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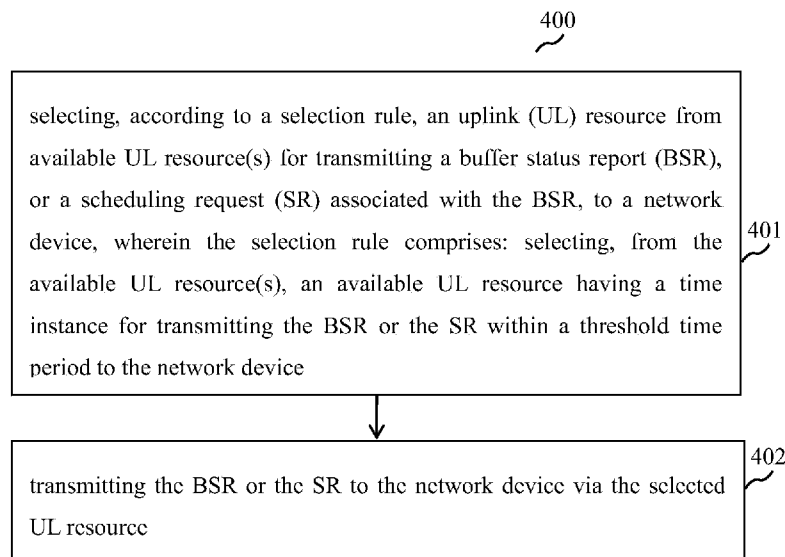


FIG. 4

(57) Abstract: Embodiments of the present disclosure relate to methods and apparatuses for enhancing a buffer status report (BSR) reporting mechanism in a large propagation delay scenario. According to an embodiment of the present disclosure, a method which may be performed by a UE includes: selecting, according to a selection rule, an uplink (UL) resource from one or more available UL resources for transmitting a buffer status report (BSR), or a scheduling request (SR) associated with the BSR, to a network device, wherein the selection rule comprises: selecting, from the one or more available UL resources, an available UL resource having a time instance for transmitting the BSR or the SR within a threshold time period to the network device; and transmitting the BSR or the SR to the network

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**METHOD AND APPARATUS FOR ENHANCEING A BUFFER STATUS
REPORT REPORTING MECHANISM IN A LARGE PROPAGATION DELAY
SCENARIO**

TECHNICAL FIELD

[0001] Embodiments of the present disclosure generally relate to wireless communication technology, especially to a method and apparatus for enhancing a buffer status report (BSR) reporting mechanism in a large propagation delay scenario.

BACKGROUND

[0002] In general, a BSR reporting mechanism may be used to provide a serving base station (BS) with information about uplink (UL) data volume in a medium access control (MAC) entity. If a UE does not have sufficient UL resource(s) for transmitting a BSR, the UE may trigger a scheduling request (SR) to ask for UL resource(s). If the UE does not have sufficient UL resource(s) for transmitting the SR either, the UE may trigger a random access (RA) procedure. In the RA procedure, the BSR can be included in *MSG3* if the room allows. It is observed that if there is no sufficient UL resource(s) to transmit the BSR, UL data in buffer has to wait for at least 2 Round Trip Time (RTT) durations to get UL resource(s) for a data transmission. There could be a latency issue for time-sensitive service(s) of the UE when the RTT is large, e.g., in a non-terrestrial network (NTN) environment where the RTT can be up to 540ms due to the large propagation delay between a satellite and a ground.

[0003] An NTN environment refers to networks or segments of networks, which use a spaceborne vehicle or an airborne vehicle for transmission. For example, a spaceborne vehicle includes a satellite, which may be a Low Earth Orbiting (LEO) satellite, a Medium Earth Orbiting (MEO) satellite, a Geostationary Earth Orbiting (GEO) satellite as well as a Highly Elliptical Orbiting (HEO) satellite. An airborne vehicle includes a High Altitude Platform (HAP) encompassing Unmanned Aircraft Systems (UAS) which includes Lighter than Air UAS (LTA), and a Heavier than Air UAS (HTA).

[0004] In 3rd Generation Partnership Project (3GPP), details regarding how to select an UL resource for reporting a BSR for a user equipment (UE) in a large propagation delay scenario, e.g., an NTN environment, have not been discussed.

SUMMARY

[0005] Some embodiments of the present disclosure provide a method, which may be performed by a UE. The method includes: selecting, according to a selection rule, an uplink (UL) resource from one or more available UL resources for transmitting a buffer status report (BSR), or a scheduling request (SR) associated with the BSR, to a network device, wherein the selection rule comprises: selecting, from the one or more available UL resources, an available UL resource having a time instance for transmitting the BSR or the SR within a threshold time period to the network device; and transmitting the BSR or the SR to the network device via the selected UL resource.

[0006] Some embodiments of the present application also provide an apparatus for wireless communications. The apparatus includes: a non-transitory computer-readable medium having stored thereon computer-executable instructions; a receiving circuitry; a transmitting circuitry; and a processor coupled to the non-transitory computer-readable medium, the receiving circuitry and the transmitting circuitry, wherein the computer-executable instructions cause the processor to implement any of the above-mentioned methods performed by a UE.

[0007] Some embodiments of the present application also provide a UE. The UE includes a processor and a wireless transceiver coupled to the processor; and the processor is configured to select, according to a selection rule, an UL resource from one or more available UL resources for transmitting a BSR, or a SR associated with the BSR, to a network device, wherein the selection rule comprises: selecting, from the one or more available UL resources, an available UL resource having a time instance for transmitting the BSR or the SR within a threshold time period to the network device; and to transmit, via the wireless transceiver, the BSR or the SR to the network device via the selected UL resource.

[0008] Some embodiments of the present application provide a method, which may be performed by a network device. The method includes: transmitting, to a UE,

configuration information related to a selection rule, wherein the selection rule is used by the UE to select an UL resource from one or more available UL resources for transmitting a BSR, or a SR associated with the BSR, to the network device, and wherein the selection rule comprises: selecting, from the one or more available UL resources, an available UL resource having a time instance for transmitting the BSR or the SR within a threshold time period from the UE to the network device; and receiving the BSR or the SR from the UE via the selected UL resource.

[0009] Some embodiments of the present application also provide an apparatus for wireless communications. The apparatus includes: a non-transitory computer-readable medium having stored thereon computer-executable instructions; a receiving circuitry; a transmitting circuitry; and a processor coupled to the non-transitory computer-readable medium, the receiving circuitry and the transmitting circuitry, wherein the computer-executable instructions cause the processor to implement the above-mentioned further method performed by a network device.

[0010] Some embodiments of the present application also provide a network device. The network device includes a processor; and a wireless transceiver coupled to the processor, and the processor is configured: to transmit, via the wireless transceiver to a UE, configuration information related to a selection rule, wherein the selection rule is used by the UE to select an UL resource from one or more available UL resources for transmitting a BSR or a SR associated with the BSR, to the network device, and wherein the selection rule comprises: selecting, from one or more available UL resources, an available UL resource having a time instance for transmitting the BSR or the SR within a threshold time period from the UE to the network device; and to receive, via the wireless transceiver, the BSR or the SR from the UE via the selected UL resource.

[0011] The details of one or more examples are set forth in the accompanying drawings and the descriptions below. Other features, objects, and advantages will be apparent from the descriptions and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] In order to describe the manner in which advantages and features of the application can be obtained, a description of the application is rendered by reference to

specific embodiments thereof, which are illustrated in the appended drawings. These drawings depict only example embodiments of the application and are not therefore to be considered limiting of its scope.

[0013] FIG. 1 illustrates a schematic diagram of a wireless communication system in accordance with some embodiments of the present application.

[0014] FIGS. 2A-2E illustrate exemplary BSR reporting mechanisms for a large propagation delay scenario as studied in 3GPP standard documents.

[0015] FIGS. 3A and 3B illustrate exemplary BSR reporting mechanisms with far UL resources in accordance with some embodiments of the present application.

[0016] FIG. 4 illustrates an exemplary flow chart of a method for selecting an UL resource according to a selection rule in accordance with some embodiments of the present application.

[0017] FIG. 5 illustrates an exemplary flow chart of a method for transmitting configuration information related to a selection rule of an UL resource in accordance with some embodiments of the present application.

[0018] FIG. 6 illustrates an exemplary flow chart for enhancing a BSR reporting mechanism in a large propagation delay scenario in accordance with some embodiments of the present application.

[0019] FIG. 7 illustrates a further exemplary flow chart for selecting an UL resource according to a selection rule in accordance with some embodiments of the present application.

[0020] FIG. 8 illustrates an exemplary block diagram of an apparatus in accordance with some embodiments of the present application.

DETAILED DESCRIPTION

[0021] The detailed description of the appended drawings is intended as a description of the currently preferred embodiments of the present disclosure and is not intended to

represent the only form in which the present disclosure may be practiced. It is to be understood that the same or equivalent functions may be accomplished by different embodiments that are intended to be encompassed within the spirit and scope of the present disclosure.

[0022] Also, the use of the expression “A and/or B” means any one of the following: “A” alone or “B” alone; or both “A” and “B” together.

[0023] Reference will now be made in detail to some embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. To facilitate understanding, embodiments are provided under specific network architecture and new service scenarios, such as 3GPP 5G New Radio (NR), 3GPP long-term evolution (LTE) Release 8 and so on. Persons skilled in the art know very well that, with the development of network architecture and new service scenarios, the embodiments in the present disclosure are also applicable to other similar technical problems.

[0024] FIG. 1 illustrates a schematic diagram of a wireless communication system in accordance with some embodiments of the present application.

[0025] As shown in FIG. 1, the wireless communication system 100 includes two UEs, i.e., UE 101-A and UE 101-B, and one BS, i.e., BS 102. For example, BS 102 is a satellite BS. Although merely one BS is illustrated in FIG. 1 for simplicity, it is contemplated that the wireless communication system 100 may include more BSs in some other embodiments of the present application. Similarly, although merely two UEs are illustrated in FIG. 1 for simplicity, it is contemplated that the wireless communication system 100 may include more UEs in some other embodiments of the present application. In the coverage of BS 102, UE 101-A is located at the nearest position to BS 102, that is, the distance between the position of UE 101-A and BS 102 is the smallest among all the positions in the coverage of BS 102, and UE 101-B is located at the farthest location to BS 102.

[0026] BS 102 may also be referred to as an access point, an access terminal, a base, a macro cell, a node-B, an enhanced node B (eNB), a gNB, a home node-B, a relay node, or a device, or described using other terminology used in the art. BS 102 is generally

part of a radio access network that may include a controller communicably coupled to BS 102.

[0027] UE 101-A may include computing devices, such as desktop computers, laptop computers, personal digital assistants (PDAs), tablet computers, smart televisions (e.g., televisions connected to the Internet), set-top boxes, game consoles, security systems (including security cameras), vehicle on-board computers, network devices (e.g., routers, switches, and modems), or the like. According to an embodiment of the present application, UE 101-A may include a portable wireless communication device, a smart phone, a cellular telephone, a flip phone, a device having a subscriber identity module, a personal computer, a selective call receiver, or any other device that is capable of sending and receiving communication signals on a wireless network. In some embodiments, UE 101-A may include wearable devices, such as smart watches, fitness bands, optical head-mounted displays, or the like. Moreover, UE 101-A may be referred to as a subscriber unit, a mobile, a mobile station, a user, a terminal, a mobile terminal, a wireless terminal, a fixed terminal, a subscriber station, a user terminal, or a device, or described using other terminology used in the art.

[0028] The wireless communication system 100 is compatible with any type of network that is capable of sending and receiving wireless communication signals. For example, the wireless communication system 100 is compatible with a wireless communication network, a cellular telephone network, a time division multiple access (TDMA) based network, a code division multiple access (CDMA) based network, an orthogonal frequency division multiple access (OFDMA) based network, an LTE network, a 3GPP based network, a 3GPP 5G network, a satellite communications network, a high altitude platform network, and/or other communications networks.

[0029] Currently, both a 2-step RA procedure and a 4-step RA procedure support contention-based random access (CBRA) and contention-free random access (CFRA). A UE may select the type of a RA procedure at an initiation of the RA procedure based on network configuration information in following three cases:

- (1) When CFRA resources are not configured, an RSRP threshold *msgA-RSRP-Threshold* is used by the UE to select between a 2-step RA type and a 4-step RA type; if $RSRP > msgA-RSRP-Threshold$, the 2-step RA type is selected;

and if $RSRP < msgA-RSRP-Threshold$, the 4-step RA type is selected.

- (2) When CFRA resources for the 4-step RA type are configured, the UE may perform random access with the 4-step RA type.
- (3) When CFRA resources for the 2-step RA type are configured, the UE may perform random access with the 2-step RA type.

[0030] To reduce the latency of requesting UL resource(s) via a BSR reporting mechanism, enhancement options were discussed for an NTN environment during the study of 3GPP standard documents, of which a BSR reporting mechanism over 2-step RA procedure is agreed to be used. That is, a BSR can be reported to a network via *MSGA* in a 2-step RA procedure so that UL resource(s) for data transmission(s) can be configured via *MSGB*. Other options include an enhancement for a SR so that a network can directly configure a large UL grant for a data transmission(s) in a SR response. Details are described in FIGS. 2A-2E as follows.

[0031] FIGS. 2A-2E illustrate exemplary BSR reporting mechanisms for a large propagation delay scenario as studied in 3GPP standard documents. Each of FIGS. 2A-2E illustrates signals transmitted between a UE and a BS in the time domain in an exemplary BSR reporting mechanism.

[0032] In particular, FIG. 2A shows a BSR reporting mechanism in a case of sufficient resource(s) for BSR reporting. As shown in FIG. 2A, a BSR is triggered, e.g., due to UL data, at time instance T_a in the time domain of a UE. During a RTT, the UE transmits a BSR to a BS at time instance T_b on a next available UL resource for BSR transmission. Then, the BS grants an UL resource for an UL data transmission. At time instance T_c , the UE transmits UL data on the granted UL resource for the UL data transmission.

[0033] FIG. 2B shows a SR-BSR reporting mechanism in a case of sufficient resource(s) for a SR but not for a BSR. As shown in FIG. 2B, a BSR is triggered, e.g., due to UL data, at time instance T_a in the time domain of a UE. During a RTT, the UE transmits a SR to a BS at time instance T_b on a next available UL resource for SR transmission. The BS grants an UL resource for the BSR, and the UE transmits the

BSR at the granted UL resource. Then, the BS grants an UL resource for an UL data transmission. At time instance T_c , the UE transmits UL data on the granted UL resource for the UL data transmission.

[0034] FIG. 2C shows a large UL grant in a SR response mechanism in a case of sufficient resource(s) for a SR and possibly a BSR indication. This mechanism may be named as “an enhanced SR mechanism” or the like in some embodiments. A BSR indication may be of 1 bit. A BSR indication may be transmitted together with the SR, so that BS can directly configure an UL grant for an UL data transmission. For instance, in a response for the SR, the BS may directly configure a large UL grant for an UL data transmission, instead of configuring an UL grant for transmitting a BSR. As shown in FIG. 2C, a BSR is triggered, e.g., due to UL data, at time instance T_a in the time domain of a UE. During a RTT, the UE may transmit both a SR and a BSR indication at time instance T_b on a next available UL resource for SR transmission. In a response for the SR, the BS grants a large UL resource for an UL data transmission. Then, at time instance T_c , the UE transmits UL data on the granted UL resource for the UL data transmission.

[0035] FIG. 2D shows a BSR reporting mechanism over a 2-step RA procedure. In this mechanism, there is no sufficient resource for a SR (and a BSR), but it is configured with 2-step CFRA or $RSRP > msgA-RSRP-Threshold$. As shown in FIG. 2D, a BSR is triggered, e.g., due to UL data, at time instance T_a in the time domain of a UE. During a RTT, the UE transmits both *MSG_A* and a BSR at time instance T_b on a next available 2-step RA resource. Then, the BS transmits *MSG_B* and grants an UL resource for an UL data transmission. At time instance T_c , the UE transmits UL data on the granted UL resource for the UL data transmission.

[0036] FIG. 2E shows a BSR reporting mechanism over a 4-step RA procedure. In this mechanism, there is no sufficient resource for a SR (and a BSR), but it is configured with 4-step CFRA or $RSRP < msgA-RSRP-Threshold$. As shown in FIG. 2E, a BSR is triggered, e.g., due to UL data, at time instance T_a in the time domain of a UE. During a RTT, the UE transmits *MSG1* at time instance T_b at a next available 4-step RA resource, and the BS transmits *MSG2* to the UE. After that, the UE transmits both *MSG3* and a BSR, and the BS transmits *MSG4* and grants an UL resource for an UL data

transmission. At time instance T_c , the UE transmits UL data on the granted UL resource for the UL data transmission.

[0037] Currently, when multiple methods (e.g., a BSR reporting mechanism over a configured grant (CG), a SR-BSR reporting mechanism, an enhanced SR mechanism, a BSR reporting mechanism over 2-step or 4-step CBRA, or a BSR reporting mechanism over 2-step or 4-step CFRA) can be used, an issue of how to select UL resource(s) for a BSR especially for a UE with time-sensitive service(s) or in a large propagation delay scenario, e.g., an NTN environment, needs to be solved.

[0038] Some embodiments of the present application provide a BSR reporting method for a UE, especially for time-sensitive service(s) or in scenario(s) with a large propagation delay between a UE and a BS, e.g., in an NTN environment. Some embodiments of the present application allow a UE to select UL resource(s) from multiple available UL resources for transmitting a BSR (or a SR associated with the BSR) when the BSR is triggered, and the selected UL resource can be used to transmit the BSR within a threshold time period (e.g., associated with a packet delay budget (PDB) requirement) or as early as possible, so that the UE can obtain UL resource(s) for a data transmission fulfilling a latency requirement. This enhancement in the BSR reporting mechanism can help in coping with the large propagation delay and meet the latency requirement of an urgent data transmission.

[0039] In some embodiments of the present application, a UE can determine the availability of UL resource(s) before a selection when a BSR is triggered, which avoids a case that a RA type selection is after an UL resource selection and a 4-step RA procedure could be selected. In some embodiments of the present application, a time-based UL resource selection can be applied considering several factors, e.g., a BSR, a BSR type, a logical channel (LCH), a logical channel group (LCG), a data radio bearer (DRB), or a network slice, to provide flexible implementation(s). Some embodiments of the present application introduce configurable time offset value(s) in a time-based UL resource selection considering urgency of service(s), RA load information, possible time delay(s) of requested UL resource(s) for data transmission(s), and possible data retransmission(s).

[0040] In some embodiments of the present application, although a BSR reporting

mechanism over a 2-step RA procedure can reduce the time of acquiring UL resource(s) for a data transmission (from 2 RTTs to 1 RTT), a UE is required to fulfill following Conditions (1) and (2), to use the BSR reporting mechanism over a 2-step RA procedure according to current agreements of 3GPP standard documents.

Condition (1): There is no sufficient UL resource for transmitting a SR and a BSR.

Condition (2): CFRA resource(s) for a 2-step RA type are configured; or CFRA resource(s) for a 2-step RA type are not configured but the UE's RSRP (Reference Signal Receiving Power) is larger than *msgA-RSRP-Threshold*.

[0041] In a case that a UE only fulfills the abovementioned Condition (2), but a next available UL resource for transmitting a SR or a BSR is far away in time, the UE still needs to wait for this UL resource to send the SR or the BSR, while a BSR reporting mechanism over a 2-step RA procedure has a chance to obtain an UL resource earlier. According to some embodiments of the present application, if a BSR reporting mechanism over a 2-step RA procedure can be used as indicated by dashed lines shown in embodiments of FIGS. 3A and 3B, the UL data has a chance to be transmitted earlier than that of a legacy BSR reporting mechanism.

[0042] FIGS. 3A and 3B illustrate exemplary BSR reporting mechanisms with far UL resources in accordance with some embodiments of the present application.

[0043] FIG. 3A shows a BSR reporting mechanism with a far resource in a case that a next available UL resource for BSR transmission is far away in time. As shown in FIG. 3A, a BSR is triggered at time instance T_t in the time domain of a UE. In a legacy BSR reporting mechanism, a next available UL resource for transmitting the BSR is at time instance T_b , which is far away in the time domain. If the embodiments of FIG. 3A use a BSR reporting mechanism over a 2-step RA procedure, the UE may transmit both *MSG_A* and a BSR to a BS at time instance T_r . Then, the BS may transmit *MSG_B* and grants an UL resource for an UL data transmission to the UE, and the UE may transmit UL data on the granted UL resource for the UL data transmission. Based on this BSR reporting mechanism over a 2-step RA procedure, the UL data can be transmitted earlier than the legacy BSR reporting mechanism, and a time difference between this two mechanisms is " t_0 " as shown in FIG. 3A.

[0044] FIG. 3B shows a SR-BSR reporting mechanism with a far resource in a case that there is no available UL resource for s BSR but a next available UL resource for SR transmission is far away in time. As shown in FIG. 3B, a BSR is triggered at time instance T_t in the time domain of a UE. In a legacy SR-BSR reporting mechanism, if there is no available UL resource for transmitting a BSR while a next available UL resource for transmitting a SR is at time instance T_s , which is far away in the time domain, a UE has to wait for an UL resource grant to transmit UL data after transmitting the SR at time instance T_s and transmitting the BSR at time instance T_b . If the embodiments of FIG. 3B use a SR-BSR reporting mechanism over a 2-step RA procedure, the UE may transmit both *MSG_A* and the BSR to a BS at time instance T_r . Then, the BS may transmit *MSG_B* and grants an UL resource for an UL data transmission to the UE, and the UE may transmit UL data on the granted UL resource for the UL data transmission. Based on this SR-BSR reporting mechanism over a 2-step RA procedure, the UL data can be transmitted earlier than the legacy SR-BSR reporting mechanism, i.e., with a time difference “ t_0 ” between this two mechanisms as shown in FIG. 3B.

[0045] FIG. 4 illustrates an exemplary flow chart of a method for selecting an UL resource according to a selection rule in accordance with some embodiments of the present application. The exemplary method 400 illustrated in FIG. 4 may be implemented by a UE (e.g., UE 101-A, UE 101-B, a UE, UE 620, UE1, UE2, UE3, UE4, or UE5 as illustrated and shown in any of FIGS. 1, 2A-2E, 3A, 3B, 6, and 7). Although described with respect to a UE, it should be understood that other devices may be configured to perform a method similar to that of FIG. 4.

[0046] In the embodiments of FIG. 4, in operation 401, a UE (e.g., UE 101-A as shown in FIG. 1) selects, according to a selection rule(s), an UL resource from available UL resource(s) for transmitting a BSR, or a scheduling request (SR) associated with the BSR, to a network device (e.g., BS 102 as shown in FIG. 1). The selection rule(s) may comprise: selecting, from the available UL resource(s), an available UL resource having a time instance for transmitting the BSR or the SR within a threshold time period to the network device. The threshold time period may be associated with: a PDB requirement of a data service of the UE; and/or RTT duration(s) (e.g., 2 RTTs). A specific example of “a threshold time period” may be represented by “a reference time instance T_0 ” as

described in the embodiments of FIG. 7.

[0047] In some embodiments, selecting the available UL resource having the time instance for transmitting the BSR or the SR within the threshold time period further comprises one of:

- (1) Selecting an available UL resource having an earliest time instance for transmitting the BSR or the SR within the threshold time period, as the selected UL resource.
- (2) Randomly selecting an available UL resource having the time instance for transmitting the BSR or the SR within the threshold time period, as the selected UL resource.

[0048] In some embodiments, the UE determines the available UL resource(s), and each available UL resource within the available UL resource(s) can be used for transmitting the BSR or the SR. In some embodiments, the available UL resource(s) include at least one of:

- (1) an earliest uplink shared channel (UL-SCH) resource for transmitting the BSR or the SR.
- (2) an earliest resource for transmitting the SR to request an UL resource for the BSR.
- (3) an earliest resource for transmitting the SR and an indication associated with the BSR (e.g., a BSR indication).
- (4) an earliest resource for transmitting the SR to request an UL resource for transmitting data associated with the BSR.
- (5) an earliest resource for starting to perform a 2-step CFRA procedure.
- (6) an earliest resource for starting to perform a 4-step CFRA procedure.
- (7) an earliest resource for starting to perform a 2-step CBRA procedure; and
- (8) an earliest resource for starting to perform a 4-step CBRA procedure.

[0049] In an embodiment, the UE determines the available UL resource(s) with time instances earlier than a time threshold according to at least one of the following rules:

- (1) An UL-SCH resource (e.g., a CG) that is sufficient for transmitting the BSR or the SR;
- (2) A physical uplink control channel (PUCCH) resource that is sufficient for transmitting the SR, if there is no sufficient resource for BSR arriving within a time period (e.g., 1 RTT);
- (3) A PUCCH resource that is sufficient for transmitting the SR, if there is no sufficient resource for BSR arriving within a time period (e.g., 2 RTTs);
- (4) A 2-step CFRA resource, if configured by the BS or the network device;
- (5) A 4-step CFRA resource, if configured by the BS or the network device;
- (6) A 2-step CBRA resource, if no 2-step/4-step CFRA is configured by the BS or the network device, and condition(s) of selecting 2-step CBRA is partly or completely fulfilled (e.g., $RSRP > msgA-RSRP-Threshold$), and/or an indication of disabling 2-step CBRA resource for BSR is not received from the BS or the network device;
- (7) A 4-step CBRA resource, if no 2-step or 4-step CFRA is configured by the BS or the network device, and condition(s) of selecting 2-step CBRA is partly or completely not fulfilled (e.g., $RSRP < msgA-RSRP-Threshold$), and/or an indication of disabling 4-step CBRA resource for the BSR is not received from the BS or the network device.

[0050] In some embodiments, the UE further determines a time instance of each available UL resource within the available UL resource(s) for transmitting the BSR or the SR. A specific example is described in FIG. 7 as follows. For example, the UE may determine the time instance of each available UL resource for transmitting the BSR or the SR based on at least one of following items:

- (1) A time offset value(s) applied to the each available UL resource. The time offset value(s) is related to transmitting the BSR. The time offset value(s) may be set by

the UE or configured by the network device. The UE may apply the time offset value(s) to a time-based UL resource selection for a BSR. Specific examples of offset1 to offset7 are described in embodiments of FIG. 7. The time offset value may be associated with at least one of:

- 1) urgency of a data service of the UE, e.g., a smaller positive offset or a larger negative offset if a data service is more urgent;
 - 2) RA load information, e.g., a larger positive offset or a smaller negative offset if the 2-step RA load is heavier;
 - 3) a possible time delay of an UL resource requested by the data service of the UE, e.g., a smaller positive offset or a larger negative offset if the possible time delay of requested UL resources for data is smaller; and
 - 4) a possible data retransmission, e.g., a larger positive offset or a smaller negative offset if the probability of a retransmission is higher.
- (2) A time instance of an earliest available UL-SCH resource, e.g., “T1” as shown in the embodiments of FIG. 7.
 - (3) “A time instance of an earliest available resource for transmitting the SR” plus “a length of a RTT duration”, e.g., “T2 + RTT” as shown in the embodiments of FIG. 7.
 - (4) A time instance of an earliest available resource for transmitting the SR and an indication associated with the BSR, e.g., “T3” as shown in the embodiments of FIG. 7.
 - (5) A time instance of an earliest available resource for transmitting the SR to request an UL resource for transmitting data associated with the BSR, e.g., “T3” as shown in the embodiments of FIG. 7.
 - (6) A time instance of an earliest available resource for starting to perform a 2-step CFRA procedure, e.g., “T4” as shown in the embodiments of FIG. 7.
 - (7) “A time instance of an earliest available resource for starting to perform a 4-step CFRA procedure” plus “the length of the RTT duration”, e.g., “T5 + RTT” as

shown in the embodiments of FIG. 7.

- (8) A time instance of an earliest available resource for starting to perform a 2-step CBRA procedure, e.g., “T6” as shown in the embodiments of FIG. 7.
- (9) “A time instance of an earliest available resource for starting to perform a 4-step CBRA procedure” plus “the length of the RTT duration”, e.g., “T7 + RTT” as shown in the embodiments of FIG. 7.

[0051] Referring back to FIG. 4, in operation 402, the UE transmits the BSR or the SR to the network device via the selected UL resource. In some embodiments, the BSR may be at least one of:

- (1) a regular BSR, as defined in 3GPP standard document TS38.321;
- (2) a periodic BSR, as defined in 3GPP standard document TS38.321;
- (3) a padding BSR, as defined in 3GPP standard document TS38.321;
- (4) a BSR triggered by UL data on a specific LCH;
- (5) a BSR triggered by UL data on a specific LCG; and
- (6) a BSR triggered by UL data on a LCH or a LCG which is related to: a specific quality of service (QoS) requirement; a specific DRB; a specific network slice; or a specific data service of the UE.

[0052] In some embodiments, the UE further receives, from the network device, configuration information related to the selection rule(s). For example, the UE receives the configuration information via radio resource control (RRC) signaling; a system information broadcast message; and/or a medium access control (MAC) control element (CE).

[0053] In an embodiment, the configuration information related to the selection rule(s) includes at least one of:

- (1) An indication of disabling a 2-step or 4-step CBRA resource for the BSR.
- (2) A time threshold related to the threshold time period. The time threshold may be: 1) “a PDB requirement of a data service of the UE” minus “two RTT durations”; or 2) two RTT durations. Each RTT duration within these two RTT durations may be one of: a round trip propagation delay between the UE and a network device; and timing advance applied at the UE. The network device may be a BS or a reference point.
- (3) Configuration information for a timer related to the threshold time period. The timer may start when the BSR is triggered at the UE. A length of the timer may be: 1) “a PDB requirement of a data service of the UE” minus “two RTT durations”; or 2) two RTT durations. Each RTT duration within these two RTT durations may be one of: a round trip propagation delay between the UE and a network device; and timing advance applied at the UE.
- (4) An indication for enabling or disabling the selection rule(s).

[0054] In some embodiments, during selecting the UL resource from the available UL resource(s) in operation 402, the UE further determines whether the selection rule(s) is enabled or disabled. If the UE determines that the selection rule(s) is enabled, the UE selects the UL resource according to the selection rule(s). If the UE determines that the selection rule(s) is disabled, the UE does not select the UL resource according to the selection rule(s). In an embodiment, the UE determines that the selection rule(s) is enabled, in response to receiving following at least one item:

- (1) An indication for enabling the selection rule(s).
- (2) A time offset value configured by a network. The time offset value is applied to the one or more available UL resources and related to transmitting the BSR. Specific examples of offset1 to offset7 are described in embodiments of FIG. 7. The time offset value may be associated with at least one of:
 - 1) urgency of a data service of the UE;
 - 2) RA load information;

- 3) a possible time delay of an UL resource requested by the data service of the UE; and
 - 4) a possible data retransmission.
- (3) A list of BSR type(s) configured by the network.
- (4) A list of LCH(s) configured by the network.
- (5) A list of LCG(s) configured by the network.
- (6) A list of DRB(s) configured by the network.
- (7) A list of network slice(s) configured by the network.
- (8) A time threshold configured by the network. The time threshold is related to the threshold time period. The time threshold may be: 1) “a PDB requirement of a data service of the UE” minus “two RTT durations”; or 2) two RTT durations. Each RTT duration within two RTT durations may be one of: a round trip propagation delay between the UE and a network device in the network; and timing advance applied at the UE. The network device may be a BS or a reference point.
- (9) Configuration information for a timer configured by the network. The timer is related to the threshold time period. The timer may start when the BSR is triggered at the UE. A length of the timer may be: 1) “a PDB requirement of a data service of the UE” minus “two RTT durations”; or 2) two RTT durations. Each RTT duration within two RTT durations may be one of: a round trip propagation delay between the UE and a network device in the network; and timing advance applied at the UE.

[0055] In a further embodiment, the UE determines that the selection rule(s) is disabled in response to not receiving the abovementioned at least one item. In another embodiment, the UE determines that the selection rule(s) is disabled in response to receiving an indication for disabling the selection rule(s).

[0056] Details described in the embodiments as illustrated and shown in FIGS. 1-3 and

5-8, especially, contents regarding how to select an UL resource according to a selection rule for transmitting a BSR or a SR associated with the BSR, are applicable for the embodiments as illustrated and shown in FIG. 4. Moreover, details described in the embodiments of FIG. 4 are applicable for all the embodiments of FIGS. 1-3 and 5-8.

[0057] FIG. 5 illustrates an exemplary flow chart of a method for transmitting configuration information related to a selection rule of an UL resource in accordance with some embodiments of the present application. The exemplary method 500 illustrated in FIG. 5 may be implemented by a network device, e.g., a BS (e.g., BS 102, BS, BS 610, BS1, BS2, BS3, BS4, or BS5 as illustrated and shown in any of FIGS. 1, 2A-2E, 3A, 3B, 6, and 7). Although described with respect to a network device, it should be understood that other devices may be configured to perform a method similar to that of FIG. 5.

[0058] In the embodiments of FIG. 5, in operation 501, a network device transmits, to a UE, configuration information related to a selection rule. The selection rule(s) may be used by the UE to select an UL resource from available UL resource(s) for transmitting a BSR, or a SR associated with the BSR, to the network device. The selection rule(s) may comprises: selecting, from the one or more available UL resources, an available UL resource having a time instance for transmitting the BSR or the SR within a threshold time period from the UE to the network device.

[0059] In some embodiments, the available UL resource(s) include at least one of:

- (1) an earliest UL-SCH resource for transmitting the BSR or the SR;
- (2) an earliest resource for transmitting the SR to request an UL resource for the BSR;
- (3) an earliest resource for transmitting the SR and an indication associated with the BSR (e.g., a BSR indication);
- (4) an earliest resource for transmitting the SR to request an UL resource for transmitting data associated with the BSR;
- (5) an earliest resource for starting to perform a 2-step CFRA procedure;

- (6) an earliest resource for starting to perform a 4-step CFRA procedure;
- (7) an earliest resource for starting to perform a 2-step CBRA procedure; and
- (8) an earliest resource for starting to perform a 4-step CBRA procedure.

[0060] In some embodiments, the threshold time period may be associated with: a PDB requirement of a data service of the UE; and/or RTT duration(s) (e.g., 2 RTTs).

[0061] In some embodiments, selecting the available UL resource having the time instance for transmitting the BSR or the SR from the UE to the network device within the threshold time period further comprises one of: selecting an available UL resource having an earliest time instance for transmitting the BSR or the SR within the threshold time period, as the selected UL resource; and randomly selecting an available UL resource having the time instance for transmitting the BSR or the SR within the threshold time period, as the selected UL resource.

[0062] In some embodiments, in operation 501, the configuration information may be transmitted via RRC signaling; a system information broadcast message; and/or a MAC CE. In some embodiments, the configuration information related to the selection rule(s) includes at least one of:

- (1) An indication of disabling a 2-step or 4-step CBRA resource for the BSR.
- (2) A time threshold related to the threshold time period. The time threshold may be: 1) “a PDB requirement of a data service of the UE” minus “two RTT durations”; or 2) two RTT durations. Each RTT duration within two RTT durations may be one of: a round trip propagation delay between the UE and a network device in the network, wherein the network device is a BS or a network device; and timing advance applied at the UE.
- (3) Configuration information for a timer related to the threshold time period. The timer may start when the BSR is triggered at the UE. A length of the timer may be: 1) “a PDB requirement of a data service of the UE” minus “two RTT durations”; or 2) two RTT durations. Each RTT duration within two RTT durations may be one of: a

round trip propagation delay between the UE and a network device in the network, wherein the network device is a BS or a network device; and timing advance applied at the UE.

(4) An indication for enabling or disabling the selection rule(s).

[0063] Referring back to FIG. 5, in operation 502, the network device receives the BSR or the SR from the UE on the selected UL resource. In some embodiments, the BSR may be at least one of:

- (1) a regular BSR, as defined in 3GPP standard document TS38.321;
- (2) a periodic BSR, as defined in 3GPP standard document TS38.321;
- (3) a padding BSR, as defined in 3GPP standard document TS38.321;
- (4) a BSR triggered by UL data on a specific LCH;
- (5) a BSR triggered by UL data on a specific LCG; and
- (6) a BSR triggered by UL data on a LCH or a LCG which is related to: a specific quality of service (QoS) requirement; a specific DRB; a specific network slice; or a specific data service of the UE.

[0064] In some embodiments, a time instance of each available UL resource within the available UL resource(s) is based on at least one of:

- (1) A time offset value applied to the each available UL resource. The time offset value is related to transmitting the BSR. The time offset value may be set by the UE or configured by the network device. Specific examples of offset1 to offset7 are described in embodiments of FIG. 7. The time offset value may be associated with at least one of:
 - 1) urgency of a data service of the UE;
 - 2) RA load information;

- 3) a possible time delay of an UL resource requested by the data service of the UE; and
 - 4) a possible data retransmission.
- (2) A time instance of an earliest available UL-SCH resource, e.g., “T1” as shown in the embodiments of FIG. 7.
- (3) “A time instance of an earliest available resource for transmitting the SR” plus “a length of a RTT duration”, e.g., “T2 + RTT” as shown in the embodiments of FIG. 7.
- (4) A time instance of an earliest available resource for transmitting the SR and an indication associated with the BSR, e.g., “T3” as shown in the embodiments of FIG. 7.
- (5) A time instance of an earliest available resource for transmitting the SR to request an UL resource for transmitting data associated with the BSR, e.g., “T3” as shown in the embodiments of FIG. 7.
- (6) A time instance of an earliest available resource for starting to perform a 2-step CFRA procedure, e.g., “T4” as shown in the embodiments of FIG. 7.
- (7) “A time instance of an earliest available resource for starting to perform a 4-step CFRA procedure” plus “the length of the RTT duration”, e.g., “T5 + RTT” as shown in the embodiments of FIG. 7.
- (8) A time instance of an earliest available resource for starting to perform a 2-step CBRA procedure, e.g., “T6” as shown in the embodiments of FIG. 7.
- (9) “A time instance of an earliest available resource for starting to perform a 4-step CBRA procedure” plus “the length of the RTT duration”, e.g., “T7 + RTT” as shown in the embodiments of FIG. 7.

[0065] In some embodiments, in response to enabling the selection rule(s), the UL resource is selected according to the selection rule(s); and in response to disabling the

selection rule(s), the UL resource is not selected according to the selection rule(s).

[0066] In some embodiments, the network device further transmits, to the UE, at least one item of:

- (1) An indication for enabling the selection rule(s).
- (2) An indication for disabling the selection rule(s).
- (3) A time offset value configured by the network device. The time offset value is applied to the available UL resource(s) and related to transmitting the BSR or the SR. Specific examples of offset1 to offset7 are described in embodiments of FIG. 7. The time offset value may be associated with at least one of:
 - 1) urgency of a data service of the UE;
 - 2) RA load information;
 - 3) a possible time delay of an UL resource requested by the data service of the UE; and
 - 4) a possible data retransmission.
- (4) A list of BSR type(s) configured by the network device;
- (5) A list of LCH(s) configured by the network device;
- (6) A list of LCG(s) configured by the network device;
- (7) A list of DRB(s) configured by the network device;
- (8) A list of network slice(s) configured by the network device;
- (9) A time threshold configured by the network device. The time threshold is related to the threshold time period. The time threshold may be: 1) “a PDB requirement of a data service of the UE” minus “two RTT durations”; or 2) two RTT durations. Each RTT duration within two RTT durations may be one of: a round trip propagation delay between the UE and a network device in the network, wherein the network device is a BS or a network device; and timing advance applied at the UE.

(10) Configuration information for a timer configured by the network device. The timer is related to the threshold time period. The timer may start when the BSR is triggered at the UE. A length of the timer may be: 1) “a PDB requirement of a data service of the UE” minus “two RTT durations”; or 2) two RTT durations. Each RTT duration within two RTT durations may be one of: a round trip propagation delay between the UE and a network device in the network, wherein the network device is a BS or a network device; and timing advance applied at the UE.

[0067] Details described in the embodiments as illustrated and shown in FIGS. 1-4 and 6-8, especially, contents regarding how to select an UL resource according to a selection rule for transmitting a BSR or a SR associated with the BSR, are applicable for the embodiments as illustrated and shown in FIG. 5. Moreover, details described in the embodiments of FIG. 5 are applicable for all the embodiments of FIGS. 1-4 and 6-8.

[0068] FIG. 6 illustrates an exemplary flow chart for enhancing a BSR reporting mechanism in a large propagation delay scenario in accordance with some embodiments of the present application. In operation 601, BS 610 transmits, to UE 620, configuration information of a time-based UL resource selection for a BSR or a SR associated with the BSR. The SR associated with the BSR may be named as the associated SR or the like. In operation 602, UE 620 performs the time-based UL resource selection for the BSR or the associated SR.

[0069] In some embodiments of FIG. 6, in operation 602, UE 620 selects, based on the arrival time of multiple resources, an UL resource for the BSR or the associated SR. For instance, UE 620 selects an UL resource for any BSR, for some specific type(s) of BSR(s), for BSR(s) that is triggered by UL data on some specific LCH(s) or LCG(s), or for BSR(s) that is triggered by UL data on LCH(s) or LCG(s) which is associated with some specific DRB(s), some specific slice(s), or some specific service(s).

[0070] In some embodiments of FIG. 6, UE 620 may determine to apply a time-based UL resource selection for a BSR or a SR associated with the BSR according to the following:

Point (1): any type of BSR(s), e.g., a regular BSR, a periodic BSR, or a padding BSR;

Point (2): some specific type(s) of BSR(s), e.g., a regular BSR;

Point (3): BSR(s) that is triggered by UL data on some specific LCH(s) or LCG(s), e.g., LCH(s) or LCG(s) for URLLC data; and/or

Point (4): BSR(s) that is triggered by UL data on LCH(s) or LCG(s) that associated to some specific QoS requirement(s)/DRB(s)/slice(s)/service(s) , e.g., data interruption time is less than 2 RTTs.

Point (5): network configuration information that is received from the BS or the network device. In an embodiment, UE 620 may select an UL resource for a BSR or the associated SR based on the received network configuration information of a time-based UL selection for the BSR or the associated SR. The network configuration information may apply to BSR(s) in any of the abovementioned Points (1) to (4).

[0071] The network configuration information received by UE 620 may be related to a selection rule and could configure UE 620 to:

- (1) randomly select an UL resource in multiple available resources having a time instance of transmitting the BSR or the associated SR in a threshold time period; or
- (2) select an UL resource having the earliest time instance of transmitting the BSR or the associated SR in the threshold time period.

[0072] According to one selection rule, UE 620 could randomly select an UL resource for the BSR or the associated SR from multiple resources with the time instance of transmitting the BSR or the associated SR in a threshold time period. In an embodiment, the threshold time period can be represented as a time threshold, before which the UL resources can be randomly selected by UE 620. The time threshold can be equal to: (1) “a PDB requirement of a data service (that is beared on the LCH or LCG which triggers the BSR)” minus “2*RTT”; or (2) 2 RTTs. In a further embodiment, the threshold time period can be represented as a timer, which starts when BSR is triggered at UE 620, and UE 620 can randomly select the arrived UL resources for the BSR or the associated SR before the timer expires. The length of the timer can be equal to: (1) “a PDB requirement of data” minus “2*RTT”; or (2) 2 RTTs.

[0073] According to a further selection rule, UE 620 could select an UL resource for a BSR or the associated SR from multiple resources having an earliest time instance of transmitting the BSR or the associated SR. For each kind of an UL resource, a time instance of transmitting the BSR or the associated SR (or equivalent to transmission of BSR) may be different. A specific example is described in FIG. 7 as follows.

[0074] In some embodiments of FIG. 6 that UE 620 randomly selects an UL resource from the available UL resources for a BSR or the associated SR, a possible implementation for an UL-SCH resource and a 2-step RA resource in 3GPP specification TS38.321 may be as follows:

5.4.5 Buffer Status Reporting

...

The MAC entity shall:

1> if the Buffer Status reporting procedure determines that at least one BSR has been triggered and not cancelled:

2> if UL-SCH resources are available for a new transmission and the UL-SCH resources can accommodate the BSR MAC CE plus its subheader as a result of logical channel prioritization:

3> *if UL-SCH resources are within BSR-threshold and PUSCH resources corresponding to 2-step RA are available for a new transmission and the PUSCH resources can accommodate the BSR MAC CE plus its subheader;*

4> *Randomly select the UL-SCH resources or PUSCH resources corresponding to 2-step RA for reporting the BSR;*

3> *else*

4> *Select the UL-SCH resources for reporting the BSR;*

3> start or restart *periodicBSR-Timer* except when all the generated BSRs are long or short Truncated BSRs;

3> start or restart *retxBSR-Timer*.

3> instruct the Multiplexing and Assembly procedure to generate the BSR MAC CE(s) as defined in clause 6.1.3.1;

3> start or restart *periodicBSR-Timer* except when all the generated BSRs are long or short Truncated BSRs;

3> start or restart *retxBSR-Timer*.

- 2> if a Regular BSR has been triggered and *logicalChannelSR-DelayTimer* is not running;
- 3> if there is no UL-SCH resource available for a new transmission; or
- 3> if the MAC entity is configured with configured uplink grant(s) and the Regular BSR was triggered for a logical channel for which *logicalChannelSR-Mask* is set to *false*; or
- 3> if the UL-SCH resources available for a new transmission do not meet the LCP mapping restrictions (see clause 5.4.3.1) configured for the logical channel that triggered the BSR;
- 4> trigger a Scheduling Request.

NOTE 2: UL-SCH resources are considered available if the MAC entity has an active configuration for either type of configured uplink grants, or if the MAC entity has received a dynamic uplink grant, or if both of these conditions are met. If the MAC entity has determined at a given point in time that UL-SCH resources are available, this need not imply that UL-SCH resources are available for use at that point in time.

NOTE 3: PUSCH resources corresponding to 2-step RA are considered available if its time instance is within *BSR-threshold*, and CFRA resources for 2-step RA type are configured, or if CFRA resources are not configured and the RSRP of the downlink pathloss reference is above *msgA-RSRP-Threshold*.

[0075] In some embodiments of FIG. 6 that UE 620 selects, from multiple available resources, an UL resource having an earliest time instance of transmitting a BSR or the associated SR, a possible implementation for an UL-SCH resource and a 2-step RA resource in 3GPP specification TS38.321 may be as follows:

5.4.5 Buffer Status Reporting

...

The MAC entity shall:

- 1> if the Buffer Status reporting procedure determines that at least one BSR has been triggered and not cancelled;
- 2> if UL-SCH resources are available for a new transmission and the UL-SCH resources can accommodate the BSR MAC CE plus its subheader as a result of logical channel prioritization;

- 3> if PUSCH resources corresponding to 2-step RA are available for a new transmission and the PUSCH resources can accommodate the BSR MAC CE plus its subheader, and the time instance of PUSCH resources corresponding to 2-step RA is earlier than that of the UL-SCH resources;
 - 4> Select the PUSCH resources corresponding to 2-step RA for reporting the BSR;
- 3> else
 - 4> Select the UL-SCH resources for reporting the BSR;
- 3> start or restart *periodicBSR-Timer* except when all the generated BSRs are long or short Truncated BSRs;
- 3> start or restart *retxBSR-Timer*.
- 3> instruct the Multiplexing and Assembly procedure to generate the BSR MAC CE(s) as defined in clause 6.1.3.1;
- 3> start or restart *periodicBSR-Timer* except when all the generated BSRs are long or short Truncated BSRs;
- 3> start or restart *retxBSR-Timer*.
- 2> if a Regular BSR has been triggered and *logicalChannelSR-DelayTimer* is not running:
 - 3> if there is no UL-SCH resource available for a new transmission; or
 - 3> if the MAC entity is configured with configured uplink grant(s) and the Regular BSR was triggered for a logical channel for which *logicalChannelSR-Mask* is set to *false*; or
 - 3> if the UL-SCH resources available for a new transmission do not meet the LCP mapping restrictions (see clause 5.4.3.1) configured for the logical channel that triggered the BSR:
 - 4> trigger a Scheduling Request.

NOTE 2: UL-SCH resources are considered available if the MAC entity has an active configuration for either type of configured uplink grants, or if the MAC entity has received a dynamic uplink grant, or if both of these conditions are met. If the MAC entity has determined at a given point in time that UL-SCH resources are available, this needs not imply that UL-SCH resources are available for use at that point in time.

NOTE 3: PUSCH resources corresponding to 2-step RA are considered available if CFRA resources for 2-step RA type are configured, or if CFRA resources are not

configured and the RSRP of the downlink pathloss reference is above *msgA-RSRP-Threshold*.

[0076] In the embodiments of FIG. 6, BS 610 may enable the selection rule(s) to UE 620 by at least one of the following:

- (1) Transmitting a flag or an indication to UE 620 for enabling the selection rule(s).
- (2) Transmitting time offset value(s) applied to an available UL resource, and the time offset value is related to transmitting the BSR or the associated SR and configured to UE 620.
- (3) Transmitting a list of BSR types/LCHs/LCGs/DRBs/slices configured to UE 620.
- (4) Transmitting a time threshold which is related to the threshold time period and configured to UE 620.
- (5) Transmitting configuration information for a timer which is related to the threshold time period and configured to UE 620.

[0077] In the embodiments of FIG. 6, BS 610 may disable the selection rule(s) to UE 620 by at least one of the following:

- (1) Transmitting a flag or an indication to UE 620 for disabling the selection rule(s).
- (2) Transmitting no/absent time offset value(s) applied to an available UL resource, and the time offset value is related to transmitting the BSR or the SR and configured to UE 620.
- (3) Transmitting no/absent list of BSR types/LCHs/LCGs/DRBs/slices configured to UE 620.
- (4) Transmitting no/absent time threshold which is related to the threshold time period and configured to UE 620.
- (5) Transmitting no/absent configuration information for a timer which is related to the

threshold time period and configured to UE 620.

[0078] In the embodiments of FIG. 6, UE 620 may consider the selection rule(s) enabled by at least one of the following:

- (1) Receiving a flag or an indication from BS 610 for enabling the selection rule(s).
- (2) Receiving time offset value(s) applied to an available UL resource, and the time offset value is related to transmitting the BSR or the SR and configured from BS 610.
- (3) Receiving a list of BSR types/LCHs/LCGs/DRBs/slices configured from BS 610.
- (4) Receiving a time threshold which is related to the threshold time period and configured from BS 610.
- (5) Receiving configuration information for a timer which is related to the threshold time period and configured from BS 610.

[0079] In the embodiments of FIG. 6, UE 620 may consider the selection rule(s) disabled by at least one of the following:

- (1) Receiving a flag indication from BS 610 for disabling the selection rule(s).
- (2) Receiving no/absent time offset value(s) applied to an available UL resource, and the time offset value is related to transmitting the BSR or the SR and configured from BS 610.
- (3) Receiving no/absent list of BSR types/LCHs/LCGs/DRBs/slices configured from BS 610.
- (4) Receiving no/absent time threshold which is related to the threshold time period and configured from BS 610.
- (5) Receiving no/absent configuration information for a timer which is related to the threshold time period and configured from BS 610.

[0080] Details described in the embodiments as illustrated and shown in FIGS. 1-5, 7, and 8, especially, contents regarding how to select an UL resource according to a selection rule for transmitting a BSR or a SR associated with the BSR, are applicable for the embodiments as illustrated and shown in FIG. 6. Moreover, details described in the embodiments of FIG. 6 are applicable for all the embodiments of FIGS. 1-5, 7, and 8.

[0081] FIG. 7 illustrates a further exemplary flow chart for selecting an UL resource according to a selection rule in accordance with some embodiments of the present application.

[0082] In embodiments of FIG. 7, for each kind of available UL resource(s), the earliest time instance of transmitting the BSR or the associated SR (or equivalent to transmission of BSR) may be considered as:

- (1) For an UL-SCH resource (e.g., a CG): Arrival time of a next available UL-SCH resource (e.g., a CG) for a BSR or a SR associated with the BSR, e.g., “T1” as shown in FIG. 7 (with offset1 or a scaling factor a1).
- (2) For a SR resource: Arrival time of a next available SR resource, e.g., “T2 + RTT” as shown in FIG. 7 (with offset2 or a scaling factor a2), if there is no sufficient resource for a BSR but a sufficient resource for a SR;
- (3) For an enhanced SR resource: Arrival time of a next available enhanced SR resource, e.g., “T3” as shown in FIG. 7 (with offset3 or a scaling factor a3), if there is no sufficient resource for a BSR but a sufficient resource for a SR;
- (4) For a 2-step CFRA resource: Arrival time of a next available 2-step CFRA resource, e.g., “T4” as shown in FIG. 7 (with offset4 or a scaling factor a4) if a 2-step CFRA resource is configured, could be available in any case or only when there is no sufficient resource for a BSR and/or a SR;
- (5) For a 4-step CFRA resource: Arrival time of a next available 4-step CFRA resource, e.g., “T5 + RTT” as shown in FIG. 7 (with offset5 or a scaling factor a5) if a 4-step CFRA resource is configured, could be available in any case or only when there is no sufficient resource for a BSR and/or a SR;

- (6) For a 2-step CBRA resource: Arrival time of a next available 2-step CBRA resource, e.g., “T6” as shown in FIG. 7 (with offset6 or a scaling factor a6) if none CFRA resource is configured, could be available in any case or only when there is no sufficient resource for a BSR and/or a SR, and/or only when condition(s) of selecting 2-step CBRA is fulfilled (e.g., $RSRP > msgA-RSRP-Threshold$), and/or only when an indication of disabling 2-step CBRA resource for the BSR is not received from the network device;
- (7) For a 4-step CBRA resource: Arrival time of a next available 4-step CBRA resource, e.g., “T7 + RTT” as shown in FIG. 7 (with offset7 or a scaling factor a7) if none CFRA resource is configured, could be available in any case or only when there is no sufficient resource for a BSR and/or a SR, and/or only when condition(s) of selecting 2-step CBRA is not fulfilled (e.g., $RSRP < msgA-RSRP-Threshold$), and/or only when an indication of disabling 4-step CBRA resource for the BSR is not received from the network device.

[0083] In particular, UE1 and BS1 refer to a BSR reporting mechanism via CG similar to the embodiments of FIG. 2A, a BSR is triggered at time instance T_r in the time domain of UE1, and the time instance of a next CG for a BSR “T1” with “offset1” can be considered as a reference for resource selection. In an embodiment, BS1 could configure offset1 considering a time duration “t11” as shown in FIG. 7. Similar to the embodiments of FIG. 2A, UE1 may transmit a BSR to BS1 at time instance T1 on a next available UL resource for BSR transmission. Then, BS1 grants UL resource1 for an UL data transmission. After time duration t11, UE1 may transmit UL data on the granted UL resource1 for the UL data transmission.

[0084] UE2 and BS2 refer to a SR-BSR reporting mechanism similar to the embodiments of FIG. 2B, and a BSR is triggered at time instance T_r in the time domain of UE2. To achieve BSR transmission no later than T1 with “offset2”, the time instance of a resource for a SR “T2” should be “RTT+ offset2” earlier than it. In an embodiment, BS2 could configure offset2 considering a time duration “t21” and/or “t22” as shown in FIG. 7. RTT could be included in offset2 as well.

[0085] UE3 and BS3 refer to a large UL grant in SR response (i.e., an enhanced SR mechanism) similar to the embodiments of FIG. 2C, and a BSR is triggered at time

instance T_r in the time domain of UE3. To achieve what is equivalent to BSR transmission no later than T_1 with “offset3”, the time instance of a resource for a SR “T3” should be “offset3” earlier than it. In an embodiment, BS3 could configure offset3 considering a time duration “t31” as shown in FIG. 7.

[0086] UE4 and BS4 refer to a BSR reporting mechanism over a 2-step RA procedure similar to the embodiments of FIG. 2D, and a BSR is triggered at time instance T_r in the time domain of UE4. To achieve BSR transmission no later than T_1 with “offset4 or offset6”, the time instance of a resource for a 2-step RA procedure “T4 or T6” should be “offset4 or offset6” earlier than it. In an embodiment, BS4 could configure offset4 or offset6 considering a time duration “t41” or “t61” as shown in FIG. 7 and/or 2-step RA load.

[0087] UE5 and BS5 refer to a BSR reporting mechanism over a 4-step RA procedure similar to the embodiments of FIG. 2E, and a BSR is triggered at time instance T_r in the time domain of UE5. To achieve BSR transmission no later than T_1 with “offset5 or offset7”, the time instance of a resource for a 4-step RA procedure “T5 or T7” should be “RTT+offset5” or “RTT+offset7” earlier than it. In an embodiment, BS3 could configure offset5 or offset7 considering a time duration “t51 or t71” and/or “t52 or t72” as shown in FIG. 7 and/or 4-step RA load. RTT could be included in offset5 or offset7 as well.

[0088] In the embodiments of FIG. 7, a RTT is a time interval, and the RTT could refer to the round trip propagation delay between the UE and the BS or the network device or refer to the timing advance applied at the UE.

[0089] In the embodiments of FIG. 7, an offset value (e.g., any of offset1 to offset7) could be configured by the BS or the network device with considering the urgency of data service(s), RA load information, or possible time delay of requested UL resources, and possible data retransmission.

[0090] In the embodiments of FIG. 7, a next available SR resource could refer to the nearest PUCCH resource for SR after *sr-ProhibitTimer* or *logicalChannelSR-DelayTimer* expiration. A next available 2-step CFRA or a next available 2-step CBRA resource could refer to the nearest PUSCH resource for *MSG4*

payload transmission corresponding to a preamble and a PRACH occasion of 2-step CFRA or CBRA.

[0091] In the embodiments of FIG. 7, a reference time instance “T0” could be used when selecting an UL resource for a BSR or an associated SR. In other words, “a threshold time period” in the embodiments of FIG. 7 may start from Tr when the BSR is triggered and may end at T0, and resource(s) arriving later than T0 will not be considered as available for transmitting a BSR or an associated SR. In some embodiments, the value and usage of T0 could include one of:

- (1) T0 indicates the assumed BSR transmission time instance using the earliest available CG, and resource(s) arriving later than T0 will not be considered as available for transmitting a BSR or an associated SR. If offset1 is not used, T0 may be equal to T1 or later than T1; and if offset1 is used, T0 may be equal to “T1 + offset1” or later than “T1 + offset1”.
- (2) T0 is equal to or later than 2 RTTs after Tr when the BSR is triggered, and resource(s) arriving later than T0 will not be considered as available for transmitting a BSR or an associated SR. In the time domain, T0 is equal to “Tr + 2 RTTs” or equal to “Tr + 2 RTTs + a possible offset”.

[0092] In some embodiments of FIG. 7, if a UE selects an UL resource from multiple available resources having an earliest time instance for transmitting a BSR or an associated SR, following Table 1 shows some possible selection results of how to select an UL resource having the earliest time instance.

Table 1

Available UL resources	Conditions for selection	Selected resource
case (1): UL-SCH resource for BSR or SR (at T1) 2-step CFRA resource (at T4)	T4 is offset earlier than T1 (e.g., $T4 + \text{offset4} < T1 + \text{offset1}$)	2-step CFRA resource
	T4 is offset later than T1 (e.g., $T4 + \text{offset4} > T1 + \text{offset1}$)	UL-SCH resource

case (2): UL-SCH resource for BSR or SR (at T1) 4-step CFRA resource (at T5)	T5+RTT is offset earlier than T1 (e.g., $T5+RTT+offset5 < T1+offset1$)	4-step CFRA resource
	T5+RTT is offset later than T1 (e.g., $T5+RTT+offset5 > T1+offset1$)	UL-SCH resource
case (3): UL-SCH resource for BSR or SR (at T1) 2-step CBRA resource (at T6) 4-step CBRA resource (at T7)	2-step CBRA condition(s) fulfilled AND T6 is offset earlier than T1 (e.g., $T6+offset6 < T1+offset1$)	2-step CBRA resource
	2-step CBRA condition(s) fulfilled AND T6 is offset later than T1 (e.g., $T6+offset6 > T1+offset1$)	UL-SCH resource
	2-step CBRA condition(s) not fulfilled AND T7+RTT is offset earlier than T1 (e.g., $T7+RTT+offset7 < T1+offset1$)	4-step CBRA resource
	2-step CBRA condition(s) not fulfilled AND T7+RTT is offset later than T1 (e.g., $T7+RTT+offset7 > T1+offset1$)	UL-SCH resource
case (4): PUCCH resource for SR (at T2) 2-step CFRA resource (at T4)	T4 is offset earlier than T2+RTT (e.g., $T4+offset4 < T2+RTT+offset2$)	2-step CFRA resource
	T4 is offset later than T2+RTT (e.g., $T4+offset4 > T2+RTT+offset2$)	PUCCH resource
case (5): PUCCH resource for SR (at T2) 4-step CFRA resource (at T5)	T5 is offset earlier than T2 (e.g., $T5+offset5 < T2+offset2$)	4-step CFRA resource
	T5 is offset later than T2 (e.g., $T5+offset5 > T2+offset2$)	PUCCH resource
case (6): PUCCH resource for SR	2-step CBRA condition(s) fulfilled AND T6 is offset earlier than T2+RTT (e.g.,	2-step CBRA resource

(at T2)	$T6 + \text{offset}_6 < T2 + \text{RTT} + \text{offset}_2$)	
2-step CBRA resource (at T6)	2-step CBRA condition(s) fulfilled AND	PUCCH resource
4-step CBRA resource (at T7)	$T6$ is offset later than $T2 + \text{RTT}$ (e.g., $T6 + \text{offset}_6 < T2 + \text{RTT} + \text{offset}_2$)	
	2-step CBRA condition(s) not fulfilled AND	4-step CBRA resource
	$T7$ is offset earlier than $T2$ (e.g., $T7 + \text{offset}_7 < T2 + \text{offset}_2$)	
	2-step CBRA condition(s) not fulfilled AND	PUCCH resource
	$T7$ is offset later than $T2$ (e.g., $T7 + \text{offset}_7 > T2 + \text{offset}_2$)	
case (7):		
PUCCH resource for enhanced SR (at T3)	$T4$ is offset earlier than $T3$ (e.g., $T4 + \text{offset}_4 < T3 + \text{offset}_3$)	2-step CFRA resource
2-step CFRA resource (at T4)	$T4$ is offset later than $T3$ (e.g., $T4 + \text{offset}_4 > T3 + \text{offset}_3$)	PUCCH resource
case (8):		
PUCCH resource for enhanced SR (at T3)	$T5 + \text{RTT}$ is offset earlier than $T3$ (e.g., $T5 + \text{RTT} + \text{offset}_5 < T3 + \text{offset}_3$)	4-step CFRA resource
4-step CFRA resource (at T5)	$T5 + \text{RTT}$ is offset later than $T3$ (e.g., $T5 + \text{RTT} + \text{offset}_5 > T3 + \text{offset}_3$)	PUCCH resource
case (9):		
PUCCH resource for enhanced SR (at T3)	2-step CBRA condition(s) fulfilled AND	2-step CBRA resource
2-step CBRA resource (at T6)	$T6$ is offset earlier than $T3$ (e.g., $T6 + \text{offset}_6 < T3 + \text{offset}_3$)	
4-step CBRA resource (at T7)	2-step CBRA condition(s) fulfilled AND	PUCCH resource
	$T6$ is offset later than $T3$ (e.g., $T6 + \text{offset}_6 > T3 + \text{offset}_3$)	
	2-step CBRA condition(s) not fulfilled AND	4-step CBRA resource
	$T7 + \text{RTT}$ is offset earlier than $T3$ (e.g.,	

	$T7+RTT+offset7 < T3+offset3$)	
	2-step CBRA condition(s) not fulfilled AND $T7+RTT$ is offset later than $T3$ (e.g., $T7+RTT+offset7 > T3+offset3$)	PUCCH resource

[0093] In Table, 1, cases (1)~(9) are different combinations of multiple available UL resources for transmitting a BSR or an associated SR. Typically, cases (1)~(9) are mutually exclusive to each other.

[0094] For example, in case (1), both an UL-SCH resource for BSR or SR (at $T1$) and a 2-step CFRA resource (at $T4$) are available as determined by a UE. In case (1), when $T4$ is offset earlier than $T1$ (e.g., $T4+offset4 < T1+offset1$) in the time domain, the 2-step CFRA resource has an earliest time instance of transmitting the BSR or the associated SR, and thus the UE may select the 2-step CFRA resource to transmit the BSR or the associated SR. In case (1), when $T4$ is offset later than $T1$ (e.g., $T4+offset4 > T1+offset1$) in the time domain, the UL-SCH resource has an earliest time instance of transmitting the BSR or the associated SR, and thus the UE may select the UL-SCH resource to transmit the BSR or the associated SR.

[0095] For example, in case (2), both an UL-SCH resource for BSR or SR (at $T1$) and a 4-step CFRA resource (at $T5$) are available as determined by a UE. In case (2), when $T5+RTT$ is offset earlier than $T1$ (e.g., $T5+RTT+offset5 < T1+offset1$) in the time domain, the 4-step CFRA resource has an earliest time instance of transmitting the BSR or the associated SR, and thus the UE may select the 4-step CFRA resource to transmit the BSR or the associated SR. In case (2), when $T5+RTT$ is offset later than $T1$ (e.g., $T5+RTT+offset5 > T1+offset1$) in the time domain, the UL-SCH resource has an earliest time instance of transmitting the BSR or the associated SR, and thus the UE may select the UL-SCH resource to transmit the BSR or the associated SR. As shown in Table 1, case (3) to case (9) refer to other combinations of multiple available UL resources and other selection results, which are similar to case (1) and case (2).

[0096] Details described in the embodiments as illustrated and shown in FIGS. 1-6 and 8, especially, contents regarding how to select an UL resource according to a selection

rule for transmitting a BSR or a SR associated with the BSR, are applicable for the embodiments as illustrated and shown in FIG. 7. Moreover, details described in the embodiments of FIG. 7 are applicable for all the embodiments of FIGS. 1-6 and 8.

[0097] FIG. 8 illustrates an exemplary block diagram of an apparatus in accordance with some embodiments of the present application. As shown in FIG. 8, the apparatus 800 may include at least one processor 804 and at least one transceiver 802 coupled to the processor 804. The apparatus 800 may be a UE or a network device.

[0098] Although in this figure, elements such as the at least one transceiver 802 and processor 804 are described in the singular, the plural is contemplated unless a limitation to the singular is explicitly stated. In some embodiments of the present application, the transceiver 802 may be divided into two devices, such as a receiving circuitry and a transmitting circuitry. In some embodiments of the present application, the apparatus 800 may further include an input device, a memory, and/or other components.

[0099] In some embodiments of the present application, the apparatus 800 may be a UE. The processor 804 may be configured to select, according to a selection rule, an UL resource from one or more available UL resources for transmitting a BSR, or a SR associated with the BSR, to a network device, wherein the selection rule comprises: selecting, from the one or more available UL resources, an available UL resource having a time instance for transmitting the BSR or the SR within a threshold time period to the network device; and to transmit, via the wireless transceiver, the BSR or the SR to the network device via the selected UL resource.

[00100] In some embodiments of the present application, the apparatus 800 may be a network device. The transceiver 802 may be configured to transmit, to a UE, configuration information related to a selection rule. The selection rule is used by the UE to select an UL resource from one or more available UL resources for transmitting a BSR or a SR associated with the BSR, to the network device, and the selection rule comprises: selecting, from one or more available UL resources, an available UL resource having a time instance for transmitting the BSR or the SR within a threshold time period from the UE to the network device. The transceiver 802 may be further configured to receive the BSR or the SR from the UE via the selected UL resource.

[00101] In some embodiments of the present application, the apparatus 800 may further include at least one non-transitory computer-readable medium. In some embodiments of the present disclosure, the non-transitory computer-readable medium may have stored thereon computer-executable instructions to cause a processor to implement the method with respect to a UE or a network device as described above. For example, the computer-executable instructions, when executed, cause the processor 804 interacting with transceiver 802, so as to perform operations of the methods, e.g., as described in view of any of FIGS. 3A-7.

[00102] While this disclosure has been described with specific embodiments thereof, it is evident that many alternatives, modifications, and variations may be apparent to those skilled in the art. For example, various components of the embodiments may be interchanged, added, or substituted in the other embodiments. Also, all of the elements of each figure are not necessary for operation of the disclosed embodiments. For example, those having ordinary skills in the art would be enabled to make and use the teachings of the disclosure by simply employing the elements of the independent claims. Accordingly, embodiments of the disclosure as set forth herein are intended to be illustrative, not limiting. Various changes may be made without departing from the spirit and scope of the disclosure.

[00103] In this document, the terms "includes," "including," or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that includes a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element preceded by "a," "an," or the like does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that includes the element. Also, the term "another" is defined as at least a second or more. The term "having" and the like, as used herein, are defined as "including."

What is claimed:

1. A method performed by a user equipment (UE), comprising:

selecting, according to a selection rule, an uplink (UL) resource from one or more available UL resources for transmitting a buffer status report (BSR), or a scheduling request (SR) associated with the BSR, to a network device, wherein the selection rule comprises:

selecting, from the one or more available UL resources, an available UL resource having a time instance for transmitting the BSR or the SR within a threshold time period to the network device; and

transmitting the BSR or the SR to the network device via the selected UL resource.

2. The method of Claim 1, wherein the one or more available UL resources include at least one of:

an earliest uplink shared channel (UL-SCH) resource for transmitting the BSR or the SR;

an earliest resource for transmitting the SR to request an UL resource for the BSR;

an earliest resource for transmitting the SR and an indication associated with the BSR;

an earliest resource for transmitting the SR to request an UL resource for transmitting data associated with the BSR;

an earliest resource for starting to perform a 2-step contention-free random access (CFRA) procedure;

an earliest resource for starting to perform a 4-step CFRA procedure;

an earliest resource for starting to perform a 2-step contention-based random access (CBRA) procedure; and

an earliest resource for starting to perform a 4-step CBRA procedure.

3. The method of Claim 1, wherein selecting the available UL resource having the time instance for transmitting the BSR or the SR within the threshold time period further comprises one of:

selecting an available UL resource having an earliest time instance for transmitting the BSR or the SR within the threshold time period, as the selected UL resource; and

randomly selecting an available UL resource having the time instance for transmitting the BSR or the SR within the threshold time period, as the selected UL resource.

4. The method of Claim 3, further comprising:

determining a time instance of each available UL resource within the one or more available UL resources for transmitting the BSR or the SR, based on at least one of:

a time offset value applied to the each available UL resource, wherein the time offset value is related to transmitting the BSR or the SR;

a time instance of an earliest available uplink shared channel (UL-SCH) resource;

a time instance of an earliest available resource for transmitting the SR plus a length of a round trip time (RTT) duration;

a time instance of an earliest available resource for transmitting the SR and an indication associated with the BSR;

a time instance of an earliest available resource for transmitting the SR to request an UL resource for transmitting data associated with the BSR;

a time instance of an earliest available resource for starting to perform a 2-step contention-free random access (CFRA) procedure;

a time instance of an earliest available resource for starting to perform a 4-step CFRA procedure plus the length of the RTT duration;

a time instance of an earliest available resource for starting to perform a 2-step contention-based random access (CBRA) procedure; and

a time instance of an earliest available resource for starting to perform a 4-step CBRA procedure plus the length of the RTT duration.

5. The method of Claim 1, further comprising:

receiving, from the network device, configuration information related to the selection rule.

6. The method of Claim 1, wherein the BSR is at least one of:

a regular BSR;

a periodic BSR;

a padding BSR;

a BSR triggered by UL data on a specific logical channel (LCH);

a BSR triggered by UL data on a specific logical channel group (LCG); and

a BSR triggered by UL data on a LCH or a LCG, wherein the LCH or the LCG is related to one of:

a specific quality of service (QoS) requirement;

a specific data radio bearer (DRB);

a specific network slice; and

a specific data service of the UE.

7. The method of Claim 1, wherein selecting the UL resource further comprises:

determining whether the selection rule is enabled or disabled;

in response to determining that the selection rule is enabled, selecting the available UL resource according to the selection rule; and

in response to determining that the selection rule is disabled, not selecting the available UL resource according to the selection rule.

8. The method of Claim 7, further comprising:

determining that the selection rule is enabled, in response to receiving at least one item of:

an indication for enabling the selection rule;

a time offset value configured by a network, wherein the time offset value is applied to the one or more available UL resources and related to transmitting the BSR;

a list of one or more BSR types configured by the network;

a list of one or more logical channels (LCHs) configured by the network;

a list of one or more logical channel groups (LCGs) configured by the network;

a list of one or more data radio bearers (DRBs) configured by the network;

a list of one or more network slices configured by the network;

a time threshold configured by the network, wherein the time threshold is related to the threshold time period; and

configuration information for a timer configured by the network, wherein the timer is related to the threshold time period; and

determining that the selection rule is disabled, in response to receiving an indication for disabling the selection rule or in response to not receiving the at least one item.

9. The method of Claim 1, wherein the threshold time period is associated with at least one of:

a packet delay budget (PDB) requirement of a data service of the UE; and

a round trip time (RTT) duration.

10. A method performed by a network device, comprising:

transmitting, to a user equipment (UE), configuration information related to a selection rule, wherein the selection rule is used by the UE to select an uplink (UL) resource from one or more available UL resources for transmitting a buffer status report (BSR), or a scheduling request (SR) associated with the BSR, to the network device, and wherein the selection rule comprises:

selecting, from the one or more available UL resources, an available UL resource having a time instance for transmitting the BSR or the SR within a threshold time period from the UE to the network device; and

receiving the BSR or the SR from the UE via the selected UL resource.

11. The method of Claim 10, wherein the one or more available UL resources include at least one of:

an earliest uplink shared channel (UL-SCH) resource for transmitting the BSR or the SR;

an earliest resource for transmitting the SR;

an earliest resource for transmitting the SR and an indication associated with the BSR;

an earliest resource for transmitting the SR to request an UL resource for transmitting data associated with the BSR;

an earliest resource for starting to perform a 2-step contention-free random access (CFRA) procedure;

an earliest resource for starting to perform a 4-step CFRA procedure;

an earliest resource for starting to perform a 2-step contention-based random access (CBRA) procedure; and

an earliest resource for starting to perform a 4-step CBRA procedure.

12. The method of Claim 10, wherein selecting the available UL resource having the time instance for transmitting the BSR or the SR within the threshold time period from the UE to the network device further comprises one of:

selecting an available UL resource having an earliest time instance for transmitting the BSR or the SR within the threshold time period, as the selected UL resource; and

randomly selecting an available UL resource having the time instance for transmitting the BSR or the SR within the threshold time period, as the selected UL resource.

13. The method of Claim 12, wherein a time instance of each available UL resource within the one or more available UL resources for transmitting the BSR or the SR is based on at least one of:

- a time offset value applied to each available UL resource, wherein the time offset value is related to transmitting the BSR or the SR;

- a time instance of an earliest available uplink shared channel (UL-SCH) resource;

- a time instance of an earliest available resource for transmitting the SR plus a length of a round trip time (RTT) duration;

- a time instance of an earliest available resource for transmitting the SR and an indication associated with the BSR;

- a time instance of an earliest available resource for transmitting the SR to request an UL resource for transmitting data associated with the BSR;

- a time instance of an earliest available resource for starting to perform a 2-step contention-free random access (CFRA) procedure;

- a time instance of an earliest available resource for starting to perform a 4-step CFRA procedure plus the length of the RTT duration;

- a time instance of an earliest available resource for starting to perform a 2-step contention-based random access (CBRA) procedure; and

- a time instance of an earliest available resource for starting to perform a 4-step CBRA procedure plus the length of the RTT duration.

14. A user equipment (UE), comprising:

- a processor; and

- a wireless transceiver coupled to the processor,

wherein the processor is configured:

- to select, according to a selection rule, an uplink (UL) resource from one or more available UL resources for transmitting a buffer status report (BSR), or a scheduling request (SR) associated with the BSR, to a network device, wherein the selection rule comprises:

selecting, from the one or more available UL resources, an available UL resource having a time instance for transmitting the BSR or the SR within a threshold time period to the network device; and

to transmit, via the wireless transceiver, the BSR or the SR to the network device via the selected UL resource.

15. A network device, comprising:

a processor; and

a wireless transceiver coupled to the processor,

wherein the processor is configured:

to transmit, via the wireless transceiver to a user equipment (UE), configuration information related to a selection rule, wherein the selection rule is used by the UE to select an uplink (UL) resource from one or more available UL resources for transmitting a buffer status report (BSR) or a scheduling request (SR) associated with the BSR, to the network device, and wherein the selection rule comprises:

selecting, from one or more available UL resources, an available UL resource having a time instance for transmitting the BSR or the SR within a threshold time period from the UE to the network device; and

to receive, via the wireless transceiver, the BSR or the SR from the UE via the selected UL resource.

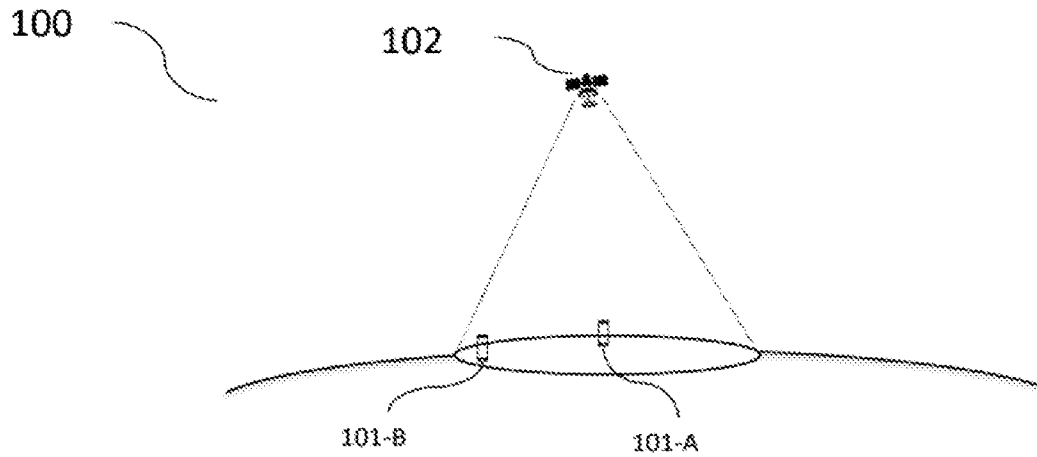
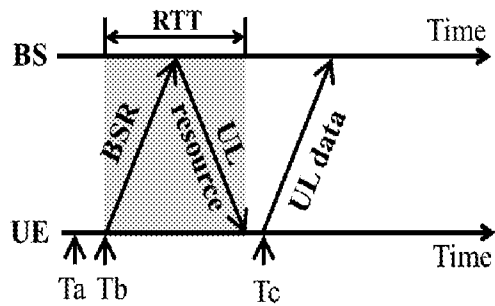


FIG. 1

**A BSR reporting mechanism**

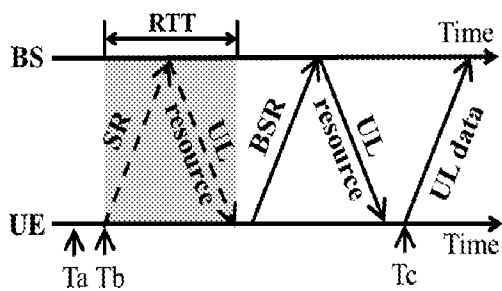
Sufficient resource(s) for BSR reporting

Ta: BSR is triggered, e.g., due to UL data

Tb: Next available UL resource for BSR transmission

Tc: The granted UL resource for UL data transmission

FIG. 2A

**A SR-BSR reporting mechanism**

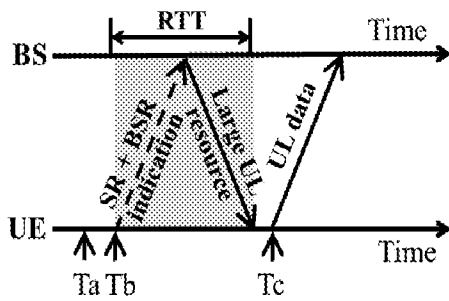
Sufficient resource for SR but not for BSR

Ta: BSR is triggered, e.g., due to UL data

Tb: Next available UL resource for SR transmission

Tc: The granted UL resource for UL data transmission

FIG. 2B



Large UL grant in a SR response (Enhanced SR) mechanism

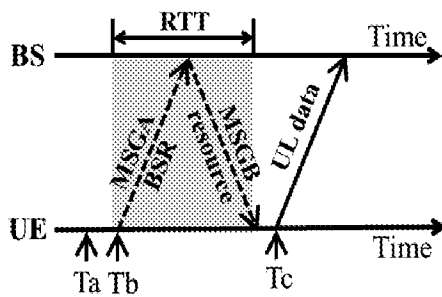
Sufficient resource for SR (and possibly a BSR indication)

T_a : BSR is triggered, e.g., due to UL data

T_b : Next available UL resource for SR transmission

T_c : The granted UL resource for UL data transmission

FIG. 2C



A BSR reporting mechanism over a 2-step RA procedure

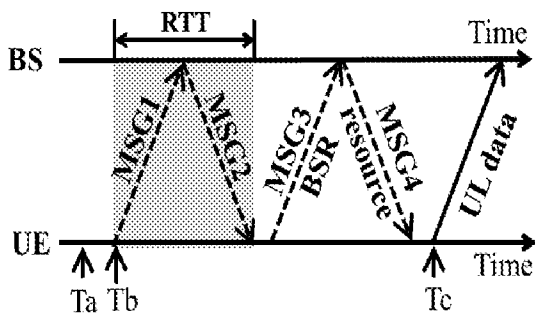
No sufficient resource for SR (and BSR); and configured with 2-step CFRA or $RSRP > msgA-RSRP-Threshold$

T_a : BSR is triggered, e.g., due to UL data

T_b : Next available 2-step RA resource

T_c : The granted UL resource for UL data transmission

FIG. 2D



A BSR reporting mechanism over a 4-step RA procedure

No sufficient resource for SR (and BSR); and configured with 4-step CFRA or $RSRP < msgA-RSRP-Threshold$

T_a : BSR is triggered, e.g., due to UL data

T_b : Next available 4-step RA resource

T_c : The granted UL resource for UL data transmission

FIG. 2E

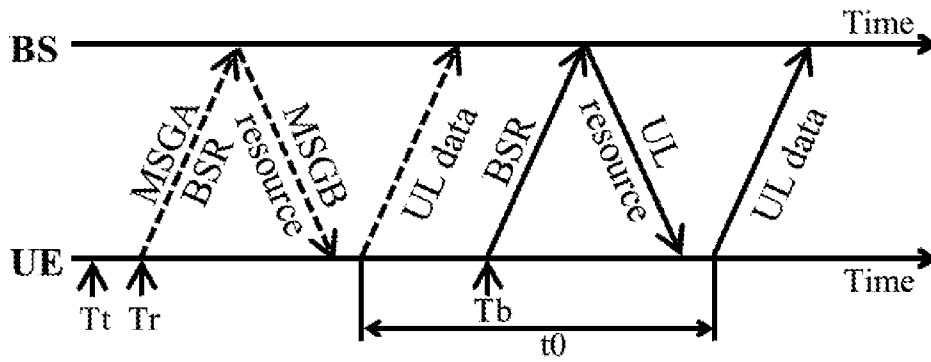


FIG. 3A

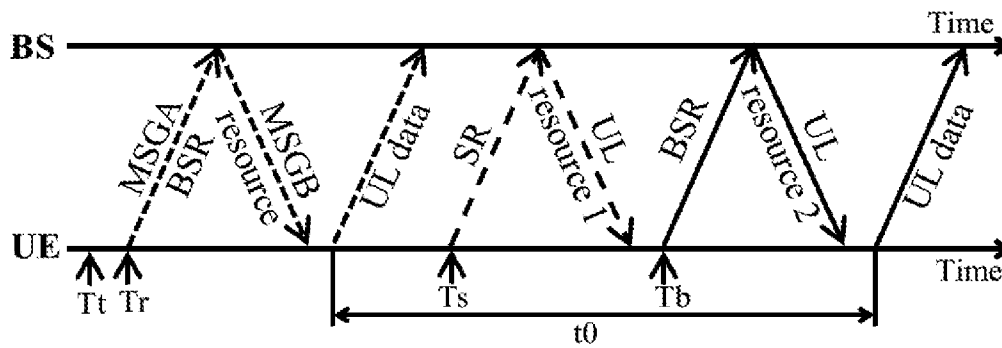


FIG. 3B

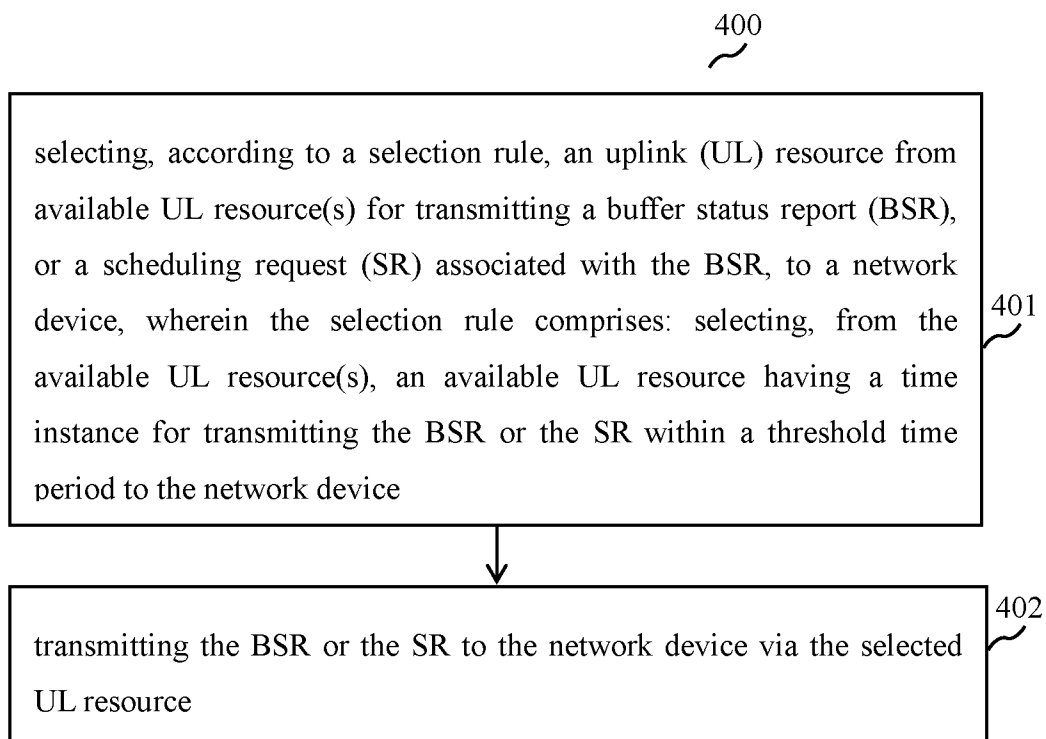


FIG. 4

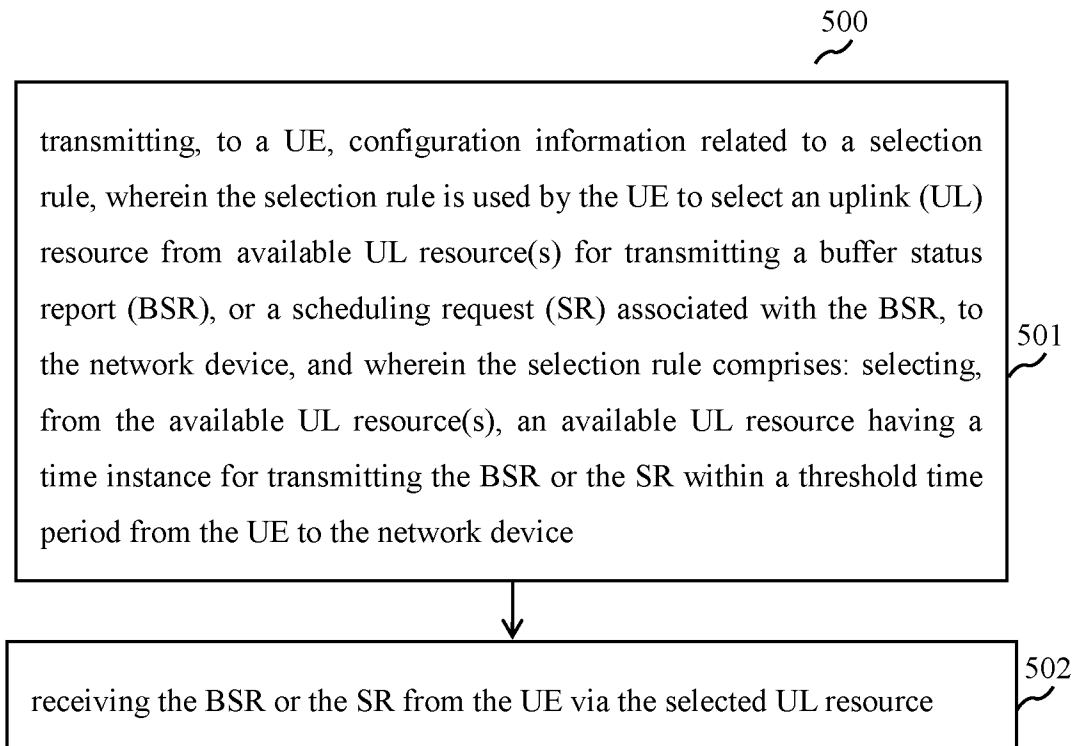


FIG. 5

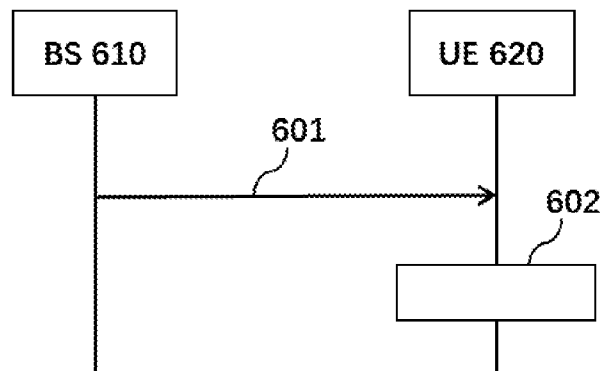


FIG. 6

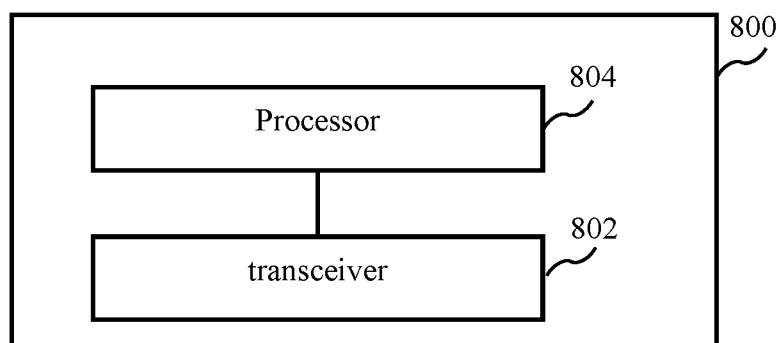


FIG. 8

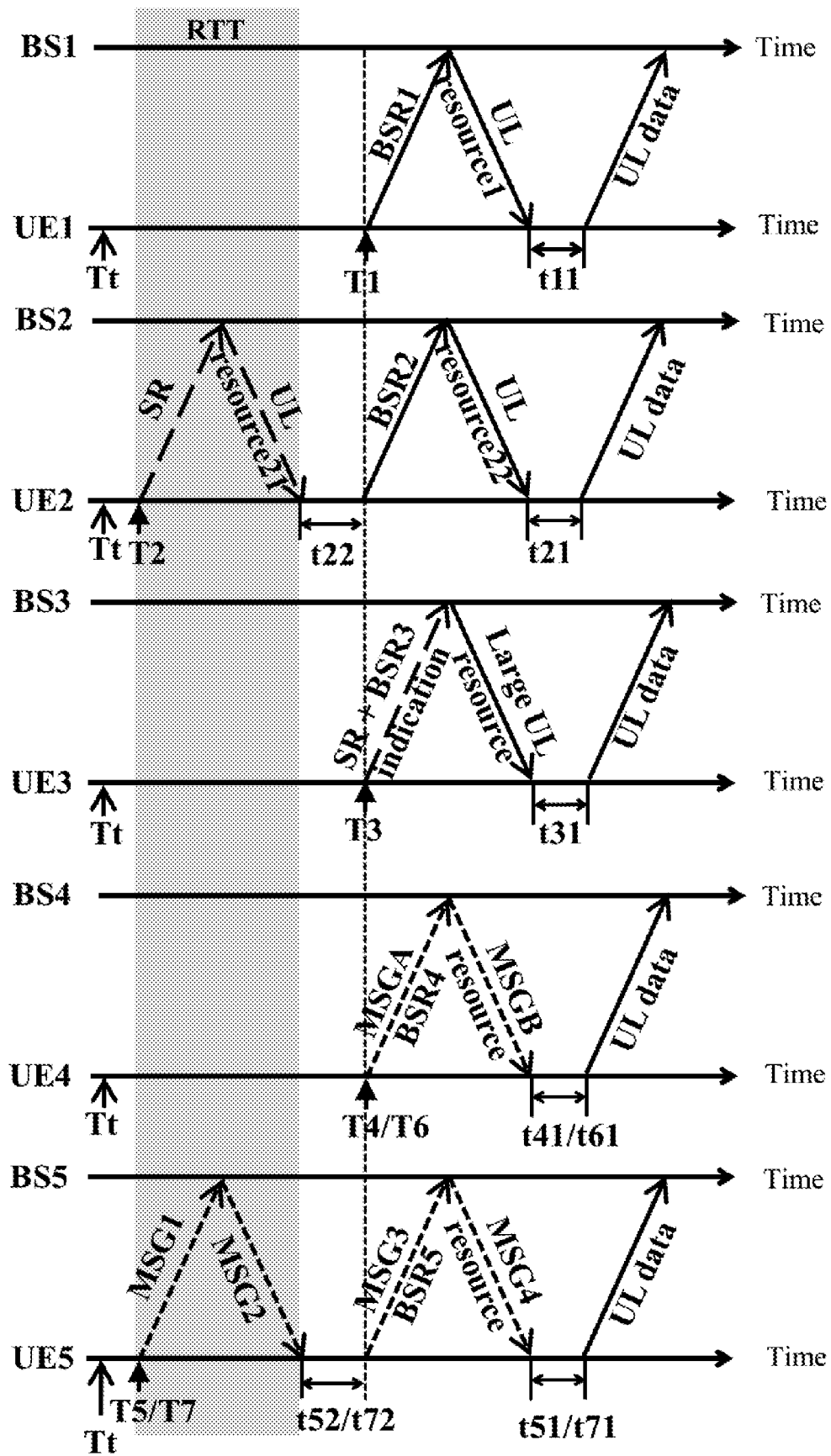


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2021/100848

A. CLASSIFICATION OF SUBJECT MATTER H04W 74/00(2009.01)i According to International Patent Classification (IPC) or to both national classification and IPC																	
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H04W Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CNPAT,CNKI,EPODOC,WPI,3GPP:UL,uplink, resource, buffer status report, BSR, schedul+ request, SR, time, interval, threshold, RTT, RTD, period, PDB, packet delay budget																	
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>NOKIA et al. "Discussion on UL scheduling enhancements for NTN" 3GPP TSG-RAN WG2 Meeting #114 Electronic R2-2105414, 27 May 2021 (2021-05-27), sections 1-2</td> <td>1-15</td> </tr> <tr> <td>A</td> <td>OPPO. "Discussion on other MAC issues in NTN" 3GPP TSG-RAN WG2 Meeting #112 electronic R2-2009109, 13 November 2020 (2020-11-13), the whole document</td> <td>1-15</td> </tr> <tr> <td>A</td> <td>WO 2020169314 A1 (PANASONIC INTELLECTUAL PROPERTY CORPORATION OF AMERICA) 27 August 2020 (2020-08-27) the whole document</td> <td>1-15</td> </tr> <tr> <td>A</td> <td>CN 112806090 A (BEIJING XIAOMI MOBILE SOFTWARE CO., LTD.) 14 May 2021 (2021-05-14) the whole document</td> <td>1-15</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	NOKIA et al. "Discussion on UL scheduling enhancements for NTN" 3GPP TSG-RAN WG2 Meeting #114 Electronic R2-2105414, 27 May 2021 (2021-05-27), sections 1-2	1-15	A	OPPO. "Discussion on other MAC issues in NTN" 3GPP TSG-RAN WG2 Meeting #112 electronic R2-2009109, 13 November 2020 (2020-11-13), the whole document	1-15	A	WO 2020169314 A1 (PANASONIC INTELLECTUAL PROPERTY CORPORATION OF AMERICA) 27 August 2020 (2020-08-27) the whole document	1-15	A	CN 112806090 A (BEIJING XIAOMI MOBILE SOFTWARE CO., LTD.) 14 May 2021 (2021-05-14) the whole document	1-15
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Date of the actual completion of the international search 21 January 2022		Date of mailing of the international search report 25 February 2022															
Name and mailing address of the ISA/CN National Intellectual Property Administration, PRC 6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China Facsimile No. (86-10)62019451		Authorized officer TONG,Honghong Telephone No. 86-(10)-53961595															

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2021/100848

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2020169314	A1	27 August 2020	US	2021385833	A1	09 December 2021
				EP	3700283	A1	26 August 2020
				CN	113330803	A	31 August 2021
CN	112806090	A	14 May 2021	None			