



(51) International Patent Classification:

H04W 52/36 (2009.01) H04W 52/42 (2009.01)

(21) International Application Number:

PCT/KR2018/007952

(22) International Filing Date:

13 July 2018 (13.07.2018)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/531,882 13 July 2017 (13.07.2017) US
62/535,219 20 July 2017 (20.07.2017) US

(71) Applicant: **LG ELECTRONICS INC.** [KR/KR]; 128, Yeoui-daero, Yeongdeungpo-gu, Seoul 07336 (KR).

(72) Inventors: **LEE, Eunjong**; IP Center, LG Electronics Inc., 19, Yangjae-daero 11-gil, Seocho-gu, Seoul 06772 (KR). **LEE, Sunyoung**; IP Center, LG Electronics Inc., 19, Yangjae-daero 11-gil, Seocho-gu, Seoul 06772 (KR). **YI, Seungjune**; IP Center, LG Electronics Inc., 19, Yangjae-daero 11-gil, Seocho-gu, Seoul 06772 (KR).

(74) Agent: **KIM, Yong In** et al.; KBK & Associates, 7th Floor, 82, Olympic-ro, Songpa-gu, Seoul 05556 (KR).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,

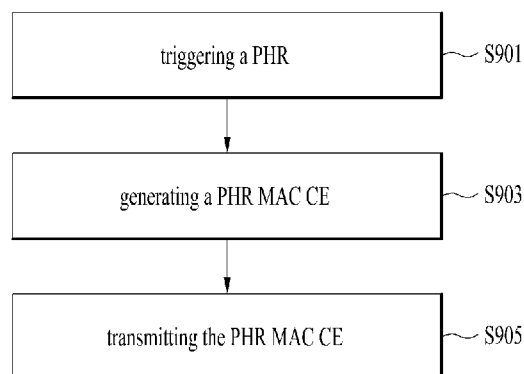
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: METHOD FOR TRANSMITTING A POWER HEADROOM REPORTING IN WIRELESS COMMUNICATION SYSTEM AND A DEVICE THEREFOR



(57) Abstract: The present invention relates to a wireless communication system. More specifically, the present invention relates to a method and a device for transmitting a power headroom reporting in wireless communication system, the method comprising: generating a PHR MAC CE including PH information per BWP within a serving cell, in a state that the UE is configured with one or more BWPs per serving cell; and transmitting the PHR MAC CE, wherein the PHR MAC CE includes a BWP bitmap indicating presence of the PH information per BWP within the serving cell, wherein the BWP bitmap is present when the serving cell is activated.



Description

Title of Invention: METHOD FOR TRANSMITTING A POWER HEADROOM REPORTING IN WIRELESS COMMUNICATION SYSTEM AND A DEVICE THEREFOR

Technical Field

- [1] The present invention relates to a wireless communication system and, more particularly, to a method for transmitting a power headroom reporting in wireless communication system and a device therefor.

Background Art

- [2] As an example of a mobile communication system to which the present invention is applicable, a 3rd Generation Partnership Project Long Term Evolution (hereinafter, referred to as LTE) communication system is described in brief.
- [3] FIG. 1 is a view schematically illustrating a network structure of an E-UMTS as an exemplary radio communication system. An Evolved Universal Mobile Telecommunications System (E-UMTS) is an advanced version of a conventional Universal Mobile Telecommunications System (UMTS) and basic standardization thereof is currently underway in the 3GPP. E-UMTS may be generally referred to as a Long Term Evolution (LTE) system. For details of the technical specifications of the UMTS and E-UMTS, reference can be made to Release 7 and Release 8 of "3rd Generation Partnership Project; Technical Specification Group Radio Access Network".
- [4] Referring to FIG. 1, the E-UMTS includes a User Equipment (UE), eNode Bs (eNBs), and an Access Gateway (AG) which is located at an end of the network (E-UTRAN) and connected to an external network. The eNBs may simultaneously transmit multiple data streams for a broadcast service, a multicast service, and/or a unicast service.
- [5] One or more cells may exist per eNB. The cell is set to operate in one of bandwidths such as 1.25, 2.5, 5, 10, 15, and 20 MHz and provides a downlink (DL) or uplink (UL) transmission service to a plurality of UEs in the bandwidth. Different cells may be set to provide different bandwidths. The eNB controls data transmission or reception to and from a plurality of UEs. The eNB transmits DL scheduling information of DL data to a corresponding UE so as to inform the UE of a time/frequency domain in which the DL data is supposed to be transmitted, coding, a data size, and hybrid automatic repeat and request (HARQ)-related information. In addition, the eNB transmits UL scheduling information of UL data to a corresponding UE so as to inform the UE of a time/frequency domain which may be used by the UE, coding, a data size, and HARQ-related information. An interface for transmitting user traffic or control traffic may be

used between eNBs. A core network (CN) may include the AG and a network node or the like for user registration of UEs. The AG manages the mobility of a UE on a tracking area (TA) basis. One TA includes a plurality of cells.

- [6] Although wireless communication technology has been developed to LTE based on wideband code division multiple access (WCDMA), the demands and expectations of users and service providers are on the rise. In addition, considering other radio access technologies under development, new technological evolution is required to secure high competitiveness in the future. Decrease in cost per bit, increase in service availability, flexible use of frequency bands, a simplified structure, an open interface, appropriate power consumption of UEs, and the like are required.

- [7] As more and more communication devices demand larger communication capacity, there is a need for improved mobile broadband communication compared to existing RAT. Also, massive machine type communication (MTC), which provides various services by connecting many devices and objects, is one of the major issues to be considered in the next generation communication (NR, New Radio). In addition, a communication system design considering a service/UE sensitive to reliability and latency is being discussed. The introduction of next-generation RAT, which takes into account such Enhanced Mobile BroadBand (eMBB) transmission, and ultra-reliable and low latency communication (URLLC) transmission, is being discussed.

Disclosure of Invention

Technical Problem

- [8] An object of the present invention devised to solve the problem lies in a method and device for transmitting a power headroom reporting in wireless communication system.
- [9] In LTE, the Power Headroom Reporting (PHR) procedure is used to provide the serving eNB with information about the difference between the nominal UE maximum transmit power and the estimated power for UL-SCH transmission and also with information about the difference between the nominal UE maximum power and the estimated power for UL-SCH and PUCCH transmission on SpCell and PUCCH SCell. And the eNB can use the PHR report as input to the scheduler. Based on the available power headroom the scheduler will decide a suitable number of PRBs and an appropriate MCS as well a correct transmit power adjustment.
- [10] In Rel-15, NR system supports the wider bandwidth (WB) operation. The carrier performing the wider bandwidth operation can be composed of one or more bandwidth part(s) and each bandwidth part is associated with a specific numerology. In this operation, gNB can configure or activate a specific bandwidth part for a UE. According to the current RAN1 agreement, UE expects at least one DL bandwidth part

and one UL bandwidth part being active among the set of configured bandwidth parts for a given time instant. In addition, for a single carrier WB UE, multiple active bandwidth parts with different numerologies can be configured for a UE simultaneously.

[11] In this WB operation, the gNB may require PH information per BWP in order to decide a suitable UL resource of a UE.

[12] The technical problems solved by the present invention are not limited to the above technical problems and those skilled in the art may understand other technical problems from the following description.

Solution to Problem

[13] The object of the present invention can be achieved by providing a method for User Equipment (UE) operating in a wireless communication system as set forth in the appended claims.

[14] In another aspect of the present invention, provided herein is a communication apparatus as set forth in the appended claims.

[15] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

Advantageous Effects of Invention

[16] This invention proposes to define a new PHR trigger event and a new PHR MAC CE format in order for a UE to transmit a PH information for a bandwidth part (BWP) when a UE performs wider bandwidth operation.

[17] For BWP operation, this invention proposes to define a new PHR MAC CE which a UE can transmit a PH information per BWP within a serving cell.

[18] It will be appreciated by persons skilled in the art that the effects achieved by the present invention are not limited to what has been particularly described hereinabove and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings.

Brief Description of Drawings

[19] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention.

[20] FIG. 1 is a diagram showing a network structure of an Evolved Universal Mobile Telecommunications System (E-UMTS) as an example of a wireless communication system;

[21] FIG. 2a is a block diagram illustrating network structure of an evolved universal

mobile telecommunication system (E-UMTS), and FIG. 2b is a block diagram depicting architecture of a typical E-UTRAN and a typical EPC;

[22] FIG. 3 is a diagram showing a control plane and a user plane of a radio interface protocol between a UE and an E-UTRAN based on a 3rd generation partnership project (3GPP) radio access network standard;

[23] FIG. 4a is a block diagram illustrating network structure of NG Radio Access Network (NG-RAN) architecture, and FIG. 4b is a block diagram depicting architecture of functional Split between NG-RAN and 5G Core Network (5GC);

[24] FIG. 5 is a diagram showing a control plane and a user plane of a radio interface protocol between a UE and a NG-RAN based on a 3rd generation partnership project (3GPP) radio access network standard;

[25] FIG. 6 is a block diagram of a communication apparatus according to an embodiment of the present invention;

[26] FIG. 7 is a diagram for signaling of power headroom reporting via a MAC CE;

[27] FIG. 8 is an example for Bandwidth part configuration and activation/deactivation;

[28] FIG. 9 is a conceptual diagram for transmitting a power headroom reporting in wireless communication system according to embodiments of the present invention; and

[29] FIGs. 10 to 13 are examples for a PHR MAC CE for Bandwidth Part (BWP) operation according to embodiments of the present invention.

Best Mode for Carrying out the Invention

[30] Universal mobile telecommunications system (UMTS) is a 3rd Generation (3G) asynchronous mobile communication system operating in wideband code division multiple access (WCDMA) based on European systems, global system for mobile communications (GSM) and general packet radio services (GPRS). The long-term evolution (LTE) of UMTS is under discussion by the 3rd generation partnership project (3GPP) that standardized UMTS.

[31] The 3GPP LTE is a technology for enabling high-speed packet communications. Many schemes have been proposed for the LTE objective including those that aim to reduce user and provider costs, improve service quality, and expand and improve coverage and system capacity. The 3G LTE requires reduced cost per bit, increased service availability, flexible use of a frequency band, a simple structure, an open interface, and adequate power consumption of a terminal as an upper-level requirement.

[32] Hereinafter, structures, operations, and other features of the present invention will be readily understood from the embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Embodiments described later are

examples in which technical features of the present invention are applied to a 3GPP system.

- [33] Although the embodiments of the present invention are described using a long term evolution (LTE) system and a LTE-advanced (LTE-A) system in the present specification, they are purely exemplary. Therefore, the embodiments of the present invention are applicable to any other communication system corresponding to the above definition. In addition, although the embodiments of the present invention are described based on a frequency division duplex (FDD) scheme in the present specification, the embodiments of the present invention may be easily modified and applied to a half-duplex FDD (H-FDD) scheme or a time division duplex (TDD) scheme.
- [34] FIG. 2a is a block diagram illustrating network structure of an evolved universal mobile telecommunication system (E-UMTS). The E-UMTS may be also referred to as an LTE system. The communication network is widely deployed to provide a variety of communication services such as voice (VoIP) through IMS and packet data.
- [35] As illustrated in FIG. 2a, the E-UMTS network includes an evolved UMTS terrestrial radio access network (E-UTRAN), an Evolved Packet Core (EPC) and one or more user equipment. The E-UTRAN may include one or more evolved NodeB (eNodeB) 20, and a plurality of user equipment (UE) 10 may be located in one cell. One or more E-UTRAN mobility management entity (MME)/system architecture evolution (SAE) gateways 30 may be positioned at the end of the network and connected to an external network.
- [36] As used herein, "downlink" refers to communication from eNodeB 20 to UE 10, and "uplink" refers to communication from the UE to an eNodeB. UE 10 refers to communication equipment carried by a user and may be also referred to as a mobile station (MS), a user terminal (UT), a subscriber station (SS) or a wireless device.
- [37] FIG. 2b is a block diagram depicting architecture of a typical E-UTRAN and a typical EPC.
- [38] As illustrated in FIG. 2B, an eNodeB 20 provides end points of a user plane and a control plane to the UE 10. MME/SAE gateway 30 provides an end point of a session and mobility management function for UE 10. The eNodeB and MME/SAE gateway may be connected via an S1 interface.
- [39] The eNodeB 20 is generally a fixed station that communicates with a UE 10, and may also be referred to as a base station (BS) or an access point. One eNodeB 20 may be deployed per cell. An interface for transmitting user traffic or control traffic may be used between eNodeBs 20.
- [40] The MME provides various functions including NAS signaling to eNodeBs 20, NAS signaling security, AS Security control, Inter CN node signaling for mobility between 3GPP access networks, Idle mode UE Reachability (including control and execution of

paging retransmission), Tracking Area list management (for UE in idle and active mode), PDN GW and Serving GW selection, MME selection for handovers with MME change, SGSN selection for handovers to 2G or 3G 3GPP access networks, Roaming, Authentication, Bearer management functions including dedicated bearer establishment, Support for PWS (which includes ETWS and CMAS) message transmission. The SAE gateway host provides assorted functions including Per-user based packet filtering (by e.g. deep packet inspection), Lawful Interception, UE IP address allocation, Transport level packet marking in the downlink, UL and DL service level charging, gating and rate enforcement, DL rate enforcement based on APN-AMBR. For clarity MME/SAE gateway 30 will be referred to herein simply as a "gateway," but it is understood that this entity includes both an MME and an SAE gateway.

- [41] A plurality of nodes may be connected between eNodeB 20 and gateway 30 via the S1 interface. The eNodeBs 20 may be connected to each other via an X2 interface and neighboring eNodeBs may have a meshed network structure that has the X2 interface.
- [42] As illustrated, eNodeB 20 may perform functions of selection for gateway 30, routing toward the gateway during a Radio Resource Control (RRC) activation, scheduling and transmitting of paging messages, scheduling and transmitting of Broadcast Channel (BCCH) information, dynamic allocation of resources to UEs 10 in both uplink and downlink, configuration and provisioning of eNodeB measurements, radio bearer control, radio admission control (RAC), and connection mobility control in LTE_ACTIVE state. In the EPC, and as noted above, gateway 30 may perform functions of paging origination, LTE-IDLE state management, ciphering of the user plane, System Architecture Evolution (SAE) bearer control, and ciphering and integrity protection of Non-Access Stratum (NAS) signaling.
- [43] The EPC includes a mobility management entity (MME), a serving-gateway (S-GW), and a packet data network-gateway (PDN-GW). The MME has information about connections and capabilities of UEs, mainly for use in managing the mobility of the UEs. The S-GW is a gateway having the E-UTRAN as an end point, and the PDN-GW is a gateway having a packet data network (PDN) as an end point.
- [44] FIG. 3 is a diagram showing a control plane and a user plane of a radio interface protocol between a UE and an E-UTRAN based on a 3GPP radio access network standard. The control plane refers to a path used for transmitting control messages used for managing a call between the UE and the E-UTRAN. The user plane refers to a path used for transmitting data generated in an application layer, e.g., voice data or Internet packet data.
- [45] A physical (PHY) layer of a first layer provides an information transfer service to a higher layer using a physical channel. The PHY layer is connected to a medium access control (MAC) layer located on the higher layer via a transport channel. Data is

transported between the MAC layer and the PHY layer via the transport channel. Data is transported between a physical layer of a transmitting side and a physical layer of a receiving side via physical channels. The physical channels use time and frequency as radio resources. In detail, the physical channel is modulated using an orthogonal frequency division multiple access (OFDMA) scheme in downlink and is modulated using a single carrier frequency division multiple access (SC-FDMA) scheme in uplink.

- [46] The MAC layer of a second layer provides a service to a radio link control (RLC) layer of a higher layer via a logical channel. The RLC layer of the second layer supports reliable data transmission. A function of the RLC layer may be implemented by a functional block of the MAC layer. A packet data convergence protocol (PDCP) layer of the second layer performs a header compression function to reduce unnecessary control information for efficient transmission of an Internet protocol (IP) packet such as an IP version 4 (IPv4) packet or an IP version 6 (IPv6) packet in a radio interface having a relatively small bandwidth.
- [47] A radio resource control (RRC) layer located at the bottom of a third layer is defined only in the control plane. The RRC layer controls logical channels, transport channels, and physical channels in relation to configuration, re-configuration, and release of radio bearers (RBs). An RB refers to a service that the second layer provides for data transmission between the UE and the E-UTRAN. To this end, the RRC layer of the UE and the RRC layer of the E-UTRAN exchange RRC messages with each other.
- [48] One cell of the eNB is set to operate in one of bandwidths such as 1.25, 2.5, 5, 10, 15, and 20 MHz and provides a downlink or uplink transmission service to a plurality of UEs in the bandwidth. Different cells may be set to provide different bandwidths.
- [49] Downlink transport channels for transmission of data from the E-UTRAN to the UE include a broadcast channel (BCH) for transmission of system information, a paging channel (PCH) for transmission of paging messages, and a downlink shared channel (SCH) for transmission of user traffic or control messages. Traffic or control messages of a downlink multicast or broadcast service may be transmitted through the downlink SCH and may also be transmitted through a separate downlink multicast channel (MCH).
- [50] Uplink transport channels for transmission of data from the UE to the E-UTRAN include a random access channel (RACH) for transmission of initial control messages and an uplink SCH for transmission of user traffic or control messages. Logical channels that are defined above the transport channels and mapped to the transport channels include a broadcast control channel (BCCH), a paging control channel (PCCH), a common control channel (CCCH), a multicast control channel (MCCH), and a multicast traffic channel (MTCH).

- [51] FIG. 4a is a block diagram illustrating network structure of NG Radio Access Network (NG-RAN) architecture, and FIG. 4b is a block diagram depicting architecture of functional Split between NG-RAN and 5G Core Network (5GC).
- [52] An NG-RAN node is a gNB, providing NR user plane and control plane protocol terminations towards the UE, or an ng-eNB, providing E-UTRA user plane and control plane protocol terminations towards the UE.
- [53] The gNBs and ng-eNBs are interconnected with each other by means of the Xn interface. The gNBs and ng-eNBs are also connected by means of the NG interfaces to the 5GC, more specifically to the AMF (Access and Mobility Management Function) by means of the NG-C interface and to the UPF (User Plane Function) by means of the NG-U interface.
- [54] The Xn Interface includes Xn user plane (Xn-U), and Xn control plane (Xn-C). The Xn User plane (Xn-U) interface is defined between two NG-RAN nodes. The transport network layer is built on IP transport and GTP-U is used on top of UDP/IP to carry the user plane PDUs. Xn-U provides non-guaranteed delivery of user plane PDUs and supports the following functions: i) Data forwarding, and ii) Flow control. The Xn control plane interface (Xn-C) is defined between two NG-RAN nodes. The transport network layer is built on SCTP on top of IP. The application layer signalling protocol is referred to as XnAP (Xn Application Protocol). The SCTP layer provides the guaranteed delivery of application layer messages. In the transport IP layer point-to-point transmission is used to deliver the signalling PDUs. The Xn-C interface supports the following functions: i) Xn interface management, ii) UE mobility management, including context transfer and RAN paging, and iii) Dual connectivity.
- [55] The NG Interface includes NG User Plane (NG-U) and NG Control Plane (NG-C). The NG user plane interface (NG-U) is defined between the NG-RAN node and the UPF. The transport network layer is built on IP transport and GTP-U is used on top of UDP/IP to carry the user plane PDUs between the NG-RAN node and the UPF. NG-U provides non-guaranteed delivery of user plane PDUs between the NG-RAN node and the UPF.
- [56] The NG control plane interface (NG-C) is defined between the NG-RAN node and the AMF. The transport network layer is built on IP transport. For the reliable transport of signalling messages, SCTP is added on top of IP. The application layer signalling protocol is referred to as NGAP (NG Application Protocol). The SCTP layer provides guaranteed delivery of application layer messages. In the transport, IP layer point-to-point transmission is used to deliver the signalling PDUs.
- [57] NG-C provides the following functions: i) NG interface management, ii) UE context management, iii) UE mobility management, iv) Configuration Transfer, and v) Warning Message Transmission.

- [58] The gNB and ng-eNB host the following functions: i) Functions for Radio Resource Management: Radio Bearer Control, Radio Admission Control, Connection Mobility Control, Dynamic allocation of resources to UEs in both uplink and downlink (scheduling), ii) IP header compression, encryption and integrity protection of data, iii) Selection of an AMF at UE attachment when no routing to an AMF can be determined from the information provided by the UE, iv) Routing of User Plane data towards UPF(s), v) Routing of Control Plane information towards AMF, vi) Connection setup and release, vii) Scheduling and transmission of paging messages (originated from the AMF), viii) Scheduling and transmission of system broadcast information (originated from the AMF or O&M), ix) Measurement and measurement reporting configuration for mobility and scheduling, x) Transport level packet marking in the uplink, xi) Session Management, xii) Support of Network Slicing, and xiii) QoS Flow management and mapping to data radio bearers. The Access and Mobility Management Function (AMF) hosts the following main functions: i) NAS signalling termination, ii) NAS signalling security, iii) AS Security control, iv) Inter CN node signalling for mobility between 3GPP access networks, v) Idle mode UE Reachability (including control and execution of paging retransmission), vi) Registration Area management, vii) Support of intra-system and inter-system mobility, viii) Access Authentication, ix) Mobility management control (subscription and policies), x) Support of Network Slicing, and xi) SMF selection.
- [59] The User Plane Function (UPF) hosts the following main functions: i) Anchor point for Intra-/Inter-RAT mobility (when applicable), ii) External PDU session point of interconnect to Data Network, iii) Packet inspection and User plane part of Policy rule enforcement, iv) Traffic usage reporting, v) Uplink classifier to support routing traffic flows to a data network, vi) QoS handling for user plane, e.g. packet filtering, gating, UL/DL rate enforcement, and vii) Uplink Traffic verification (SDF to QoS flow mapping).
- [60] The Session Management function (SMF) hosts the following main functions: i) Session Management, ii) UE IP address allocation and management, iii) Selection and control of UP function, iv) Configures traffic steering at UPF to route traffic to proper destination, v) Control part of policy enforcement and QoS, vi) Downlink Data Notification.
- [61] FIG. 5 is a diagram showing a control plane and a user plane of a radio interface protocol between a UE and a NG-RAN based on a 3rd generation partnership project (3GPP) radio access network standard.
- [62] The user plane protocol stack contains Phy, MAC, RLC, PDCP and SDAP (Service Data Adaptation Protocol) which is newly introduced to support 5G QoS model.
- [63] The main services and functions of SDAP entity include i) Mapping between a QoS

flow and a data radio bearer, and ii) Marking QoS flow ID (QFI) in both DL and UL packets. A single protocol entity of SDAP is configured for each individual PDU session.

- [64] At the reception of an SDAP SDU from upper layer for a QoS flow, the transmitting SDAP entity may map the SDAP SDU to the default DRB if there is no stored QoS flow to DRB mapping rule for the QoS flow. If there is a stored QoS flow to DRB mapping rule for the QoS flow, the SDAP entity may map the SDAP SDU to the DRB according to the stored QoS flow to DRB mapping rule. And the SDAP entity may construct the SDAP PDU and deliver the constructed SDAP PDU to the lower layers.
- [65] FIG. 6 is a block diagram of a communication apparatus according to an embodiment of the present invention.
- [66] The apparatus shown in FIG. 6 can be a user equipment (UE) and/or eNB or gNB adapted to perform the above mechanism, but it can be any apparatus for performing the same operation.
- [67] As shown in FIG. 6, the apparatus may comprises a DSP/microprocessor (110) and RF module (transceiver; 135). The DSP/microprocessor (110) is electrically connected with the transceiver (135) and controls it. The apparatus may further include power management module (105), battery (155), display (115), keypad (120), SIM card (125), memory device (130), speaker (145) and input device (150), based on its implementation and designer's choice.
- [68] Specifically, FIG. 6 may represent a UE comprising a receiver (135) configured to receive a request message from a network, and a transmitter (135) configured to transmit the transmission or reception timing information to the network. These receiver and the transmitter can constitute the transceiver (135). The UE further comprises a processor (110) connected to the transceiver (135: receiver and transmitter).
- [69] Also, FIG. 6 may represent a network apparatus comprising a transmitter (135) configured to transmit a request message to a UE and a receiver (135) configured to receive the transmission or reception timing information from the UE. These transmitter and receiver may constitute the transceiver (135). The network further comprises a processor (110) connected to the transmitter and the receiver. This processor (110) may be configured to calculate latency based on the transmission or reception timing information.
- [70] FIG. 7 is a diagram for signaling of power headroom reporting via a MAC CE.
- [71] The amount of transmission power available in each UE is also relevant for the uplink scheduler. Obviously, there is little reason to schedule a higher data rate than the available transmission power can support. In the downlink, the available power is immediately known to the scheduler as the power amplifier is located in the same node

as the scheduler. For the uplink, the power availability, or power headroom is defined as the difference between the nominal maximum output power and the estimated output power for UL-SCH transmission.

- [72] This quantity can be positive as well as negative (on a dB scale), where a negative value would indicate that the network has scheduled a higher data rate than the terminal can support given its current power availability. The power headroom depends on the power-control mechanism and thereby indirectly on factors such as the interference in the system and the distance to the base stations. Information about the power headroom is fed back from the terminals to the eNodeB in a similar way as the buffer-status reports—that is, only when the terminal is scheduled to transmit on the UL-SCH.
- [73] A Power Headroom Report (PHR) shall be triggered if any of the following events occur: i) prohibitPHR-Timer expires or has expired and the path loss has changed more than dl-PathlossChange dB for at least one activated Serving Cell of any MAC entity which is used as a pathloss reference since the last transmission of a PHR in this MAC entity when the MAC entity has UL resources for new transmission; ii) periodicPHR-Timer expires; iii) upon configuration or reconfiguration of the power headroom reporting functionality by upper layers, which is not used to disable the function; iv) activation of an SCell of any MAC entity with configured uplink, v) addition of the PSCell, vi) prohibitPHR-Timer expires or has expired, when the MAC entity has UL resources for new transmission, and the following is true in this TTI for any of the activated Serving Cells of any MAC entity with configured uplink: there are UL resources allocated for transmission or there is a PUCCH transmission on this cell, and the required power backoff due to power management for this cell has changed more than dl-PathlossChange dB since the last transmission of a PHR when the MAC entity had UL resources allocated for transmission or PUCCH transmission on this cell.
- [74] It is also possible to configure a prohibit timer to control the minimum time between two power-headroom reports and thereby the signaling load on the uplink.
- [75] If the MAC entity has UL resources allocated for new transmission for this TTI the MAC entity shall start periodicPHR-Timer if it is the first UL resource allocated for a new transmission since the last MAC reset. If the Power Headroom reporting procedure determines that at least one PHR has been triggered and not cancelled, the MAC entity shall obtain the value of the Type 1 power headroom from the physical layer, and instruct the Multiplexing and Assembly procedure to generate and transmit a PHR MAC control element based on the value reported by the physical layer. And the MAC entity start or restart periodicPHR-Timer, start or restart prohibitPHR-Timer, and cancel all triggered PHR.
- [76] For the uplink transmission, the UE uses the PHR in order to provide the network

with information about the difference between the nominal maximum transmit power and the estimated required transmit power. Thus, PHR indicates how much transmission power can be additionally used from the UE side.

[77] In LTE, the Power Headroom Report (PHR) MAC control element is identified by a MAC PDU subheader with LCID as specified in Table 1. It has a fixed size and consists of a single octet defined as follows (FIG. 7a):

[78] [Table 1]

[79]

Index	LCID values
00000	CCCH
00001-01010	Identity of the logical channel
01011	CCCH
01100	CCCH
01101-10011	Reserved
10100	Recommended bit rate query
10101	SPS confirmation
10110	Truncated Sidelink BSR
10111	Sidelink BSR
11000	Dual Connectivity Power Headroom Report
11001	Extended Power Headroom Report
11010	Power Headroom Report
11011	C-RNTI
11100	Truncated BSR
11101	Short BSR
11110	Long BSR
11111	Padding

[80] 'R' is reserved bit, set to "0";

[81] Power Headroom (PH) field indicates the power headroom level. The length of the field is 6 bits. The reported PH and the corresponding power headroom levels are shown in Table 2;

[82] [Table 2]

[83]

PH	Power Headroom Level
0	POWER_HEADROOM_0
1	POWER_HEADROOM_1
2	POWER_HEADROOM_2
3	POWER_HEADROOM_3
...	...
60	POWER_HEADROOM_60
61	POWER_HEADROOM_61
62	POWER_HEADROOM_62
63	POWER_HEADROOM_63

[84] For extendedPHR, the Extended Power Headroom Report (PHR) MAC control element is identified by a MAC PDU subheader with LCID as specified in Table 1. It

has a variable size and is defined in FIGs. 7b and 7c. When Type 2 PH is reported, the octet containing the Type 2 PH field is included first after the octet indicating the presence of PH per SCell and followed by an octet containing the associated $P_{\text{CMAX},c}$ field (if reported). Then follows an octet with the Type 1 PH field and an octet with the associated $P_{\text{CMAX},c}$ field (if reported), for the PCell. And then follows in ascending order based on the ServCellIndex an octet with the Type x PH field, wherein x is equal to 3 when the ul-Configuration-r14 is configured for this SCell (i.e., Sounding Reference Signal (SRS) is configured on the SCell), x is equal to 1 otherwise, and an octet with the associated $P_{\text{CMAX},c}$ field (if reported), for each SCell indicated in the bitmap.

- [85] When the highest SCellIndex of SCell with configured uplink is less than 8, one octet with C fields is used for indicating the presence of PH per SCell (FIG. 7b), Otherwise, four octets are used (FIG. 7c).
- [86] The UE determines whether PH value for an activated Serving Cell is based on real transmission or a reference format by considering the downlink control information which has been received until and including the PDCCH occasion in which the first UL grant is received since a PHR has been triggered.
- [87] FIG. 7b is an example for Extended PHR MAC Control Elements with the highest SCellIndex of SCell with configured uplink is less than 8, and FIG. 7c is an example for Extended PHR MAC Control Elements with the highest SCellIndex of SCell with configured uplink is equal to or higher than 8.
- [88] The PHR MAC CEs are defined as follows:
- [89] 'Ci field' indicates the presence of a PH field for the SCell with SCellIndex i. The Ci field set to "1" indicates that a PH field for the SCell with SCellIndex i is reported. The Ci field set to "0" indicates that a PH field for the SCell with SCellIndex i is not reported.
- [90] 'V field' indicates if the PH value is based on a real transmission or a reference format. For Type 1 PH, V=0 indicates real transmission on PUSCH and V=1 indicates that a PUSCH reference format is used. For Type 2 PH, V=0 indicates real transmission on PUCCH and V=1 indicates that a PUCCH reference format is used. For Type 3 PH, V=0 indicates real transmission on SRS and V=1 indicates that an SRS reference format is used. Furthermore, for Type 1, Type 2, and Type 3 PH, V=0 indicates the presence of the octet containing the associated $P_{\text{CMAX},c}$ field, and V=1 indicates that the octet containing the associated $P_{\text{CMAX},c}$ field is omitted.
- [91] 'PH field' indicates the power headroom level. The length of the field is 6 bits. The reported PH and the corresponding power headroom levels are shown in Table 2.
- [92] 'P field' indicates whether the MAC entity applies power backoff due to power management. The MAC entity shall set P=1 if the corresponding $P_{\text{CMAX},c}$ field would have had a different value if no power backoff due to power management had been

applied.

- [93] $P_{\text{CMAX},c}$: if present, this field indicates the $P_{\text{CMAX},c}$ or $PP_{\text{CMAX},c}$ used for calculation of the preceding PH field. The reported $P_{\text{CMAX},c}$ and the corresponding nominal UE transmit power levels are shown in Table 3

- [94] [Table 3]

[95]

$P_{\text{CMAX},c}$	Nominal UE transmit power level
0	PCMAX_C_00
1	PCMAX_C_01
2	PCMAX_C_02
...	...
61	PCMAX_C_61
62	PCMAX_C_62
63	PCMAX_C_63

- [96] In NR, the Single Entry PHR MAC CE is identified by a MAC PDU subheader with LCID as specified in Table 4. It has a fixed size and consists of two octet defined as follows (FIG. 7d):

- [97] [Table 4]

[98]

Index	LCID values
000000	CCCH
000001–100000	Identity of the logical channel
100001–110110	Reserved
110111	Configured Grant Confirmation
111000	Multiple Entry PHR
111001	Single Entry PHR
111010	C-RNTI
111011	Short Truncated BSR
111100	Long Truncated BSR
111101	Short BSR
111110	Long BSR
111111	Padding

- [99] 'R' is reserved bit, set to "0";

- [100] Power Headroom (PH) field indicates the power headroom level. The length of the field is 6 bits. The reported PH and the corresponding power headroom levels are shown in Table 5;

- [101] [Table 5]

[102]

PH	Power Headroom Level
0	POWER_HEADROOM_0
1	POWER_HEADROOM_1
2	POWER_HEADROOM_2
3	POWER_HEADROOM_3
...	...
60	POWER_HEADROOM_60
61	POWER_HEADROOM_61
62	POWER_HEADROOM_62
63	POWER_HEADROOM_63

[103] $P_{\text{CMAX},c}$ field indicates the $P_{\text{CMAX},c}$ used for calculation of the preceding PH field. The reported $P_{\text{CMAX},c}$ and the corresponding nominal UE transmit power levels are shown in Table 6.

[104] [Table 6]

[105]

$P_{\text{CMAX},c}$	Nominal UE transmit power level
0	PCMAX_C_00
1	PCMAX_C_01
2	PCMAX_C_02
...	...
61	PCMAX_C_61
62	PCMAX_C_62
63	PCMAX_C_63

[106] The Multiple Entry PHR MAC CE is identified by a MAC PDU subheader with LCID as specified in Table 4. It includes the bitmap, a Type 2 PH field and an octet containing the associated $P_{\text{CMAX},c}$ field (if reported) for the PCell, a Type 2 PH field and an octet containing the associated $P_{\text{CMAX},c}$ field (if reported) for either PSCell or PUCCH SCell, a Type 1 PH field and an octet containing the associated $P_{\text{CMAX},c}$ field (if reported) for the PCell. It further includes, in ascending order based on the Serv-CellIndex , one or multiple of Type 1 PH fields and octets containing the associated $P_{\text{CMAX},c}$ fields (if reported) for SCells indicated in the bitmap.

[107] The presence of Type 2 PH field for PCell is configured by `phr-Type2PCell`, and the presence of Type 2 PH field for either PSCell or for PUCCH SCell is configured by `phr-Type2OtherCell`.

[108] A single octet bitmap is used for indicating the presence of PH per SCell when the highest SCellIndex of SCell with configured uplink is less than 8, otherwise four octets are used.

[109] The UE determines whether PH value for an activated Serving Cell is based on real

transmission or a reference format by considering the downlink control information which has been received until and including the PDCCH occasion in which the first UL grant is received since a PHR has been triggered.

- [110] FIG. 7e is an example for Multiple Entry PHR MAC CE with the highest SCellIndex of SCell with configured uplink is less than 8, and FIG. 7f is an example for Multiple Entry PHR MAC CE with the highest SCellIndex of SCell with configured uplink is equal to or higher than 8.
- [111] The PHR MAC CEs are defined as follows:
- [112] 'Ci field' indicates the presence of a PH field for the SCell with SCellIndex i. The Ci field set to "1" indicates that a PH field for the SCell with SCellIndex i is reported. The Ci field set to "0" indicates that a PH field for the SCell with SCellIndex i is not reported.
- [113] 'V field' indicates if the PH value is based on a real transmission or a reference format. For Type 1 PH, V=0 indicates real transmission on PUSCH and V=1 indicates that a PUSCH reference format is used. For Type 2 PH, V=0 indicates real transmission on PUCCH and V=1 indicates that a PUCCH reference format is used. For Type 3 PH, V=0 indicates real transmission on SRS and V=1 indicates that an SRS reference format is used. Furthermore, for Type 1, Type 2, and Type 3 PH, V=0 indicates the presence of the octet containing the associated $P_{\text{CMAX},c}$ field, and V=1 indicates that the octet containing the associated $P_{\text{CMAX},c}$ field is omitted.
- [114] 'PH field' indicates the power headroom level. The length of the field is 6 bits. The reported PH and the corresponding power headroom levels are shown in Table 2 (the corresponding measured values in dB for the NR Serving Cell are specified in TS 38.133 while the corresponding measured values in dB for the LTE Serving Cell are specified in TS 36.133).
- [115] 'P field' indicates whether the MAC entity applies power backoff due to power management. The MAC entity shall set P=1 if the corresponding $P_{\text{CMAX},c}$ field would have had a different value if no power backoff due to power management had been applied.
- [116] $P_{\text{CMAX},c}$: if present, this field indicates the $P_{\text{CMAX},c}$ or $PP_{\text{CMAX},c}$ used for calculation of the preceding PH field. The reported $P_{\text{CMAX},c}$ and the corresponding nominal UE transmit power levels are shown in Table 6 (the corresponding measured values in dB for the NR Serving Cell are specified in TS 38.133 while the corresponding measured values in dB for the LTE Serving Cell are specified in TS 36.133).
- [117] FIG. 8 is an example for Bandwidth part configuration and activation/deactivation.
- [118] According to the NR, the maximum channel bandwidth of NR is 400MHz per carrier. Operating the wider bandwidth on a single carrier is more efficient than aggregating contiguous intra-band CCs with smaller bandwidth. In order to provide the

carrier with maximum bandwidth for UEs with different RF chain capabilities, RAN1 agreed to support the aggregation of multiple sub-bands with smaller bandwidth. In this wider bandwidth (WB) operation, it assumes that one or multiple bandwidth part (BWP) configurations for each CC can be semi-statically signaled to a UE and each bandwidth part is associated with a specific numerology.

- [119] FIG. 8 shows the example for BWP configurations and activation/deactivation to UEs. As illustrated in FIG. 8, 400MHz carrier bandwidth could be supported by aggregating four sub-bands of 100MHz channel bandwidth and one or multiple bandwidth parts with different numerology can be configured to a UE. The configured BWP(s) of a UE can be activated or deactivated by gNB. Currently, RAN1 is discussing how to activate/deactivate the BWPs for a UE and it is considering using Downlink Control Information (DCI) for dynamic and fast BWP activation/deactivation in addition to RRC signalling and MAC CE.
- [120] According to the current RAN1 agreement, the UE expects at least one DL BWP and one UL BWP being active among the set of configured BWPs for a given time instant. In addition, for a single carrier wider bandwidth (WB) UE, multiple active BWPs with different numerologies can be configured for a UE simultaneously.
- [121] In this WB operation, the gNB may require PH information per BWP in order to decide a suitable UL resource of a UE. NR PHR will be designed based on the legacy principles taking into account the new features, i.e., BWP aggregation, multiple beams, numerology, etc. However, the current PHR scheme does not support this WB operation.
- [122] FIG. 9 is a conceptual diagram for transmitting a power headroom reporting in wireless communication system according to embodiments of the present invention.
- [123] In LTE CA, the power headroom is contained in PHR MAC CE per activated cell because the power allocation may be different per cell. With wider bandwidth operation, since each BWP is associated with a different numerology, the gNB may need to know PH information per BWP to allocate suitable resources for a UE. Therefore, it may be desirable to report PH per BWP. Further, if NR supports to activate or deactivate one or more BWP(s) for a single CC, we think that it may be necessary to trigger PHR for BWP activation because activating additional BWP would impact the power allocation of the UE.
- [124] When the UE is configured with one or more BWPs per serving cell, the UE triggers a Power Headroom reporting (PHR) when BWP is (re) configuration, activation, switching or deactivation (S901).
- [125] First, the UE can be a PHR when BWP(s) is (re)configured.
- [126] In WB operation, the gNB can configure one or more BWP(s) for a CC of UE. This means that one or more BWP(s) could be allocated/(re)configured to a UE while/after

gNB activates CC with WB, but before activating the specific DL/UL BWP. After BWP configuration, the gNB can activate or deactivate a specific BWP for a UE.

- [127] So, our invention proposes to trigger the PHR when BWP(s) of a UE is configured by gNB. If the BWP activation/deactivation is indicated by means of Downlink Control Information (DCI), i.e., dynamic BWP activation/deactivation, the PHR may be very frequently triggered since the prohibit timer would be independently performed with the PHR trigger event for BWP activation. So, in case of dynamic BWP activation/deactivation, it would be preferable that BWP configuration is used for PHR trigger event. If a BWP is configured at the same time as the serving cell activation, it would be preferable that the PHR is triggered when BWP is reconfigured.
- [128] Secondly, the UE can be a PHR when a (Secondary) BWP(s) is activated or deactivated. In WB operation, the gNB can activate or deactivate one or more BWP(s) for a UE. This means that a UE can transmit/receive data on the BWP(s) activated by any indication. So, our invention proposes to trigger the PHR when BWP(s) of a UE is newly activated or deactivated by the gNB. If a primary BWP is activated at the same time as the serving cell activation, it would be preferable that the PHR is triggered when a secondary BWP is activated.
- [129] Lastly, the UE can be a PHR when BWP is switched. In WB operation, the gNB can activate a single BWP for a UE at a given time instant. This means that a UE can transmit/receive data on a single BWP and gNB may indicate to switch from one BWP to another BWP (or to activate a new BWP) if it needs to activate another BWP.
- [130] The purpose of the BWP switching command is to change an active BWP used in a particular cell. That is, the BWP switching command is for switching active BWP.
- [131] Currently, the UE is configured with four BWPs per cell, and only one of them will be in active state. When a BWP switching command is received via DCI, the UE deactivates the active BWP and activates the new BWP autonomously (i.e, there is no BWP deactivation command). Our invention proposes to trigger the PHR when a BWP of UE is switched to another BWP by gNB.
- [132] When the PHR is triggered, the UE generates a Power Headroom Reporting (PHR) Medium Access Control (MAC) Control Element (CE) including PH information per Bandwidth Part (BWP) within a serving cell (S903). And the UE transmits the PHR MAC CE to a network (S905).
- [133] With wider bandwidth operation in NR, RAN2 needs to discuss whether the PH is reported only for the activated BWP(s) or for all configured BWPs. In general, PH reporting only for the activated BWP(s) would be sufficient because only the activated BWP is used for scheduling. However, if BWP is dynamically activated/deactivated via DCI and the PHR is not triggered due to prohibition, the gNB may also want to know the PH information for the deactivated BWPs.

- [134] For a single carrier wider bandwidth UE, there may be two cases where a single BWP is activated for a UE at a given time (Case 1) or multiple BWPs are activated simultaneously (Case 2).
- [135] In Case 1, if PHR contains PH information only for the single active BWP of a cell, the PHR MAC CE doesn't need to include the BWP indication for which PH is reported and the PH and $P_{\text{CMAX},c}$ may be derived from the BWP specific values according to the RAN1 decision. However, if the gNB wants to know the PH information for all configured BWPs including the deactivated BWP even in Case 1 or if multiple BWPs can be activated simultaneously (Case 2), the PHR MAC CE may need to include PH information of multiple BWPs for one cell. To transmit the PH information of multiple BWPs, RAN2 may need to discuss how to indicate PH information per BWP of the cell.
- [136] For BWP operation, this invention proposes to define new several PHR MAC CE formats which a UE can transmit a PH information per BWP within a serving cell.
- [137] FIGs. 10 and 11 are examples for a PHR MAC CE for BWP operation (format A) according to embodiments of the present invention.
- [138] This format A proposes to newly define a BWP bitmap per serving cell to indicate whether PH for the BWP is present or not. The BWP bitmap for a specific C_i is present if the C_i field is set to 1. That is the BWP bitmap is present when the serving cell is activated
- [139] The BWP bitmap for primary cell (PCell) may be always located after an octet containing C_i fields (C_i bitmap) or an indication bit (C_0) for PCell may be defined to indicate whether BWP bitmap of PCell is present or not.
- [140] In here, we assume that the maximum number of configured BWP(s) is set to j and the length of BWP bitmap is defined to j (or $j-1$) bits, where j is an integer value greater than zero.
- [141] Each of the one or more fields corresponds to a respective BWP with a BWP index j , and B_j field indicates presence of a PH field for the respective BWP identified by j . If the indication bit for BWP index (B_j) is set to 1, information of PH (i.e., type x) and maximum power for the BWP is in the PHR MAC CE to be transmitted by UE.
- [142] If the C_i field is set to 1, in descending (or ascending) order of the C_i set to 1, a set of BWP bitmap follows after the C_i bitmap as shown in the FIG. 10.
- [143] Alternatively, if the C_i field is set to 1, a BWP bitmap for the serving cell follows before the first PH information (e.g., PH and $P_{\text{CMAX},c}$) of the serving cell as shown in the FIG.11.
- [144] In addition, if the C_i field is set to 1, a BWP bitmap for the serving cell can follow right after each C_i field. The BWP bitmap can be located in a variety of ways not described here.

- [145] In here, the indication bit (B_0) for the primary BWP of each cell can be omitted since the primary BWP may be always present if the serving cell is present. The PH information for each BWP can be composed of PH and $P_{\text{CMAX},c}$ for Type 1 or 2.
- [146] Format A benefits that the processing can be performed more efficiently at the receiving end, since the proposed PHR MAC CE includes an octet containing the BWP bitmap is included first after an octet containing the C_i bitmap and followed by an octet containing PH information. Further, Format A reports all of the active BWP PHs for the active cell, so it is advantageous for the base station to know the PH of each BWP accurately.
- [147] FIGs. 12 is an example for a PHR MAC CE for BWP operation (format B) according to embodiments of the present invention.
- [148] This format B proposes that a UE transmits the configured/fixed number of PH information for each serving cell. The PH information may consist of the P, V, PH for type x and P, R, $P_{\text{CMAX},c}$ field.
- [149] Since every serving cell may not consist of more than one BWP, in order to reduce the signaling overhead, we also propose to define the BWP bitmap (B_i) to indicate whether additional PHs for the serving cell (C_i) are present or not.
- [150] That is, when the number of PH that can be reported for a certain serving cell is fixed to a specific value, the BWP bitmap is always located after the octet containing C_i fields (C_i bitmap) and a length of the BWP bitmap is equal to a number of configured serving cells, e.g., based on LTE, the length of B_i bitmap can be 8 or 32.
- [151] If the C_i bit for the serving cell is set to 1, the gNB should check whether the corresponding B_i bit is set to 1 or 0. Based on LTE, the gNB would always check the indication bit (B_0) for the primary cell. If the corresponding B_i bit is also set to 1, the fixed number of PH information are contained in the PH section for the serving cell as described in FIG. 12.
- [152] From a UE perspective, if a UE needs to inform at least two PHs for a certain serving cell, the UE should set the C_i and B_i bit corresponding to the serving cell and sequentially contain PH information for the configured BWPs for the serving cell. Here, the value of j may follow the number of configured/activated bandwidth parts for the serving cell. Also, this scheme is preferably applied when multiple PHs that can be reported for a particular serving cell is fixed to a certain number.
- [153] The Format B is useful when the number of multiple PHs that can be reported for a serving cell is fixed, because the PHR MAC CE contains one octet containing the B_i field, thereby reducing signal overhead.
- [154] FIG. 13 is an example for a PHR MAC CE for BWP operation (format C) according to embodiments of the present invention.
- [155] The format C proposes to newly define BWP index field in the PHR MAC CE.

- [156] If the gNB needs to know whether the additional PH information for secondary BWP is present or not, it also proposes to define a PH extension field in the PHR MAC CE. The PH extension field indicates whether additional PH related information is present or not. It will be 1-bit length. If the PH extension is set to 1, BWP index and corresponding PH information (e.g., PH for type x and maximum power for the BWP) are transmitted by UE. In here, we assume that the length of BWP index can be defined to j bits according to the maximum number of configured BWP, where j is an integer value greater than zero.
- [157] The PH extension field can be defined using the reserved bit before each $P_{\text{CMAX},c}$ as shown in the FIG. 13. If the extension field is set to 1, the BWP index and corresponding PH information is included after the $P_{\text{CMAX},c}$ for the type1. Or the extension field can be defined only before the last $P_{\text{CMAX},c}$ of each BWP.
- [158] The PH extension and BWP index can be located in a variety of ways not described here.
- [159] Format C is advantageous in a case that the UE is configured with many BWPs per cell (e.g., a 4-bit or 8-bit bitmap or longer BWP bitmap field is needed). That is, there is an advantage in view of transmission overhead.
- [160] The PHR triggered by the new triggering events described above may use the new PHR MAC CE proposed in formats A to C of the present inventions.
- [161] The embodiments of the present invention described hereinbelow are combinations of elements and features of the present invention. The elements or features may be considered selective unless otherwise mentioned. Each element or feature may be practiced without being combined with other elements or features. Further, an embodiment of the present invention may be constructed by combining parts of the elements and/or features. Operation orders described in embodiments of the present invention may be rearranged. Some constructions of any one embodiment may be included in another embodiment and may be replaced with corresponding constructions of another embodiment. It is obvious to those skilled in the art that claims that are not explicitly cited in each other in the appended claims may be presented in combination as an embodiment of the present invention or included as a new claim by subsequent amendment after the application is filed.
- [162] In the embodiments of the present invention, a specific operation described as performed by the BS may be performed by an upper node of the BS. Namely, it is apparent that, in a network comprised of a plurality of network nodes including a BS, various operations performed for communication with an MS may be performed by the BS, or network nodes other than the BS. The term 'eNB' may be replaced with the term 'fixed station', 'Node B', 'Base Station (BS)', 'access point', etc.
- [163] The above-described embodiments may be implemented by various means, for

example, by hardware, firmware, software, or a combination thereof.

[164] In a hardware configuration, the method according to the embodiments of the present invention may be implemented by one or more Application Specific Integrated Circuits (ASICs), Digital Signal Processors (DSPs), Digital Signal Processing Devices (DSPDs), Programmable Logic Devices (PLDs), Field Programmable Gate Arrays (FPGAs), processors, controllers, microcontrollers, or microprocessors.

[165] In a firmware or software configuration, the method according to the embodiments of the present invention may be implemented in the form of modules, procedures, functions, etc. performing the above-described functions or operations. Software code may be stored in a memory unit and executed by a processor. The memory unit may be located at the interior or exterior of the processor and may transmit and receive data to and from the processor via various known means.

[166] Those skilled in the art will appreciate that the present invention may be carried out in other specific ways than those set forth herein without departing from essential characteristics of the present invention. The above embodiments are therefore to be construed in all aspects as illustrative and not restrictive. The scope of the invention should be determined by the appended claims, not by the above description, and all changes coming within the meaning of the appended claims are intended to be embraced therein.

Industrial Applicability

[167] While the above-described method has been described centering on an example applied to the 3GPP LTE and NR system, the present invention is applicable to a variety of wireless communication systems in addition to the 3GPP LTE and NRsystem.

Claims

- [Claim 1] A method for a User Equipment (UE) operating in a wireless communication system, the method comprising:
generating a Power Headroom Reporting (PHR) Medium Access Control (MAC) Control Element (CE) including Power Headroom (PH) information per Bandwidth Part (BWP) within a serving cell, in a state that the UE is configured with one or more BWPs per serving cell; and
transmitting the PHR MAC CE,
wherein the PHR MAC CE includes a BWP bitmap indicating presence of the PH information per BWP within the serving cell,
wherein the BWP bitmap is present when the serving cell is activated.
- [Claim 2] The method according to claim 1, wherein when the serving cell with a serving cell index i is activated, a value of a C_i field is set to 1.
- [Claim 3] The method according to claim 1, wherein the BWP bitmap includes one or more fields, each of the one or more fields corresponding to a respective BWP with a index j , and indicating presence of a PH field for the respective BWP identified by the index j .
- [Claim 4] The method according to claim 1, wherein an octet containing the BWP bitmap is included first after an octet indicating presence of PH per SCell and followed by an octet containing PH information in the PHR MAC CE.
- [Claim 5] The method according to claim 1, further comprising:
triggering a PHR for generating the PHR MAC CE when one of followings:
a BWP is newly configured, or a configured BWP is activated or deactivated, or an activated BWP is switched.
- [Claim 6] A User Equipment (UE) for operating in a wireless communication system, the UE comprising:
a Radio Frequency (RF) module; and
a processor operably coupled with the RF module and configured to:
calculate multiple Power Headroom (PH) values per an active cell,
generate a Power Headroom Reporting (PHR) Medium Access Control (MAC) Control Element (CE) including Power Headroom (PH) information per Bandwidth Part (BWP) within a serving cell, in a state that the UE is configured with one or more BWPs per serving cell, and
transmit the PHR MAC CE,

wherein the PHR MAC CE includes a BWP bitmap indicating presence of the PH information per BWP within the serving cell,
wherein the BWP bitmap is present when the serving cell is activated.

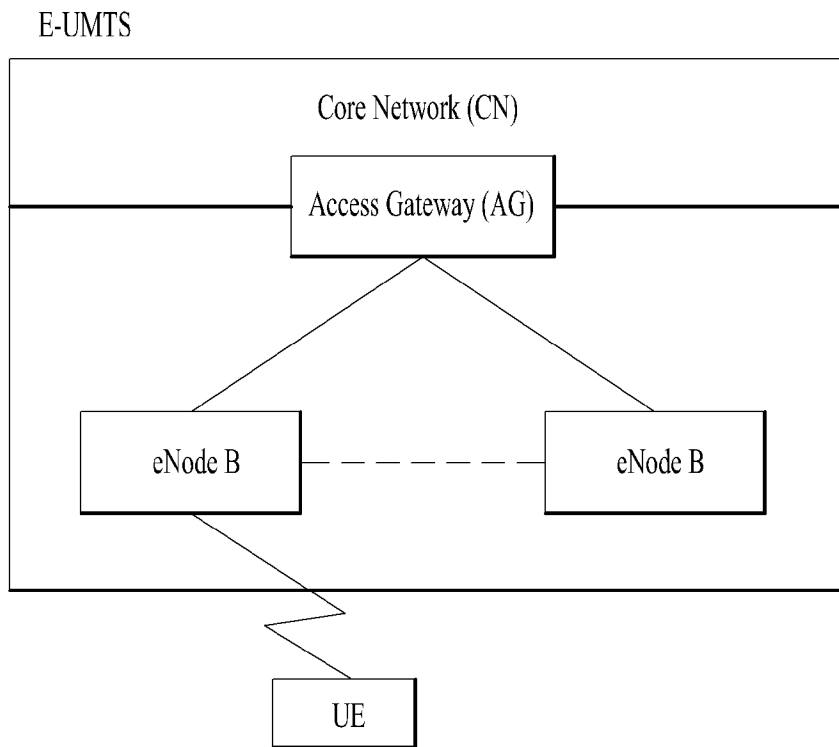
[Claim 7] The UE according to claim 6, wherein when the serving cell with a serving cell index i is activated, a value of a C_i field is set to 1.

[Claim 8] The UE according to claim 6, wherein the BWP bitmap includes one or more fields, each of the one or more fields corresponding to a respective BWP with a index j , and indicating presence of a PH field for the respective BWP identified by the index j .

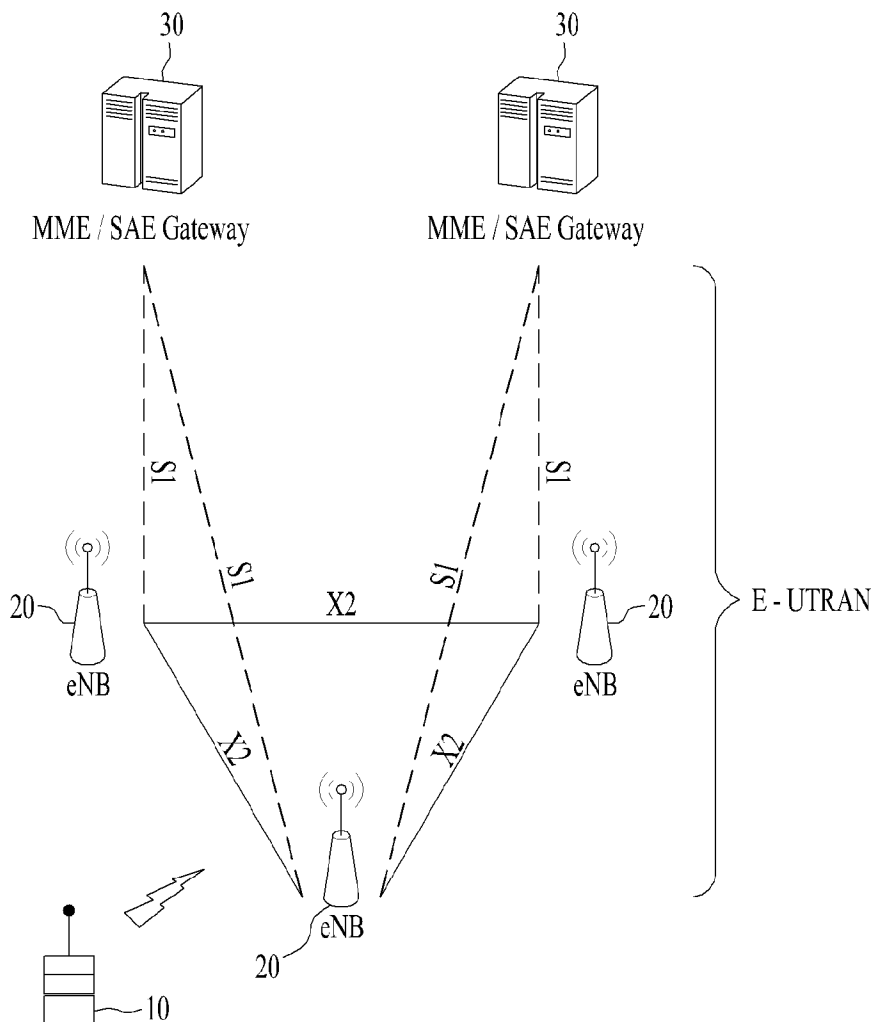
[Claim 9] The UE according to claim 6, wherein an octet containing the BWP bitmap is included first after an octet indicating presence of PH per SCell and followed by an octet containing PH information in the PHR MAC CE.

[Claim 10] The UE according to claim 6, wherein the processor is further configured to:
trigger a PHR for generating the PHR MAC CE when one of followings:
a BWP is newly configured, or a configured BWP is activated or deactivated, or an activated BWP is switched.

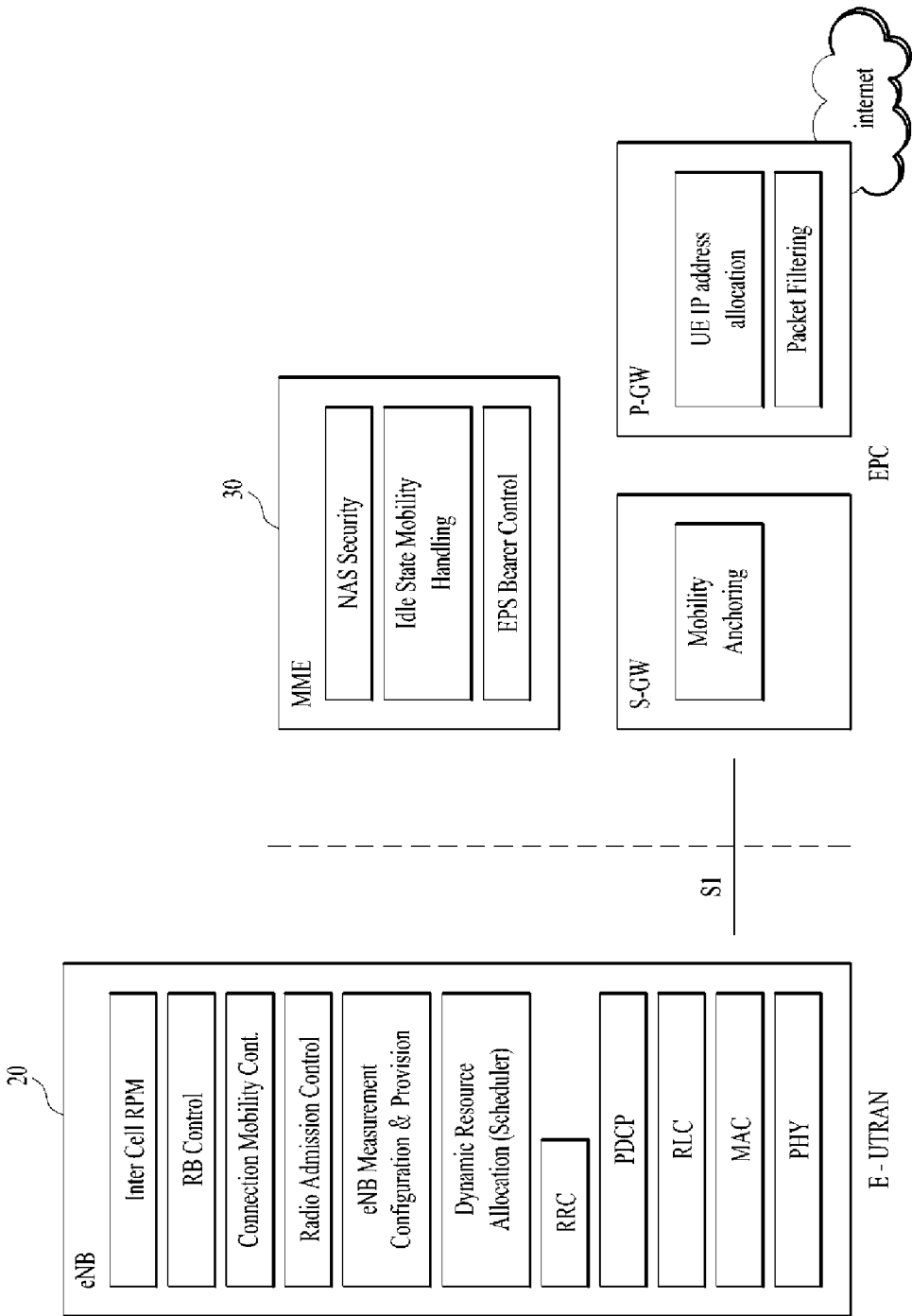
[Fig. 1]



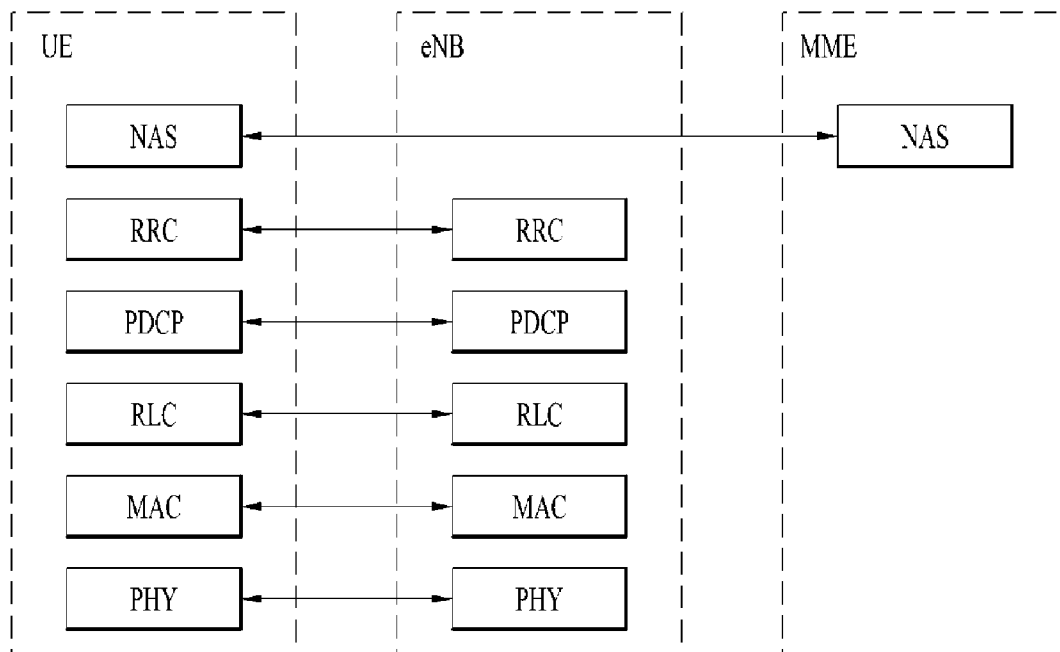
[Fig. 2a]



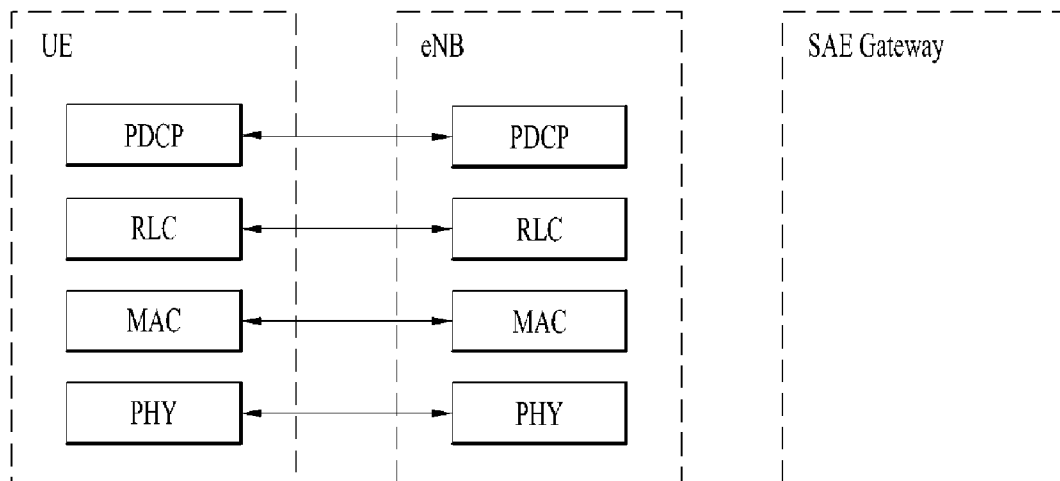
[Fig. 2b]



[Fig. 3]

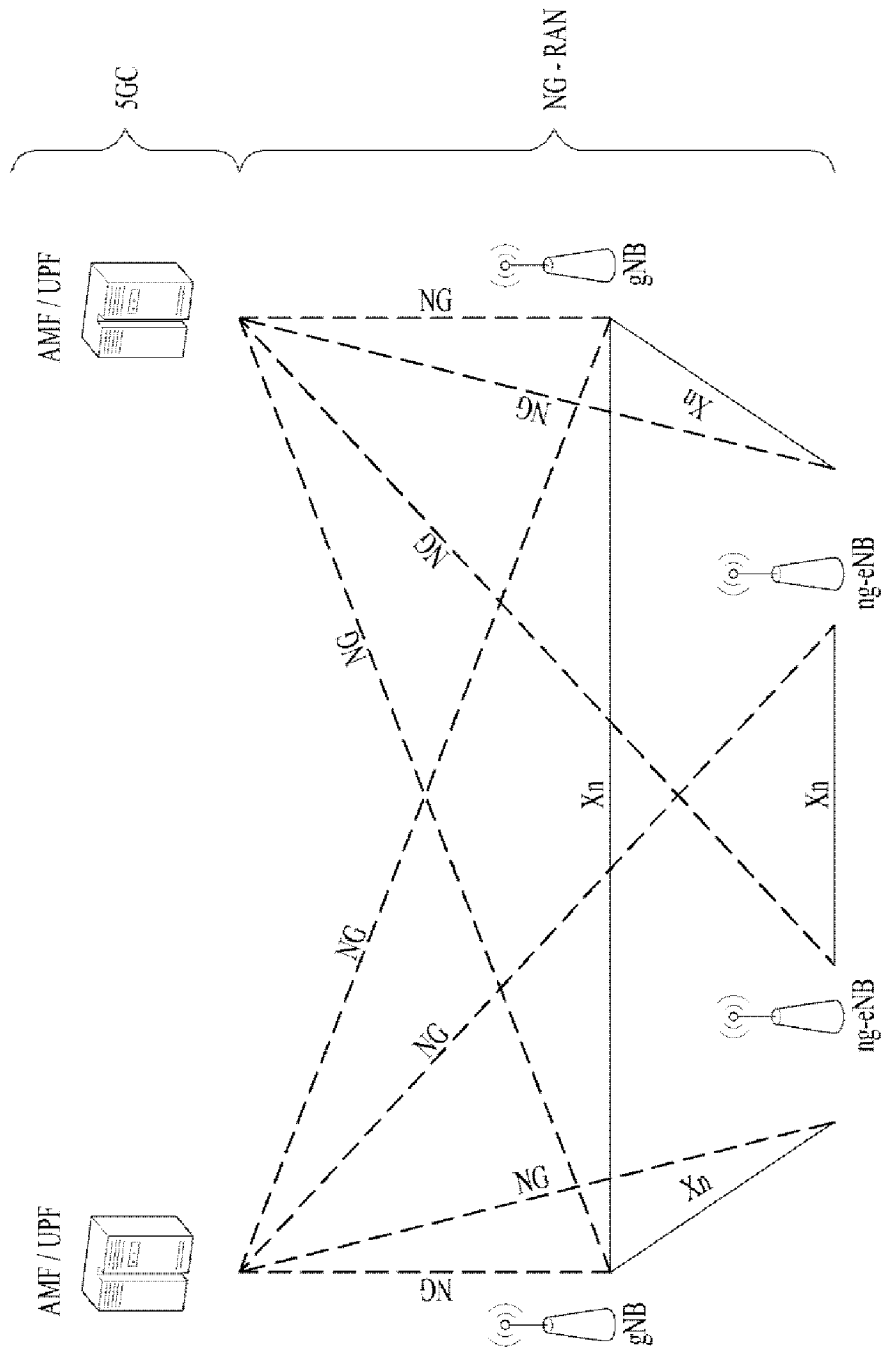


(a) Control-Plane Protocol Stack

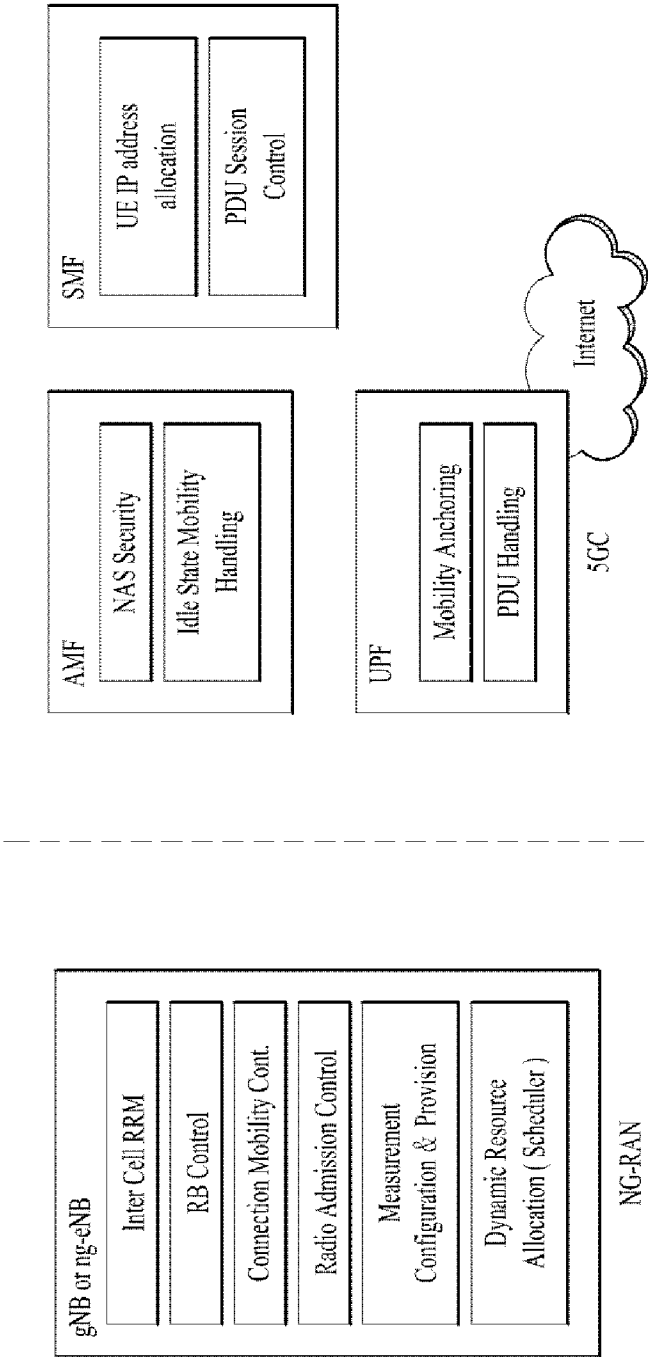


(b) User-Plane Protocol Stack

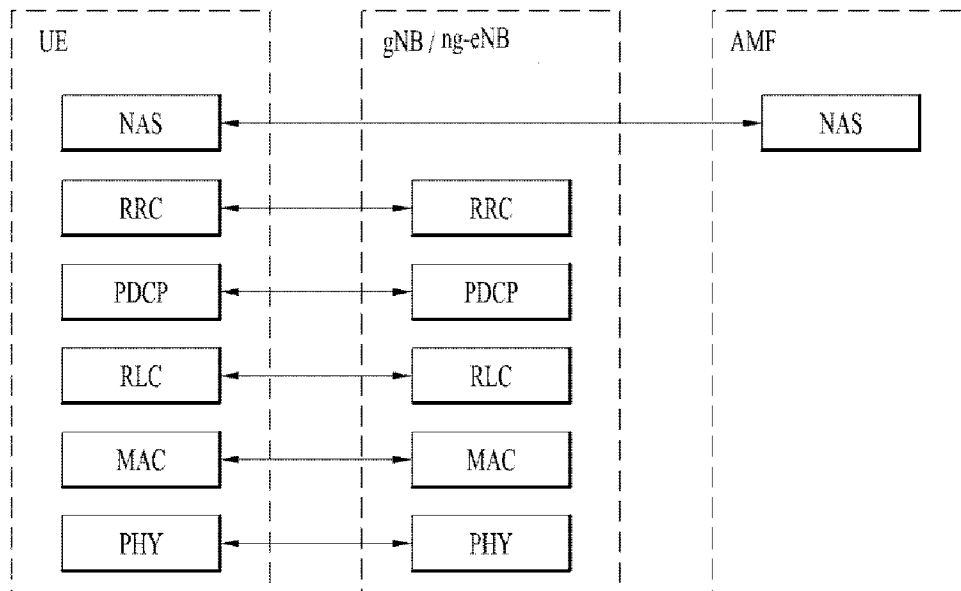
[Fig. 4a]



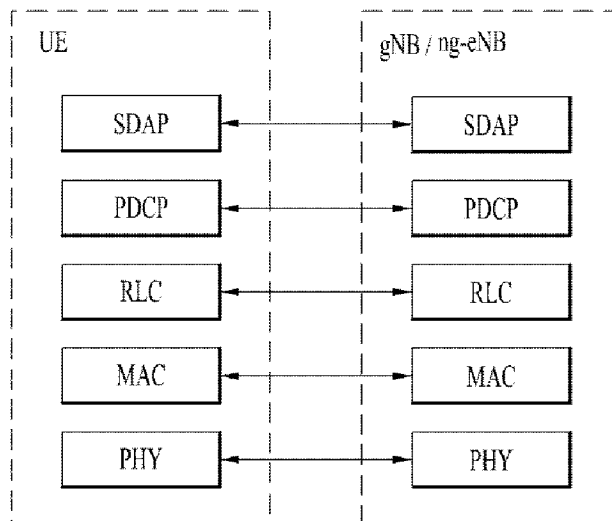
[Fig. 4b]



[Fig. 5]

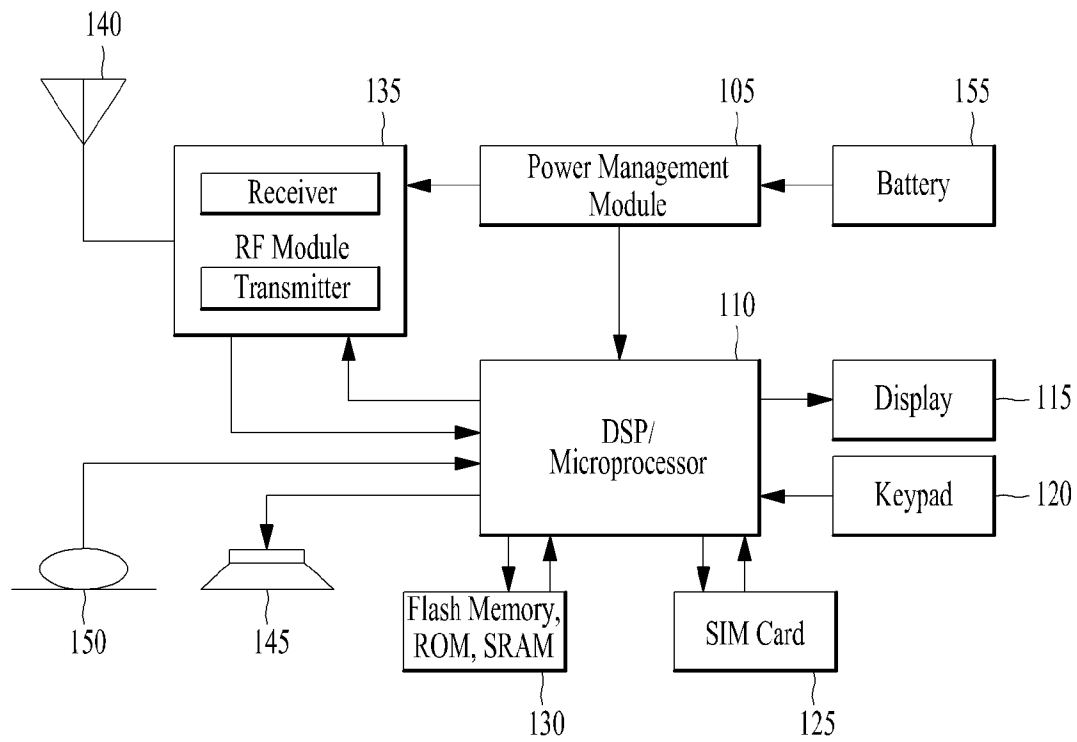


(a) Control-Plane Protocol Stack

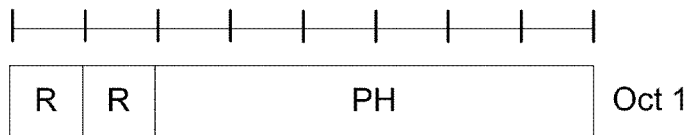


(b) User-Plane Protocol Stack

[Fig. 6]



[Fig. 7a]



[Fig. 7b]

C ₇	C ₆	C ₅	C ₄	C ₃	C ₂	C ₁	R
P	V	PH (Type 2, PCell)					
R	R	P _{CMAX,c} 1					
P	V	PH (Type 1, PCell)					
R	R	P _{CMAX,c} 2					
P	V	PH (Type x, SCell 1)					
R	R	P _{CMAX,c} 3					
...							
P	V	PH (Type x, SCell n)					
R	R	P _{CMAX,c} m					

[Fig. 7c]

C ₇	C ₆	C ₅	C ₄	C ₃	C ₂	C ₁	R
C ₁₅	C ₁₄	C ₁₃	C ₁₂	C ₁₁	C ₁₀	C ₉	C ₈
C ₂₃	C ₂₂	C ₂₁	C ₂₀	C ₁₉	C ₁₈	C ₁₇	C ₁₆
C ₃₁	C ₃₀	C ₂₉	C ₂₈	C ₂₇	C ₂₆	C ₂₅	C ₂₄
P	V	PH (Type 2, PCell)					
R	R	P _{CMAX,c} 1					
P	V	PH (Type 1, PCell)					
R	R	P _{CMAX,c} 2					
P	V	PH (Type x, SCell 1)					
R	R	P _{CMAX,c} 3					
...							
P	V	PH (Type x, SCell n)					
R	R	P _{CMAX,c} m					

[Fig. 7d]

R	R	PH (Type X, PCell)
R	R	$P_{\text{CMAX},c}$

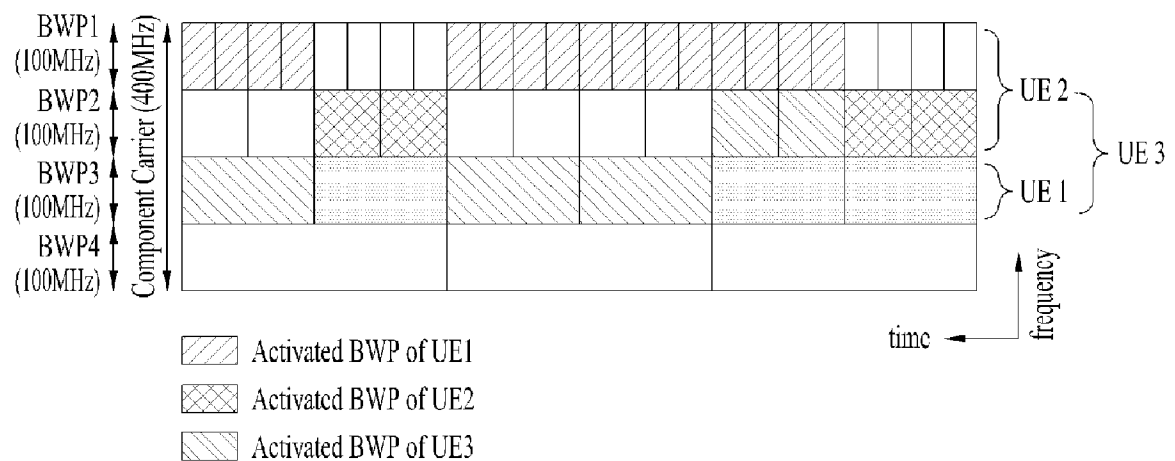
[Fig. 7e]

C ₇	C ₆	C ₅	C ₄	C ₃	C ₂	C ₁	R
P	V	PH (Type 2, PCell)					
R	R	P _{C_{MAX,c} 1}					
P	V	PH (Type 2, PSCell or PUCCH SCell)					
R	R	P _{C_{MAX,c} 2}					
P	V	PH (Type X, PCell)					
R	R	P _{C_{MAX,c} 3}					
P	V	PH (Type X, SCell 1)					
R	R	P _{C_{MAX,c} 4}					
...							
P	V	PH (Type X, SCell n)					
R	R	P _{C_{MAX,c} m}					

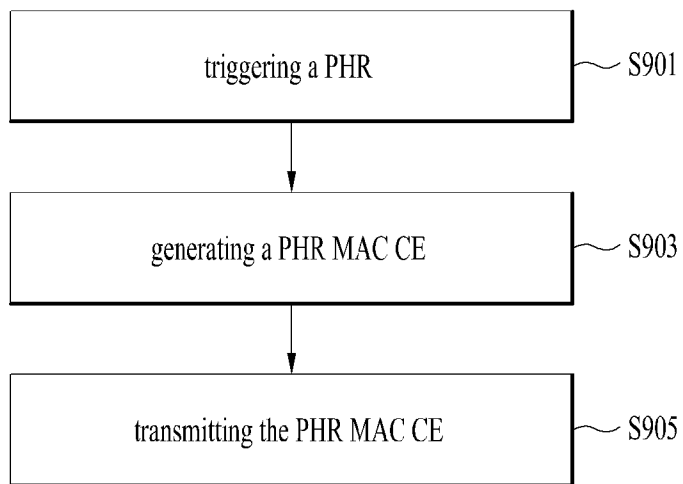
[Fig. 7f]

C ₇	C ₆	C ₅	C ₄	C ₃	C ₂	C ₁	R
C ₁₅	C ₁₄	C ₁₃	C ₁₂	C ₁₁	C ₁₀	C ₉	C ₈
C ₂₃	C ₂₂	C ₂₁	C ₂₀	C ₁₉	C ₁₈	C ₁₇	C ₁₆
C ₃₁	C ₃₀	C ₂₉	C ₂₈	C ₂₇	C ₂₆	C ₂₅	C ₂₄
P	V	PH (Type 2, PCell)					
R	R	P _{CMAX,c} 1					
P	V	PH (Type 2, PSCell or PUCCH SCell)					
R	R	P _{CMAX,c} 2					
P	V	PH (Type X, PCell)					
R	R	P _{CMAX,c} 3					
P	V	PH (Type X, SCell 1)					
R	R	P _{CMAX,c} 4					
...							
P	V	PH (Type X, SCell n)					
R	R	P _{CMAX,c} m					

[Fig. 8]



[Fig. 9]



C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0	BWP bitmap for Primary cell	BWP bitmap for C ₃
B_{j-1}	B_{j-2}	...	...	B_1	B_0				
B_{j-1}	B_{j-2}	...	...	B_1	B_0				
P	V	PH (Type 2, Pcell, P _{BWP})	P _{CMAX,c 1}				PH information for Primary BWP of PCell		
P	R								
P	V	PH (Type 1, Pcell, P _{BWP})	P _{CMAX,c 2}				PH information for a BWP(B _{j-1}) which is set to 1		
P	R								
P	V	PH (Type 2, Pcell, S _{BWP 1})	P _{CMAX,c 3}				PH information for a BWP(B ₁) which is set to 1		
P	R								
P	V	PH (Type 1, Pcell, S _{BWP 1})	P _{CMAX,c 4}				PH information for a BWP(B ₂) which is set to 1		
P	R								
P	V	PH (Type x, Scell 3, P _{BWP})	P _{CMAX,c 5}						
P	R								
P	V	PH (Type x, Scell 3, S _{BWP 2})	P _{CMAX,c 6}						
P	R								

(a) Generic format

(b) Example format of j = 4

C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0	BWP bitmap for Primary cell
B_3	B_2	B_1	B_0	R	R	R	R	
P	V	PH (Type 2, Pcell, P_{BWP})						
P	R	$P_{CMAX,c 1}$						
P	V	PH (Type 1, Pcell, P_{BWP})						
P	R	$P_{CMAX,c 2}$						
P	V	PH (Type 2, Pcell, $S_{BWP 2}$)						
P	R	$P_{CMAX,c 3}$						
P	V	PH (Type 1, Pcell, $S_{BWP 2}$)						
P	R	$P_{CMAX,c 4}$						
B_3	B_2	B_1	B_0	R	R	R	R	BWP bitmap for C_4
P	V	PH (Type x, Scell 1, P_{BWP})						
P	R	$P_{CMAX,c 5}$						
P	V	PH (Type x, Scell n, $S_{BWP 1}$)						
P	R	$P_{CMAX,c 6}$						

C_7	C_6	C_5	C_4	C_3	C_2	C_1	R
B_{j-1}	B_{j-2}	...				B_1	B_0
P	V	PH (Type 2, Peell, P_{BWP})					
P	R	$P_{CMAX,c,1}$					
P	V	PH (Type 1, Peell, P_{BWP})					
P	R	$P_{CMAX,c,2}$					
P	V	PH (Type 2, Peell, $S_{BWP,1}$)					
P	R	$P_{CMAX,c,3}$					
P	V	PH (Type 1, Peell, $S_{BWP,1}$)					
P	R	$P_{CMAX,c,4}$					
B_{j-1}	B_{j-2}	...				B_1	B_0
P	V	PH (Type x, Seell n, P_{BWP})					
P	R	$P_{CMAX,c,5}$					
...							
P	V	PH (Type x, Seell n, P_{BWP})					
P	R	$P_{CMAX,c,m}$					

(a) Generic format

B₇	B₆	C₅	C₄	C₃	C₂	C₁	R
B ₇	B ₆	B ₅	B ₄	B ₃	B ₂	B ₁	B₀
P	V	PH (Type 2, Peell, BWP ₀)					
P	R	P _{C_{MAX}, c 1}					
P	V	PH (Type 1, Peell, BWP ₀)					
P	R	P _{C_{MAX}, c 2}					
P	V	PH (Type x, Seell 2, BWP ₀)					
P	R	P _{C_{MAX}, c 3}					
P	V	PH (Type x, Seell 3, BWP ₀)					
P	R	P _{C_{MAX}, c 4}					
P	V	PH (Type x, Seell 3, BWP ₀)					
P	R	P _{C_{MAX}, c 5}					
P	V	PH (Type x, Seell 5, BWP ₀)					
P	R	P _{C_{MAX}, c 6}					

(b) Example format of $i = 7$ and $j = 2$

(b) Example format of $i = 7$ and $j = 2$

																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														</
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	----

(a) Generic format of $j = 7$

[Fig. 13]

C ₇	C ₆	C ₅	C ₄	C ₃	C ₂	C ₁	R
P	V	PH (Type 2, P _{cell} , P _{BWP})					
P	R	P _{CMAX,c 1}					
P	V	PH (Type 1, P _{cell} , P _{BWP})					
P	E	P _{CMAX,c 2}					
BWP index (y)							
P	V	PH (Type 2, P _{cell} , S _{BWP y})					
P	R	P _{CMAX,c 3}					
P	V	PH (Type 1, P _{cell} , S _{BWP y})					
P	E	P _{CMAX,c 4}					
P	V	PH (Type x, Scell 1, P _{BWP})					
P	E	P _{CMAX,c 5}					
BWP index (y)							
P	V	PH (Type x, Scell 1, S _{BWP y})					
P	E	P _{CMAX,c 6}					
...							
P	V	PH (Type x, Scell n, P _{BWP})					
P	E	P _{CMAX,c m}					

PH information
for Primary BWP of PCell

Activated / Configured
Secondary BWP index

PH information
for BWP_y

PH information for Primary
BWP of C_j which is set to 1

Activated / Configured
Secondary BWP index

PH information for BWP_y

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2018/007952**A. CLASSIFICATION OF SUBJECT MATTER****H04W 52/36(2009.01)i, H04W 52/42(2009.01)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)

H04W 52/36; H04W 52/32; H04W 74/00; H04W 76/04; H04W 52/42

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: PHR(Power Headroom Report), PHR MAC CE, BWP(Bandwidth Part)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2016-0150485 A1 (LG ELECTRONICS INC.) 26 May 2016 See paragraph [0017]; and claim 1.	1-10
A	US 2016-0309504 A1 (OFINNO TECHNOLOGIES, LLC) 20 October 2016 See paragraphs [0171]-[0220]; and figures 17A-23.	1-10
A	US 2016-0242128 A1 (PANASONIC INTELLECTUAL PROPERTY CORPORATION OF AMERICA) 18 August 2016 See claims 1-9; and figure 9.	1-10
A	SAMSUNG, `PHR triggering events for NR`, R2-1704481, 3GPP TSG-RAN WG2 Meeting #98, Hangzhou, China, 04 May 2017 See section 2.	1-10
A	SAMSUNG, `PHR reporting for two-step scheduling`, R1-1608981, 3GPP TSG RAN WG1 Meeting #86b, Lisbon, Portugal, 14 October 2016 See sections 2.1-2.2.	1-10



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

17 October 2018 (17.10.2018)

Date of mailing of the international search report

17 October 2018 (17.10.2018)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea

Facsimile No. +82-42-481-8578

Authorized officer

LEE, Seoung Young

Telephone No. +82-42-481-3535



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2018/007952

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2016-0150485 A1	26/05/2016	CN 105393610 A	09/03/2016
		CN 105830507 A	03/08/2016
		EP 3085169 A1	26/10/2016
		EP 3085170 A1	26/10/2016
		JP 06259083 B2	10/01/2018
		JP 2016-527816 A	08/09/2016
		KR 10-2016-0100818 A	24/08/2016
		RU 2633524 C1	13/10/2017
		US 2016-0309425 A1	20/10/2016
		US 9992755 B2	05/06/2018
		WO 2015-093746 A1	25/06/2015
		WO 2015-093747 A1	25/06/2015
US 2016-0309504 A1	20/10/2016	CN 107637001 A	26/01/2018
		EP 3143717 A1	22/03/2017
		EP 3143717 B1	13/09/2017
		EP 3261283 A1	27/12/2017
		JP 2018-514113 A	31/05/2018
		JP 6319862 B1	09/05/2018
		KR 10-2017-0127022 A	20/11/2017
		US 2017-0353973 A1	07/12/2017
		WO 2016-168342 A1	20/10/2016
US 2016-0242128 A1	18/08/2016	BR 112016006376 A2	01/08/2017
		CN 105580449 A	11/05/2016
		EP 2854460 A1	01/04/2015
		EP 2854460 B1	05/04/2017
		EP 3050369 A1	03/08/2016
		EP 3280196 A1	07/02/2018
		JP 2016-532326 A	13/10/2016
		KR 10-2016-0062098 A	01/06/2016
		MX 2016003172 A	24/06/2016
		RU 2016110783 A	01/11/2017
		RU 2645753 C2	28/02/2018
		SG 10201801087 A	28/03/2018
		WO 2015-045283 A1	02/04/2015