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(54) Title: PROCEDURES FOR REPORTING BUFFER STATUS

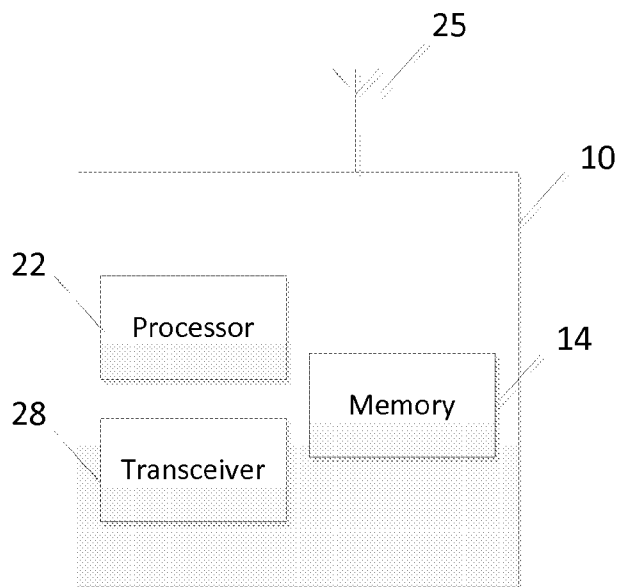


Fig. 1a

(57) Abstract: Systems, methods, apparatuses, and computer program products for reporting buffer status. One method includes determining, by a network node, at least one condition for triggering sending of a buffer status report scheduling request (BSR-SR), and determining whether sending of a medium access control layer buffer status report (MAC BSR) should also be triggered based on the at least one condition. The method may then include triggering transmission of the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR) when the at least one condition is met. The triggering may include configuring a user equipment with the determined triggers.



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PROCEDURES FOR REPORTING BUFFER STATUS

BACKGROUND:

Field:

[0001] Embodiments of the invention generally relate to wireless communications networks, such as, but not limited to, the Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access Network (UTRAN), Long Term Evolution (LTE) Evolved UTRAN (E-UTRAN), LTE-Advanced (LTE-A), and/or 5G radio access technology. Some embodiments may generally relate to transmitting buffer status report(s).

Description of the Related Art:

[0002] Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access Network (UTRAN) refers to a communications network including base stations, or Node Bs, and for example radio network controllers (RNC). UTRAN allows for connectivity between the user equipment (UE) and the core network. The RNC provides control functionalities for one or more Node Bs. The RNC and its corresponding Node Bs are called the Radio Network Subsystem (RNS). In case of E-UTRAN (enhanced UTRAN), no RNC exists and most of the RNC functionalities are contained in the evolved Node B (eNodeB or eNB).

[0003] Long Term Evolution (LTE) or E-UTRAN refers to improvements of the UMTS through improved efficiency and services, lower costs, and use of new spectrum opportunities. In particular, LTE is a 3GPP standard that provides for uplink peak rates of at least, for example, 75 megabits per second (Mbps) per carrier and downlink peak rates of at least, for example, 300 Mbps per carrier. LTE supports scalable carrier bandwidths from 20 MHz down to 1.4 MHz and supports both Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD).

[0004] As mentioned above, LTE may also improve spectral efficiency in networks, allowing carriers to provide more data and voice services over a given bandwidth. Therefore, LTE is designed to fulfill the needs for high-speed data and media transport in addition to high-capacity voice support. Advantages of LTE include, for example, high throughput, low latency, FDD and TDD support in the same platform, an improved end-user experience, and a simple architecture resulting in low operating costs.

[0005] Certain releases of 3GPP LTE (e.g., LTE Rel-10, LTE Rel-11, LTE Rel-12, LTE Rel-13) are targeted towards international mobile telecommunications advanced (IMT-A) systems, referred to herein for convenience simply as LTE-Advanced (LTE-A).

[0006] LTE-A is directed toward extending and optimizing the 3GPP LTE radio access technologies. A goal of LTE-A is to provide significantly enhanced services by means of higher data rates and lower latency with reduced cost. LTE-A is a more optimized radio system fulfilling the international telecommunication union-radio (ITU-R) requirements for IMT-Advanced while keeping the backward compatibility. One the key features of LTE-A, introduced in LTE Rel-10, is carrier aggregation, which allows for increasing the data rates through aggregation of two or more LTE carriers.

SUMMARY:

[0007] One embodiment is directed to a method which may include determining, by a network node, at least one condition for triggering sending of a buffer status report scheduling request (BSR-SR). The method may also include determining whether sending of a medium access control layer buffer status report (MAC BSR) should also be triggered based on the at least one condition. The method may then include triggering transmission of the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR) when the at least one

condition is met, wherein the triggering comprises configuring a user equipment with the determined triggers.

[0008] Another embodiment is directed to an apparatus that includes at least one processor and at least one memory comprising computer program code. The at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus at least to determine at least one condition for triggering sending of a buffer status report scheduling request (BSR-SR), to determine whether sending of a medium access control layer buffer status report (MAC BSR) should also be triggered based on the at least one condition, and to trigger transmission of the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR) when the at least one condition is met, wherein the triggering comprises configuring a user equipment with the determined triggers.

[0009] Another embodiment is directed to an apparatus which may include determining means for determining at least one condition for triggering sending of a buffer status report scheduling request (BSR-SR), determining whether sending of a medium access control layer buffer status report (MAC BSR) should also be triggered based on the at least one condition, and triggering means for triggering transmission of the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR) when the at least one condition is met, wherein the triggering comprises configuring a user equipment with the determined triggers.

[0010] Another embodiment is directed to a computer program embodied on a computer readable medium. The computer program may be configured to control a processor to perform a process that includes determining at least one condition for triggering sending of a buffer status report scheduling request (BSR-SR). The process may also include determining whether sending of a medium access control layer buffer status report (MAC BSR)

should also be triggered based on the at least one condition. The process may then include triggering transmission of the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR) when the at least one condition is met, wherein the triggering comprises configuring a user equipment with the determined triggers.

[0011] Another embodiment is directed to a method which may include receiving, by a user equipment, a trigger for transmission of a buffer status report scheduling request (BSR-SR) and/or a medium access control layer buffer status report (MAC BSR) based on at least one condition. The method may also include transmitting the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR).

[0012] Another embodiment is directed to an apparatus that includes at least one processor and at least one memory comprising computer program code. The at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus at least to receive a trigger for transmission of a buffer status report scheduling request (BSR-SR) and/or a medium access control layer buffer status report (MAC BSR) based on at least one condition, and to transmit the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR).

[0013] Another embodiment is directed to an apparatus that may include receiving means for receiving a trigger for transmission of a buffer status report scheduling request (BSR-SR) and/or a medium access control layer buffer status report (MAC BSR) based on at least one condition, and transmitting means for transmitting the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR).

[0014] Another embodiment is directed to a computer program embodied on a computer readable medium. The computer program may be configured to control a processor to perform a process that includes receiving a trigger for transmission of a buffer status report scheduling request (BSR-SR) and/or a medium access control layer buffer status report (MAC BSR) based on at least one condition. The process may also include transmitting the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR).

BRIEF DESCRIPTION OF THE DRAWINGS:

[0015] For proper understanding of the invention, reference should be made to the accompanying drawings, wherein:

[0016] Fig. 1a illustrates a block diagram of an apparatus, according to one embodiment;

[0017] Fig. 1b illustrates a block diagram of an apparatus, according to another embodiment;

[0018] Fig. 2a illustrates a flow diagram of a method, according to one embodiment; and

[0019] Fig. 2b illustrates a flow diagram of a method, according to another embodiment.

DETAILED DESCRIPTION:

[0020] It will be readily understood that the components of the invention, as generally described and illustrated in the figures herein, may be arranged and designed in a wide variety of different configurations. Thus, the following detailed description of embodiments of systems, methods, apparatuses, and computer program products for reporting buffer status, as represented in the attached figures, is not intended to limit the scope of the invention, but is merely representative of some selected embodiments of the invention.

[0021] The features, structures, or characteristics of the invention described throughout this specification may be combined in any suitable manner in one or more embodiments. For example, the usage of the phrases “certain embodiments,” “some embodiments,” or other similar language, throughout this specification refers to the fact that a particular feature, structure, or characteristic described in connection with the embodiment may be included in at least one embodiment of the present invention. Thus, appearances of the phrases “in certain embodiments,” “in some embodiments,” “in other embodiments,” or other similar language, throughout this specification do not necessarily all refer to the same group of embodiments, and the described features, structures, or characteristics may be combined in any suitable manner in one or more embodiments.

[0022] Additionally, if desired, the different functions discussed below may be performed in a different order and/or concurrently with each other. Furthermore, if desired, one or more of the described functions may be optional or may be combined. As such, the following description should be considered as merely illustrative of the principles, teachings and embodiments of this invention, and not in limitation thereof.

[0023] Embodiments of the invention may relate to the future 5G radio access technology and may also be applicable to other technologies like LTE-A. One potential enhancement in 5G is directed to configuring physical layer resources for fast transmission of scheduling request(s) accompanied with additional information to improve latency of initial resource allocation. The additional information could include buffer status—an indication of the amount of available data to be transmitted that a UE currently has in at least one of the L2 buffers or priority queues of the corresponding L2 configured logical channels or logical channel groups. This new request or message may be referred to as a buffer status report – scheduling request (BSR-SR).

[0024] Information other than BSR, such as grant request type (periodical/non-periodical), channel quality indicator (CQI) or a power

headroom report, may also be included or mapped to this message. It is assumed that, since this resource would be dedicated (as scheduling request (SR)) and periodically/semi-statically available, it would not be able to carry too much data. In other words, BSR-RS is a physical layer signaling message which is sent on dedicated physical layer resources in a preconfigured manner (e.g., a predefined physical control channel). It is expected that physical layer signaling should be rather short in terms of the number of bits.

[0025] These physical layer resources may be configured in a similar manner as currently done for ACK/NACK and channel quality indicator (CQI) in 3GPP TS 36.211 physical uplink control channel (PUCCH) formats (table 5.4-1). An example is shown below as TABLE 1. BSR-SR resources may be configured as a new PUCCH format.

TABLE 1: Supported PUCCH formats

PUCCH format	Modulation scheme	Number of bits per subframe, M_{bit}
1	N/A	N/A
1a	BPSK	1
1b	QPSK	2
2	QPSK	20
2a	QPSK+BPSK	21
2b	QPSK+QPSK	22
3	QPSK	48

[0026] An alternative way could be to configure the aforementioned BSR-SR resources more flexibly to physical uplink shared channel (PUSCH) in similar manner as random access channel (RACH) resources. The use of these resources may be a sequenced based so that transmitted sequences provide code division multiplexing (CDM) as is done in PUCCH or in OFDMA/TDMA manner multiplexing users in time-frequency grid.

[0027] However, regardless how the BSR-SR resources are mapped to physical layer resource it would be expected that these resources would have some level of periodicity and predictability.

[0028] Considering potential enhancements for indicating L2 buffer status and scheduling request together on dedicated L1 resources in 5G radio

access networks as described above, specific conditions or triggers should be controlled and applied for sending L1 BSR-SR and MAC layer BSR so as to avoid waste of resources as well as unnecessary UL transmissions which may cause unnecessary interference.

[0029] Additionally, L1 resources for reporting BSR-SR may not always be available with the same periodicity as SR resources (due to the different resource requirement and, thus, BSR-SR resources may be available when explicitly indicated). Hence, specific rules may need to be set for the cases when to trigger transmission of SR / BSR-SR when both are configured.

[0030] Therefore, certain embodiments of the invention provide a method for determining triggering of buffer status reports utilizing BSR-SR and/or MAC BSR mechanisms. In addition, some embodiments are directed to applying a set of rules to conditionally use MAC BSR and BSR-SR when BSR has been triggered in the UE.

[0031] It is noted that, herein, the L1 buffer status report is referred to as BSR-SR, and MAC layer indication of buffer status is referred to as BSR or L2 BSR.

[0032] In one embodiment, the network (e.g., eNB or 5G access point) may dynamically indicate the BSR-SR resources when the UE is requested to enter discontinuous reception (DRX), for example in enhanced DRX command. This enhanced DRX command may indicate the L1 resources explicitly by indicating, e.g., resource index (similar to SR allocation on PUCCH resources) or indicate availability (1 bit indication) of such resources in DRX; when the UE may derive such resources based on, for example, its ID (e.g., radio network temporary identifier (RNTI)) and/or system frame number / subframe number or DRX cycle related parameters when DRX starts.

[0033] Alternatively, such L1 BSR resources may have been configured during initial access by higher layers (such as radio resource control (RRC))

and activated by media access control (MAC) layer message when UE enters DRX or receives DRX command. In case of dynamically assigned BSR-SR resources, sending a MAC BSR releases BSR-SR resources (UE may receive UL grant for MAC BSR earlier than BSR-SR resources become available or it may transmit it on UL contention based channel).

[0034] This embodiment enables fast initiation of a data connection from DRX. In addition, indicating of amount of data in the buffer in the scheduling request enables eNB to determine more accurately the sufficient allocation for UE. Configuring BSR-SR resources dynamically allows the network to utilize resources more efficiently and on need basis.

[0035] According to one embodiment, when BSR-SR transmission is triggered, it triggers a MAC Buffer Status Report (BSR) to be sent on the next UL grant with the following possible extensions. In an embodiment, in case there is no room in MAC PDU to report regular BSR (with separated buffers for each logical channel group (LCG)/logical channel (LC)), the UE reports only the buffer status of the highest priority logical channel or the LCG including the highest priority LC which has data available in the MAC BSR. Alternatively, in another embodiment, in case BSR-SR is transmitted, it triggers only MAC BSR for highest priority logical channel or the LCG including the highest priority LC which has data available. Alternatively, in yet another embodiment, in case BSR-SR is transmitted and the UE has data in only one LCG, it does not report the MAC BSR or it reports the MAC BSR with all the data available for transmission. Alternatively, in another embodiment, in case BSR-SR is transmitted and the UE has data in multiple LCGs, one of the LCGs' buffers is not reported (e.g., the LCG having lowest priority LCs with data); the UE may still indicate all the LCGs having data in the MAC BSR.

[0036] It is noted that all the above cases may also include the option that BSR-SR is transmitted in the same time transmission interval (TTI) as the

said UL grant (within the TTI, UL data resources may be located before UL control resources i.e., BSR-SR resources).

[0037] A BSR-SR may have limited amount of bits available; thus, MAC BSR as described above provides more accurate report for each LCG while BSR-SR may report the total buffer status

[0038] According to an embodiment, when BSR-SR resources are configured, the network may configure the UE to allow use of BSR-SR resources only for specific LCG or LCGs or alternatively specific LC or LCs. In one option, when BSR-SR and SR resources are both configured, for other LCGs the UE may use normal SR plus MAC BSR. Since BSR-SR resources may not be able to carry much information in addition for amount of data in the buffer (e.g., LCG, of LC identifiers), having resources for pre-configured logical channels allows the network to know that high priority data has arrived to UE buffer.

[0039] In an embodiment, when BSR-SR has been transmitted and pending and no UL grant is available before new BSR-SR resources become available, the following is provided: If the buffer status has not changed N-bytes during the time since a BSR-SR was transmitted and new BSR-SR resources are available the UE is not allowed to use the resources; or, in case the buffer status of all LCGs was transmitted in the pending BSR-SR the UE may transmit the BSR of highest priority LC or alternatively the LCG including the highest priority LC which has data available (i.e., which LCG/LC is transmitted and N-byte thresholds may also be configured explicitly by network). One use case for this option may be that the network has sent UE DL data which will trigger UE feedback to be sent, the feedback resources (e.g., a specific PUCCH format) may incorporate the BSR-SR resources.

[0040] In another embodiment, when SR is pending (*sr-ProhibitTimer running*) and BSR-SR resources are available, the following is provided: the UE ignores *sr-ProhibitTimer* and transmits BSR-SR; or, alternatively the

network may configure to allow UE to ignore *sr-ProhibitTimer* if specific LCG or LCGs have new data available. When new data is available for the said LCG(s) the BSR-SR includes the buffer status only of the said LCG(s) or the highest priority LCG. Since prohibit timers prevent user to unnecessarily request again resources (e.g. the eNB may have already processed the earlier request, or in the case of SPS), it may be beneficial to provide additional information rather than just SR indication (e.g., buffer status, CQI, power headroom).

[0041] According to one embodiment when BSR-SR and SR resources are located inside the configured time window (N-subframes) and SR resource is available first, the UE may defer the SR transmission and wait for the SR-BSR resource. In one embodiment, the deferring may also depend on which LCG is having data, or on the amount of data in the buffer (below/above threshold). For instance, if the amount of data available to transmit is below threshold, it will send SR, otherwise it will wait for BSR-SR resource. This avoids unnecessary triggering of multiple scheduling requests in too short intervals.

[0042] In one embodiment, when PUCCH feedback which included the BSR-SR resources is transmitted in response to DL assignment and the reported feedback is ACK, in case the eNB schedules an adaptive re-transmission of the said DL assignment, the UE will trigger BSR-SR and/or MAC BSR. BSR is re-triggered/transmitted since the UE notices an ACK to NACK error has occurred and the BSR included in the feedback was not received correctly.

[0043] In another embodiment, the BSR-SR format may have bitmap of LCs/LCGs which have data, the BSR-SR indicates scheduling request per logical channel (or group). This allows the eNB to do scheduling decisions based on the priority. The LCs/LCGs included in the bitmap may be configured dynamically by the network using MAC or RRC signaling or such bitmap may be fixed.

[0044] Fig. 1a illustrates an example of an apparatus 10 according to an embodiment. In an embodiment, apparatus 10 may be a node, host, or server in a communications network or serving such a network. For example, in certain embodiments, apparatus 10 may be a network node or access node for a radio access network, such as a base station in UMTS or eNB in LTE or LTE-A. However, in other embodiments, apparatus 10 may be other components within a radio access network. It should be noted that one of ordinary skill in the art would understand that apparatus 10 may include components or features not shown in Fig. 1a.

[0045] As illustrated in Fig. 1a, apparatus 10 includes a processor 22 for processing information and executing instructions or operations. Processor 22 may be any type of general or specific purpose processor. While a single processor 22 is shown in Fig. 1a, multiple processors may be utilized according to other embodiments. In fact, processor 22 may include one or more of general-purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs), field-programmable gate arrays (FPGAs), application-specific integrated circuits (ASICs), and processors based on a multi-core processor architecture, as examples.

[0046] Apparatus 10 may further include or be coupled to a memory 14 (internal or external), which may be coupled to processor 22, for storing information and instructions that may be executed by processor 22. Memory 14 may be one or more memories and of any type suitable to the local application environment, and may be implemented using any suitable volatile or nonvolatile data storage technology such as a semiconductor-based memory device, a magnetic memory device and system, an optical memory device and system, fixed memory, and removable memory. For example, memory 14 can be comprised of any combination of random access memory (RAM), read only memory (ROM), static storage such as a magnetic or optical disk, or any other type of non-transitory machine or computer readable media. The instructions stored in memory 14 may

include program instructions or computer program code that, when executed by processor 22, enable the apparatus 10 to perform tasks as described herein.

[0047] In some embodiments, apparatus 10 may also include or be coupled to one or more antennas 25 for transmitting and receiving signals and/or data to and from apparatus 10. Apparatus 10 may further include or be coupled to a transceiver 28 configured to transmit and receive information. For instance, transceiver 28 may be configured to modulate information on to a carrier waveform for transmission by the antenna(s) 25 and demodulate information received via the antenna(s) 25 for further processing by other elements of apparatus 10. In other embodiments, transceiver 28 may be capable of transmitting and receiving signals or data directly.

[0048] Processor 22 may perform functions associated with the operation of apparatus 10 which may include, for example, precoding of antenna gain/phase parameters, encoding and decoding of individual bits forming a communication message, formatting of information, and overall control of the apparatus 10, including processes related to management of communication resources.

[0049] In an embodiment, memory 14 may store software modules that provide functionality when executed by processor 22. The modules may include, for example, an operating system that provides operating system functionality for apparatus 10. The memory may also store one or more functional modules, such as an application or program, to provide additional functionality for apparatus 10. The components of apparatus 10 may be implemented in hardware, or as any suitable combination of hardware and software.

[0050] In one embodiment, apparatus 10 may be a network node or access node, such as a base station in UMTS or an eNB in LTE or LTE-A, for example. According to certain embodiments, apparatus 10 may be controlled by memory 14 and processor 22 to determine at least one condition

for triggering the sending of a buffer status report scheduling request (BSR-SR), and to determine whether a sending of a medium access control layer buffer status report (MAC BSR) should also be triggered based on the at least one condition. In an embodiment, apparatus 10 may be further controlled by memory 14 and processor 22 to trigger transmission of the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR) when the at least one condition is met. According to one embodiment, the triggering may also include configuring a user equipment with the determined triggers.

[0051] In an embodiment, when a user equipment is requested to enter discontinuous reception (DRX), apparatus 10 may be controlled by memory 14 and processor 22 to dynamically indicate BSR-SR resources in an enhanced DRX command. The DRX command may indicate one or more of the following: layer 1 resources by indicating resource index or indicate availability of resources in DRX, when the user equipment may derive the resources based on an identifier of the user equipment and/or system frame number or DRX cycle related parameters when DRX starts.

[0052] In one embodiment, sending the MAC BSR may release BSR-SR resources. In certain embodiments, BSR-SR resources may be configured during initial access by higher layers and activated by MAC layer message when a user equipment enters DRX or receives DRX command.

[0053] According to an embodiment, when BSR-SR transmission is triggered, apparatus 10 may be controlled by memory 14 and processor 22 to trigger MAC BSR to be sent on a next uplink grant. In one embodiment, when BSR-SR resources are configured, apparatus 10 may be controlled by memory 14 and processor 22 to configure a user equipment to allow use of BSR-SR resources only for specific logical channel group(s) or for specific logical channel(s).

[0054] In an embodiment, when the BSR-SR has been transmitted and pending and no uplink grant is available before new BSR-SR resources

become available, apparatus 10 may be controlled by memory 14 and processor 22 to prevent user equipment from using the resources when the buffer status has not changed N-bytes during a time since a BSR-SR was transmitted and new BSR-SR resources are available. Alternatively, when buffer status of all logical channel groups was transmitted in the pending BSR-SR, apparatus 10 may be controlled by memory 14 and processor 22 to allow the user equipment to transmit the BSR of highest priority logical channel or the logical channel group including the highest priority logical channel which has data available.

[0055] In certain embodiments, when a scheduling request is pending, sr-ProhibitTimer is running, and BSR-SR resources are available, apparatus 10 may be controlled by memory 14 and processor 22 to allow user equipment to ignore sr-ProhibitTimer and to transmit BSR-SR, or to allow user equipment to ignore sr-ProhibitTimer when specific logical channel group(s) have new data available and to transmit BSR-SR including buffer status of only said specific logical channel group(s) or of highest priority logical channel group.

[0056] According to an embodiment, when BSR-SR and scheduling request resources are located inside configured time window and scheduling request resource is available first, apparatus 10 may be controlled by memory 14 and processor 22 to allow user equipment to defer the scheduling request transmission and wait for the BSR-SR resource. In one embodiment, the BSR-SR format has a bitmap of logical channels or logical channel groups which have data, and the BSR-SR indicates scheduling request per logical channel or logical channel group. In an embodiment, the LCs/LCGs included in the bitmap may be configured dynamically by the apparatus 10 using MAC or RRC signaling or the bitmap may be fixed.

[0057] Fig. 5b illustrates an example of an apparatus 20 according to another embodiment. In an embodiment, apparatus 20 may be a node or element in a communications network or associated with such a network, such as a UE, mobile device, mobile unit, a machine type UE or other device. For

instance, in some embodiments, apparatus 20 may be UE in LTE or LTE-A. It should be noted that one of ordinary skill in the art would understand that apparatus 20 may include components or features not shown in Fig. 5b.

[0058] As illustrated in Fig. 5b, apparatus 20 includes a processor 32 for processing information and executing instructions or operations. Processor 32 may be any type of general or specific purpose processor. While a single processor 32 is shown in Fig. 5b, multiple processors may be utilized according to other embodiments. In fact, processor 32 may include one or more of general-purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs), field-programmable gate arrays (FPGAs), application-specific integrated circuits (ASICs), and processors based on a multi-core processor architecture, as examples.

[0059] Apparatus 20 may further include or be coupled to a memory 34 (internal or external), which may be coupled to processor 32, for storing information and instructions that may be executed by processor 32. Memory 34 may be one or more memories and of any type suitable to the local application environment, and may be implemented using any suitable volatile or nonvolatile data storage technology such as a semiconductor-based memory device, a magnetic memory device and system, an optical memory device and system, fixed memory, and removable memory. For example, memory 34 can be comprised of any combination of random access memory (RAM), read only memory (ROM), static storage such as a magnetic or optical disk, or any other type of non-transitory machine or computer readable media. The instructions stored in memory 34 may include program instructions or computer program code that, when executed by processor 32, enable the apparatus 20 to perform tasks as described herein.

[0060] In some embodiments, apparatus 20 may also include or be coupled to one or more antennas 35 for transmitting and receiving signals and/or data to and from apparatus 20. Apparatus 20 may further include a transceiver 38

configured to transmit and receive information. For instance, transceiver 38 may be configured to modulate information on to a carrier waveform for transmission by the antenna(s) 35 and demodulate information received via the antenna(s) 35 for further processing by other elements of apparatus 20. In other embodiments, transceiver 38 may be capable of transmitting and receiving signals or data directly.

[0061] Processor 32 may perform functions associated with the operation of apparatus 20 including, without limitation, precoding of antenna gain/phase parameters, encoding and decoding of individual bits forming a communication message, formatting of information, and overall control of the apparatus 20, including processes related to management of communication resources.

[0062] In an embodiment, memory 34 stores software modules that provide functionality when executed by processor 32. The modules may include, for example, an operating system that provides operating system functionality for apparatus 20. The memory may also store one or more functional modules, such as an application or program, to provide additional functionality for apparatus 20. The components of apparatus 20 may be implemented in hardware, or as any suitable combination of hardware and software.

[0063] As mentioned above, according to one embodiment, apparatus 20 may be a mobile device, such as a UE in LTE or LTE-A. In one embodiment, apparatus 20 may be controlled by memory 34 and processor 32 to receive a trigger for transmission of a buffer status report scheduling request (BSR-SR) and/or a medium access control layer buffer status report (MAC BSR) based on at least one condition, and to transmit the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR).

[0064] According to one embodiment, apparatus 20 may be controlled by memory 34 and processor 32 to receive a dynamic indication of BSR-SR

resources in an enhanced DRX command, when the apparatus is requested to enter discontinuous reception (DRX). In one embodiment, apparatus 20 may also be controlled by memory 34 and processor 32 to release BSR-SR resources triggered by the transmitting of the MAC BSR.

[0065] In certain embodiments, BSR-SR resources may be configured during initial access by higher layers and activated by MAC layer message when the apparatus 20 enters DRX or receives DRX command. According to an embodiment, when BSR-SR transmission is triggered, apparatus 20 may be controlled by memory 34 and processor 32 to trigger transmitting of the MAC BSR on a next uplink grant.

[0066] According to some embodiments, when there is no space in MAC packet data unit (PDU) to report regular BSR, apparatus 20 may also be controlled by memory 34 and processor 32 to report only the buffer status of the highest priority logical channel or the logical channel group including the highest priority logical channel which has data available in the MAC BSR. Alternatively, when the BSR-SR is transmitted, apparatus 20 may also be controlled by memory 34 and processor 32 to trigger transmitting of only MAC BSR for highest priority logical channel or the logical channel group including the highest priority logical channel which has data available. As another alternative, when the BSR-SR is transmitted and the apparatus has data in only one logical channel group, apparatus 20 may also be controlled by memory 34 and processor 32 to not report the MAC BSR or reporting the MAC BSR with all the data available for transmission. As yet another alternative, when the BSR-SR is transmitted and the apparatus has data in multiple logical channel groups, a buffer of the logical channel group with a lowest priority is not reported.

[0067] In certain embodiments, when a scheduling request is pending, sr-ProhibitTimer is running, and BSR-SR resources are available, apparatus 20 may also be controlled by memory 34 and processor 32 to ignore sr-ProhibitTimer and transmitting BSR-SR, or to ignore sr-ProhibitTimer when

specific logical channel group(s) have new data available and transmitting BSR-SR including buffer status of only said specific logical channel group(s) or of highest priority logical channel group.

[0068] According to some embodiments, when BSR-SR and scheduling request resources are located inside configured time window and scheduling request resource is available first, apparatus 20 may also be controlled by memory 34 and processor 32 to defer the scheduling request transmission and waiting for the BSR-SR resource. In an embodiment, the deferring of the scheduling request transmission may depend on which logical channel group contains data or on an amount of data available in the buffer.

[0069] In certain embodiments, when physical uplink control channel (PUCCH) feedback including the BSR-SR resources is transmitted in response to downlink assignment and reported feedback is ACK, apparatus 20 may also be controlled by memory 34 and processor 32 to re-transmit BSR-SR and/or MAC BSR. According to one embodiment, the BSR-SR format has a bitmap of logical channel groups which have data, and the BSR-SR indicates scheduling request per logical channel or logical channel group.

[0070] Fig. 2a illustrates an example flow diagram of a method for triggering and/or reporting buffer status, according to one embodiment of the invention. In certain embodiments, the method of Fig. 2a may be performed by a network node, such as a base station or eNB. As illustrated in Fig. 2a, the method may include, at 200, determining at least one condition for triggering the sending of a buffer status report scheduling request (BSR-SR). The method may also include, at 205, determining whether sending of a medium access control layer buffer status report (MAC BSR) should also be triggered based on the at least one condition. The method may then include, at 210, triggering transmission of the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR) when the at least one condition is met. In an embodiment, the triggering may include configuring a user equipment with the determined triggers.

[0071] In an embodiment, the triggering may further comprise, when a user equipment is requested to enter discontinuous reception (DRX), dynamically indicating BSR-SR resources in an enhanced DRX command. The DRX command may indicate one or more of the following: layer 1 resources by indicating resource index or indicate availability of resources in DRX, when the user equipment may derive the resources based on an identifier of the user equipment and/or system frame number or DRX cycle related parameters when DRX starts. In an embodiment, sending the MAC BSR releases BSR-SR resources.

[0072] In another embodiment, BSR-SR resources may be configured during initial access by higher layers and activated by MAC layer message when a user equipment enters DRX or receives DRX command.

[0073] According to an embodiment, when BSR-SR transmission is triggered, the triggering further comprises triggering MAC BSR to be sent on a next uplink grant. In certain embodiments, the method may further include, when BSR-SR resources are configured, configuring a user equipment to allow use of BSR-SR resources only for specific logical channel group(s) or for specific logical channel(s).

[0074] In certain embodiments, when the BSR-SR has been transmitted and pending and no uplink grant is available before new BSR-SR resources become available, the method may further include preventing user equipment from using the resources when the buffer status has not changed N-bytes during a time since a BSR-SR was transmitted and new BSR-SR resources are available. Alternatively, when buffer status of all logical channel groups was transmitted in the pending BSR-SR, the method may also include allowing the user equipment to transmit the BSR of highest priority logical channel or the logical channel group including the highest priority logical channel which has data available.

[0075] In some embodiments, when a scheduling request is pending, sr-ProhibitTimer is running, and BSR-SR resources are available, the method may further include allowing user equipment to ignore sr-ProhibitTimer and to transmit BSR-SR, or allowing user equipment to ignore sr-ProhibitTimer when specific logical channel group(s) have new data available and to transmit BSR-SR including buffer status of only said specific logical channel group(s) or of highest priority logical channel group.

[0076] According to an embodiment, when BSR-SR and scheduling request resources are located inside configured time window and scheduling request resource is available first, the method may further include allowing user equipment to defer the scheduling request transmission and wait for the BSR-SR resource. In one embodiment, the BSR-SR format has a bitmap of logical channel groups which have data, and the BSR-SR indicates scheduling request per logical channel or logical channel group.

[0077] Fig. 2b illustrates an example flow diagram of a method for triggering and/or reporting buffer status, according to one embodiment of the invention. In certain embodiments, the method of Fig. 2b may be performed by a device, such as a UE in LTE or LTE-A. As illustrated in Fig. 2b, the method may include, at 250, receiving, by a user equipment, a trigger for transmission of a buffer status report scheduling request (BSR-SR) and/or a medium access control layer buffer status report (MAC BSR) based on at least one condition. The method may also include, at 260, transmitting the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR).

[0078] In an embodiment, the receiving may further include receiving a dynamic indication of BSR-SR resources in an enhanced DRX command, when the user equipment is requested to enter discontinuous reception (DRX). According to one embodiment, the transmitting of the MAC BSR releases BSR-SR resources.

[0079] In one embodiment, BSR-SR resources are configured during initial access by higher layers and activated by MAC layer message when the user equipment enters DRX or receives DRX command. According to an embodiment, when BSR-SR transmission is triggered, the transmitting may further include triggering transmitting of the MAC BSR on a next uplink grant.

[0080] According to some embodiments, when there is no space in MAC packet data unit (PDU) to report regular BSR, the method may include reporting only the buffer status of the highest priority logical channel or the logical channel group including the highest priority logical channel which has data available in the MAC BSR. Alternatively, when the BSR-SR is transmitted, the method may include triggering transmitting of only MAC BSR for highest priority logical channel or the logical channel group including the highest priority logical channel which has data available. As another alternative, when the BSR-SR is transmitted and the user equipment has data in only one logical channel group, the method may include not reporting the MAC BSR or reporting the MAC BSR with all the data available for transmission. As yet another alternative, when the BSR-SR is transmitted and the user equipment has data in multiple logical channel groups, a buffer of the logical channel group with a lowest priority is not reported.

[0081] In some embodiments, when a scheduling request is pending, sr-ProhibitTimer is running, and BSR-SR resources are available, the method may also include ignoring sr-ProhibitTimer and transmitting BSR-SR, or ignoring sr-ProhibitTimer when specific logical channel group(s) have new data available and transmitting BSR-SR including buffer status of only said specific logical channel group(s) or of highest priority logical channel group.

[0082] According to an embodiment, when BSR-SR and scheduling request resources are located inside configured time window and scheduling request resource is available first, the method may further include deferring the

scheduling request transmission and waiting for the BSR-SR resource. In one embodiment, the deferring may depend on which logical channel group contains data or on an amount of data available in the buffer.

[0083] In certain embodiments, when physical uplink control channel (PUCCH) feedback including the BSR-SR resources is transmitted in response to downlink assignment and reported feedback is ACK, the method may include re-transmitting BSR-SR and/or MAC BSR. According to an embodiment, the BSR-SR format has a bitmap of logical channel groups which have data, and the BSR-SR indicates scheduling request per logical channel or logical channel group.

[0084] According to embodiments, programs, also called program products or computer programs, including software routines, applets and macros, may be stored in any apparatus-readable data storage medium and they include program instructions to perform particular tasks. A computer program product may comprise one or more computer-executable components which, when the program is run, are configured to carry out embodiments. The one or more computer-executable components may be at least one software code or portions of it. Modifications and configurations required for implementing functionality of an embodiment may be performed as routine(s), which may be implemented as added or updated software routine(s). Software routine(s) may be downloaded into the apparatus.

[0085] Software or a computer program code or portions of it may be in a source code form, object code form, or in some intermediate form, and it may be stored in some sort of carrier, distribution medium, or computer readable medium, which may be any entity or device capable of carrying the program. Such carriers include a record medium, computer memory, read-only memory, photoelectrical and/or electrical carrier signal, telecommunications signal, and software distribution package, for example. Depending on the processing power needed, the computer program may be executed in a single electronic digital computer or it may be distributed

amongst a number of computers. The computer readable medium or computer readable storage medium may be a non-transitory medium.

[0086] In other embodiments, the functionality of any method or apparatus described herein may be performed by hardware, for example through the use of an application specific integrated circuit (ASIC), a programmable gate array (PGA), a field programmable gate array (FPGA), or any other combination of hardware and software. In yet another embodiment, the functionality may be implemented as a signal, a non-tangible means that may be carried by an electromagnetic signal downloaded from the Internet or other network.

[0087] According to an embodiment, an apparatus, such as a node, device, or a corresponding component, may be configured as a computer or a microprocessor, such as single-chip computer element, or as a chipset, including at least a memory for providing storage capacity used for arithmetic operation and an operation processor for executing the arithmetic operation.

[0088] One having ordinary skill in the art will readily understand that the invention as discussed above may be practiced with steps in a different order, and/or with hardware elements in configurations which are different than those which are disclosed. Therefore, although the invention has been described based upon these preferred embodiments, it would be apparent to those of skill in the art that certain modifications, variations, and alternative constructions would be apparent, while remaining within the spirit and scope of the invention. In order to determine the metes and bounds of the invention, therefore, reference should be made to the appended claims.

WE CLAIM:

1. A method, comprising:

determining, by a network node, at least one condition for triggering sending of a buffer status report scheduling request (BSR-SR);

determining whether sending of a medium access control layer buffer status report (MAC BSR) should also be triggered based on the at least one condition; and

triggering transmission of the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR) when the at least one condition is met, wherein the triggering comprises configuring a user equipment with the determined triggers.

2. The method according to claim 1, wherein the triggering further comprises, when the user equipment is requested to enter discontinuous reception (DRX), dynamically indicating BSR-SR resources in an enhanced DRX command.

3. The method according to claim 2, wherein the DRX command indicates at least one of: layer 1 resources by indicating resource index or indicate availability of resources in DRX, when the user equipment may derive the resources based on an identifier of the user equipment and/or system frame number or DRX cycle related parameters when DRX starts.

4. The method according to claim 2, wherein sending the MAC BSR releases BSR-SR resources.

5. The method according to claim 1, wherein BSR-SR resources are configured during initial access by higher layers and activated by MAC layer message when the user equipment enters DRX or receives DRX command.

6. The method according to any one of claims 1-5, wherein, when BSR-SR transmission is triggered, the triggering further comprises triggering MAC BSR to be sent on a next uplink grant.

7. The method according to any one of claims 1-5, further comprising, when BSR-SR resources are configured, configuring the user equipment to allow use of BSR-SR resources only for specific logical channel group(s) or for specific logical channel(s).

8. The method according to claim 1, wherein, when the BSR-SR has been transmitted and pending and no uplink grant is available before new BSR-SR resources become available, the method further comprises:

preventing the user equipment from using the resources when the buffer status has not changed N-bytes during a time since a BSR-SR was transmitted and new BSR-SR resources are available; or

when buffer status of all logical channel groups was transmitted in the pending BSR-SR, allowing the user equipment to transmit the BSR of highest priority logical channel or the logical channel group including the highest priority logical channel which has data available.

9. The method according to claim 1, wherein, when a scheduling request is pending, sr-ProhibitTimer is running, and BSR-SR resources are available, the method further comprises:

allowing the user equipment to ignore sr-ProhibitTimer and to transmit BSR-SR; or

allowing the user equipment to ignore sr-ProhibitTimer when specific logical channel group(s) have new data available and to transmit BSR-SR including buffer status of only said specific logical channel group(s) or of highest priority logical channel group.

10. The method according to claim 1, wherein, when BSR-SR and scheduling request resources are located inside configured time window and scheduling request resource is available first, the method further comprises:

allowing the user equipment to defer the scheduling request transmission and wait for the BSR-SR resource.

11. The method according to claim 1, wherein the BSR-SR format has a bitmap of logical channels or logical channel groups which have data, and wherein the BSR-SR indicates scheduling request per logical channel or logical channel group.

12. An apparatus, comprising:

at least one processor; and

at least one memory comprising computer program code,

the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus at least to determine at least one condition for triggering sending of a buffer status report scheduling request (BSR-SR);

determine whether sending of a medium access control layer buffer status report (MAC BSR) should also be triggered based on the at least one condition; and

trigger transmission of the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR) when the at least one condition is met, wherein the triggering comprises configuring a user equipment with the determined triggers.

13. An apparatus, comprising:

determining means for determining at least one condition for triggering sending of a buffer status report scheduling request (BSR-SR);

determining whether sending of a medium access control layer buffer

status report (MAC BSR) should also be triggered based on the at least one condition; and

triggering means for triggering transmission of the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR) when the at least one condition is met, wherein the triggering comprises configuring a user equipment with the determined triggers.

14. The apparatus according to claim 13, wherein the triggering means further comprises, when the user equipment is requested to enter discontinuous reception (DRX), means for dynamically indicating BSR-SR resources in an enhanced DRX command.

15. The apparatus according to claim 14, wherein the DRX command indicates at least one of: layer 1 resources by indicating resource index or indicate availability of resources in DRX, when the user equipment may derive the resources based on an identifier of the user equipment and/or system frame number or DRX cycle related parameters when DRX starts.

16. The apparatus according to claim 14, further comprising means for releasing BSR-SR resources when the MAC BSR is sent.

17. The apparatus according to claim 13, wherein BSR-SR resources are configured during initial access by higher layers and activated by MAC layer message when the user equipment enters DRX or receives DRX command.

18. The apparatus according to any one of claims 13-17, wherein, when BSR-SR transmission is triggered, the triggering means further comprises means for triggering MAC BSR to be sent on a next uplink grant.

19. The apparatus according to any one of claims 13-17, further comprising, when BSR-SR resources are configured, means for configuring a user equipment to allow use of BSR-SR resources only for specific logical channel group(s) or for specific logical channel(s).

20. The apparatus according to claim 13, wherein, when the BSR-SR has been transmitted and pending and no uplink grant is available before new BSR-SR resources become available, the apparatus further comprises:

means for preventing the user equipment from using the resources when the buffer status has not changed N-bytes during a time since a BSR-SR was transmitted and new BSR-SR resources are available; or

when buffer status of all logical channel groups was transmitted in the pending BSR-SR, means for allowing the user equipment to transmit the BSR of highest priority logical channel or the logical channel group including the highest priority logical channel which has data available.

21. The apparatus according to claim 13, wherein, when a scheduling request is pending, sr-ProhibitTimer is running, and BSR-SR resources are available, the apparatus further comprises:

means for allowing the user equipment to ignore sr-ProhibitTimer and to transmit BSR-SR; or

means for allowing the user equipment to ignore sr-ProhibitTimer when specific logical channel group(s) have new data available and to transmit BSR-SR including buffer status of only said specific logical channel group(s) or of highest priority logical channel group.

22. The apparatus according to claim 13, wherein, when BSR-SR and scheduling request resources are located inside configured time window and scheduling request resource is available first, the apparatus further comprises:

means for allowing the user equipment to defer the scheduling request

transmission and wait for the BSR-SR resource.

23. The apparatus according to claim 13, wherein the BSR-SR format has a bitmap of logical channels or logical channel groups which have data, and wherein the BSR-SR indicates scheduling request per logical channel or logical channel group.

24. A method, comprising:

receiving, by a user equipment, a trigger for transmission of a buffer status report scheduling request (BSR-SR) and/or a medium access control layer buffer status report (MAC BSR) based on at least one condition; and

transmitting the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR).

25. The method according to claim 24, wherein the receiving further comprises receiving a dynamic indication of BSR-SR resources in an enhanced DRX command, when the user equipment is requested to enter discontinuous reception (DRX).

26. The method according to claims 24 or 25, wherein the transmitting of the MAC BSR releases BSR-SR resources.

27. The method according to claim 24, wherein BSR-SR resources are configured during initial access by higher layers and activated by MAC layer message when the user equipment enters DRX or receives DRX command.

28. The method according to claim 24, wherein, when BSR-SR transmission is triggered, the transmitting further comprises triggering transmitting of the MAC BSR on a next uplink grant.

29. The method according to claim 28,

wherein, when there is no space in MAC packet data unit (PDU) to report regular BSR, reporting only the buffer status of the highest priority logical channel or the logical channel group including the highest priority logical channel which has data available in the MAC BSR; or

when the BSR-SR is transmitted, triggering transmitting of only MAC BSR for highest priority logical channel or the logical channel group including the highest priority logical channel which has data available; or

when the BSR-SR is transmitted and the user equipment has data in only one logical channel group, not reporting the MAC BSR or reporting the MAC BSR with all the data available for transmission; or

when the BSR-SR is transmitted and the user equipment has data in multiple logical channel groups, a buffer of the logical channel group with a lowest priority is not reported.

30. The method according to claim 24, wherein, when a scheduling request is pending, sr-ProhibitTimer is running, and BSR-SR resources are available, the method further comprises:

ignoring sr-ProhibitTimer and transmitting BSR-SR; or

ignoring sr-ProhibitTimer when specific logical channel group(s) have new data available and transmitting BSR-SR including buffer status of only said specific logical channel group(s) or of highest priority logical channel group.

31. The method according to claim 24, wherein, when BSR-SR and scheduling request resources are located inside configured time window and scheduling request resource is available first, the method further comprises:

deferring the scheduling request transmission and waiting for the BSR-SR resource.

32. The method according to claim 31, wherein the deferring depends on which logical channel group contains data or on an amount of data available in the buffer.

33. The method according to claim 24, wherein, when physical uplink control channel (PUCCH) feedback including the BSR-SR resources is transmitted in response to downlink assignment and reported feedback is ACK, re-transmitting BSR-SR and/or MAC BSR.

34. The method according to claim 24, wherein the BSR-SR format has a bitmap of logical channels or logical channel groups which have data, and wherein the BSR-SR indicates scheduling request per logical channel or logical channel group.

35. An apparatus, comprising:

at least one processor; and

at least one memory comprising computer program code,

the at least one memory and the computer program code are configured, with the at least one processor, to cause the apparatus at least to receive a trigger for transmission of a buffer status report scheduling request (BSR-SR) and/or a medium access control layer buffer status report (MAC BSR) based on at least one condition; and

transmit the buffer status report scheduling request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR).

36. An apparatus, comprising:

receiving means for receiving a trigger for transmission of a buffer status report scheduling request (BSR-SR) and/or a medium access control layer buffer status report (MAC BSR) based on at least one condition; and

transmitting means for transmitting the buffer status report scheduling

request (BSR-SR) and/or the medium access control layer buffer status report (MAC BSR).

37. The apparatus according to claim 36, wherein the receiving means further comprises means for receiving a dynamic indication of BSR-SR resources in an enhanced DRX command, when the apparatus is requested to enter discontinuous reception (DRX).

38. The apparatus according to claims 36 or 37, further comprising means for releasing BSR-SR resources triggered by the transmitting of the MAC BSR.

39. The apparatus according to claim 36, wherein BSR-SR resources are configured during initial access by higher layers and activated by MAC layer message when the apparatus enters DRX or receives DRX command.

40. The apparatus according to claim 36, wherein, when BSR-SR transmission is triggered, the transmitting means further comprises means for triggering transmitting of the MAC BSR on a next uplink grant.

41. The apparatus according to claim 40,

wherein, when there is no space in MAC packet data unit (PDU) to report regular BSR, means for reporting only the buffer status of the highest priority logical channel or the logical channel group including the highest priority logical channel which has data available in the MAC BSR; or

when the BSR-SR is transmitted, means for triggering transmitting of only MAC BSR for highest priority logical channel or the logical channel group including the highest priority logical channel which has data available; or

when the BSR-SR is transmitted and the apparatus has data in only one logical channel group, means for not reporting the MAC BSR or

reporting the MAC BSR with all the data available for transmission; or

when the BSR-SR is transmitted and the apparatus has data in multiple logical channel groups, a buffer of the logical channel group with a lowest priority is not reported.

42. The apparatus according to claim 36, wherein, when a scheduling request is pending, sr-ProhibitTimer is running, and BSR-SR resources are available, the apparatus further comprises:

means for ignoring sr-ProhibitTimer and transmitting BSR-SR; or

means for ignoring sr-ProhibitTimer when specific logical channel group(s) have new data available and transmitting BSR-SR including buffer status of only said specific logical channel group(s) or of highest priority logical channel group.

43. The apparatus according to claim 36, wherein, when BSR-SR and scheduling request resources are located inside configured time window and scheduling request resource is available first, the apparatus further comprises:

means for deferring the scheduling request transmission and waiting for the BSR-SR resource.

44. The apparatus according to claim 43, wherein the deferring means depends on which logical channel group contains data or on an amount of data available in the buffer.

45. The apparatus according to claim 24, wherein, when physical uplink control channel (PUCCH) feedback including the BSR-SR resources is transmitted in response to downlink assignment and reported feedback is ACK, means for re-transmitting BSR-SR and/or MAC BSR.

46. The apparatus according to claim 36, wherein the BSR-SR format has a

bitmap of logical channels or logical channel groups which have data, and wherein the BSR-SR indicates scheduling request per logical channel or logical channel group.

47. A computer program, embodied on a non-transitory computer readable medium, wherein the computer program is configured to control a processor to perform a process according to any one of claims 1-11 or 24-34.

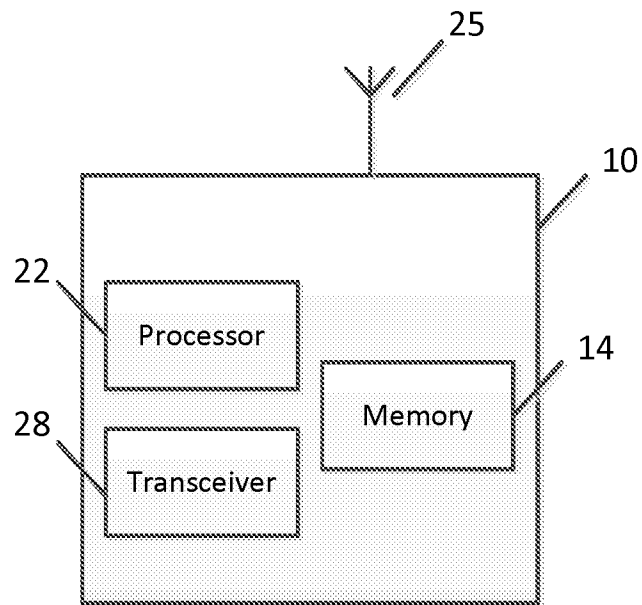


Fig. 1a

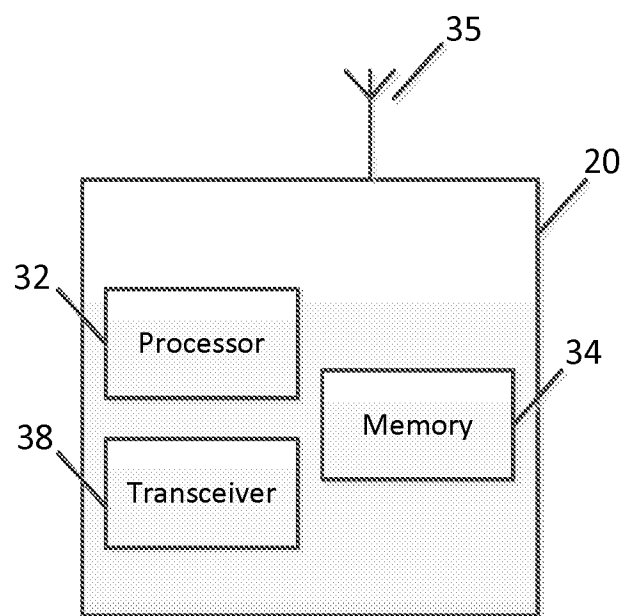


Fig. 1b

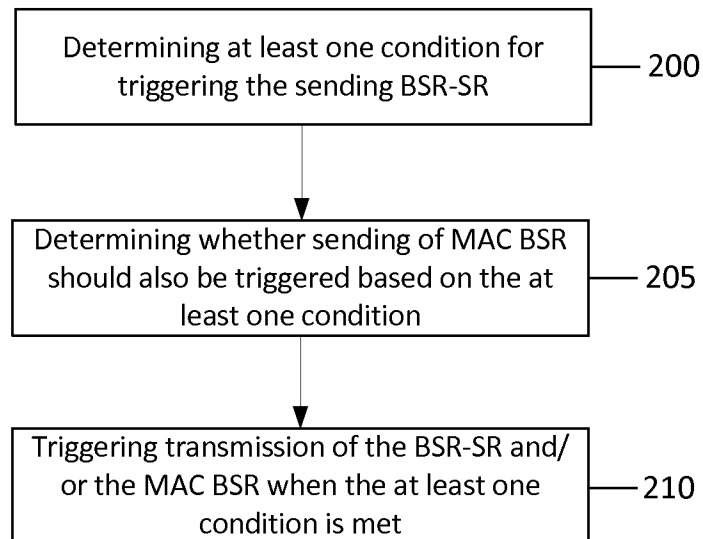


Fig. 2a

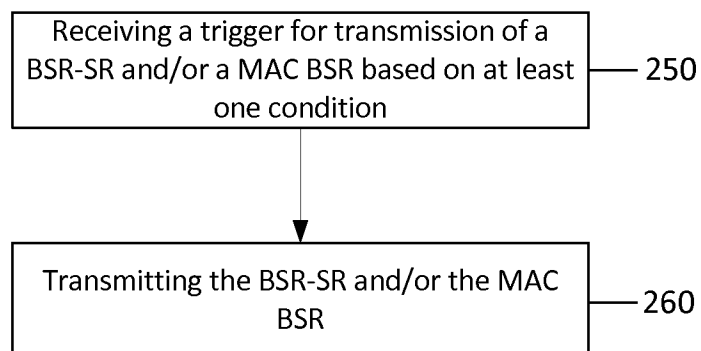


Fig. 2b

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2015/058390

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H04W 28/02 (2015.01)

CPC - H04W 28/0278 (2015.10)

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - H04W 28/02, 72/04, 72/12 (2015.01) (2015.01)

CPC - H04W 28/0215, 28/0231, 28/0247, 28/0268, 28/0278, 72/1205, 72/1257 (2015.10) (2015.10)

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

U.S. Class/Subclass(es): 370/230, 252, 329 (Keyword delimited)

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

PatBase, Orbit, Google Patents, Google Scholar

Search terms used: BSR, buffer status report, MAC, medium access control layer, DRX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2015/0003371 A1 (LG ELECTRONICS INC.) 01 January 2015 (01.01.2015) entire document	24, 26, 28, 29, 31, 35, 36, 38, 40, 41, 43
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Y		1-23, 25, 27, 30, 32-34, 37, 39, 42, 44-46
Y	US 2012/0149298 A1 (JIANG et al.) 14 January 2012 (14.01.2012) entire document	1-23, 30, 42
Y	US 2012/0087341 A1 (JANG et al.) 12 April 2012 (12.04.2012) entire document	2-5, 14-17, 25, 27, 37, 39
Y	US 2012/0099452 A1 (DAI et al.) 26 April 2012 (26.04.2012) entire document	7, 11, 19, 23, 32, 34, 44, 46
Y	US 2015/0092542 A1 (ALCATEL-LUCENT USA, INC.) 02 April 2015 (02.04.2015) entire document	8, 20, 33, 45
Y	US 2013/0003678 A1 (QUAN et al.) 03 January 2013 (03.01.2013) entire document	33, 45

☐ 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

16 December 2015

Date of mailing of the international search report

20 JAN 2016

Name and mailing address of the ISA/

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PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2015/058390

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 47
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.