

MAC PDU TRANSMISSION

FIELD

5 [0001] Various embodiments of the present disclosure generally relate to the field of telecommunication and in particular to devices, methods, apparatuses and computer readable storage media for configuring, transmitting, and/or receiving a medium access control protocol data unit (MAC PDU) including one or more MAC subheader.

BACKGROUND

10 [0002] In 5G New Radio, different kinds of data transfer services are offered by the medium access control (MAC) layer. To accommodate different kinds of data transfer services, multiple types of logical channels are defined. A MAC protocol data unit (MAC PDU) may consist of one or more MAC control elements (MAC CEs) corresponding to one or more features requiring the MAC CEs. According to the third generation partnership project
15 (3GPP) technical specification (TS) 38.321, the MAC PDU contains a subheader with a logical channel identification (LCID) value or an extended LCID (eLCID) value.

SUMMARY

20 [0003] The scope of protection sought for various example embodiments is set out by the claims. The example embodiments and features, if any, described in this specification that do not fall under the scope of the claims are to be interpreted as examples useful for understanding various embodiments.

[0004] In a first aspect, there is provided an apparatus comprising at least one processor; and at least one memory storing instructions that, when executed by the at least one
25 processor, cause the apparatus at least to perform configuring a medium access control protocol data unit, MAC PDU, including one or more MAC subheaders and transmitting the MAC PDU. A MAC subheader of the one or more MAC subheaders includes a first indication field indicating an existence of a first information field in the MAC subheader, and the first information field indicates information associated with at least one of a common control
30 channel (CCCH) a size of the CCCH service data unit (CCCH SDU), a device type, a device

capability, or scheduling information.

[0005] In a second aspect, there is provided an apparatus comprising at least one processor and at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus at least to perform transmitting a message related to a first information field and receiving a medium access control protocol data unit, MAC PDU, including one or more MAC subheaders. A MAC subheader of the one or more MAC subheaders may include a first indication field indicating an existence of the first information field in the MAC subheader. The first information field may indicate information associated with at least one of a common control channel (CCCH) a size of the CCCH service data unit (CCCH SDU), a device type, a device capability, or scheduling information.

[0006] In a third aspect, there is provided a method comprising steps of configuring a medium access control protocol data unit, MAC PDU, including one or more MAC subheaders and transmitting the MAC PDU. A MAC subheader of the one or more MAC subheaders may include a first indication field indicating an existence of a first information field in the MAC subheader. The first information field may indicate information associated with at least one of a common control channel, CCCH, a size of the CCCH service data unit, CCCH SDU, a device type, a device capability, or scheduling information.

[0007] In a fourth aspect, there is provided a method comprising steps of transmitting a message related to a first information field and receiving a medium access control protocol data unit, MAC PDU, including one or more MAC subheaders. A MAC subheader of the one or more MAC subheaders may include a first indication field indicating an existence of the first information field in the MAC subheader. The first information field may indicate information associated with at least one of a common control channel (CCCH), a size of the CCCH service data unit (CCCH SDU), a device type, a device capability, or scheduling information.

[0008] In a fifth aspect, there is provided a computer readable medium comprising instructions stored thereon for causing an apparatus at least to perform: configuring a medium access control protocol data unit, MAC PDU, including one or more MAC subheaders and transmitting the MAC PDU. A MAC subheader of the one or more MAC subheaders may include a first indication field indicating an existence of a first information field in the MAC subheader. The first information field may indicate information associated

with at least one of a common control channel, CCCH, a size of the CCCH service data unit, CCCH SDU, a device type, a device capability, or scheduling information. In this case, the computer program medium is a non-transitory computer readable medium.

[0009] In a sixth aspect, there is provided a computer readable medium comprising
5 instructions stored thereon for causing a network node at least to perform: transmitting a message related to a first information field and receiving a medium access control protocol data unit, MAC PDU, including one or more MAC subheaders. A MAC subheader of the one or more MAC subheaders may include a first indication field indicating an existence of the first information field in the MAC subheader. The first information field may indicate
10 information associated with at least one of a common control channel (CCCH), a size of the CCCH service data unit (CCCH SDU), a device type, a device capability, or scheduling information. In this case, the computer program medium is a non-transitory computer readable medium.

[0010] Other features and advantages of the embodiments of the present disclosure will
15 also be apparent from the following description of specific embodiments when read in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of embodiments of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

20 [0011] Embodiments of the disclosure are presented in the sense of examples and their advantages are explained in greater detail below, with reference to the accompanying drawings.

[0012] FIG. 1 illustrates an example communication environment 100 in which example embodiments of the present disclosure can be implemented.

25 [0013] Fig. 2 illustrates some examples of MAC subheaders that may be applied to embodiments of the invention disclosure.

[0014] Fig. 3 illustrates some example of MAC subheaders that may be applied to embodiments of the invention disclosure.

[0015] Fig. 4 illustrates one of the signaling procedures for configuration MAC PDU
30 including one or more MAC subheaders that may be applied to embodiments of the

invention disclosure.

[0016] Fig. 5 illustrates some of MAC subheaders according to the embodiments of the invention disclosure.

[0017] Fig. 6 illustrates a flowchart providing one of embodiments for configuring the MAC PDU including one or more MAC subheaders.

[0018] Fig. 7 illustrates a flowchart providing one of embodiments for supporting the generation of the MAC PDU.

[0019] FIG. 8 illustrates an example of an apparatus comprising means for performing one or more of the example embodiments described above.

[0020] Throughout the drawings, the same or similar reference numerals may represent the same or similar element.

DETAILED DESCRIPTION

[0021] The following embodiments are exemplifying. Principle of the present disclosure will now be described with reference to some example embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure. Embodiments described herein may be implemented in various manners other than the ones described below.

[0022] In the following description and claims, unless defined otherwise, all technical and scientific terms used herein may have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

[0023] References in the present disclosure to “one embodiment,” “an embodiment,” “an example embodiment,” and the like indicate that the embodiment described may include a particular feature, structure, element or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, element or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect

such feature, structure, element or characteristic in connection with other embodiments whether or not explicitly described.

[0024] It shall be understood that although the terms “first,” “second” and the like may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and similarly, a second element could be termed a first element, without departing from the scope of example embodiments. As used herein, the term “and/or” includes any and all combinations of one or more of the listed terms.

[0025] As used herein, “at least one of the following: <a list of two or more elements>” and “at least one of <a list of two or more elements>” and similar wording, where the list of two or more elements are joined by “and” or “or”, mean at least any one of the elements, or at least any two or more of the elements, or at least all the elements.

[0026] As used herein, unless stated explicitly, performing a step “in response to A” does not indicate that the step is performed immediately after “A” occurs and one or more intervening steps may be included.

[0027] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example embodiments. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises”, “comprising”, “has”, “having”, “includes” and/or “including”, when used herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/or combinations thereof.

[0028] As used in this application, the term “circuitry” may refer to one or more or all of the following:

(a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and

(b) combinations of hardware circuits and software, such as (as applicable):

(i) a combination of analog and/or digital hardware circuit(s) with

software/firmware and

(ii) any portions of hardware processor(s) with software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions) and

5 (c) hardware circuit(s) and or processor(s), such as a microprocessor(s) or a portion of a microprocessor(s), that requires software (e.g., firmware) for operation, but the software may not be present when it is not needed for operation.

[0029] This definition of circuitry applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term circuitry
10 also covers an implementation of merely a hardware circuit or processor (or multiple processors) or portion of a hardware circuit or processor and its (or their) accompanying software and/or firmware. The term circuitry also covers, for example and if applicable to the particular claim element, a baseband integrated circuit or processor integrated circuit for a mobile device or a similar integrated circuit in server, a cellular network device, or other
15 computing or network device.

[0030] As used herein, the term “communication network” refers to a network following any suitable communication standards, such as New Radio (NR), Long Term Evolution (LTE), LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), High-Speed Packet Access (HSPA), Narrow Band Internet of Things (NB-IoT) and so on. Furthermore, the
20 communications between a terminal device and a network device in the communication network may be performed according to any suitable generation communication protocols, including, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G), the sixth generation (6G) communication protocols, and/or any other protocols either
25 currently known or to be developed in the future. Embodiments of the present disclosure may be applied in various communication systems. Given the rapid development in communications, there will of course also be future type communication technologies and systems with which the present disclosure may be embodied. It should not be seen as limiting the scope of the present disclosure to only the aforementioned system.

30 [0031] As used herein, the term “network device” refers to a node in a communication

network via which a terminal device accesses the network and receives services therefrom. The network device may refer to a base station (BS) or an access point (AP), for example, a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), an NR NB (also referred to as a gNB), a radio access network (RAN) node, a new generation RAN (NG-RAN) node, a Remote
5 Radio Unit (RRU), a radio header (RH), a transmission and reception point (TRP), a remote radio head (RRH), a relay, an Integrated Access and Backhaul (IAB) node, a low power node such as a femto, a pico, a non-terrestrial network (NTN) or non-ground network device such as a satellite network device, a low earth orbit (LEO) satellite and a geosynchronous earth orbit (GEO) satellite, an aircraft network device, and so forth, depending on the applied
10 terminology and technology. In some example embodiments, radio access network (RAN) split architecture includes a Centralized Unit (CU) and a Distributed Unit (DU) at an IAB donor node. An IAB node includes a Mobile Terminal (IAB-MT) part that behaves like a UE toward the parent node, and a DU part of an IAB node behaves like a base station toward the next-hop IAB node.

15 **[0032]** The term “terminal device” refers to any end device that may be capable of wireless communication. By way of example rather than limitation, a terminal device may also be referred to as a communication device, user equipment (UE), a Subscriber Station (SS), a Portable Subscriber Station, a Mobile Station (MS), a user device or an Access Terminal (AT). The terminal device may include, but not limited to, a mobile phone, a cellular phone, a
20 smart phone, voice over IP (VoIP) phones, wireless local loop phones, a tablet, a wearable terminal device, a personal digital assistant (PDA), portable computers, desktop computer, image capture terminal devices such as digital cameras, gaming terminal devices, music storage and playback appliances, vehicle-mounted wireless terminal devices, wireless endpoints, mobile stations, laptop-embedded equipment (LEE), laptop-mounted equipment
25 (LME), USB dongles, smart devices, wireless customer-premises equipment (CPE), an Internet of Things (IoT) device, a watch or other wearable, a head-mounted display (HMD), a vehicle, a drone, a medical device and applications (e.g., remote surgery), an industrial device and applications (e.g., a robot and/or other wireless devices operating in an industrial and/or an automated processing chain contexts), a consumer electronics device, a device
30 operating on commercial and/or industrial wireless networks, and the like. The terminal device may also correspond to a Mobile Termination (MT) part of an IAB node (e.g., a relay

node). In the following description, the term “terminal device” may be used interchangeably with the other terms explained above.

[0033] As used herein, the term “resource,” “transmission resource,” “resource block,” “physical resource block” (PRB), “uplink resource,” “downlink resource” or “sidelink resource” may refer to any resource for performing a communication, for example, a communication between a terminal device and a network device, such as a resource in time domain, a resource in frequency domain, a resource in space domain, a resource in code domain, or any other resource enabling a communication, and the like. In the following, unless explicitly stated, a resource in both frequency domain and time domain will be used as an example of a transmission resource for describing some example embodiments of the present disclosure. It is noted that example embodiments of the present disclosure are equally applicable to other resources in other domains.

[0034] **Communication environment**

[0035] FIG. 1 illustrates an example communication environment 100 in which example embodiments of the present disclosure can be implemented.

[0036] In the communication environment 100, a plurality of communication devices, comprising a terminal device 110 and a network device 120, can communicate with each other. The network device 120 may serve a coverage area, called a cell 125. The terminal device 110 may have access to a communication network via the cell 125. In some example embodiments, both the terminal device 110 and the network device 120 may be configured to implement a beamforming technique and communicate with each other via a plurality of beams.

[0037] In some example embodiments, a link from the network device 120 to the terminal device 110 is referred to as a downlink (DL), while a link from the terminal device 110 to the network device 120 is referred to as an uplink (UL). In DL, the network device 120 is a Tx device (or a transmitter), and the terminal device 110 is a Rx device (or a receiver). In UL, the user device 110 is a Tx device (or a transmitter), and the network device 120 is a Rx device (or a receiver). A link between the terminal device 110 and other terminal device (not shown) is referred to as a sidelink (SL). In SL, one of the terminal devices is a Tx device

(or a transmitter), and the other of the terminal devices is a Rx device (or a receiver).

[0038] Communications in the communication environment 100 may be implemented according to any proper communication protocol(s), comprising, but not limited to, cellular communication protocols of the first generation (1G), the second generation (2G), the third generation (3G), the fourth generation (4G), the fifth generation (5G), the sixth generation (6G), and the like, wireless local network communication protocols such as Institute for Electrical and Electronics Engineers (IEEE) 802.11 and the like, and/or any other protocols currently known or to be developed in the future. Moreover, the communication may utilize any proper wireless communication technology, comprising but not limited to: Code Division Multiple Access (CDMA), Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Frequency Division Duplex (FDD), Time Division Duplex (TDD), Multiple-Input Multiple-Output (MIMO), Orthogonal Frequency Division Multiple (OFDM), Discrete Fourier Transform spread OFDM (DFT-s-OFDM) and/or any other technologies currently known or to be developed in the future.

[0039] It is to be understood that the number of devices and their connections are shown in FIG. 1 only for the purpose of illustration without suggesting any limitation. The communication environment 100 may include any suitable number of devices configured to implement example embodiments of the present disclosure.

[0040] **MAC PDU**

[0041] Fig. 2 illustrates some examples of MAC subheaders that may be applied to embodiments of the invention disclosure. For example, Fig. 2(a) shows an example of a downlink MAC PDU and Fig. 2(b) shows an example of an uplink MAC PDU.

[0042] A MAC PDU is a bit string that is byte aligned (i.e., multiple of 8 bits) in length. The bit strings are represented by tables in which the most significant bit is the leftmost bit of the first line of the table, the least significant bit is the rightmost bit on the last line of the table, and more generally the bit string is to be read from left to right and then in the reading order of the lines. The bit order of each parameter field within a MAC PDU is represented with the first and most significant bit in the leftmost bit and the last and least significant bit in the rightmost bit.

[0043] A MAC SDU is a bit string that is byte aligned (i.e., multiple of 8 bits) in length. A MAC SDU is included into a MAC PDU from the first bit onward. A MAC CE is a bit string that is byte aligned (i.e., multiple of 8 bits) in length. A MAC subheader is a bit string that is byte aligned (i.e., multiple of 8 bits) in length. Each MAC subheader is placed immediately in front of the corresponding MAC SDU, MAC CE, or padding. The MAC entity shall ignore the value of the Reserved bits in downlink MAC PDUs.

[0044] Referring to Figs. 2(a) or 2(b), the MAC PDU comprises one or more MAC subPDUs. Each MAC subPDU comprises one of the following:

- a MAC subheader only (including padding);
- 10 - a MAC subheader and a MAC SDU;
- a MAC subheader and a MAC CE; or
- a MAC subheader and padding.

[0045] The MAC SDUs may have variable sizes.

[0046] Referring back to Figs. 2(a) and 2(b), the MAC CEs are placed together. DL MAC subPDU(s) with MAC CE(s) is placed before any MAC subPDU with MAC SDU and MAC subPDU with padding. UL MAC subPDU(s) with MAC CE(s) is placed after all the MAC subPDU(s) with MAC SDU and before the MAC subPDU with padding in the MAC PDU. The size of padding can be zero.

[0047] A maximum of one MAC PDU can be transmitted per TB per MAC entity.

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[0048] Fig. 3 illustrates some example of MAC subheaders that may be applied to embodiments of the invention disclosure.

[0049] Each MAC subheader corresponds to either a MAC SDU, a MAC CE, or padding. Referring to Figs. 3(a) and 3(b), a MAC subheader except for fixed sized MAC CE, padding, and a MAC SDU containing UL common control channel (CCCH) consists of the header fields R/F/LCID/(e)LCID)/L. Referring to Figs. 3(c) and 3(d), a MAC subheader for fixed sized MAC CE, padding, and a MAC SDU containing UL CCCH may consists of the two header fields R/LCID for 1 byte size or R/LCID/eLCID for 2 bytes size.

[0050] The MAC subheader consists of at least one of following fields such as a LCID field,

an eLCID field, a L field, a F field, and a R field. Alternatively or additionally, the MAC subheader may include two or more L fields, two or more eLCID fields, and two or more R fields. The MAC subheader is octet aligned.

[0051] The LCID field identifies the logical channel instance (e.g., index, or codepoint) of the corresponding MAC SDU or the type of the corresponding MAC CE or padding as described in Tables 1 and 2 for the DL-SCH and UL-SCH, respectively. There is one LCID field per MAC subheader. The size of the LCID field is 6 bits. If the LCID field is set to 34, one additional octet is present in the MAC subheader containing the eLCID field and follow the octet containing LCID field. If the LCID field is set to 33, two additional octets are present in the MAC subheader containing the eLCID field and these two additional octets follow the octet containing LCID field. For MBS broadcast, a logical channel is identified based on G-RNTI and LCID if the same LCID is allocated for logical channels corresponding to different G-RNTIs.

[0052] The eLCID field identifies the logical channel instance of the corresponding MAC SDU or the type of the corresponding MAC CE as described in tables 6.2.1-1a, 6.2.1-1b, 6.2.1-1c, 6.2.1-2a, and 6.2.1-2b of TS38.321 for the DL-SCH and UL-SCH, respectively. The size of the eLCID field is either 8 bits or 16 bits. The eLCID space using two-octet eLCID and the relevant MAC subheader format is used, only when configured, on the NR backhaul links between IAB nodes or between IAB node and IAB Donor, or for multicast MTCHs.

[0053] The Length (L) field indicates the length of the corresponding MAC SDU or variable-sized MAC CE in bytes. There is one L field per MAC subheader except for subheaders corresponding to fixed-sized MAC CEs, padding, and MAC SDUs containing UL CCCH.

[0054] The Format (F) field indicates the size of the Length field. There is one F field per MAC subheader except for subheaders corresponding to fixed-sized MAC CEs, padding, and MAC SDUs containing UL CCCH. The size of the F field is 1 bit. The value 0 of the F field indicates 8 bits of the Length field while the value 1 of the F field indicates 16 bits of the Length field.

[0055] The Reserved (R) bit may set to 0.

[0056] As discussed above, the LCID value may identify the logical channel instances of the type of corresponding MAC CE as described in the Table 1 for a downlink-shared channel

(DL-SCH) and Table 2 for an uplink shared channel (UL-SCH) as the following.

[Table 1]

Codepoint/Index	LCID values
0	CCCH
1–32	Identity of the logical channel of DCCH, DTCH and multicast MTCH
33	Extended logical channel ID field (two-octet eLCID field)
34	Extended logical channel ID field (one-octet eLCID field)
35–46	Reserved
47	Recommended bit rate
48	SP ZP CSI-RS Resource Set Activation/Deactivation
49	PUCCH spatial relation Activation/Deactivation
50	SP SRS Activation/Deactivation
51	SP CSI reporting on PUCCH Activation/Deactivation
52	TCI State Indication for UE-specific PDCCH
53	TCI States Activation/Deactivation for UE-specific PDSCH
54	Aperiodic CSI Trigger State Subselection
55	SP CSI-RS/CSI-IM Resource Set Activation/Deactivation
56	Duplication Activation/Deactivation
57	SCell Activation/Deactivation (four octets)
58	SCell Activation/Deactivation (one octet)
59	Long DRX Command
60	DRX Command
61	Timing Advance Command
62	UE Contention Resolution Identity
63	Padding

[Table 2]

Codepoint/ Index	LCID values
0	CCCH of size 64 bits (referred to as "CCCH1" in TS 38.331 [5]), except for a RedCap UE
1–32	Identity of the logical channel of DCCH and DTCH
33	Extended logical channel ID field (two-octet eLCID field)
34	Extended logical channel ID field (one-octet eLCID field)
35	CCCH of size 48 bits (referred to as "CCCH" in TS 38.331 [5]) for a RedCap UE
36	CCCH of size 64 bits (referred to as "CCCH1" in TS 38.331 [5]) for a RedCap UE
37–42	Reserved
43	Truncated Enhanced BFR (one octet C _i)
44	Timing Advance Report
45	Truncated Sidelink BSR
46	Sidelink BSR
47	Reserved
48	LBT failure (four octets)
49	LBT failure (one octet)
50	BFR (one octet C _i)
51	Truncated BFR (one octet C _i)
52	CCCH of size 48 bits (referred to as "CCCH" in TS 38.331 [5]), except for a RedCap UE
53	Recommended bit rate query
54	Multiple Entry PHR (four octets C _i)
55	Configured Grant Confirmation
56	Multiple Entry PHR (one octet C _i)
57	Single Entry PHR
58	C-RNTI
59	Short Truncated BSR
60	Long Truncated BSR
61	Short BSR
62	Long BSR
63	Padding

[0057] As can be seen from the tables, there are currently very few LCID values available

5 for new MAC CEs. The reserved values can be used to introduce new MAC CEs. However,

as can be seen in the tables 1 and 2, only 12 LCID values for DL-SCH and 10 LCID values for UL-SCH are currently available. Although there are plenty of eLCID values available in both downlink and uplink directions, using an eLCID value will always result in one byte of additional overhead in the MAC subheader compared to a LCID value.

5 [0058] Referring back to Figs. 3(a) and (b), currently there is only one reserved (R) bit for the MAC subheader for flexible size MAC CEs and MAC SDUs not containing UL CCCH. And referring to Figs. 3(c) and 3(d), there are two R bits in a MAC subheader for fixed size MAC CEs, and a MAC SDU containing UL CCCH.

[0059] It can be thought to use the R bit as indication of LCID extension so that it could
10 extend 64 more LCID spaces when R bit is set to 1. However, that would spend the last available R bit and MAC PDU could not be extended in the future.

[0060] The LCID space (or instance, index) of tables 1 or 2 has almost been used for the NR while many use cases would benefit from the LCID. This is because the LCID preserves only 6 bits in the MAC subheader having 1 byte (compared to eLCID which takes either 2 or 3
15 bytes) and, hence, overhead can be reduced. This is extremely important for the message A (MsgA) or the message 3 (Msg3) of the random access procedure, where the minimum size of the MAC PDU is intended to have a cell coverage as good as in the legacy.

[0061] However, since new features are being specified in the 3GPP for Rel-18 and future releases, new information would need to be carried to the network as early as possible (e.g.,
20 in MsgA/Msg3) for coverage enhancement, redcap, NTN, and/or Mult-SIM features.

[0062] Meanwhile, partitioning the RACH preambles is not a practical solution as too many partitions for different features would increase the collision rate. Besides, not all network device and terminal devices (UEs) support the random access partitioning since it is rather complex to implement. Besides, using the last R bit for LCID extension would leave the MAC
25 header without any more reserved bits left.

[0063] Detailed embodiments

[0064] In a first embodiment of the present disclosure, it is proposed that the second (2nd) leftmost bit in the MAC subheader is encoded to indicate “a new LCID” field existence in the
30 MAC subheader when the MAC subheader is the first MAC subheader in the MAC PDU. In

this case, the MAC PDU may be included in a message A (MsgA) and/or a message 3 (Msg3) of a random access procedure (i.e., the MAC PDU may be obtained or stored in a MsgA/Msg3 buffer). This is because the first MAC subheader would be always encoded without the F field considering the MAC subheader would be either for a CCCH or for a C-RNTI MAC CE (since they are highest priority according to multiplexing rules specified).

[0065] The 2nd leftmost bit may be an indication field (or a first indication field) indicating the presence of the new LCID field or the presence of the legacy LCID field. The legacy LCID field may be the LCID field explained in Fig.3 and the description thereof.

[0066] Alternatively or additionally, the above may be applicable only for a MAC subheader for CCCH. Hence, in some examples, the indication already serves as an indication of a CCCH SDU and the new LCID field can be used to indicate the CCCH SDU size (e.g., 48 or 64 bits) and additional information associated with the device, the device type, the device capabilities, and/or different repetition numbers, etc.

[0067] In some examples of the first embodiment, the indication field is followed by an additional indication field (or a second indication field) indicating a size of the CCCH SDU. For example, the size of the CCCH SDU is one of two different sizes (e.g., 48 or 64 bits) and the new LCID field follows this additional indication field specifying the additional information associated with the device, the device type, the device capabilities, and/or different repetition numbers, etc.

[0068] Alternatively, in some examples of the first embodiment, the indication field is followed by an additional indication field (or a second indication field) indicating either the CCCH or the cell radio network temporary identifier (C-RNTI) MAC CE, and the new LCID field follows this additional indication field specifying additional information associated with the device, the device type, the device capabilities, and/or different repetition numbers, etc.

[0069] In some examples of the first embodiment, the size of the new LCID field may be 1 to 6 bits long.

[0070] In some examples of the first embodiment, a separate table from tables 1 and 2 can be defined for the new LCID field for different combinations of terminal device's features and different CCCH SDU size. In this case, 2ⁿ LCIDs would be used for different feature combinations of n features (n = the number of features equals to or more 1) for each CCCH

SDU size.

[0071] In some examples of the first embodiment, only one CCCH size (e.g. the 48 bits or the 64 bits) is supported for the new LCID.

[0072] In a second embodiment of the present disclosure, it is proposed that the leftmost bit (e.g., the first bit) in the MAC subheader is encoded to indicate an existence of the new LCID field in the MAC subheader and an existence of additional at least one R bit in the MAC subheader. For example, the 3rd leftmost bit of the MAC subheader could be assigned as the R bit and the new LCID field would be 5 bits long. This would enable future extensions of the MAC subheader by means of the additional R bit when the last one in the current MAC subheader is used. In this case, the new LCID could be used for any MAC subheader (e.g., even for MAC subPDU that includes a variable size MAC CE and, hence, Length field).

[0073] In some examples of the second embodiment, the “new LCID” field may be 1-5 bits long.

[0074] Fig. 4 illustrates one of the signaling procedures for configuration MAC PDU including one or more MAC subheaders that may be applied to embodiments of the invention disclosure.

[0075] Referring to Fig. 4, the communication environment includes a terminal device (110) and a network device (120). The communication environment may further comprise one or more terminal devices or one or more network devices. Each of the terminal device 110 and the network device 120 comprises means for performing the signaling procedure depicted in Fig. 4. Additionally or alternatively, each of the terminal device 110 and the network device 120 comprises at least one processor and at least one memory storing instructions that, when executed by the at least one processor, cause the terminal device 110 or the network device 120 at least to perform the signalling procedure explained in Fig. 4 and the following explanations.

[0076] At 410, the network device 120 is caused to transmit the message related to a first information field, and the terminal device is caused to receive a message related to a first information field. For example, the message may indicate the first information field is supported by the network device 120.

- [0077] The terminal device 110 may determine whether the first information field (e.g., a new LCID) is supported. The determination is done by using an explicit way based on the message transmitted from the network device. Or, the determination is done by using an implicit way, at 410. For example, the determination is based on a feature being enabled in the cell (e.g., PUCCH repetition for a Msg4), the device type of the terminal device being allowed to access the cell (e.g., a reduced capability (RedCap) UE), or the cell being a non-terrestrial network (NTN) cell. The message and the first information field may be used to configure a MAC subheader. The message may be broadcast via a system information block (SIB). The phase 410 may be configured as an optional.
- 10 [0078] At 420, the terminal device 110 is caused to configure (or generate) a medium access control protocol data unit (MAC PDU) including one or more MAC subheaders. At 420, the terminal device 110 generates the one or more MAC subheaders by setting each of the fields (such as the reserved bit, the first indication field, a second indication field and/or the new LCID fields) to be comprised in the MAC subheaders.
- 15 [0079] At 430, the terminal device 110 is caused to transmit the MAC PDU to the network device 120, and the network device 120 is caused to receive a MAC PDU including one or more MAC subheaders. A MAC subheader of the one or more MAC subheaders may include a first indication field indicating an existence of the first information field in the MAC subheader. If the first indication field has set to indicate the first information field is included
- 20 in the MAC subheader, the MAC subheader includes the first information field.
- [0080] The first information field indicates information associated with at least one of a common control channel (CCCH), a size of the CCCH service data unit (CCCH SDU) a device type, a device capability, or scheduling information.
- [0081] The first indication field may be set to indicate the existence of the first information field or an existence of a second information field. For example, the first information field
- 25 may be a new LCID and the second information field may be a legacy LCID field.
- [0082] The MAC subheader may be an initial MAC subheader of the one or more MAC subheaders. The initial MAC subheader means the first MAC subheader (or the very first MAC subheader) included in the MAC PDU amongst the one or more MAC subheaders.
- 30 [0083] In some examples, the MAC PDU may be transmitted via a message A (MsgA) or a

Message 3 (Msg3) of a random access procedure.

[0084] In some examples, the MAC subheader may include a second indication field indicating 1) the size of CCCH SDU, or 2) the CCCH SDU or a MAC control element (MAC CE) is included in the MAC PDU.

5 [0085] In some examples, the first indication field may be followed by the second indication field, and the second indication field may be followed by the new LCID field.

[0086] In some examples, the size of the first information field may be set one of 1 bit, 2 bits, 3 bits, 4 bits, 5 bits and 6 bits.

[0087] In some examples, the MAC subheader may include at least one reserved bit, the
10 first indication field may be located at a second leftmost bit in the MAC subheader, and a size of the MAC subheader may be 1 byte.

[0088] In some examples, the MAC subheader may include at least one reserved bit, the first indication may be located at a leftmost bit in the MAC subheader, one of the at least one reserved bit may be located at a second leftmost bit or a third leftmost bit in the MAC
15 subheader, and a size of the MAC subheader may be 1 byte.

[0089] The information associated with each or the combination of at least one of a common control channel (CCCH), a size of the CCCH service data unit (CCCH SDU) a device type, a device capability, or scheduling information is defined in a new LCID table (to be explained) corresponding to the new LCID field.

20 [0090] In some examples, the MAC subheader may consist of the at least one reserved field, the first indication field and the new LCID field.

[0091] In some examples, the MAC subheader may consist of the at least one reserved field, the first indication field, the second indication field, and the new LCID field.

[0092] In some examples, the MAC subheader may consist of the at least one reserved
25 field, the first indication field, a format field, and the new LCID field.

[0093] In some examples, the device type may indicate at least one of a regular user device, a reduced capability user device, or an extended reduced capability user device.

[0094] In some examples, the scheduling information may indicate at least one of a repetition number, a buffer status, a power headroom, or a beam information.

[0095] Fig. 5 illustrates some of MAC subheaders according to the embodiments of the invention disclosure.

[0096] In Fig. 5, the 1 octet consists of 8 bits. Overall functions or explanations of the fields such as the R field, the F field, and the L field can be referred to Fig. 3 and the description thereof. For Fig. 5, the new indication fields (e.g., the EL and CS fields) and the new LCID field will be explained.

[0097] Firstly, a new LCID field may identify (indicate) each or the combinations of additional information associated with the CCCH, the device, the device type, the device capabilities and/or the different repetition numbers. Table 3 is one of examples of new LCID tables. It is to be understood that these are merely examples of the usage of the new LCID field while the codepoint/index usage can be completely different or in a different order.

[Table 3]

Codepoint/Index	LCID values
0	CCCH of size 48 bits (referred to as "CCCH" in TS 38.331) with Msg4 HARQ ACK repetition request/supported
1	CCCH of size 64 bits (referred to as "CCCH1" in TS 38.331) with Msg4 HARQ ACK repetition request/supported
2	C-RNTI MAC CE with Msg4 HARQ ACK repetition request
3	CCCH of size 48 bits (referred to as "CCCH" in TS 38.331) for a RedCap UE with Msg4 HARQ ACK repetition request/supported
4	CCCH of size 64 bits (referred to as "CCCH1" in TS 38.331) for a RedCap UE with Msg4 HARQ ACK repetition request/supported
5	CCCH of size 48 bits (referred to as "CCCH" in TS 38.331) for a eRedCap UE
6	CCCH of size 64 bits (referred to as "CCCH1" in TS 38.331) for a eRedCap UE
7	CCCH of size 48 bits (referred to as "CCCH" in TS 38.331) for a eRedCap UE with Msg4 HARQ ACK repetition request/supported
8	CCCH of size 64 bits (referred to as "CCCH1" in TS 38.331 [5]) for a eRedCap UE with Msg4 HARQ ACK repetition request/supported
9	Buffer size above a threshold level.
10	Power headroom changed a threshold amount.
11	C-RNTI MAC CE with Msg4 HARQ ACK repetition request with 2 repetitions
12	C-RNTI MAC CE with Msg4 HARQ ACK repetition request with 4 repetitions
13	C-RNTI MAC CE with Msg4 HARQ ACK repetition request with 8 repetitions
14-31	Reserved

[0098] For example, referring to Table 3, when the new LCID field is set to '0', then the new LCID field may indicate the CCCH of size 48 bits with the Msg4 HARQ ACK repetition request/supported. If the new LCID field is set to '4', then the new LCID field may indicate CCCH of size 64 bits for a RedCap UE with Msg4 HARQ ACK repetition request/supported. If the new LCID field is set to '11', then the new LCID field may indicate the C-RNTI MAC CE with Msg4 HARQ ACK repetition request with 2 repetitions.

[0099] Table 3 is the case when the size of the new LCID field is set to 5 bits. However, the

new LCID field size may be set to 1 to 6 bits in consideration of the size of the MAC subheader and the additional information.

[00100] Alternatively or additionally, the new LCID field may indicate information associated with the device, the device type, the device capabilities and/or the different repetition numbers, a buffer status, a power headroom as specified in table 2 or table 3. The size of the new LCID field may be set to 5 bits.

[00101] Alternatively or additionally, the new LCID field may identify the logical channel instance (or, index) of the corresponding MAC SDU or the type of the corresponding MAC CE as described in Table 3. The size of the new LCID field may be 4 bits or 5 bits.

[00102] Secondly, in some examples of the embodiments, a first indication field may be set. The first indication field may be called as an EL (short Extended LCID) field. The EL field may indicate the format of the MAC subheader. For example, the EL field may be set to '0' to indicate R/LCID MAC subheader.

[00103] Alternatively or additionally, the EL field may set to '1' to indicate that the MAC SDU contains at least one UL CCCH and the existence of the CS field and the New LCID field in the MAC subheader.

[00104] Alternatively or additionally, the EL field may set to '1' to indicate the existence of CS field and New LCID field in the MAC subheader.

[00105] Alternatively or additionally, the EL field may set to '1' to indicates the existence of the new LCID field in the MAC subheader, or to indicate the existence of the new LCID field or the legacy LCID field.

[00106] If the EL field is set to '0' or if the EL field is not configured in the MAC subheader, the new LCID field may be not present in the MAC subheader. Alternatively, the EL field is set to '0', then the legacy LCID field (or old LCID field) may be set to the MAC subheader.

[00107] Alternatively or additionally, the EL field may indicate a format of the MAC subheader. If the EL field set to '0', the EL field indicates EL/F/(e)LCID MAC subheader. If the EL field set to '1', it indicates EL/F/R/(e)LCID MAC subheader.

[00108] Thirdly, in some examples of the embodiments, the second indication field may be introduced. The second indication field may be called as a CS (CCCH Size) field. For example, the CS field may indicate the size of the CCCH SDU.

[00109] Alternatively or additionally, the CS field set to '0' may indicate a CCCH SDU of size 48 bits. The CS field set to '1' may indicate a CCCH SDU of size 64 bits.

[00110] Alternatively or additionally, the CS field may indicate that either a CCCH SDU or C-RNTI MAC CE is included in the MAC subheader. For example, the CS field set to '0' indicates the CCCH SDU is included in the MAC subheader, and CS field set to '1' indicates the C-RNTI MAC CE is included in the MAC subheader.

[00111] Referring to Fig. 5(a), the MAC subheader having 1 byte is disclosed. The MAC subheader may comprise the R field, the EL field, the CS field, and the new LCID field. Each of the sizes of the R, EL and CS fields is 1 bit and the size of the new LCID field is 5 bits. In some examples, the CS field may not be set in the MAC subheader. In this case, the size of the new LCID may be 6 bits. The R bit may be set at the leftmost bit in the MAC subheader, the EL field may be set at the second leftmost bit in the MAC subheader and the CS field may be set at the third leftmost bit in the MAC subheader.

[00112] Referring to Fig. 5(b), the MAC subheader having 2 bytes is disclosed. At the first octet of the MAC subheader, the EL field, the F field, the R field, and the new LCID field may be included. At the second octet, the L field is set. The EL field may be set at the leftmost bit in the MAC subheader and the F field follows the EL field. The F field is followed by the R field and new LCID field. The location of the EL field and the R field may be changed to each other.

[00113] Referring to Fig. 5(c), the MAC subheader having 3 bytes is disclosed. The configuration of the first octet in the MAC subheader may be the same as that of the MAC subheader in Fig. 5(b). The L field occupies two octets in the MAC subheader.

[00114] Referring to Fig. 5(d), the MAC subheader having one byte is disclosed. The MAC subheader includes the EL field, two R fields, and the new LCID field. The location of the EL field and the third R field may be changed to each other.

[00115] In some examples of the embodiments in Fig. 5, the additional information with the device/device type/device capabilities/buffer status/power headroom/etc. may define with no limiting example.

[00116] For example, the additional information may indicate each or the combination of:

1) whether the terminal device 110 is a normal NR UE, a RedCap UE, or an eRedCap

UE;

2) whether the terminal device 110 requests/supports PUCCH repetition for Msg4 feedback/ACK;

3) what repetition number should be used for the PUCCH repetition for Msg4 feedback/ACK;

4) whether buffer status of the UE is above a threshold level;

5) whether power headroom is above/below a threshold level; and

6) whether power headroom has changed a threshold amount since the previous PHR was transmitted.

10 **[00117]** According to the embodiments and the examples thereof, the R field for every MAC subheader is able to be preserved for future use. In addition, the new LCID space (e.g., instance, index, or codepoint) can be increased by at least 32 indexes. Besides, the network device 120 is able to interpret the new MAC subheader based on the UL grant where the MAC PDU is encoded.

15 **[00118]** The additional information of the embodiments may mean the information other than the information indicated by the legacy LCID (see, Table 1 or 2).

[00119] Fig. 6 illustrates a flowchart providing one of embodiments for configuring the MAC PDU including one or more MAC subheaders, and Fig. 7 illustrates a flowchart providing one of embodiments for supporting the generation of the MAC PDU.

[00120] Referring to Fig. 6, the terminal device 110 is caused to perform a method 600 comprising steps of:

configuring 610 a medium access control protocol data unit (MAC PDU) including one or more MAC subheaders and
25 transmitting 620 the MAC PDU.

[00121] A MAC subheader of the one or more MAC subheaders may include a first indication field indicating an existence of a first information field in the MAC subheader, and the first information field may indicate information associated with at least one of a common control channel (CCCH) a size of the CCCH service data unit (CCCH SDU), a device
30 type, a device capability, or scheduling information.

- [00122] In some examples of the embodiment, the method may further comprise a step of receiving a message related to the first information field. In this case, the MAC subheader may be configured based on the message. The message is transmitted via a SIBx (x is integer value from 1 to 20) or a RRC signalling.
- 5 [00123] Referring to Fig. 7, the network device 120 is caused to perform a method 700 comprising steps of:
- transmitting 710 a message related to a first information field; and
 - receiving 720 a medium access control protocol data unit (MAC PDU) including one or more MAC subheaders.
- 10 [00124] In some examples of the embodiment, a MAC subheader of the one or more MAC subheaders may include a first indication field indicating an existence of the first information field in the MAC subheader.
- [00125] In the embodiments explained in Figs. 6 and 7, the first information field may indicate information associated with at least one of a common control channel (CCCH), a size of the CCCH service data unit (CCCH SDU) a device type, a device capability, or
- 15 scheduling information.
- [00126] The first indication field may be set to indicate the existence of the first information field or an existence of a second information field. For example, the first information field may be a new LCID and the second information field may be a legacy LCID field.
- 20 [00127] The MAC subheader may be an initial MAC subheader of the one or more MAC subheaders. The initial MAC subheader means the first MAC subheader (or the very first MAC subheader) included in the MAC PDU amongst the one or more MAC subheaders.
- [00128] In some examples, the MAC PDU may be transmitted via a message A (MsgA) or a Message 3 (Msg3) of a random access procedure.
- 25 [00129] In some examples, the MAC subheader may include a second indication field indicating 1) the size of CCCH SDU, or 2) the CCCH SDU or a MAC control element (MAC CE) is included in the MAC PDU.
- [00130] In some examples, the first indication field may be followed by the second indication field, and the second indication field may be followed by the new LCID field.
- 30 [00131] In some examples, the size of the first information field may be set one of 1 bit, 2

bits, 3 bits, 4 bits, 5 bits and 6 bits.

[00132] In some examples, the MAC subheader may include at least one reserved bit, the first indication field may be located at a second leftmost bit in the MAC subheader, and a size of the MAC subheader may be 1 byte.

- 5 [00133] In some examples, the MAC subheader may include at least one reserved bit, the first indication may be located at a leftmost bit in the MAC subheader, one of the at least one reserved bit may be located at a second leftmost bit or a third leftmost bit in the MAC subheader, and a size of the MAC subheader may be 1 byte.

- 10 [00134] The information associated with each or the combination of at least one of a common control channel (CCCH), a size of the CCCH service data unit (CCCH SDU) a device type, a device capability, or scheduling information is defined in a new LCID table (to be explained) corresponding to the new LCID field.

[00135] In some examples, the MAC subheader may consist of the at least one reserved field, the first indication field and the new LCID field.

- 15 [00136] In some examples, the MAC subheader may consist of the at least one reserved field, the first indication field, the second indication field, and the new LCID field.

[00137] In some examples, the MAC subheader may consist of the at least one reserved field, the first indication field, a format field, and the new LCID field.

- 20 [00138] In some examples, the device type may indicate at least one of a regular user device, a reduced capability user device, or an extended reduced capability user device.

[00139] In some examples, the scheduling information may indicate at least one of a repetition number, a buffer status, a power headroom, or a beam information.

- 25 [00140] One of the embodiments of the present disclosure provides a computer program medium comprising program instructions for causing an apparatus to perform one of the methods explained in Figs 6 and 7 and the description thereof. The apparatus may be the terminal device 110 or the network device 120.

[00141] In some examples of the one of the embodiments, the computer program medium may be a non-transitory computer readable medium.

- 30 [00142] The configured structure of the MAC subheaders may be referred to one of the MAC subheaders explained by Figs. 5(a) to 5(d). In addition, the MAC subheaders explained

by Figs. 3(a) to 3(d) may be used when the first indication field indicates the legacy LCID field or when the first indication field is set to '0'.

[00143] The MAC PDU configurations and transmissions according to the embodiments of the present disclosure are explained mainly for an uplink direction. However, the
5 embodiments can be extended to a downlink direction. For example, the method 600 may be performed by the network device 120 and the step 720 may be performed by the terminal device 110.

[00144] FIG. 8 illustrates an example of an apparatus 800 comprising means for performing
10 one or more of the example embodiments described above. For example, the apparatus 800 may be an apparatus such as, or comprising, or comprised in, the terminal device 110 or the network device 120, and support the embodiments described above.

[00145] The apparatus 800 may comprise, for example, a circuitry or a chipset applicable for realizing one or more of the example embodiments described above. The apparatus 800
15 may be an electronic device comprising one or more electronic circuitries. The apparatus 800 may comprise a communication control circuitry 810 such as at least one processor, and at least one memory 820 storing instructions 822 which, when executed by the at least one processor, cause the apparatus 800 to carry out one or more of the example embodiments described above, such as the embodiments explained by Figs 1 to 7 and the description
20 thereof. Such instructions 822 may, for example, include computer program code (software). The at least one processor and the at least one memory storing the instructions may provide the means for providing or causing the performance of any of the methods and/or blocks described above.

[00146] The processor is coupled to the memory 820. The processor is configured to read
25 and write data to and from the memory 820. The memory 820 may comprise one or more memory units. The memory units may be volatile or non-volatile. It is to be noted that there may be one or more units of non-volatile memory and one or more units of volatile memory or, alternatively, one or more units of non-volatile memory, or, alternatively, one or more units of volatile memory. Volatile memory may be for example random-access
30 memory (RAM), dynamic random-access memory (DRAM) or synchronous dynamic

random-access memory (SDRAM). Non-volatile memory may be for example read-only memory (ROM), programmable read-only memory (PROM), electronically erasable programmable read-only memory (EEPROM), flash memory, optical storage or magnetic storage. In general, memories may be referred to as non-transitory computer readable medium. The term “non-transitory,” as used herein, is a limitation of the medium itself (i.e., tangible, not a signal) as opposed to a limitation on data storage persistency (e.g., RAM vs. ROM). The memory 820 stores computer readable instructions that are executed by the processor. For example, non-volatile memory stores the computer readable instructions, and the processor executes the instructions using volatile memory for temporary storage of data and/or instructions.

[00147] The computer readable instructions may have been pre-stored to the memory 820 or, alternatively or additionally, they may be received, by the apparatus, via an electromagnetic carrier signal and/or may be copied from a physical entity such as a computer program product. Execution of the computer readable instructions causes the apparatus 800 to perform one or more of the functionalities described above.

[00148] The memory 820 may be implemented using any suitable data storage technology, such as semiconductor-based memory devices, flash memory, magnetic memory devices and systems, optical memory devices and systems, fixed memory and/or removable memory. The memory may comprise a configuration database for storing configuration data, such as a current neighbour cell list, and, in some example embodiments, structures of frames used in the detected neighbour cells.

[00149] In some example embodiments a non-transitory computer readable medium may be provided. The non-transitory computer readable medium may comprise instructions to perform the embodiments explained in Figures 4, 6 to 7 and the description thereof.

[00150] As one example, the non-transitory computer readable medium may comprise program instructions which, when executed by an apparatus, cause the apparatus to perform at least the following: configuring a medium access control protocol data unit, MAC PDU, including one or more MAC subheaders; and transmitting the MAC PDU. In this case, a MAC subheader of the one or more MAC subheaders includes a first indication field indicating an existence of a first information field in the MAC subheader, and the first

information field indicates information associated with at least one of a common control channel, CCCH, a size of the CCCH service data unit, CCCH SDU, a device type, a device capability, or scheduling information.

[00151] As the other example, a non-transitory computer readable medium may be provided. The non-transitory computer readable medium may comprise program instructions which, when executed by an apparatus, cause the apparatus to perform at least the following: transmitting a message related to a first information field; and receiving a medium access control protocol data unit, MAC PDU, including one or more MAC subheaders. In this case, a MAC subheader of the one or more MAC subheaders includes a first indication field indicating an existence of the first information field in the MAC subheader, and the first information field indicates information associated with at least one of a common control channel (CCCH) a size of the CCCH service data unit (CCCH SDU) a device type, a device capability, or scheduling information.

[00152] Referring back to Fig. 8, the apparatus 800 may further comprise or be connected to a communication interface 830, such as a radio unit, comprising hardware and/or software for realizing communication connectivity with one or more wireless communication devices according to one or more communication protocols. The communication interface 830 comprises at least one transmitter (Tx) and at least one receiver (Rx) that may be integrated to the apparatus 800 or that the apparatus 800 may be connected to. The communication interface 830 may provide means for performing some of the blocks for one or more example embodiments described above. The communication interface 830 may comprise one or more components, such as: power amplifier, digital front end (DFE), analog-to-digital converter (ADC), digital-to-analog converter (DAC), frequency converter, (de)modulator, and/or encoder/decoder circuitries, controlled by the corresponding controlling units.

[00153] The communication interface 830 provides the apparatus with radio communication capabilities to communicate in the wireless communication network. The communication interface may, for example, provide a radio interface to one or more wireless communication devices. The apparatus 800 may further comprise or be connected to another interface towards a core network such as the network coordinator apparatus or

AMF, and/or to the access nodes of the wireless communication network.

[00154] The apparatus 800 may further comprise a scheduler 840 that is configured to allocate radio resources. The scheduler 840 may be configured along with the communication control circuitry 810 or it may be separately configured.

5 [00155] It is to be noted that the apparatus 800 may further comprise various components not illustrated in FIG. 8. The various components may be hardware components and/or software components.

[00156] The techniques and methods described herein may be implemented by various
10 means. For example, these techniques may be implemented in hardware (one or more devices), firmware (one or more devices), software (one or more modules), or combinations thereof. For a hardware implementation, the apparatus(es) of example embodiments may be implemented within one or more application-specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic
15 devices (PLDs), field programmable gate arrays (FPGAs), graphics processing units (GPUs), processors, controllers, micro-controllers, microprocessors, other electronic units designed to perform the functions described herein, or a combination thereof. For firmware or software, the implementation can be carried out through modules of at least one chipset (for example procedures, functions, and so on) that perform the functions described herein.
20 The software codes may be stored in a memory unit and executed by processors. The memory unit may be implemented within the processor or externally to the processor. In the latter case, it can be communicatively coupled to the processor via various means, as is known in the art. Additionally, the components of the systems described herein may be rearranged and/or complemented by additional components in order to facilitate the
25 achievements of the various aspects, etc., described with regard thereto, and they are not limited to the precise configurations set forth in the given figures, as will be appreciated by one skilled in the art.

[00157] It will be obvious to a person skilled in the art that, as technology advances, the inventive concept may be implemented in various ways. The embodiments are not limited
30 to the example embodiments described above, but may vary within the scope of the claims.

Therefore, all words and expressions should be interpreted broadly, and they are intended to illustrate, not to restrict, the embodiments.

WHAT IS CLAIMED IS:**Listing of claims**

1. An apparatus comprising:
5 at least one processor; and
 at least one memory storing instructions that, when executed by the at least one processor, cause the apparatus at least to perform:
 configuring a medium access control protocol data unit, MAC PDU, including one or more MAC subheaders; and
10 transmitting the MAC PDU,
 wherein a MAC subheader of the one or more MAC subheaders includes a first indication field indicating an existence of a first information field in the MAC subheader, and
 wherein the first information field indicates information associated with at least one of a common control channel, CCCH, a size of the CCCH service data unit, CCCH SDU, a device
15 type, a device capability, or scheduling information.
2. The apparatus according to claim 1, wherein the apparatus is further caused to perform:
 receiving a message related to the first information field, and
20 wherein the MAC subheader is configured based on the message.
3. An apparatus comprising:
 at least one processor; and
 at least one memory storing instructions that, when executed by the at least one
25 processor, cause the apparatus at least to perform:
 transmitting a message related to a first information field; and
 receiving a medium access control protocol data unit, MAC PDU, including one or more MAC subheaders,
 wherein a MAC subheader of the one or more MAC subheaders includes a first
30 indication field indicating an existence of the first information field in the MAC subheader,
 and
 wherein the first information field indicates information associated with at least one of a common control channel, CCCH, a size of the CCCH service data unit, CCCH SDU, a device
 type, a device capability, or scheduling information.
35
4. The apparatus according to any one of claims 1 to 3, wherein the first indication field indicates the existence of the first information field or an existence of a second information field.

5. The apparatus according to claim 4, wherein the first information field is a new logical control channel identification, LCID, and the second information field is a legacy LCID field.

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6. The apparatus according to any one of claims 1 to 5, wherein the MAC subheader is an initial MAC subheader of the one or more MAC subheaders.

7. The apparatus according to any one of claims 1 to 6, wherein the MAC PDU is transmitted via a message A, MsgA, or a Message 3, Msg3, of a random access procedure.

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8. The apparatus according to any one of claims 1 to 7, wherein the MAC subheader includes a second indication field indicating 1) the size of CCCH SDU, or 2) the CCCH SDU or a MAC control element, CE is included in the MAC PDU, and

15

wherein the first indication field is followed by the second indication field, and the second indication field is followed by the new LCID field.

9. The apparatus according to any one of claims 1 to 8, wherein a size of the first information field is one of 1 bit, 2 bits, 3 bits, 4 bits, 5 bits, and 6 bits.

20

10. The apparatus according to claim 9, wherein:

the MAC subheader includes at least one reserved bit,

the first indication field is located at a second leftmost bit in the MAC subheader, and a size of the MAC subheader is 1 byte.

25

11. The apparatus according to claim 9, wherein:

the MAC subheader includes at least one reserved bit,

the first indication is located at a leftmost bit in the MAC subheader,

one of the at least one reserved bit is located at a second leftmost bit or a third

leftmost bit in the MAC subheader, and

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a size of the MAC subheader is 1 byte.

12. The apparatus according to any one of claims 1 to 11, wherein the device type indicates at least one of a regular user device, a reduced capability user device, or an extended reduced capability user device; and

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wherein the scheduling information indicates at least one of a repetition number, a buffer status, a power headroom, or a beam information.

13. A method comprising:
configuring a medium access control protocol data unit, MAC PDU, including one or more MAC subheaders; and
transmitting the MAC PDU,
5 wherein a MAC subheader of the one or more MAC subheaders includes a first indication field indicating an existence of a first information field in the MAC subheader, and
wherein the first information field indicates information associated with at least one of a common control channel, CCCH, a size of the CCCH service data unit, CCCH SDU, a device type, a device capability, or scheduling information.
- 10 14. The method according to claim 13, comprising:
receiving a message related to the first information field,
wherein the MAC subheader is configured based on the message.
- 15 15. A method comprising:
transmitting a message related to a first information field; and
receiving a medium access control protocol data unit, MAC PDU, including one or more MAC subheaders,
wherein a MAC subheader of the one or more MAC subheaders includes a first
20 indication field indicating an existence of the first information field in the MAC subheader, and
wherein the first information field indicates information associated with at least one of a common control channel, CCCH, a size of the CCCH service data unit, CCCH SDU, a device type, a device capability, or scheduling information.
- 25 16. The method according to any one of claims 13 to 15, wherein the first indication field indicates the existence of the first information field or an existence of a second information field.
- 30 17. The method according to claim 16, wherein the first information field is a new logical control channel identification, LCID, and the second information field is a legacy LCID field.
- 35 18. The method according to any one of claims 13 to 19, wherein the MAC subheader is an initial MAC subheader of the one or more MAC subheaders.
19. The method according to any one of claims 13 to 18, wherein the MAC PDU is transmitted via a message A, MsgA, or a Message 3, Msg3, of a random access procedure.

20. The method according to any one of claims 13 to 19, wherein the MAC subheader includes a second indication field indicating 1) the size of CCCH SDU, or 2) the CCCH SDU or a MAC control element, CE is included in the MAC PDU, and

5 wherein the first indication field is followed by the second indication field, and the second indication field is followed by the new LCID field.

21. The method according to any one of claims 13 to 20, wherein a size of the first information field is one of 1 bit, 2 bits, 3 bits, 4 bits, 5 bits, and 6 bits.

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22. The method according to claim 21, wherein:
the MAC subheader includes at least one reserved bit,
the first indication field is located at a second leftmost bit in the MAC subheader, and
a size of the MAC subheader is 1 byte.

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23. The method according to claim 21, wherein:
the MAC subheader includes at least one reserved bit,
the first indication is located at a leftmost bit in the MAC subheader,
one of the at least one reserved bit is located at a second leftmost bit or a third
20 leftmost bit in the MAC subheader, and
a size of the MAC subheader is 1 byte.

24. A computer program medium comprising program instructions for causing an apparatus to perform the method of claims 13 to 23.

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25. The computer program medium according to claim 24, wherein the computer program medium is a non-transitory computer readable medium.

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