiving MBS data associated with the at least one MBS session based on the RRC message or the MAC CE. Embodiments of the present application design an RRC message or a MAC CE to inform the activation and/or deactivation of at least one MBS session and propose the operations performed by the UE when at least one MBS session is activated or activated.



METHODS AND APPARATUSES FOR MULTICAST AND BROADCAST SERVICES

TECHNICAL FIELD

[0001] Embodiments of the present application generally relate to wireless communication technologies, and especially to methods and apparatuses for multicast and broadcast services (MBS).

BACKGROUND

[0002] In new radio (NR), the work item on NR support of MBS was agreed in Release 17 (e.g., RP-201038), wherein all radio resource control (RRC) states, i.e., RRC_IDLE state, RRC_INACTIVE state and RRC_CONNECTED state will be supported in MBS according to the following objectives of the work item description (WID): 1) specify radio access network (RAN) basic functions for broadcast and multicast for user equipment (UEs) in RRC_CONNECTED state; and 2) specify RAN basic functions for broadcast and multicast for UEs in RRC_IDLE or RRC_INACTIVE state.

[0003] In addition, at RAN2#112e meeting, RAN2 agreed the following two modes for NR MBS delivery: 1) the first delivery mode is provided to meet high quality of service (QoS) (e.g., high reliability, low latency, and so on) requirement, and is available to a UE in RRC_CONNECTED state; and 2) the second delivery mode is provided to meet low QoS requirement, where a UE can also receive MBS data in RRC_IDLE state or RRC_INACTIVE state.

[0004] When a UE in RRC_CONNECTED state is configured with an MBS session, the network may inform the activation and/or deactivation of the MBS session to the UE. However, how to inform the activation and/or deactivation of the MBS session to the UE has not been discussed yet.

SUMMARY OF THE DISCLOSURE

[0005] Embodiments of the present application at least provide a technical solution for MBS, which designs an RRC message or a medium access control (MAC) control element (CE) to inform the activation and/or deactivation of at least one MBS session and proposes the operations performed by a UE when at least one MBS session is activated or activated.

[0006] According to some embodiments of the present application, a method may include: receiving an RRC message or a MAC CE indicating activation or deactivation of at least one MBS session configured to a UE in an RRC_CONNECTED state; and starting or stopping receiving MBS data associated with the at least one MBS session based on the RRC message or the MAC CE.

[0007] In some embodiments, the RRC message includes MBS session information, and the MBS session information includes at least one of: a first list of one or more MBS session information units each associated with an MBS session to be added or modified; a second list of one or more MBS session identifiers (IDs) each associated with an MBS session to be released; a third list of one or more MBS session indexes of an MBS session list each associated with an MBS session to be released, wherein the MBS session list includes one or more MBS sessions configured to the UE; a fourth list of one or more MBS session IDs each associated with an MBS session to be activated; a fifth list of one or more MBS session indexes of the MBS session list each associated with an MBS session to be activated; a sixth list of one or more MBS session IDs each associated with an MBS session to be deactivated; and a seventh list of one or more MBS session indexes of the MBS session list each associated with an MBS session to be deactivated.

[0008] In an embodiment, the RRC message is a dedicated RRC message to the UE, the MBS session information is included in a first information element (IE) of the RRC message, and the method further includes: receiving a multicast radio bearer (MRB) configuration associated with the MBS session information in a second IE of the RRC message, wherein the second IE is different from the first IE.

[0009] In another embodiment, the RRC message is a dedicated RRC message to the UE, and the method further includes: receiving an MRB configuration associated with the MBS session information in another dedicated RRC message different from the dedicated RRC message.

[0010] In yet another embodiment, the RRC message is received via a multicast control channel (MCCH) or received in a system information block (SIB), and the method further includes: receiving an MRB configuration associated with the MBS session information in a dedicated RRC message to the UE.

[0011] In yet another embodiment, starting or stopping receiving MBS data associated with the at least one MBS session based on the RRC message or the MAC CE includes: when the received RRC message includes the first list, starting receiving MBS data associated with each MBS session to be added which is included in the first list, and when the received RRC message includes the fourth list or the fifth list, starting receiving MBS data associated with each MBS session to be activated which is included in the fourth list or the fifth list.

[0012] In yet another embodiment, starting receiving MBS data associated with an MBS session includes performing one of the followings: starting to receive MBS data associated with the MBS session via a point to multipoint (PTM) mode; continuing to receive MBS data associated with the MBS session via a PTM mode or a point to point (PTP) mode which was being used before the last deactivation of the MBS session; and starting to receive MBS data associated with the MBS session via a PTP mode or a PTM mode indicated in the received RRC message.

[0013] In yet another embodiment, starting to receive MBS data associated with the MBS session via a PTM mode or continuing to receive MBS data associated with the MBS session via a PTM mode includes: starting monitoring a group radio network temporary identifier (G-RNTI) associated with the MBS session and starting a discontinuous reception (DRX) operation associated with the MBS session.

[0014] In yet another embodiment, starting receiving MBS data associated with an MBS session includes starting monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session.

[0015] In yet another embodiment, starting or stopping receiving MBS data associated with the at least one MBS session based on the RRC message or the MAC CE includes: when the received RRC message includes the sixth list or the seventh list, stopping receiving MBS data associated with each MBS session to be deactivated, which is included in the sixth list or the seventh list.

[0016] In yet another embodiment, stopping receiving MBS data associated with an MBS session includes stopping receiving MBS data associated with the MBS session via a PTM mode, which includes stopping monitoring a G-RNTI associated with the MBS session and stopping a DRX operation associated with the MBS session.

[0017] In yet another embodiment, stopping receiving MBS data associated with an MBS session includes stopping monitoring a G-RNTI associated with the MBS session and stopping a DRX operation associated with the MBS session.

[0018] In yet another embodiment, starting or stopping receiving MBS data associated with the at least one MBS session based on the RRC message or the MAC CE includes: when the received RRC message includes the second list or the third list, performing the following for each MBS session to be released which is included in the second list or the third list: stopping monitoring a G-RNTI associated with the MBS session and stopping a DRX operation associated with the MBS session; and deleting an MBS session context associated with the MBS session.

[0019] In some other embodiments, the MAC CE includes an activation MAC CE indicating activation of the at least one MBS session or a deactivation MAC CE indicating deactivation of the at least one MBS session, the activation MAC CE is associated with a first logical channel (LCH) ID, and the deactivation MAC CE is associated with a second LCH ID different from the first LCH ID.

[0020] In an embodiment, the activation MAC CE includes one of: at least one MBS session ID each associated with an MBS session to be activated; and at least one MBS session index of an MBS session list each associated with an MBS session to be activated, wherein the MBS session list includes one or more MBS sessions configured to the UE.

[0021] In another embodiment, starting or stopping receiving MBS data associated with the at least one MBS session based on the RRC message or the MAC CE includes: when the received MAC CE includes the activation MAC CE, starting receiving MBS data associated with each MBS session to be activated which is indicated in the activation MAC CE.

[0022] In yet another embodiment, starting receiving MBS data associated with an MBS session includes performing one of the followings: starting to receive MBS data associated with the MBS session via a PTM mode; continuing to receive MBS data associated with the MBS session via a PTM mode or a PTP mode which was being used before the last deactivation of the MBS session; and starting to receive MBS data associated with the MBS session via a PTP mode or a PTM mode indicated in the received MAC CE.

[0023] In yet another embodiment, starting to receive MBS data associated with the MBS session via a PTM mode or continuing to receive MBS data associated with the MBS session via a PTM mode includes: starting monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session.

[0024] In yet another embodiment, starting receiving MBS data associated with an MBS session includes starting monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session.

[0025] In yet another embodiment, the deactivation MAC CE includes one of: at least one MBS session ID each associated with an MBS session to be deactivated; and at least one MBS session index of an MBS session list each associated with an MBS session to be deactivated, wherein the MBS session list includes one or more MBS sessions configured to the UE.

[0026] In yet another embodiment, starting or stopping receiving MBS data associated with the at least one MBS session based on the RRC message or the MAC CE includes: when the received MAC CE includes the deactivation MAC CE, stopping receiving MBS data associated with each MBS session to be deactivated which is indicated in the deactivation MAC CE.

[0027] In yet another embodiment, stopping receiving MBS data associated with an MBS session includes stopping receiving MBS data associated with the MBS session via a PTM mode, which includes stopping monitoring a G-RNTI associated with the MBS session and stopping a DRX operation associated with the MBS session.

[0028] In yet another embodiment, stopping receiving MBS data associated with an MBS session includes stopping monitoring a G-RNTI associated with the MBS session and stopping a DRX operation associated with the MBS session.

[0029] In some embodiments, the MAC CE includes one or more indicators each corresponding to an MBS session configured to the UE, and each indicator indicates whether a corresponding MBS session is to be activated or deactivated.

[0030] In some embodiments, the MAC CE is received in a transport block (TB), and wherein the TB is scheduled by downlink control information (DCI) associated with a G-RNTI associated with an MBS session to be activated or deactivated and transmitted to a group of UEs including the UE via a multicast manner.

[0031] In an embodiment, the MAC CE has a size of zero bit.

[0032] In another embodiment, the method may further include: identifying the associated MBS session to be activated or deactivated based on the G-RNTI; and identifying whether the MAC CE is the activation MAC CE or the deactivation MAC CE based on an LCH ID associated with the MAC CE.

[0033] According to some embodiments of the present application, a method may include: transmitting an RRC message or a MAC CE indicating activation or deactivation of at least one MBS session configured to a UE in an RRC_CONNECTED state.

[0034] In some embodiments, the RRC message includes MBS session information, and the MBS session information includes at least one of: a first list of one or more MBS session information units each associated with an MBS session to be added or modified; a second list of one or more MBS session IDs each associated with an MBS session to be released; a third list of one or more MBS session indexes of an MBS

session list each associated with an MBS session to be released, wherein the MBS session list includes one or more MBS sessions configured to the UE; a fourth list of one or more MBS session IDs each associated with an MBS session to be activated; a fifth list of one or more MBS session indexes of the MBS session list each associated with an MBS session to be activated; a sixth list of one or more MBS session IDs each associated with an MBS session to be deactivated; and a seventh list of one or more MBS session indexes of the MBS session list each associated with an MBS session to be deactivated.

[0035] In an embodiment, the RRC message is a dedicated RRC message to the UE, the MBS session information is included in a first IE of the RRC message, and the method further includes: transmitting an MRB configuration associated with the MBS session information in a second IE of the RRC message, wherein the second IE is different from the first IE.

[0036] In another embodiment, the RRC message is a dedicated RRC message to the UE, and the method further includes: transmitting an MRB configuration associated with the MBS session information in another dedicated RRC message different from the dedicated RRC message.

[0037] In yet another embodiment, the RRC message is transmitted via an MCCH or transmitted in a SIB, and the method further includes: transmitting an MRB configuration associated with the MBS session information in a dedicated RRC message to the UE.

[0038] In yet another embodiment, the method may further include: when the transmitted RRC message includes the first list, the fourth list or the fifth list, for each MBS session to be added which is included in the first list or each MBS session to be activated which is included in the fourth list or the fifth list, transmitting, in the RRC message, an indication indicating the UE to receive MBS data associated with the MBS session via a PTP mode or a PTM mode.

[0039] In some other embodiments, the MAC CE includes an activation MAC CE indicating activation of the at least one MBS session or a deactivation MAC CE indicating deactivation of the at least one MBS session, the activation MAC CE is

associated with a first LCH ID, and the deactivation MAC CE is associated with a second LCH ID different from the first LCH ID.

[0040] In an embodiment, the activation MAC CE includes one of: at least one MBS session ID each associated with an MBS session to be activated; and at least one MBS session index of an MBS session list each associated with an MBS session to be activated, wherein the MBS session list includes one or more MBS sessions configured to the UE.

[0041] In another embodiment, the deactivation MAC CE includes one of: at least one MBS session ID each associated with an MBS session to be deactivated; and at least one MBS session index of an MBS session list each associated with an MBS session to be deactivated, wherein the MBS session list includes one or more MBS sessions configured to the UE.

[0042] In some embodiments, the MAC CE includes one or more indicators each corresponding an MBS session configured to the UE, and each indicator indicates whether a corresponding MBS session is to be activated or deactivated.

[0043] In some embodiments, the MAC CE is transmitted in a TB, and wherein the TB is scheduled by DCI associated with a G-RNTI associated with an MBS session to be activated or deactivated and transmitted to a group of UEs including the UE via a multicast manner.

[0044] In an embodiment, the MAC CE has a size of zero bit.

[0045] Some embodiments of the present application also provide an apparatus including: at least one non-transitory computer-readable medium having computer executable instructions stored therein, at least one receiving circuitry; at least one transmitting circuitry; and at least one processor coupled to the at least one non-transitory computer-readable medium, the at least one receiving circuitry and the at least one transmitting circuitry. The computer executable instructions are programmed to implement any method as stated above with the at least one receiving circuitry, the at least one transmitting circuitry and the at least one processor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046] In order to describe the manner in which advantages and features of the application can be obtained, a description of the application is rendered by reference to specific embodiments thereof, which are illustrated in the appended drawings. These drawings depict only example embodiments of the application and are not therefore to be considered limiting of its scope.

[0047] FIG. 1 is a schematic diagram illustrating an exemplary wireless communication system according to some embodiments of the present application;

[0048] FIG. 2 illustrates exemplary delivery methods of MBS traffic according to some embodiments of the present application;

[0049] FIG. 3 is a flow chart illustrating a method for MBS according to some embodiments of the present application;

[0050] FIG. 4 illustrates an exemplary RRC message according to some embodiments of the present application;

[0051] FIG. 5 illustrates an exemplary MAC CE according to some embodiments of the present application;

[0052] FIG. 6 illustrates an exemplary MAC CE according to some other embodiments of the present application;

[0053] FIG. 7 illustrates an exemplary MAC CE according to some other embodiments of the present application; and

[0054] FIG. 8 illustrates a simplified block diagram of an apparatus for MBS according to some embodiments of the present application.

DETAILED DESCRIPTION

[0055] The detailed description of the appended drawings is intended as a

description of the currently preferred embodiments of the present application and is not intended to represent the only form in which the present application may be practiced. It is to be understood that the same or equivalent functions may be accomplished by different embodiments that are intended to be encompassed within the spirit and scope of the present application.

[0056] Reference will now be made in detail to some embodiments of the present application, examples of which are illustrated in the accompanying drawings. To facilitate understanding, embodiments are provided under specific network architecture and new service scenarios, such as 3rd generation partnership project (3GPP) 5G (i.e., NR), 3GPP long term evolution (LTE) Release 8 and so on. Persons skilled in the art know very well that, with the development of network architecture and new service scenarios, the embodiments in the present application are also applicable to similar technical problems; and moreover, the terminologies recited in the present application may change, which should not affect the principle of the present application.

[0057] FIG. 1 is a schematic diagram illustrating an exemplary wireless communication system 100 according to some embodiments of the present application.

[0058] As shown in FIG. 1, the wireless communication system 100 includes at least one base station (BS) 101 and at least one UE 102. In particular, the wireless communication system 100 includes one BS 101 and two UEs 102 (e.g., a UE 102a and a UE 102b) for illustrative purpose. Although a specific number of BS 101 and UEs 102 are depicted in FIG. 1, it is contemplated that any number of BSs 101 and UEs 102 may be included in the wireless communication system 100.

[0059] The wireless communication system 100 is compatible with any type of network that is capable of sending and receiving wireless communication signals. For example, the wireless communication system 100 is compatible with a wireless communication network, a cellular telephone network, a time division multiple access (TDMA)-based network, a code division multiple access (CDMA)-based network, an orthogonal frequency division multiple access (OFDMA)-based network, an LTE network, a 3GPP-based network, a 3GPP 5G network, a satellite communications

network, a high altitude platform network, and/or other communications networks.

[0060] The BS 101 may also be referred to as an access point, an access terminal, a base, a macro cell, a node-B, an enhanced node B (eNB), a gNB, a home node-B, a relay node, or a device, or described using other terminology used in the art. The BS 101 is generally part of a radio access network that may include a controller communicably coupled to the BS 101.

[0061] According to some embodiments of the present application, the UE(s) 102 may include computing devices, such as desktop computers, laptop computers, personal digital assistants (PDAs), tablet computers, smart televisions (e.g., televisions connected to the Internet), set-top boxes, game consoles, security systems (including security cameras), vehicle on-board computers, network devices (e.g., routers, switches, and modems), or the like.

[0062] According to some other embodiments of the present application, the UE(s) 102 may include a portable wireless communication device, a smart phone, a cellular telephone, a flip phone, a device having a subscriber identity module, a personal computer, a selective call receiver, or any other device that is capable of sending and receiving communication signals on a wireless network.

[0063] According to some other embodiments of the present application, the UE(s) 102 may include wearable devices, such as smart watches, fitness bands, optical head-mounted displays, or the like.

[0064] Moreover, the UE(s) 102 may be referred to as a subscriber unit, a mobile, a mobile station, a user, a terminal, a mobile terminal, a wireless terminal, a fixed terminal, a subscriber station, a user terminal, or a device, or described using other terminology used in the art.

[0065] Both the UE 102a and the UE 102b in the embodiments of FIG. 1 may transmit information to the BS 101 and receive control information from the BS 101, for example, via LTE or new radio (NR) Uu interface.

[0066] In NR Release 17, MBS was introduced to focus on a small area mixed mode

multicast. The work item on NR support of MBS was also agreed in Release 17 (e.g., RP-201038), wherein three RRC states, i.e., RRC_IDLE state, RRC_INACTIVE state and RRC_CONNECTED state will be supported according to the following objectives:

- Specify RAN basic functions for broadcast and multicast for UEs in RRC_CONNECTED state; and
- Specify RAN basic functions for broadcast and multicast for UEs in RRC_IDLE or RRC_INACTIVE state.

[0067] Specifically, for RRC_IDLE state and RRC_INACTIVE state, NR MBS may use an LTE single cell-PTM (SC-PTM) like scheme. According to the LTE SC-PTM like scheme, MCCH will carry MBS configuration information, e.g., a 5G MBS PTM configuration message which indicates the active 5G MBS sessions and the scheduling information for each session (or bearer). The scheduling information may include: scheduling period, scheduling window and start offset etc. The information on the MCCH will be periodically transmitted using a configurable repetition period. In addition, 5G MBS user data will be carried by a multicast traffic channel (MTCH) logical channel. Usually, the MCCH configuration is provided by system information, e.g., SIB, which may contain MCCH modification period, MCCH repetition period and MCCH subframe offset, etc. In some special situations, the MCCH configuration may be provided by other adaptable manners. In addition, for RRC_CONNECTED state and multicast services with high QoS requirement, the 5G MBS configuration information is provided to a UE by RRC dedicated signaling directly.

[0068] At RAN2#112e meeting, two modes for NR MBS delivery are specified according to QoS requirement(s), e.g., reliability requirement, latency requirement, and so on. Specifically, one delivery mode is a delivery mode with high QoS requirement, which is available in RRC_CONNECTED state. The other delivery mode is a delivery mode with low QoS requirement, wherein a UE can also receive data in RRC_IDLE state or RRC_INACTIVE state.

[0069] MBS traffic needs to be delivered from a single data source (e.g., application service provider) to multiple UEs. Depending on many factors, multiple delivery

methods may be used to deliver MBS traffic in the 5G system (5GS).

[0070] FIG. 2 illustrates exemplary delivery methods of MBS traffic according to some embodiments of the present application.

[0071] Referring to FIG. 2, from the viewpoint of 5G core network (CN), two delivery methods are possible for MBS multicast service:

- 5G core network (5GC) individual MBS traffic delivery method. In this method, the 5G CN receives a single copy of MBS data packets and delivers separate copies of those MBS data packets to individual UEs via per-UE PDU sessions. Therefore, for each UE, one PDU session is required to be associated with a multicast session.
- 5GC shared MBS traffic delivery method. In this method, the 5G CN receives a single copy of MBS data packets and delivers a single copy of those MBS packets packet to a RAN node, which then delivers them to one or multiple UEs.

[0072] In the case that the 5GC shared MBS traffic delivery method is used for MBS traffic, from the viewpoint of RAN, two delivery methods or modes are available for the transmission of MBS packet flows over radio:

- PTP delivery method (also referred to as PTP mode): a RAN node delivers separate copies of MBS data packets over radio to individual UEs.
- PTM delivery method (also referred to as PTM mode): a RAN node delivers a single copy of MBS data packets over radio to a set of UEs.

[0073] Accordingly, a RAN node may use the PTP delivery method, the PTM delivery method, or a combination of the PTP delivery method and PTM delivery method to deliver an MBS packet to UEs.

[0074] As shown in FIG. 2, if the 5GC individual MBS traffic delivery method is supported, a same single copy of MBS data packets received by the CN may be delivered via both the 5GC individual MBS traffic delivery method for some UE(s)

and the 5GC shared MBS traffic delivery method for other UEs. In other words, the 5GC shared MBS traffic delivery method (e.g., the PTP mode and/or the PTM mode) and the 5GC individual MBS traffic delivery method may be used at the same time for an MBS session.

[0075] In some embodiments of the present application, a session management function (SMF) in the CN may trigger an MBS session activation using a procedure similar to the procedure of Network Triggered Service Request in clause 4.2.3.3 of 3GPP standard document TS 23.502. The procedure of the MBS session activation may be summarized as follows.

[0076] When downlink data arrives at the MBS anchor user plane function (UPF), the MBS anchor UPF notifies the MBS anchor SMF the downlink data arriving for the MBS session. Then, the MBS anchor SMF notifies the involved SMF the data arriving for the MBS session. The involved SMF determines a list of UEs associated with this MBS session, and sends N2 message transfer to an access and mobility management function (AMF) indicating the MBS session to be activated and information of the list of UEs.

[0077] The AMF determines the list of UEs to be paged in one registration area, i.e. the UEs which are in the list of UEs received from the SMF and which are registered in the registration area. Then, the AMF sends a paging request message to the next generation (NG)-RAN node(s) belonging to this registration area, including paging information (e.g., UE ID, UE DRX cycle) of the determined list of UEs.

[0078] After receiving the paging request message, the NG-RAN node(s) pages the UEs, e.g., using the existing paging mechanism. When a UE receives the paging message, the UE initiates a service request procedure and the SMF activates the MBS session. During the activation procedure, the NG-RAN establishes the access node (AN) resource(s) or context for the MBS session.

[0079] In some other embodiments of the present application, when the MBS session is established, a policy control function (PCF) can provide the SMF with the policy regarding whether the MBS session can be deactivated. The policy may be based on, e.g., local configuration or assistance information from an MBS application

function (AF).

[0080] If the MBS Session can be deactivated, the SMF can determine that the user plane (UP) connection of the MBS session will be deactivated in the case of no downlink data to be transmitted. For example, the UPF notifies the SMF detection of MBS session inactivity. Then, the SMF sends N4 session modification to the UPF and sends N2 message transfer to an AMF requesting to deactivate the MBS session. If the N2 context is per UE configured, then the SMF also needs to send information of the list of UEs associated with the MBS session. The AMF sends N2 MBS session release to release the AN context for associated UEs for this MBS session, such that the NG-RAN releases the AN resource(s) for this MBS session.

[0081] Alternatively, the NG-RAN can also detect the MBS Session inactivity based on an inactivity timer and initiate AN release for this MBS session. In this case, the AMF notifies the SMF deactivation of the MBS session. The AN release procedure can reuse the existing procedure as specified in clause 4.2.6 of TS 23.502.

[0082] The above embodiments provide the operations performed by the CN and RAN for activating and deactivating an MBS session. Such activation and deactivation of an MBS session may be informed to the UE(s) associated with the MBS session in some cases. For example, when a UE is in RRC_CONNECTED state, the BS may inform the UE about the activation and/or deactivation of an MBS session configured to the UE, and the UE may perform some operations when receiving the notification of the activation and/or deactivation of the MBS session. However, how to inform the activation and/or deactivation of the MBS session to the UE has not been discussed yet.

[0083] Given this, embodiments of the present application provides a technical solution for MBS, which designs an RRC message or a MAC CE to inform the activation and/or deactivation of at least one MBS session and proposes the operations performed by a UE when at least one MBS session is activated or activated. More details on embodiments of the present application will be illustrated in the following text in combination with the appended drawings.

[0084] FIG. 3 is a flow chart illustrating a method for MBS according to some

embodiments of the present application. Although the method is illustrated in a system level by a UE (e.g., the UE 102a or the UE 102b in FIG. 1) and a BS (e.g., the BS 101 in FIG. 1), persons skilled in the art can understand that the method implemented in the UE and that implemented in the BS can be separately implemented and incorporated in other apparatus with the like functions. In some embodiments of the present application, the UE is in an RRC_CONNECTED state.

[0085] In the exemplary method shown in FIG. 3, in step 301, the BS may transmit an RRC message to the UE. The RRC message may indicate activation or deactivation of at least one MBS session configured to the UE. Alternatively or additionally, the BS may transmit a MAC CE to the UE in step 301. The MAC CE may indicate activation or deactivation of at least one MBS session configured to the UE.

[0086] Consequently, in step 302, the UE may receive the RRC message or the MAC CE indicating activation or deactivation of at least one MBS session configured to the UE. Then, in step 303, the UE may start or stop receiving MBS data associated with the at least one MBS session based on the RRC message or the MAC CE.

[0087] According to some embodiments of the present application, the RRC message indicating activation or deactivation of at least one MBS session may include MBS session information, and the MBS session information may include at least one of:

- a first list of one or more MBS session information units, wherein each MBS session information unit of the one or more MBS session information units is associated with an MBS session to be added or modified;
- a second list of one or more MBS session IDs, wherein each MBS session ID of the one or more MBS session IDs is associated with an MBS session to be released;
- a third list of one or more MBS session indexes of an MBS session list, wherein each MBS session index of the one or more MBS session indexes is

associated with an MBS session to be released, and wherein the MBS session list includes one or more MBS sessions configured to the UE;

- a fourth list of one or more MBS session IDs, wherein each MBS session ID of the one or more MBS session IDs is associated with an MBS session to be activated;
- a fifth list of one or more MBS session indexes of the MBS session list, wherein each MBS session index of the one or more MBS session indexes is associated with an MBS session to be activated;
- a sixth list of one or more MBS session IDs, wherein each MBS session ID of the one or more MBS session IDs is associated with an MBS session to be deactivated; and
- a seventh list of one or more MBS session indexes of the MBS session list, wherein each MBS session index of the one or more MBS session indexes is associated with an MBS session to be deactivated.

[0088] An MBS session information unit associated with an MBS session may include at least one of: a G-RNTI of the MBS session, a temporary mobile group identifier (TMGI) of the MBS session, scheduling information of the MBS session, and so on. The scheduling information of the MBS session may include a DRX configuration of the MBS session.

[0089] An MBS session ID associated with an MBS session may include a G-RNTI, a TMGI, or any other ID associated with the MBS session.

[0090] An MBS session index is different from the MBS session ID. The MBS session index associated with an MBS session may be determined based on the MBS session list including one or more MBS sessions configured to the UE. For example, the BS may configure the MBS session list to the UE, and the MBS session list may include one or more MBS sessions configured to the UE. In some embodiments of the present application, the MBS session list including an MBS session may refer to the MBS session list including an MBS session information unit associated with the

MBS session. An MBS session information unit associated with the MBS session may include at least one of: a G-RNTI of the MBS session, a TMGI of the MBS session, scheduling information of the MBS session, and so on.

[0091] MBS session(s) or MBS session information unit(s) in the MBS session list may be listed in an order, and the MBS session index associated with an MBS session is based on the order. For example, assuming that the MBS session list includes five MBS sessions, which are MBS session#1 associated with MBS session information unit#1, MBS session#2 associated with MBS session information unit#2, MBS session#3 associated with MBS session information unit#3, MBS session#4 associated with MBS session information unit#4, and MBS session#5 associated with MBS session information unit#5. The five session information units are listed in the MBS session list in the following order: MBS session information unit#5, MBS session information unit#4, MBS session information unit#1, MBS session information unit#2, and MBS session information unit#3. Then, the MBS session indexes associated with MBS session#1, MBS session#2, MBS session#3, MBS session#4, and MBS session#5 are "3," "4," "5," "2," and "1," respectively.

[0092] The configured MBS session list may be modified by the BS due to addition and/or release of MBS session(s), and thus the MBS session index associated with an MBS session in the MBS session list may be changed. The MBS session index(es) in the above fifth list and seventh list should reflect the current MBS session list configured to the UE. Using an MBS session index to represent an MBS session to be activated, deactivated, or released in the RRC message may reduce the signaling overhead.

[0093] FIG. 4 illustrates an exemplary RRC message according to some embodiments of the present application.

[0094] Referring to FIG. 4, the RRC message may include an IE "*MBS-ToAddModList*," which may represent the aforementioned first list in the RRC message, and indicate or include one or more MBS sessions to be added. The parameter "*maxMBS*" may refer to the maximum number of MBS sessions that can be included in this list.

[0095] The parameter "*MBS-Info*" included in "*MBS-ToAddModList*" may represent an MBS information unit in the first list, which includes "*tmgi*," "*g-RNTI*," "*sessionId*," and "*MBS-schedulingInfo*" for an MBS session to be added. The "*MBS-schedulingInfo*" may include a DRX configuration for the MBS session, which includes, for example, "*onDurationTimerMBS*," "*drx-InactivityTimerMBS*," and "*schedulingPeriodStartOffsetMBS*."

[0096] The IE "*MBS-ToReleaseList*" may represent the aforementioned second or third list in the RRC message, which includes "*MBS-Index/MBS-ID*" indicating an MBS session to be released. The parameter "*maxMBS*" may refer to the maximum number of MBS sessions that can be included in this list.

[0097] The IE "*MBS-ToActivatedList*" may represent the aforementioned fourth or fifth list in the RRC message, which includes "*MBS-Index/MBS-ID*" indicating an MBS session to be activated. The parameter "*maxMBS*" may refer to the maximum number of MBS sessions that can be included in this list.

[0098] The IE "*MBS-ToDeactivatedList*" may represent the aforementioned sixth or seventh list in the RRC message, which includes "*MBS-Index/MBS-ID*" indicating an MBS session to be deactivated. The parameter "*maxMBS*" may refer to the maximum number of MBS sessions that can be included in this list.

[0099] In an embodiment of the present application, the RRC message is a dedicated RRC message (e.g., an *RRCReconfiguration* message as specified in 3GPP documents) to the UE, and the MBS session information is included in a first IE of the RRC message. In this embodiment, the BS may also transmit an MRB configuration associated with the MBS session information in a second IE of the RRC message, which is different from the first IE. Consequently, the UE may receive the MRB configuration associated with the MBS session information in the second IE of the RRC message. In some embodiments, in the case that the MBS session information in the first IE of the RRC message includes the first list which indicates or includes one or more MBS sessions to be added, the MRB configuration in the second IE of the RRC message may indicate the MRB(s) for each of the one or more MBS sessions to be added. In some embodiments, in the case that the MBS session information in the first IE of the RRC message includes the second list or third list which indicates or

includes one or more MBS sessions to be released, the MRB configuration in the second IE of the RRC message may indicate the MRB(s) for each of the one or more MBS sessions to be released.

[00100] In another embodiment of the present application, the RRC message including the MBS session information is a dedicated RRC message (e.g., an *MBSSessionInfo* message as specified in 3GPP documents) to the UE. In this embodiment, the BS may also transmit an MRB configuration associated with the MBS session information in another dedicated RRC message (e.g., an *RRCReconfiguration* message as specified in 3GPP documents) different from the dedicated RRC message including the MBS session information. Consequently, the UE may receive the MRB configuration associated with the MBS session information in another dedicated RRC message different from the dedicated RRC message including the MBS session information. In some embodiments, in the case that the MBS session information includes the first list which indicates or includes one or more MBS sessions to be added, the MRB configuration in another dedicated RRC message may indicate the MRB(s) for each of the one or more MBS sessions to be added. In some embodiments, in the case that the MBS session information includes the second list or third list which indicates or includes one or more MBS sessions to be released, the MRB configuration in another dedicated RRC message may indicate the MRB(s) for each of the one or more MBS sessions to be released.

[00101] In yet another embodiment of the present application, the RRC message (e.g., an *MBSSessionInfo* message as specified in 3GPP documents) including the MBS session information is transmitted via an MCCH or transmitted in a SIB, and can be received by multiple UEs. In this embodiment, the BS may also transmit an MRB configuration associated with the MBS session information in a dedicated RRC message (e.g., an *RRCReconfiguration* message as specified in 3GPP documents) to the UE. Consequently, in addition to receiving the RRC message via the MCCH or in the SIB, the UE may also receive the MRB configuration associated with the MBS session information in the dedicated RRC message. In some embodiments, in the case that the MBS session information in the MCCH or SIB includes the first list which indicates or includes one or more MBS sessions to be added, the MRB configuration in the dedicated RRC message may indicate the MRB(s) for each of the

one or more MBS sessions to be added. In some embodiments, in the case that the MBS session information in the MCCH or SIB includes the second list or third list which indicates or includes one or more MBS sessions to be released, the MRB configuration in the dedicated RRC message may indicate the MRB(s) for each of the one or more sessions to be released.

[00102] As stated above, after receiving the RRC message including the MBS session information, in step 303, the UE may start or stop receiving MBS data (e.g., one or more MBS packets) associated with at least one MBS session based on the RRC message.

[00103] In some embodiments of the present application, starting or stopping receiving MBS data includes: when the received RRC message includes the first list which indicates or includes one or more MBS sessions to be added, the UE may start receiving MBS data associated with each MBS session to be added which is indicated or included in the first list, and when the received RRC message includes the fourth list or the fifth list which indicates or includes one or more MBS sessions to be activated, the UE may start receiving MBS data associated with each MBS session to be activated which is indicated or included in the fourth list or the fifth list.

[00104] In an embodiment of the present application, starting receiving MBS data associated with an MBS session includes performing one of the followings:

- starting to receive MBS data associated with the MBS session via a PTM mode; for example, the PTM mode may be a default mode for the UE to receive MBS data associated with any MBS session that becomes activated.
- continuing to receive MBS data associated with the MBS session via a PTM mode or a PTP mode which was being used before the last deactivation of the MBS session; for example, if the UE has been receiving packets associated with an MBS session in the PTM mode and then the MBS session got deactivated, after activation of the MBS session, the UE will continue to receive packets associated with the MBS session via the PTM mode; if the UE has been receiving packets associated with an MBS session in the PTP mode and then the MBS session got deactivated, after activation of the MBS session, the UE will continue

to receive packets associated with the MBS session via the PTP mode.

- starting to receive MBS data associated with the MBS session via a PTP mode or a PTM mode indicated in the received RRC message including the MBS session information. In this case, for each MBS session to be added which is indicated or included in the first list or each MBS session to be activated which is indicated or included in the fourth list or the fifth list, the BS may transmit an indication in the RRC message including the MBS session information to indicate the UE to receive MBS data associated with the MBS session via a PTP mode or a PTM mode. Consequently, after receiving the indication, the UE may start to receive MBS data associated with an MBS session via the mode (PTP mode or PTM mode) as indicated by the corresponding indication in the RRC message.

[00105] In some embodiments, starting to receive MBS data associated with the MBS session via a PTM mode or continuing to receive MBS data associated with the MBS session via a PTM mode includes: starting monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session. For example, when the UE starts or continues to receive MBS data associated with an MBS session via a PTM mode, the UE may start monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session.

[00106] In another embodiment of the present application, starting receiving MBS data associated with an MBS session includes starting monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session.

[00107] In some other embodiments of the present application, starting or stopping receiving MBS data includes: when the received RRC message includes the sixth list or the seventh list which indicates or includes one or more MBS sessions to be deactivated, the UE may stop receiving MBS data associated with each MBS session to be deactivated, which is indicated or included in the sixth list or the seventh list.

[00108] In an embodiment of the present application, stopping receiving MBS data associated with an MBS session includes stopping receiving MBS data associated with the MBS session via a PTM mode, which includes stopping monitoring a

G-RNTI associated with the MBS session and stopping a DRX operation associated with the MBS session. In this embodiment, for each MBS session to be deactivated, the UE may still keep an MBS session context associated with the MBS session. The MBS session context may include at least one of: a G-RNTI associated with the MBS session, a DRX configuration associated with the MBS session, a radio bearer configuration associated with the MBS session, and so on.

[00109] In another embodiment of the present application, stopping receiving MBS data associated with an MBS session includes stopping monitoring a G-RNTI associated with the MBS session and stopping a DRX operation associated with the MBS session. In this embodiment, for each MBS session to be deactivated, the UE may still keep an MBS session context associated with the MBS session.

[00110] In some other embodiments of the present application, starting or stopping receiving MBS data includes: when the received RRC message comprises the second list or the third list which indicates or includes one or more MBS sessions to be released, performing the following for each MBS session to be released which is included in the second list or the third list: stopping monitoring a G-RNTI associated with the MBS session and stopping a DRX operation associated with the MBS session; and deleting an MBS session context associated with the MBS session (e.g., deleting the corresponding MBS session information unit from the MBS session list). The MBS session context may include at least one of: a G-RNTI associated with the MBS session, a DRX configuration associated with the MBS session, a radio bearer configuration associated with the MBS session, and so on.

[00111] According to some other embodiments of the present application, the BS may transmit the MAC CE indicating activation or deactivation of at least one MBS session configured to the UE.

[00112] In some embodiments of the present application, the MAC CE indicating activation or deactivation of at least one MBS session, which is transmitted in step 301 and received in step 302, may include an activation MAC CE indicating activation of the at least one MBS session or a deactivation MAC CE indicating deactivation of the at least one MBS session. The activation MAC CE is associated with a first LCH ID, and the deactivation MAC CE is associated with a second LCH

ID different from the first LCH ID. For example, the first LCH ID associated with the activation MAC CE may be included in a header of a MAC protocol data unit (PDU) including the activation MAC CE, and the second LCH ID associated with the deactivation MAC CE may be included in the header of the MAC PDU including the deactivation MAC CE. After receiving a MAC PDU, the UE may determine whether the MAC CE in the MAC PDU is an activation MAC CE or a deactivation MAC CE based on the LCH ID in the header of the MAC PDU.

[00113] In some embodiments, the MAC CE indicating activation or deactivation of at least one MBS session is transmitted in a TB via a unicast manner to the UE. The TB is scheduled by DCI associated with a cell radio network temporary identifier (C-RNTI) (e.g., the DCI is scrambled by the C-RNTI) associated with the UE.

[00114] The activation MAC CE may include one of: at least one MBS session ID, wherein each MBS session ID is associated with an MBS session to be activated; and at least one MBS session index of an MBS session list, wherein each MBS session index is associated with an MBS session to be activated, and wherein the MBS session list comprises one or more MBS sessions configured to the UE. As stated in the above embodiments, the MBS session index may be determined based on an order of the MBS sessions listed in the MBS session list. The MBS session index(es) in the activation MAC CE should reflect the current MBS session list configured to the UE.

[00115] After receiving the activation MAC CE, the UE may start receiving MBS data associated with each MBS session to be activated which is indicated in the activation MAC CE.

[00116] In an embodiment of the present application, starting receiving MBS data associated with an MBS session includes performing one of the followings:

- starting to receive MBS data associated with the MBS session via a PTM mode; for example, the PTM mode may be a default mode for the UE to receive MBS data associated with any MBS session that becomes activated.
- continuing to receive MBS data associated with the MBS session via a PTM

mode or a PTP mode which was being used before the last deactivation of the MBS session; for example, if the UE has been receiving packets associated with an MBS session in the PTM mode and then the MBS session got deactivated, after activation of the MBS session, the UE will continue to receive packets associated with the MBS session via the PTM mode; if the UE has been receiving packets associated with an MBS session in the PTP mode and then the MBS session got deactivated, after activation of the MBS session, the UE will continue to receive packets associated with the MBS session via the PTP mode.

- starting to receive MBS data associated with the MBS session via a PTP mode or a PTM mode indicated in the received activation MAC CE. In this case, for each MBS session to be activated which is indicated by the activation MAC CE, the BS may transmit an indication in the activation MAC CE to indicate the UE to receive MBS data associated with the MBS session via a PTP mode or a PTM mode. Consequently, after receiving the indication, the UE may start to receive MBS data associated with an MBS session via the mode (PTP mode or PTM mode) as indicated by the corresponding indication in the activation MAC CE.

[00117] In some embodiments, starting to receive MBS data associated with the MBS session via a PTM mode or continuing to receive MBS data associated with the MBS session via a PTM mode includes: starting monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session. For example, when the UE starts or continues to receive MBS data associated with an MBS session via a PTM mode, the UE may start monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session.

[00118] In another embodiment of the present application, starting receiving MBS data associated with an MBS session includes starting monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session.

[00119] The deactivation MAC CE may include one of: at least one MBS session ID, wherein each MBS session ID is associated with an MBS session to be deactivated; and at least one MBS session index of an MBS session list, wherein each MBS session index is associated with an MBS session to be deactivated, and wherein the

MBS session list comprises one or more MBS sessions configured to the UE. As stated in the above embodiments, the MBS session index may be determined based on an order of the MBS sessions listed in the MBS session list. The MBS session index(es) in the deactivation MAC CE should reflect the current MBS session list configured to the UE.

[00120] After receiving the activation MAC CE, the UE may stop receiving MBS data associated with each MBS session to be deactivated which is indicated in the deactivation MAC CE.

[00121] In an embodiment of the present application, stopping receiving MBS data associated with an MBS session includes stopping receiving MBS data associated with the MBS session via a PTM mode, which includes stopping monitoring a G-RNTI associated with the MBS session and stopping a DRX operation associated with the MBS session. In this embodiment, for each MBS session to be deactivated, the UE may still keep an MBS session context associated with the MBS session. The MBS session context may include at least one of: a G-RNTI associated with the MBS session, a DRX configuration associated with the MBS session, a radio bearer configuration associated with the MBS session, and so on.

[00122] In another embodiment of the present application, stopping receiving MBS data associated with an MBS session includes stopping monitoring a G-RNTI associated with the MBS session and stopping a DRX operation associated with the MBS session. In this embodiment, for each MBS session to be deactivated, the UE may still keep an MBS session context associated with the MBS session.

[00123] FIG. 5 illustrates an exemplary MAC CE according to some embodiments of the present application. The MAC CE in FIG. 5 may be used as an activation MAC CE or a deactivation MAC CE, depending on the LCH ID thereof (not shown in FIG. 5).

[00124] Referring to FIG. 5, the MAC CE includes one or more MBS session indexes (e.g., MBS index1, MBS index2, MBS index3, MBS index4, and so on). When the MAC CE is an activation MAC CE, each MBS session index may indicate an MBS session to be activated. When the MAC CE is a deactivation MAC CE, each MBS

session index may indicate an MBS session to be deactivated. In the example of FIG. 5, each MBS session index may occupy four bits in the MAC CE. However, each MBS session index may occupy fewer or more bits in the MAC CE in some other embodiments.

[00125] FIG. 6 illustrates an exemplary MAC CE according to some other embodiments of the present application. The MAC CE in FIG. 6 may be used as an activation MAC CE or a deactivation MAC CE, depending on the LCH ID thereof (not shown in FIG. 6).

[00126] Referring to FIG. 6, the MAC CE includes one or more MBS session IDs (e.g., G-RNTI1, G-RNTI2, and so on). When the MAC CE is an activation MAC CE, each G-RNTI may indicate an MBS session to be activated. When the MAC CE is a deactivation MAC CE, each G-RNTI may indicate an MBS session to be deactivated. In the example of FIG. 6, each G-RNTI may occupy 16 bits in the MAC CE. However, each MBS session ID may occupy fewer or more bits in the MAC CE in some other embodiments.

[00127] In some embodiments of the present application, the MAC CE indicating activation or deactivation of at least one MBS session, which is transmitted in step 301 and received in step 302, may include one or more indicators. Each indicator corresponds to an MBS session configured to the UE and indicates whether the corresponding MBS session is to be activated or deactivated. The MAC CE is transmitted in a TB via a unicast manner to the UE. The TB is scheduled by DCI associated with a cell radio network temporary identifier (C-RNTI) (e.g., the DCI is scrambled by the C-RNTI) associated with the UE.

[00128] As stated above, an MBS session list may be configured to the UE, and the MBS session list may include one or more MBS sessions configured to the UE. The configured MBS session list may be modified by the BS due to addition and/or release of MBS session(s). In this embodiment, the one or more indicators included in the MAC CE shall reflect states of all MBS sessions in the current MBS session list configured to the UE. MBS session(s) in the MBS session list may be listed in an order. Indicator(s) in the MAC CE may also be listed in an order which can be the same as or reversed to that of the MBS session(s), such that each indicator included in

the MAC CE indicates activation or deactivation of a corresponding MBS session in the MBS session list according to an ascending order or descending order.

[00129] In an embodiment of the present application, each indicator may be a Boolean bit, wherein the value "1" may indicate activation of the corresponding MBS session and the value "0" may indicate deactivation of the corresponding MBS session, or vice versa.

[00130] FIG. 7 illustrates an exemplary MAC CE according to some other embodiments of the present application. The MAC CE in FIG. 7 may indicate activation or deactivation of each MBS session configured to the UE.

[00131] Referring to FIG. 7, the MAC CE includes one or more indicators (e.g., M1, M2, M3, M4, ..., M16, and so on). Each indicator may indicate activation or deactivation of a corresponding MBS session. In the example of FIG. 7, each indicator may be a Boolean bit. Although the example in FIG. 7 illustrates that the number of indicators in the MAC CE may be more than 16, the MAC CE may include any number of indicators in some other embodiments.

[00132] Referring to FIG. 7, each indicator included in the MAC CE indicates activation or deactivation of a corresponding MBS session in the MBS session list according to an ascending order or descending order.

[00133] For example, assuming that the current MBS session list configured to the UE includes sixteen MBS sessions, which are listed in the current MBS session list in the following order: MBS session#1 (which is associated with MBS session information unit#1 in the MBS session list), MBS session#2 (which is associated with MBS session information unit#2 in the MBS session list), ..., MBS session#16 (which is associated with MBS session information unit#16 in the MBS session list).

[00134] In order to indicate activation or deactivation of each of these sixteen MBS sessions, the MAC CE may include sixteen indicators, as shown in FIG. 7.

[00135] In an embodiment, each indicator included in the MAC CE indicates activation or deactivation of a corresponding MBS session in the MBS session list

according to an ascending order, i.e., M1 indicates activation or deactivation of MBS session#1, M2 indicates activation or deactivation of MBS session#2, ..., and M16 indicates activation or deactivation of MBS session#16.

[00136] In another embodiment, each indicator included in the MAC CE indicates activation or deactivation of a corresponding MBS session in the MBS session list according to an descending order, i.e., M1 indicates activation or deactivation of MBS session#16, M2 indicates activation or deactivation of MBS session#15, ..., and M16 indicates activation or deactivation of MBS session#1.

[00137] After receiving the MAC CE, for each MBS session to be activated as indicated by the corresponding indicator in the MAC CE, the UE may start receiving MBS data associated with the MBS session.

[00138] In an embodiment of the present application, starting receiving MBS data associated with an MBS session includes performing one of the followings:

- starting to receive MBS data associated with the MBS session via a PTM mode; for example, the PTM mode may be a default mode for the UE to receive MBS data associated with any MBS session that becomes activated.
- continuing to receive MBS data associated with the MBS session via a PTM mode or a PTP mode which was being used before the last deactivation of the MBS session; for example, if the UE has been receiving packets associated with an MBS session in the PTM mode and then the MBS session got deactivated, after activation of the MBS session, the UE will continue to receive packets associated with the MBS session via the PTM mode; if the UE has been receiving packets associated with an MBS session in the PTP mode and then the MBS session got deactivated, after activation of the MBS session, the UE will continue to receive packets associated with the MBS session via the PTP mode.
- starting to receive MBS data associated with the MBS session via a PTP mode or a PTM mode indicated in the received MAC CE. In this case, for each MBS session to be activated which is indicated by a corresponding indication in the MAC CE, the BS may transmit a second indication in the MAC CE to indicate

the UE to receive MBS data associated with the MBS session via a PTP mode or a PTM mode. Consequently, after receiving the second indication, the UE may start to receive MBS data associated with an MBS session via the mode (PTP mode or PTM mode) as indicated by the corresponding second indication in the MAC CE.

[00139] In some embodiments, starting to receive MBS data associated with the MBS session via a PTM mode or continuing to receive MBS data associated with the MBS session via a PTM mode includes: starting monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session. For example, when the UE starts or continues to receive MBS data associated with an MBS session via a PTM mode, the UE may start monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session.

[00140] In another embodiment of the present application, starting receiving MBS data associated with an MBS session includes starting monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session.

[00141] After receiving the MAC CE, for each MBS session to be deactivated as indicated by the corresponding indicator in the MAC CE, the UE may stop receiving MBS data associated with the MBS session.

[00142] In an embodiment of the present application, stopping receiving MBS data associated with an MBS session includes stopping receiving MBS data associated with the MBS session via a PTM mode, which includes stopping monitoring a G-RNTI associated with the MBS session and stopping a DRX operation associated with the MBS session. In this embodiment, for each MBS session to be deactivated, the UE may still keep an MBS session context associated with the MBS session. The MBS session context may include at least one of: a G-RNTI associated with the MBS session, a DRX configuration associated with the MBS session, a radio bearer configuration associated with the MBS session, and so on.

[00143] In another embodiment of the present application, stopping receiving MBS data associated with an MBS session includes stopping monitoring a G-RNTI

associated with the MBS session and stopping a DRX operation associated with the MBS session. In this embodiment, for each MBS session to be deactivated, the UE may still keep an MBS session context associated with the MBS session.

[00144] In some embodiments of the present application, the MAC CE indicating activation or deactivation of an MBS session may be transmitted by the BS to inform a group of UEs (including one or more UEs) which are configured with the MBS session about activation or deactivation of the MBS session.

[00145] In these embodiments, the MAC CE may include an activation MAC CE indicating activation of an MBS session (which may also be referred to as indicating an MBS session to be activated) or a deactivation MAC CE indicating deactivation of an MBS session (which may also be referred to as indicating an MBS session to be deactivated). The activation MAC CE is associated with a first LCH ID, and the deactivation MAC CE is associated with a second LCH ID different from the first LCH ID. For example, the first LCH ID associated with the activation MAC CE may be included in a header of a MAC protocol data unit (PDU) including the activation MAC CE, and the second LCH ID associated with the deactivation MAC CE may be included in the header of the MAC PDU including the deactivation MAC CE.

[00146] In these embodiments, the MAC CE is transmitted in a TB. The TB is transmitted to a group of UEs via a multicast manner. The TB is scheduled by DCI associated with a G-RNTI (e.g., the DCI is scrambled by the G-RNTI) associated with an MBS session to be activated or deactivated.

[00147] After receiving the TB, the UE may identify the associated MBS session to be activated or deactivated based on the G-RNTI. For example, the UE may use a G-RNTI to obtain the DCI indicating the TB which includes the MAC CE; since the G-RNTI is associated with an MBS session, the UE may identify which MBS session the MAC CE is used to indicate. The UE may also identify whether the MAC CE is an activation MAC CE or a deactivation MAC CE based on an LCH ID associated with the MAC CE. For example, after receiving the MAC PDU including the MAC CE, the UE may determine whether the MAC CE is an activation MAC CE or a deactivation MAC CE based on the LCH ID in the header of the MAC PDU.

[00148] In these embodiments, the content or payload included in the MAC CE may be not necessary. Therefore, in an embodiment of the present application, the MAC CE may have a size of zero bit.

[00149] After identifying an activation MAC CE indicating activation of an MBS session, the UE may start receiving MBS data associated with the MBS session.

[00150] In an embodiment of the present application, starting receiving MBS data associated with an MBS session includes performing one of the followings:

- starting to receive MBS data associated with the MBS session via a PTM mode; for example, the PTM mode may be a default mode for the UE to receive MBS data associated with any MBS session that becomes activated.
- continuing to receive MBS data associated with the MBS session via a PTM mode or a PTP mode which was being used before the last deactivation of the MBS session; for example, if the UE has been receiving packets associated with an MBS session in the PTM mode and then the MBS session got deactivated, after activation of the MBS session, the UE will continue to receive packets associated with the MBS session via the PTM mode; if the UE has been receiving packets associated with an MBS session in the PTP mode and then the MBS session got deactivated, after activation of the MBS session, the UE will continue to receive packets associated with the MBS session via the PTP mode.
- starting to receive MBS data associated with the MBS session via a PTP mode or a PTM mode indicated in the received activation MAC CE. In this case, the BS may transmit an indication in the activation MAC CE to indicate the UE to receive MBS data associated with the MBS session via a PTP mode or a PTM mode. Consequently, after receiving the indication, the UE may start to receive MBS data associated with an MBS session via the mode (PTP mode or PTM mode) as indicated by the indication in the activation MAC CE.

[00151] In some embodiments, starting to receive MBS data associated with the MBS session via a PTM mode or continuing to receive MBS data associated with the MBS session via a PTM mode includes: starting monitoring a G-RNTI associated with the

MBS session and starting a DRX operation associated with the MBS session. For example, when the UE starts or continues to receive MBS data associated with an MBS session via a PTM mode, the UE may start monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session.

[00152] In another embodiment of the present application, starting receiving MBS data associated with an MBS session includes starting monitoring a G-RNTI associated with the MBS session and starting a DRX operation associated with the MBS session.

[00153] After identifying a deactivation MAC CE indicating deactivation of an MBS session, the UE may stop receiving MBS data associated with the MBS session.

[00154] In an embodiment of the present application, stopping receiving MBS data associated with an MBS session includes stopping receiving MBS data associated with the MBS session via a PTM mode, which includes stopping monitoring a G-RNTI associated with the MBS session and stopping a DRX operation associated with the MBS session. In this embodiment, for each MBS session to be deactivated, the UE may still keep an MBS session context associated with the MBS session. The MBS session context may include at least one of: a G-RNTI associated with the MBS session, a DRX configuration associated with the MBS session, a radio bearer configuration associated with the MBS session, and so on.

[00155] In another embodiment of the present application, stopping receiving MBS data associated with an MBS session includes stopping monitoring a G-RNTI associated with the MBS session and stopping a DRX operation associated with the MBS session. In this embodiment, for each MBS session to be deactivated, the UE may still keep an MBS session context associated with the MBS session.

[00156] FIG. 8 illustrates a simplified block diagram of an exemplary apparatus 800 for MBS according to some embodiments of the present application. The apparatus 800 may include a UE (e.g., UE 102a or UE 102b as shown in FIG. 1) or a BS (e.g., BS 101 as shown in FIG. 1).

[00157] Referring to FIG. 8, the apparatus 800 may include at least one non-transitory

computer-readable medium 802, at least one receiving circuitry 804, at least one transmitting circuitry 806, and at least one processor 808. In some embodiments of the present application, the at least one receiving circuitry 804 and the at least one transmitting circuitry 806 can be integrated into at least one transceiver. The at least one non-transitory computer-readable medium 802 may have computer executable instructions stored therein. The at least one processor 808 may be coupled to the at least one non-transitory computer-readable medium 802, the at least one receiving circuitry 804 and the at least one transmitting circuitry 806. While shown to be coupled to each other via the at least one processor 808 in the example of FIG. 8, the at least one receiving circuitry 804, the at least one transmitting circuitry 806, the at least one non-transitory computer-readable medium 802, and the at least one processor 808 may be coupled to one another in various arrangements. For example, the at least one receiving circuitry 804, the at least one transmitting circuitry 806, the at least one non-transitory computer-readable medium 802, and the at least one processor 808 may be coupled to each other via one or more local buses (not shown for simplicity). The computer executable instructions stored on the at least one non-transitory computer-readable medium 802 can be programmed to implement a method with the at least one receiving circuitry 804, the at least one transmitting circuitry 806 and the at least one processor 808. The method may include the operations or steps as shown in FIG. 3.

[00158] The method according to embodiments of the present application can also be implemented on a programmed processor. However, the controllers, flowcharts, and modules may also be implemented on a general purpose or special purpose computer, a programmed microprocessor or microcontroller and peripheral integrated circuit elements, an integrated circuit, a hardware electronic or logic circuit such as a discrete element circuit, a programmable logic device, or the like. In general, any device on which resides a finite state machine capable of implementing the flowcharts shown in the figures may be used to implement the processor functions of this application. For example, an embodiment of the present application provides an apparatus for MBS, including a processor and a memory. Computer programmable instructions for implementing a method for MBS are stored in the memory, and the processor is configured to perform the computer programmable instructions to implement the method for MBS. The method may be a method as stated above or other method

according to an embodiment of the present application.

[00159] An alternative embodiment preferably implements the methods according to embodiments of the present application in a non-transitory, computer-readable storage medium storing computer programmable instructions. The instructions are preferably executed by computer-executable components preferably integrated with a network security system. The non-transitory, computer-readable storage medium may be stored on any suitable computer readable media such as RAMs, ROMs, flash memory, EEPROMs, optical storage devices (CD or DVD), hard drives, floppy drives, or any suitable device. The computer-executable component is preferably a processor but the instructions may alternatively or additionally be executed by any suitable dedicated hardware device. For example, an embodiment of the present application provides a non-transitory, computer-readable storage medium having computer programmable instructions stored therein. The computer programmable instructions are configured to implement a method for MBS as stated above or other method according to an embodiment of the present application.

[00160] While this application has been described with specific embodiments thereof, it is evident that many alternatives, modifications, and variations may be apparent to those skilled in the art. For example, various components of the embodiments may be interchanged, added, or substituted in the other embodiments. Also, all of the elements of each figure are not necessary for operation of the disclosed embodiments. For example, one of ordinary skills in the art would be enabled to make and use the teachings of the application by simply employing the elements of the independent claims. Accordingly, embodiments of the application as set forth herein are intended to be illustrative, not limiting. Various changes may be made without departing from the spirit and scope of the application.

WHAT IS CLAIMED IS:

1. A method, comprising:

receiving a radio resource control (RRC) message or a medium access control (MAC) control element (CE) indicating activation or deactivation of at least one multicast and broadcast services (MBS) session configured to a user equipment (UE) in an RRC_CONNECTED state; and

starting or stopping receiving MBS data associated with the at least one MBS session based on the RRC message or the MAC CE.

2. The method of Claim 1, wherein the RRC message comprises MBS session information, and the MBS session information comprises at least one of:

a first list of one or more MBS session information units each associated with an MBS session to be added or modified;

a second list of one or more MBS session identifiers (IDs) each associated with an MBS session to be released;

a third list of one or more MBS session indexes of an MBS session list each associated with an MBS session to be released, wherein the MBS session list comprises one or more MBS sessions configured to the UE;

a fourth list of one or more MBS session IDs each associated with an MBS session to be activated;

a fifth list of one or more MBS session indexes of the MBS session list each associated with an MBS session to be activated;

a sixth list of one or more MBS session IDs each associated with an MBS session to be deactivated; and

a seventh list of one or more MBS session indexes of the MBS session list each associated with an MBS session to be deactivated.

3. The method of Claim 2, wherein the RRC message is a dedicated RRC message to the UE, the MBS session information is included in a first information element (IE) of the RRC message, and the method further comprises:
 - receiving a multicast radio bearer (MRB) configuration associated with the MBS session information in a second IE of the RRC message, wherein the second IE is different from the first IE.
4. The method of Claim 2, wherein the RRC message is a dedicated RRC message to the UE, and the method further comprises:
 - receiving a multicast radio bearer (MRB) configuration associated with the MBS session information in another dedicated RRC message different from the dedicated RRC message.
5. The method of Claim 2, wherein the RRC message is received via a multicast control channel (MCCH) or received in a system information block (SIB), and the method further comprises:
 - receiving a multicast radio bearer (MRB) configuration associated with the MBS session information in a dedicated RRC message to the UE.
6. The method of Claim 2, wherein starting or stopping receiving MBS data associated with the at least one MBS session based on the RRC message or the MAC CE comprises:
 - when the received RRC message comprises the first list, starting receiving MBS data associated with each MBS session to be added which is included in the first list, and
 - when the received RRC message comprises the fourth list or the fifth list, starting receiving MBS data associated with each MBS session to be activated which is included in the fourth list or the fifth list.

7. The method of Claim 6, wherein starting receiving MBS data associated with an MBS session comprises performing one of the followings:
 - starting to receive MBS data associated with the MBS session via a point to multipoint (PTM) mode;
 - continuing to receive MBS data associated with the MBS session via a PTM mode or a point to point (PTP) mode which was being used before the last deactivation of the MBS session; and
 - starting to receive MBS data associated with the MBS session via a PTP mode or a PTM mode indicated in the received RRC message.
8. The method of Claim 2, wherein starting or stopping receiving MBS data associated with the at least one MBS session based on the RRC message or the MAC CE comprises:
 - when the received RRC message comprises the sixth list or the seventh list, stopping receiving MBS data associated with each MBS session to be deactivated, which is included in the sixth list or the seventh list.
9. The method of Claim 1, wherein the MAC CE comprises an activation MAC CE indicating activation of the at least one MBS session or a deactivation MAC CE indicating deactivation of the at least one MBS session, the activation MAC CE is associated with a first logical channel (LCH) ID, and the deactivation MAC CE is associated with a second LCH ID different from the first LCH ID.
10. The method of Claim 9, wherein the activation MAC CE comprises one of:
 - at least one MBS session ID each associated with an MBS session to be activated; and
 - at least one MBS session index of an MBS session list each associated with an MBS session to be activated, wherein the MBS session list comprises one or more MBS sessions configured to the UE.

11. The method of Claim 10, wherein starting or stopping receiving MBS data associated with the at least one MBS session based on the RRC message or the MAC CE comprises:
 - when the received MAC CE comprises the activation MAC CE, starting receiving MBS data associated with each MBS session to be activated which is indicated in the activation MAC CE.
12. The method of Claim 9, wherein the deactivation MAC CE comprises one of:
 - at least one MBS session ID each associated with an MBS session to be deactivated; and
 - at least one MBS session index of an MBS session list each associated with an MBS session to be deactivated, wherein the MBS session list comprises one or more MBS sessions configured to the UE.
13. The method of Claim 12, wherein starting or stopping receiving MBS data associated with the at least one MBS session based on the RRC message or the MAC CE comprises:
 - when the received MAC CE comprises the deactivation MAC CE, stopping receiving MBS data associated with each MBS session to be deactivated which is indicated in the deactivation MAC CE.
14. A method, comprising:
 - transmitting a radio resource control (RRC) message or a medium access control (MAC) control element (CE) indicating activation or deactivation of at least one multicast and broadcast services (MBS) session configured to a user equipment (UE) in an RRC_CONNECTED state.
15. An apparatus, comprising:

at least one non-transitory computer-readable medium having computer executable instructions stored therein;

at least one receiving circuitry;

at least one transmitting circuitry; and

at least one processor coupled to the at least one non-transitory computer-readable medium, the at least one receiving circuitry and the at least one transmitting circuitry;

wherein the computer executable instructions are programmed to implement a method according to any one of Claims 1-14 with the at least one receiving circuitry, the at least one transmitting circuitry and the at least one processor.

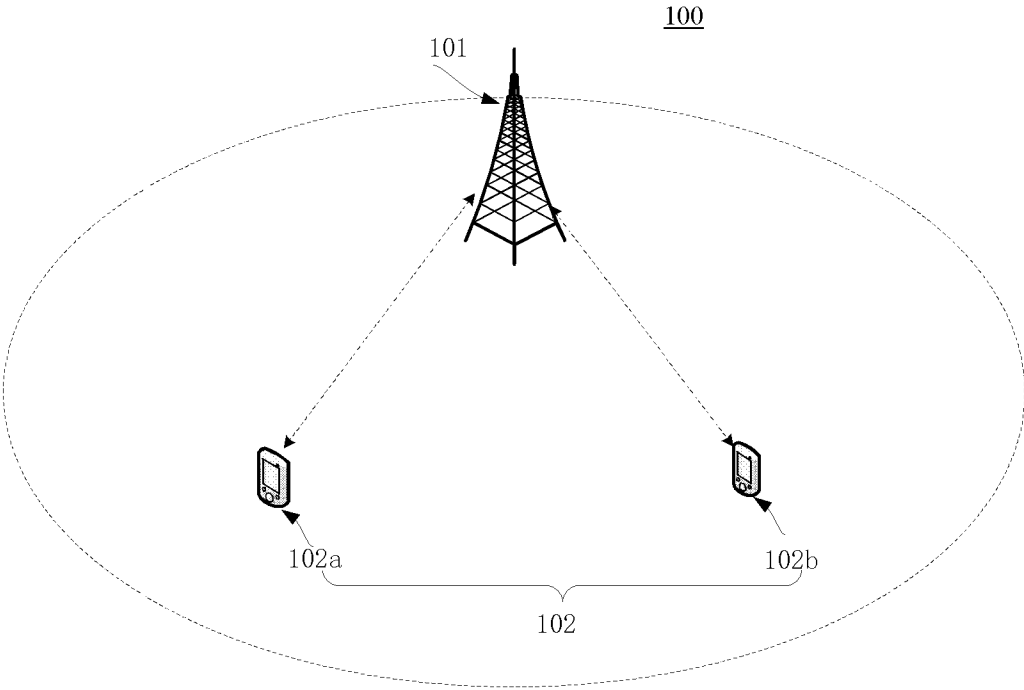


FIG. 1

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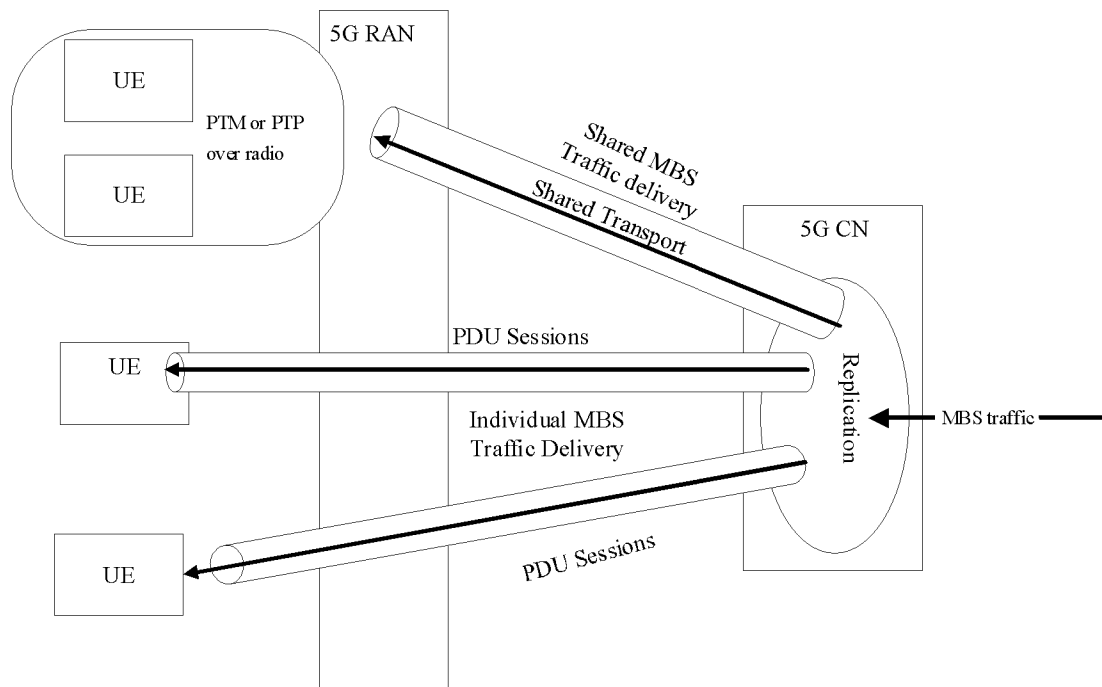


FIG. 2

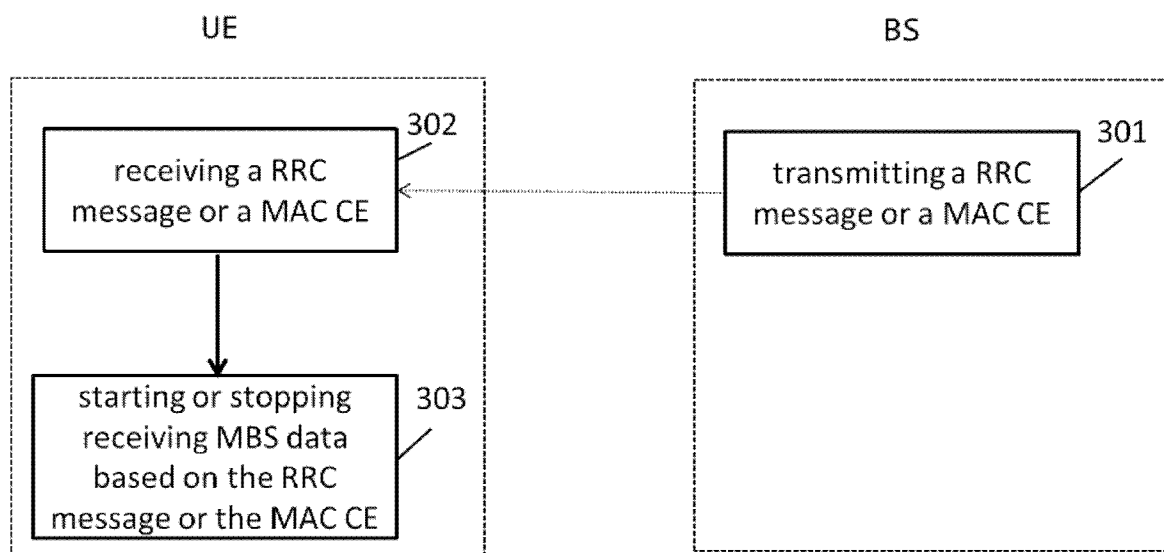


FIG. 3

```
MBS-ToAddModList ::=                               SEQUENCE (SIZE (0..maxMBS)) OF MBS-Info

MBS-Info ::=                                         SEQUENCE      {
    mbsSessionInfo          MBSSessionInfo,
    g-RNTI                   BIT STRING(SIZE(16)),
    MBS-schedulingInfo      MBS-SchedulingInfo      OPTIONAL,    -- Need OP
}

MBSSessionInfo      SEQUENCE      {
    tmgi                TMGI,
    sessionId           OCTET STRING (SIZE (1))    OPTIONAL -- Need OR
}

MBS-SchedulingInfo ::= SEQUENCE      {
    onDurationTimerMBS    ENUMERATED {
                                psf1, psf2, psf3, psf4, psf5, psf6},
    drx-InactivityTimerMBS    ENUMERATED {
                                psf0, psf1, psf2, psf4, psf8},
    schedulingPeriodStartOffsetMBS    CHOICE {

    },
    ...
}

MBS-ToReleaseList ::= SEQUENCE (SIZE (0..maxMBS)) OF MBS-Index/MBS-ID
MBS-ToActivatedList ::= SEQUENCE (SIZE (0..maxMBS)) OF MBS-Index/MBS-ID
MBS-ToDeactivatedList ::= SEQUENCE (SIZE (0..maxMBS)) OF MBS-Index/MBS-ID
```

FIG. 4

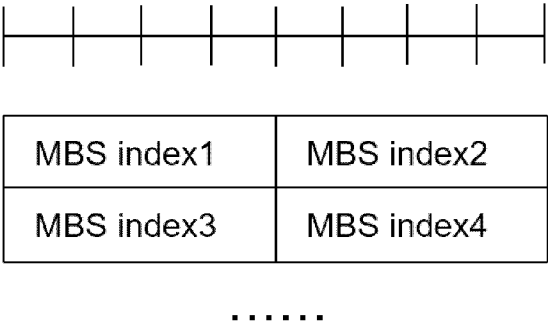


FIG. 5

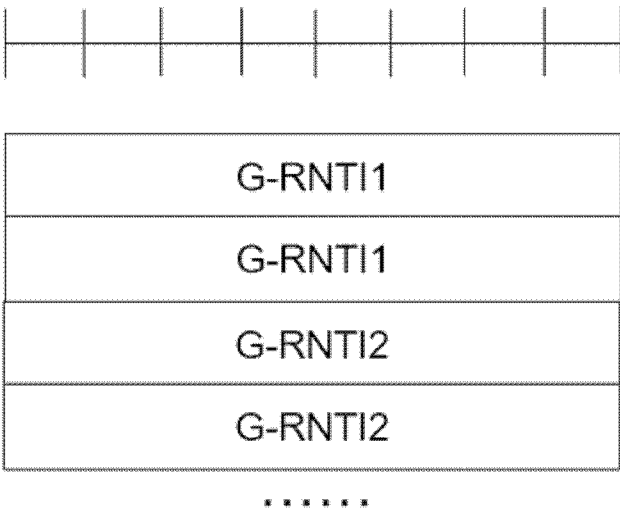


FIG. 6

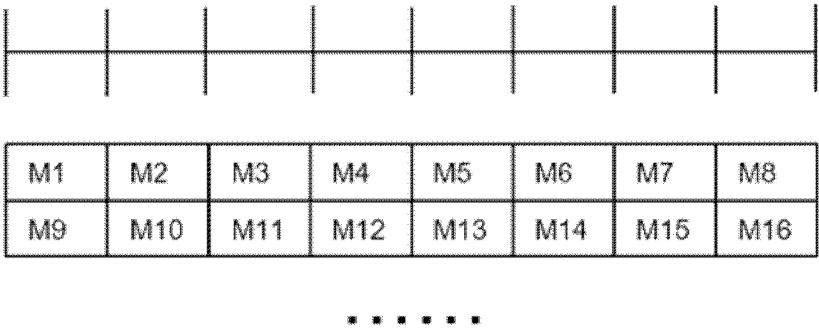


FIG. 7

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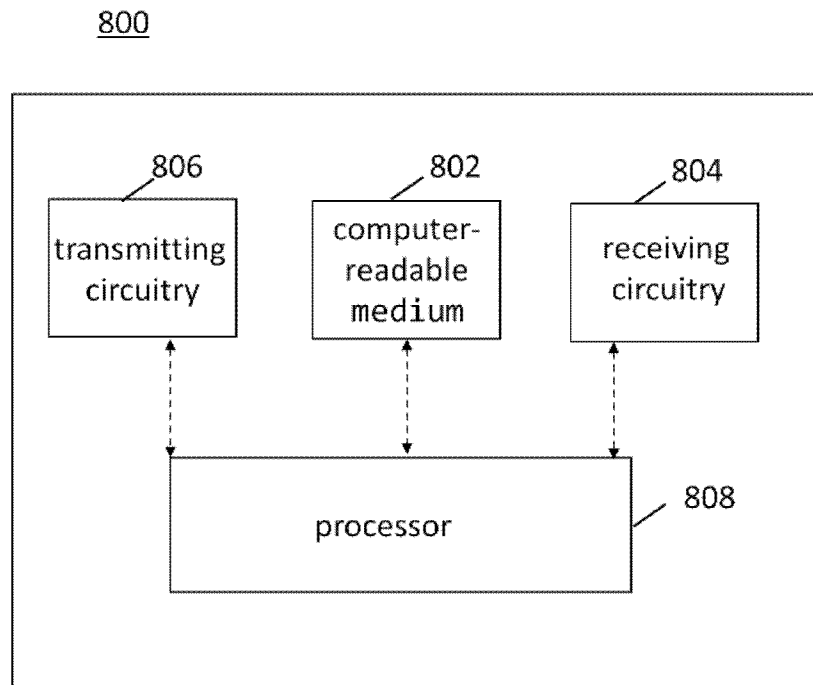


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/085001

A. CLASSIFICATION OF SUBJECT MATTER

H04L 29/06(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)

H04L; H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, CNKI, EPODOC, WPI, 3GPP: 5MBS, MBS, MBMS, MULTICAST, GROUPCAST, deactivation, deactivated, release, stop, activation, configure, start, RRC, signaling, message, SIB, MAC CE, CONNECTED, RRC_CONNECTED

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HUAWEI et al. "R2-2102307, Report of [Offline-037][MBS] MBS General (Huawei)" 3GPP TSG-RAN WG2 Meeting #113, 05 February 2021 (2021-02-05), section 2.3	1-15
A	NOKIA et al. "S2-2101017, KI#1: Conclusion update for MBS Session activation/ deactivation and UE join/leave" SA WG2 Meeting #143E, 09 March 2020 (2020-03-09), the whole document	1-15
A	CMCC et al. "R2-2102503, 38.300 Running CR for MBS in NR" 3GPP TSG-RAN WG2 Meeting #113-e, 05 February 2021 (2021-02-05), the whole document	1-15
A	WO 2021027717 A1 (VIVO MOBILE COMMUNICATION CO., LTD.) 18 February 2021 (2021-02-18) the whole document	1-15
A	US 2016249266 A1 (LG ELECTRONICS INC.) 25 August 2016 (2016-08-25) the whole document	1-15



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 another 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 be 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

06 December 2021

Date of mailing of the international search report

31 December 2021

Name and mailing address of the ISA/CN

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Telephone No. 86-(10)-53961657

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2021/085001

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2021027717	A1	18 February 2021	None			
US	2016249266	A1	25 August 2016	WO	2015065053	A1	07 May 2015
				US	10015715	B2	03 July 2018