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(54) **Title:** SOUNDING REFERENCE SIGNAL TRANSMISSION IN A COMMUNICATION NETWORK

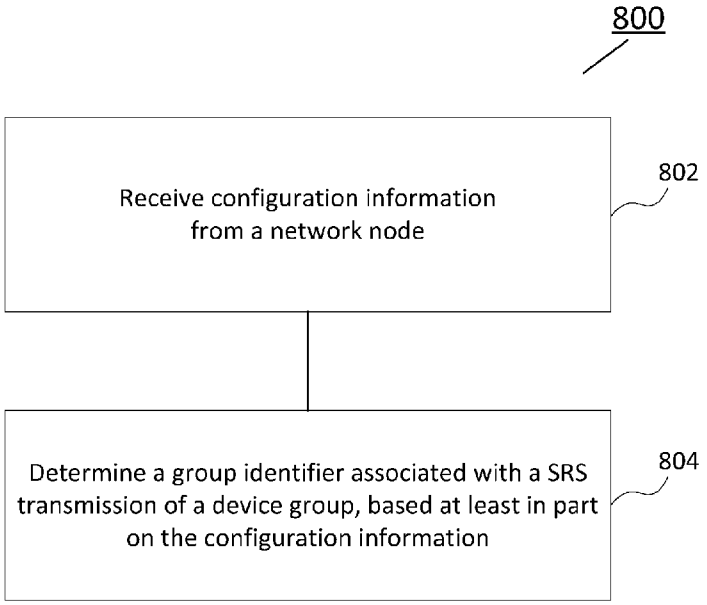

Fig.8

(57) **Abstract:** A method for communications is proposed. The method may comprise receiving configuration information from a network node. The configuration information may indicate a resource allocation for a sounding reference signal transmission of the terminal device. The method may further comprise determining a group identifier associated with a sounding reference signal transmission of a device group, based at least in part on the configuration information. The terminal device is a member of the device group.

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SOUNDING REFERENCE SIGNAL TRANSMISSION IN A COMMUNICATION NETWORK

FIELD OF THE INVENTION

[0001] The present disclosure generally relates to communication networks, and more specifically, to signal transmission in a communication network.

BACKGROUND

[0002] This section introduces aspects that may facilitate a better understanding of the disclosure. Accordingly, the statements of this section are to be read in this light and are not to be understood as admissions about what is in the prior art or what is not in the prior art.

[0003] Mobile broadband may continue to drive some demands for big overall traffic capacity and huge achievable end-user data rates in a wireless communication network. Many scenarios for network services in the future may require data rates of up to 10Gbps in local areas. These demands for very high system capacity and end-user data rates can be met by networks where distances between access nodes may range from a few meters in indoor deployments up to roughly 50 meters in outdoor deployments, for example, by next generation communication networks with an infrastructure density considerably higher than the densest networks of today. Besides the traditional licensed exclusive spectrum, the next generation communication systems such as fifth generation (5G) and new radio (NR) systems are also expected to be operable on the unlicensed spectrum which may be sharable. There may be a need for improving multiple transmissions such as sounding reference signal (SRS) transmissions from different terminal devices to achieve efficient spectrum sharing.

SUMMARY

[0004] This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the detailed description. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

[0005] A wireless communication network such as 5G or NR may be able to support flexible channel sharing and multi-user transmissions. In order to obtain reference signals for channel estimation from different terminal devices, a network node may transmit multiple downlink control information (DCI) messages to schedule multiple SRS transmissions from the terminal devices respectively. However, multiple DCI transmissions may increase signaling overhead, and multiple listen-before-talk (LBT) operations by different terminal devices may cause differentiated LBT results. Therefore, it may be desirable to schedule or trigger SRS transmissions in a more efficient way.

[0006] The present disclosure proposes a solution of SRS transmissions in a communication network, which may configure multiple terminal devices as a group for SRS transmission, so that a grouped SRS transmission may be scheduled by a single trigger message.

[0007] According to a first aspect of the present disclosure, there is provided a method implemented at a terminal device. The method may comprise receiving configuration information from a network node. The configuration information may indicate a resource allocation for a SRS transmission of the terminal device. The method may further comprise determining a group identifier associated with a SRS transmission of a device group, based at least in part on the configuration information.

The terminal device is a member of the device group.

[0008] In accordance with an exemplary embodiment, the method according to the first aspect of the present disclosure may further comprise detecting a trigger message for triggering the SRS transmission of the device group, based at least in part on the group identifier.

[0009] In accordance with an exemplary embodiment, the method according to the first aspect of the present disclosure may further comprise performing a LBT procedure one or more times prior to the SRS transmission of the terminal device, in response to the trigger message indicating that the LBT procedure is needed for the SRS transmission of the device group.

[0010] According to a second aspect of the present disclosure, there is provided an apparatus. The apparatus may comprise one or more processors and one or more memories comprising computer program codes. The one or more memories and the computer program codes may be configured to, with the one or more processors, cause the apparatus at least to perform any step of the method according to the first aspect of the present disclosure.

[0011] According to a third aspect of the present disclosure, there is provided a computer-readable medium having computer program codes embodied thereon which, when executed on a computer, cause the computer to perform any step of the method according to the first aspect of the present disclosure.

[0012] According to a fourth aspect of the present disclosure, there is provided an apparatus. The apparatus may comprise a receiving unit and a determining unit. In accordance with some exemplary embodiments, the receiving unit may be operable to carry out at least the receiving step of the method according to the first aspect of the present disclosure. The determining unit may be operable to carry out at least the

determining step of the method according to the first aspect of the present disclosure.

[0013] According to a fifth aspect of the present disclosure, there is provided a method implemented at a network node. The method may comprise determining configuration information which comprises a group identifier associated with a SRS transmission of a device group. The method may further comprise transmitting the configuration information to a terminal device which is a member of the device group. The configuration information may indicate a resource allocation for a SRS transmission of the terminal device.

[0014] In accordance with an exemplary embodiment, the method according to the fifth aspect of the present disclosure may further comprise transmitting a trigger message for triggering the SRS transmission of the device group, based at least in part on the group identifier.

[0015] In accordance with an exemplary embodiment, the method according to the fifth aspect of the present disclosure may further comprise detecting the SRS transmission of the device group in at least one of multiple slots.

[0016] In accordance with an exemplary embodiment, the method according to the fifth aspect of the present disclosure may further comprise specifying a search space for the trigger message to the terminal device.

[0017] According to a sixth aspect of the present disclosure, there is provided an apparatus. The apparatus may comprise one or more processors and one or more memories comprising computer program codes. The one or more memories and the computer program codes may be configured to, with the one or more processors, cause the apparatus at least to perform any step of the method according to the fifth aspect of the present disclosure.

[0018] According to a seventh aspect of the present disclosure, there is provided

a computer-readable medium having computer program codes embodied thereon which, when executed on a computer, cause the computer to perform any step of the method according to the fifth aspect of the present disclosure.

[0019] According to an eighth aspect of the present disclosure, there is provided an apparatus. The apparatus may comprise a determining unit and a transmitting unit. In accordance with some exemplary embodiments, the determining unit may be operable to carry out at least the determining step of the method according to the fifth aspect of the present disclosure. The transmitting unit may be operable to carry out at least the transmitting step of the method according to the fifth aspect of the present disclosure.

[0020] In accordance with an exemplary embodiment, the SRS transmission of the device group may comprises respective SRS transmissions from members of the device group.

[0021] In accordance with an exemplary embodiment, the group identifier may comprise a radio network temporary identifier (RNTI) for the device group.

[0022] In accordance with an exemplary embodiment, the trigger message may comprise downlink control information (DCI) scrambled by the group identifier.

[0023] In accordance with an exemplary embodiment, the trigger message may indicate that a LBT procedure is needed for the SRS transmission of the device group. Optionally, the trigger message may indicate a type of the LBT procedure. For example, the LBT procedure may comprise a short LBT procedure.

[0024] In accordance with an exemplary embodiment, the trigger message may indicate a backoff window size for the LBT procedure.

[0025] In accordance with an exemplary embodiment, the trigger message may indicate that no LBT procedure is needed for the SRS transmission of the device

group.

[0026] In accordance with an exemplary embodiment, there may be an interval between the detection of the trigger message and the SRS transmission of the device group, and the interval may be less than a predefined threshold. In this case, a LBT procedure may not be necessary for the SRS transmission of the device group.

[0027] In accordance with an exemplary embodiment, the trigger message may indicate that the SRS transmission of the device group may be allowable to span multiple slots.

[0028] In accordance with an exemplary embodiment, the trigger message may be detected within a search space specified by the network node.

[0029] In accordance with an exemplary embodiment, the members of the device group may be configured to perform uplink multi-user multiple-input multiple-output (UL MU-MIMO) transmissions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] The disclosure itself, the preferable mode of use and further objectives are best understood by reference to the following detailed description of the embodiments when read in conjunction with the accompanying drawings, in which:

[0031] Figs.1A-1C are diagrams illustrating resource configuration examples for SRS transmissions according to some embodiments of the present disclosure;

[0032] Fig.2 is a diagram illustrating an example of triggering SRS transmissions according to an embodiment of the present disclosure;

[0033] Fig.3 is a flowchart illustrating a method according to an embodiment of the present disclosure;

[0034] Fig.4 is a diagram illustrating an example of a short LBT procedure for SRS transmission according to an embodiment of the present disclosure;

[0035] Fig.5 is a diagram illustrating an example of multi-slot SRS transmissions according to an embodiment of the present disclosure;

[0036] Fig.6 is a diagram illustrating an example of no LBT procedure for SRS transmission according to an embodiment of the present disclosure;

[0037] Fig.7 is a diagram illustrating an example of specific triggering before SRS transmissions according to an embodiment of the present disclosure;

[0038] Fig.8 is a flowchart illustrating a method according to another embodiment of the present disclosure;

[0039] Fig.9 is a diagram illustrating an exemplary network side procedure according to an embodiment of the present disclosure;

[0040] Fig.10 is a diagram illustrating an exemplary terminal side procedure according to another embodiment of the present disclosure;

[0041] Fig.11 is a block diagram illustrating an apparatus according to an embodiment of the present disclosure;

[0042] Fig.12 is a block diagram illustrating another apparatus according to another embodiment of the present disclosure; and

[0043] Fig.13 is a block diagram illustrating yet another apparatus according to a further embodiment of the present disclosure.

DETAILED DESCRIPTION

[0044] The embodiments of the present disclosure are described in detail with

reference to the accompanying drawings. It should be understood that these embodiments are discussed only for the purpose of enabling those skilled persons in the art to better understand and thus implement the present disclosure, rather than suggesting any limitations on the scope of the present disclosure. Reference throughout this specification to features, advantages, or similar language does not imply that all of the features and advantages that may be realized with the present disclosure should be or are in any single embodiment of the disclosure. Rather, language referring to the features and advantages is understood to mean that a specific feature, advantage, or characteristic described in connection with an embodiment is included in at least one embodiment of the present disclosure. Furthermore, the described features, advantages, and characteristics of the disclosure may be combined in any suitable manner in one or more embodiments. One skilled in the relevant art will recognize that the disclosure may be practiced without one or more of the specific features or advantages of a particular embodiment. In other instances, additional features and advantages may be recognized in certain embodiments that may not be present in all embodiments of the disclosure.

[0045] As used herein, the term "communication network" refers to a network following any suitable communication standards, such as NR, long term evolution (LTE), LTE-Advanced, wideband code division multiple access (WCDMA), high-speed packet access (HSPA), and so on. Furthermore, the communications between a terminal device and a network node in the communication network may be performed according to any suitable generation communication protocols, including, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), 4G, 4.5G, 5G communication protocols, and/or any other protocols either currently known or to be developed in the future.

[0046] The term "network node" refers to a network device in a communication network via which a terminal device accesses to the network and receives services

therefrom. The network node may refer to a base station (BS), an access point (AP), a mobile management entity (MME), multi-cell/multicast coordination entity (MCE), a gateway, a server, a controller or any other suitable device in a wireless communication network. The BS may be, for example, a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a next generation NodeB (gNodeB or gNB), a remote radio unit (RRU), a radio header (RH), a remote radio head (RRH), a relay, a low power node such as a femto, a pico, and so forth.

[0047] Yet further examples of the network node comprise multi-standard radio (MSR) radio equipment such as MSR BSs, network controllers such as radio network controllers (RNCs) or base station controllers (BSCs), base transceiver stations (BTSs), transmission points, transmission nodes, MCEs, core network nodes, positioning nodes and/or the like. More generally, however, the network node may represent any suitable device (or group of devices) capable, configured, arranged, and/or operable to enable and/or provide a terminal device access to a wireless communication network or to provide some service to a terminal device that has accessed to the wireless communication network.

[0048] The term "terminal device" refers to any end device that can access a communication network and receive services therefrom. By way of example and not limitation, the terminal device may refer to a mobile terminal, a user equipment (UE), or other suitable devices. The UE may be, for example, a subscriber station, a portable subscriber station, a mobile station (MS) or an access terminal (AT). The terminal device may include, but not limited to, portable computers, image capture terminal devices such as digital cameras, gaming terminal devices, music storage and playback appliances, a mobile phone, a cellular phone, a smart phone, a tablet, a wearable device, a personal digital assistant (PDA), a vehicle, and the like.

[0049] As used herein, the terms "first", "second" and so forth refer to different

elements. The singular forms “a” and “an” are intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms “comprises”, “comprising”, “has”, “having”, “includes” and/or “including” as used herein, specify the presence of stated features, elements, and/or components and the like, but do not preclude the presence or addition of one or more other features, elements, components and/or combinations thereof. The term “based on” is to be read as “based at least in part on”. The term “one embodiment” and “an embodiment” are to be read as “at least one embodiment”. The term “another embodiment” is to be read as “at least one other embodiment”. Other definitions, explicit and implicit, may be included below.

[0050] Wireless communication networks are widely deployed to provide various telecommunication services such as voice, video, data, messaging and broadcasts. To meet dramatically increasing network requirements on system capacity and data rates, one interesting option for communication technique development is to allow a wireless communication network such as a NR or 5G system to be operable on the unlicensed bands, besides the licensed exclusive bands. By aggregation of the licensed and unlicensed carriers, a terminal device may benefit from the additional transmission capacity provided by the unlicensed bands.

[0051] However, regulatory requirements may not permit transmissions in the unlicensed bands without performing some type of channel sensing. For example, since the unlicensed bands are generally shared with other radios of similar or dissimilar wireless technologies, a LBT procedure may need to be applied by a communication device before transmitting on a channel that uses the unlicensed bands.

[0052] The LBT procedure is vital for fair coexistence of unlicensed systems with other operators and technologies operating in the unlicensed bands, such as

wireless fidelity (Wi-Fi) and licensed assisted access (LAA). The LBT procedure of a communication device attempting to transmit on a carrier in the unlicensed bands requires the communication device to perform a clear channel assessment to determine if the channel is available. Regulatory requirements, for example, in Europe, specify an energy detection threshold such that if a device receives energy greater than this threshold, the device assumes that the channel is not available for immediate use. In order to meet the regulatory requirements such as LBT in the unlicensed bands, some transmission mechanisms, for example, designed for SRS, may need to be improved to achieve efficient spectrum sharing.

[0053] In a wireless communication network, SRS is typically used by a network node to estimate the uplink (UL) channel quality at different frequencies, which may then be used for efficiently assigning radio resources for the UL data transmission. The SRS in the UL may be essential for several procedures. Apart from the ones in the LTE system for which the SRS has been primarily designed, such as scheduling and link adaptation, it is also expected that there might be increased focus on the new ones in the NR system, such as reciprocity-based precoding design for massive MIMO and UL beam management. These procedures may have significantly different requirements on the channel estimation quality. Also, while in the NR system multi-antenna UEs may become commonplace, depending on the use case and carrier frequency, they may have different hardware configurations and corresponding beamforming capabilities such as analogue or digital functionality.

[0054] In the NR system, the SRS may be configurable with respect to the density in frequency domain (such as comb levels) and/or in time domain (including multi-symbol SRS transmissions). A UE may be configured with one or more NR-SRS resource units. A NR-SRS resource unit may comprise a set of resource elements within a time duration/frequency span and one or more antenna ports. The maximum NR-SRS resource units configurable to a UE may depend on the capability

of the UE to avoid mandatory support for a large number of NR-SRS resource units. The NR SRS design can support a dynamic port/antenna/resource selection by a gNB and/or a UE.

[0055] Figs.1A-1C are diagrams illustrating resource configuration examples for SRS transmissions according to some embodiments of the present disclosure. The examples shown in Figs.1A-1C may be applicable to a NR scenario where a UE is configured with one cyclic shift and one comb level. It will be appreciated that there may be other scenarios where the communication network may apply or support various radio interface technologies which are not limited to LTE and NR technologies.

[0056] In a configuration example, a normal UE may be configured with one SRS port and one orthogonal frequency division multiplexing (OFDM) symbol for the wideband SRS, as shown in Fig.1A. In another configuration example, a cell-edge UE may be configured with one SRS port and one OFDM symbol for the partial band frequency hopping, as shown in Fig.1B. In a further configuration example, a UE may be configured with multiple SRS ports (such as four ports and four OFDM symbols with each symbol for one port) for the wideband SRS, as shown in Fig.1C. It may be realized that a UE could be configured or scheduled with multiple SRS resource units within one slot/subframe. Alternatively, it also may be allowable to schedule multiple consecutive OFDM symbols carrying SRS in partial band.

[0057] According to some exemplary embodiments, different LBT alternatives may be performed for various SRS transmission scenarios. For example, if the SRS is sent with physical uplink shared channel (PUSCH), no extra LBT before the SRS transmission is needed. In case that the SRS is sent without PUSCH nor followed immediately by PUSCH, the 25μs one-shot LBT may be used if the transmission is within the maximum channel occupancy time (MCOT) of a network node. Otherwise,

category 4 (Cat.4) based on LBT priority class 1 may be performed. If the aperiodic SRS transmission is followed by PUSCH without a gap between the SRS and the following PUSCH, a terminal device may perform the LBT indicated for the following PUSCH. These actions related with LBT may be applicable to the licensed and unlicensed operations.

[0058] In accordance with an exemplary embodiment, the NR system can support periodic, semi-persistent and/or aperiodic SRS transmissions. For example, a UE may be configured to transmit a subset or all of configured NR-SRS resources for the aperiodic SRS transmission with no precoding, the same or different precoding. For the periodic and semi-persistent SRS transmissions, a UE may be configured to transmit all of configured NR-SRS resources with no precoding, the same or different precoding.

[0059] In the licensed operation, the NR system can support the aperiodic SRS transmission in addition to the periodic SRS transmission. For example, the aperiodic SRS transmission may be configured via the radio resource control (RRC) signaling and triggered by a SRS request flag in physical downlink control channel (PDCCH) DCI. Particularly, before triggering the aperiodic SRS transmission using the DCI, one or more sets of parameters for SRS transmission (for example, sequence, cyclic shift, etc.) may be configured via the RRC signaling. In an exemplary embodiment, a SRS trigger message such as DCI may be scrambled in a UE-specific RNTI. In the licensed operation, upon detection of a positive SRS request, a UE configured for the aperiodic SRS transmission may commence the SRS transmission in the specified subframe according to the aperiodic SRS time domain configuration.

[0060] In the unlicensed operation, it may be benefit to employ the aperiodic SRS transmission due to the channel uncertainty. However, if SRS transmissions from multiple UEs are scheduled in different slots, a gNB needs to perform a LBT

procedure for each slot to send a SRS trigger message. Considering that an unlicensed channel may be shared, it may be better to schedule multiple SRS transmissions from different UEs multiplexed to occupy the channel as little as possible. In this way, only one LBT procedure may be needed from the gNB side and the UE side. Besides, the time could be saved for other transmissions. On the other hand, when UL MU-MIMO is adopted for a UE group comprising multiple UEs, the gNB would better to obtain the SRSs from the UE group at the same time so that it could perform channel estimation for all members of the UE group at a time.

[0061] Fig.2 is a diagram illustrating an example of triggering SRS transmissions according to an embodiment of the present disclosure. In the illustrated example, multiple trigger messages (denoted as DCI 1, DCI 2 and DCI 3 in Fig.2) for different UEs are transmitted from a gNB to UE 1, UE 2 and UE 3 respectively to trigger SRS transmissions of these UEs. As such, multiple UEs can transmit their SRSs (denoted as SRS 1, SRS 2 and SRS 3 in Fig.2) together in one occasion. However, in case that the gNB needs to schedule many candidate UEs for SRS transmissions, there may be very high overhead of multiple DCI transmissions. On the other hand, multiple UEs may need to perform different LBT operations for their respective SRS transmissions. Non-aligned LBT procedure with different LBT operations by multiple UEs may result in differentiated LBT results.

[0062] Therefore, it may be desirable to introduce an effective solution to trigger SRS transmissions from multiple UEs. In the proposed solution according to some exemplary embodiments, a network node (such as a gNB) may configure multiple terminal devices (such as UEs) as a device group for SRS transmission. According to an exemplary embodiment, the network node may allocate a group identifier to the device group. Then each member of the device group can monitor a SRS trigger message by using the group identifier. In this way, the SRS transmissions from the respective members of the device group could be triggered by a single signaling, and

the overhead to schedule the SRS transmissions from multiple terminal devices may be saved.

[0063] It is noted that some embodiments of the present disclosure are mainly described in relation to LTE or NR specifications being used as non-limiting examples for certain exemplary network configurations and system deployments. As such, the description of exemplary embodiments given herein specifically refers to terminology which is directly related thereto. Such terminology is only used in the context of the presented non-limiting examples and embodiments, and does naturally not limit the present disclosure in any way. Rather, any other system configuration or radio technologies may equally be utilized as long as exemplary embodiments described herein are applicable.

[0064] Fig.3 is a flowchart illustrating a method 300 according to an embodiment of the present disclosure. The method 300 illustrated in Fig.3 may be performed by an apparatus implemented in a network node or communicatively coupled to a network node. In accordance with an exemplary embodiment, the network node such as a gNB may configure radio resources in the unlicensed bands for a terminal device such as a UE. It will be appreciated that some embodiments of the present disclosure also may be applicable for other use cases, for example, operations in the licensed bands where a LBT procedure may not be necessary for a SRS transmission of the UE.

[0065] According to the exemplary method 300 illustrated in Fig.3, the network node can determine configuration information which comprises a group identifier associated with a SRS transmission of a device group, as shown in block 302. The configuration information may indicate a resource allocation for a SRS transmission of a terminal device which is a member of the device group. In accordance with an exemplary embodiment, the SRS transmission of the device group may comprise

respective SRS transmissions from members of the device group.

[0066] According to some exemplary embodiments, certain terminal devices served by the network node may be categorized as a device group for SRS transmission. Thus, the served terminal devices could be divided into one or more device groups with different group identifiers. In accordance with an exemplary embodiment, the group identifier of the group device may comprise a RNTI for the device group. Alternatively, the network node may allocate other proper indicator to the device group as the group identifier.

[0067] In accordance with an exemplary embodiment, the members of the device group may be configured to perform UL MU-MIMO transmissions. For example, the gNB may categorize some UEs which are configured for UL MU-MIMO data transmissions at the same resource as a device group for SRS transmission. In this way, the gNB could perform channel estimation for the UEs in the device group to facilitate the link adaptation for the UL-MIMO scheduling. On the other hand, the SRS transmissions from the members of the device group may be handled as the grouped SRS transmission for saving time and resource.

[0068] According to the exemplary method 300, the network node may transmit the configuration information to the terminal device which is a member of the device group, as shown in block 304. Similarly, other member of the device group also may receive the corresponding configuration information which indicates a resource allocation for a SRS transmission. According to an exemplary embodiment, the resource allocation of different members within the device group may be orthogonal in frequency/code domain so that SRSs of the different members could be transmitted at the same time.

[0069] In accordance with an exemplary embodiment, the method 300 as illustrated in Fig.3 may further comprise transmitting a trigger message for triggering

the SRS transmission of the device group based at least in part on the group identifier. In an exemplary embodiment, the trigger message may comprise DCI scrambled by the group identifier. For example, the trigger message may be one format of DCI located in a DL control region scrambled by a newly defined group-based RNTI (also referred to as a SRS-RNTI). Alternatively, the trigger message may comprise a signaling which is different from DCI while specific to the group-based SRS transmission.

[0070] In accordance with an exemplary embodiment, the trigger message may indicate that a LBT procedure is needed for the SRS transmission of the device group. In this case, the trigger message may indicate a type of the LBT procedure. For example, the LBT procedure may comprise a short LBT procedure. As such, each member of the device group may need to perform a short LBT procedure for its SRS transmission.

[0071] Fig.4 is a diagram illustrating an example of a short LBT procedure for SRS transmission according to an embodiment of the present disclosure. In the embodiment, a gNB may send a trigger message (denoted as "DCI for a UE group" in Fig.4) to trigger a SRS transmission of a UE group comprising UE 1, UE 2 and UE 3. For example, if there is no data between the trigger message and the respective SRSs of UE 1, UE 2 and UE 3 while within one transmission opportunity (TXOP), the trigger message may indicate that a short LBT procedure may be needed for each UE in the UE group before the UE commences its SRS transmission.

[0072] In accordance with an exemplary embodiment, the trigger message may indicate a backoff window size for the LBT procedure. In this case, the terminal device as a member of the device group can perform the LBT procedure to determine the channel availability according to the backoff window size indicated by the network node. Since the backoff window size for the LBT procedure is specified for

the device group at the network side, all members of the device group can transmit their respective SRSs in an aligned manner, compared with the situation where different terminal devices generate their backoff window sizes for the LBT procedures randomly.

[0073] In accordance with an exemplary embodiment, the trigger message may indicate that the SRS transmission of the device group is allowable to span multiple slots. In this case, there may be more than one slot configured for the SRS transmission of the device group by the network node. As a member of the device group, the terminal device can perform its potential SRS transmission in at least one slot according to the trigger message from the network node. Therefore, the network node can trigger one or more potential SRS transmissions of the device group by using one trigger message.

[0074] Fig.5 is a diagram illustrating an example of multi-slot SRS transmissions according to an embodiment of the present disclosure. In the embodiment, a gNB may send a trigger message (denoted as "DCI for a UE group" in Fig.5) to trigger a SRS transmission of a UE group comprising UE 1, UE 2 and UE 3. The trigger message may indicate candidate transmission pattern spanning multiple slots (instead of one slot only) for the SRS transmission of the UE group. For example, the trigger message may indicate that the SRS transmission of the UE group is allowable to span three slots, denoted as slot 1, slot 2, and slot 3 in Fig.5. As such, a member of the UE group, such as UE 1, UE 2 and UE 3, can get more opportunities to transmit SRSs. It will be appreciated that UE 1, UE 2 and UE 3 may perform a LBT procedure for their SRS transmissions independently from each other.

[0075] In accordance with an exemplary embodiment, the trigger message may indicate that no LBT procedure is needed for the SRS transmission of the device group. For example, there may be some DL data being scheduled before the SRS

transmission of the device group. If an interval between the DL data and the SRSs associated with the device group is less than a predefined value such as 16μs, no LBT procedure is needed for the SRS transmission of the device group.

[0076] Fig.6 is a diagram illustrating an example of no LBT procedure for SRS transmission according to an embodiment of the present disclosure. In the embodiment, a gNB may send a trigger message (denoted as "DCI for a UE group" in Fig.6) to trigger a SRS transmission of a UE group comprising UE 1, UE 2 and UE 3. In addition, the gNB may send another signaling message (denoted as "DCI for data" in Fig.6) associated with DL data scheduled between the trigger message and the SRSs of the UE group. In case that an interval between the DL data and the SRSs of the UE group as shown in Fig.6 is less than a specific value such as 16μs, no LBT procedure is needed for the SRS transmissions of UE 1, UE 2 and UE 3.

[0077] In the case that no DL data is scheduled between the trigger message and the SRSs of the UE group, it also may be possible to avoid performing a LBT procedure for the grouped SRS transmission. According to an exemplary embodiment, there may be an interval between the transmission of the trigger message and the SRS transmission of the device group, and the interval is less than a predefined threshold such as 16μs. Such specific location of the trigger message may make the LBT procedure for the SRS transmission of the device group to be avoided.

[0078] Fig.7 is a diagram illustrating an example of specific triggering before SRS transmissions according to an embodiment of the present disclosure. In the embodiment, a gNB may send a trigger message (denoted as "SRS trigger" in Fig.7) to trigger a SRS transmission of a UE group comprising UE 1, UE 2 and UE 3. For example, the trigger message may be a special signaling, such as a sequence related with a RNTI configured for the UE group. There may be an interval between the trigger message and the SRSs of the UE group, as shown in Fig.7. For instance, the

trigger message may be located a short time (<16μs) before the candidate SRS transmissions of UE 1, UE 2 and UE 3. As shown in Fig.7, the trigger message may be a fractional symbol sequence located before the potential SRS transmission symbols, for example, a part of the last third symbol for the trigger message while the last two symbols for SRS transmissions. In this way, the LBT procedure for the SRS transmission could be avoided at the UE side.

[0079] In accordance with an exemplary embodiment, the method 300 as illustrated in Fig.3 may further comprise specifying a search space for the trigger message to the terminal device. For example, a common search space for the trigger message may be configured to the terminal device by the network node via a RRC signaling. Thus, the terminal device can search the trigger message within the specified search space, which may reduce searching time and save power for the terminal device.

[0080] In accordance with an exemplary embodiment, the method 300 as illustrated in Fig.3 may further comprise detecting the SRS transmission of the device group in at least one of the multiple slots as indicated by the trigger message. In case that only one slot is configured for the SRS transmission of the device group, the network node may detect respective SRS transmissions from the members of the device group in the configured slot. In case that two or more slots are configured for the SRS transmission of the device group, the network node may detect multiple potential SRS transmissions spanning the configured slots.

[0081] Fig.8 is a flowchart illustrating a method 800 according to another embodiment of the present disclosure. The method 800 illustrated in Fig.8 may be performed by an apparatus implemented in a terminal device or communicatively coupled to a terminal device. In accordance with an exemplary embodiment, the terminal device such as a UE may be configured with radio resources in the licensed

bands and/or the unlicensed bands by a network node such as a gNB. The terminal device and one or more other terminal devices may be configured as a group device by the network node. Optionally, the terminal device and the one or more other terminal devices may transmit their respective SRSs simultaneously, for example, according to orthogonal resource allocation by the network node.

[0082] Corresponding to operations of the exemplary method 300 as illustrated in Fig.3, the terminal device according to the exemplary embodiment illustrated in Fig.8 may receive configuration information from a network node, as shown in block 802. The configuration information may indicate a resource allocation for a SRS transmission of the terminal device. Based at least in part on the configuration information, the terminal device can determine a group identifier associated with a SRS transmission of a device group, as shown in block 804. The group identifier may comprise a RNTI or other suitable indicator allocated for the device group by the network node. Different device groups may have different group identifiers. As described in connection with Fig.3, the SRS transmission of the device group may comprise respective SRS transmissions from members of the device group. The terminal device may be a member of the device group. Optionally, the members of the device group may be configured to perform UL MIMO transmissions.

[0083] In accordance with an exemplary embodiment, the method 800 as illustrated in Fig.8 may further comprise detecting a trigger message for triggering the SRS transmission of the device group based at least in part on the group identifier. Optionally, the trigger message (which may comprise, for example, DCI or other special signaling related with the group identifier) may be detected within a search space specified by the network node. According to the trigger message, the terminal device can determine whether to perform a LBT procedure for the SRS transmission, which kind of LBT procedure (for example, a short LBT procedure, a Cat. 4 based LBT procedure, etc.) needs to be performed, whether the SRS transmission of the

device group is allowable to span in multiple slots, and/or the like.

[0084] In accordance with an exemplary embodiment, the method 800 as illustrated in Fig.8 may further comprise performing a LBT procedure one or more times prior to the SRS transmission of the terminal device, in response to the trigger message indicating that the LBT procedure is needed for the SRS transmission of the device group. In an embodiment where the SRS transmission of the device group is allowable to span in multiple slots, such as slot 1, slot 2 and slot 3 as shown in Fig.5, the terminal device may try to perform the indicated LBT procedure slot by slot until it is successful. For example, the terminal device may try to perform the LBT procedure in slot 1 first. If it succeeds, the terminal device would not perform the LBT procedure in slot 2 and slot 3 anymore. Otherwise, the terminal device may continue to perform the LBT procedure in slot 2, and potentially in slot 3 until it succeeds. It may be realized that the members of the device group may attempt to perform the LBT procedure independently of each other. To this regard, the members of the device group may transmit their respective SRSs in different slots. Accordingly, the SRS transmission of the device group may span in multiple slots.

[0085] In accordance with an exemplary embodiment, the terminal device and one or more other terminal devices in the device group may perform the LBT procedure according to the same backoff window size indicated in the trigger message. Thus, the SRS transmissions of these terminal devices may be aligned. Optionally, the terminal device may not need to perform a LBT procedure for the SRS transmission, in case that the interval between the detection of the trigger message and the SRS transmission is less than a predefined threshold. The predefined threshold may be set as 16μs or other suitable values as required.

[0086] It will be realized that parameters, variables and settings related to the SRS transmission described herein are just examples. Other suitable network settings,

the associated configuration parameters and the specific values thereof may also be applicable to implement the proposed methods.

[0087] Fig.9 is a diagram illustrating an exemplary network side procedure according to an embodiment of the present disclosure. The exemplary procedure illustrated in Fig.9 may be performed by a network node such as a gNB. According to the procedure shown in Fig.9, the gNB may configure 902 a SRS resource for a UE served by the gNB. In an exemplary embodiment, the gNB may take 904 multiple UEs as a UE group for SRS transmission and allocate a group identifier such as a RNTI to the UE group. As such, the UEs served by the gNB may be divided into one or more UE groups with respective group identifiers. The SRS resource allocation of different UEs within one UE group may be orthogonal in frequency/code domain so that SRSs from these UEs could be transmitted at the same time.

[0088] According to the procedure illustrated in Fig.9, the gNB may transmit 906 configuration information to the UE. The configuration information may comprise the SRS resource configured for the UE and a group identifier of a UE group. The UE is a member of the UE group. Then, the gNB may send 908 a trigger message for a SRS transmission of the UE group. The trigger message may be related to the group identifier of the UE group, for example, by comprising DCI or other proper signaling scrambled by the RNTI specified for the UE group. In this way, the gNB can trigger a grouped SRS transmission from multiple UEs by using a single trigger message. Optionally, the trigger message also can schedule the grouped SRS transmission potentially spanning multiple slots. Correspondingly, the gNB may detect 910 SRSs from the multiple UEs, for example, in predefined positions, and perform channel estimation for the UE group.

[0089] Fig.10 is a diagram illustrating an exemplary terminal side procedure according to another embodiment of the present disclosure. The exemplary procedure

illustrated in Fig.10 may be performed at a terminal device such as a UE. According to the procedure shown in Fig.10, the UE may receive 1002 configuration information from a gNB. The configuration information may indicate a SRS resource and a group identifier for the UE. By using the group identifier, the UE can search 1004 for a trigger message for a grouped SRS transmission. For example, the UE may monitor a control region by using a RNTI configured for the grouped SRS transmission to see whether the trigger message is received. Optionally, the UE may detect the trigger message in a common search space specified by the network node via a RRC signaling.

[0090] If the trigger message is detected (corresponding to the "Yes" branch of block 1006), the UE can determine 1008 whether to perform a LBT procedure according to the trigger message. For example, based at least in part on the trigger message, the UE may selectively perform a short LBT procedure, an aligned Cat.4 based LBT procedure, or no LBT procedure. In an exemplary embodiment, the LBT procedure may be performed before the SRS resource configured to the UE. According to a result of the LBT procedure, the UE may prepare its SRS transmission. If the LBT procedure is not successful, the UE may search for another trigger message by using the configured group identifier. Alternatively, the UE may try to perform the LBT procedure in one or more other slots without searching for another trigger message, in the case where the trigger message indicates that the one or more other slots may be available for the LBT procedure and the grouped SRS transmission may span in multiple slots.

[0091] In the case that the LBT procedure is successful, the UE can perform 1010 the SRS transmission, for example, by using the SRS resource configured by the network node. Alternatively, the UE can perform 1010 the SRS transmission without performing a LBT procedure, for example, in response to an indication in the trigger message that the LBT procedure is not needed for the SRS transmission.

Correspondingly, the network node can detect the SRSs transmitted from the UE group at some predefined positions, and perform channel estimation accordingly.

[0092] The proposed solution according to one or more exemplary embodiments can enable a network node such as a gNB to configure multiple UEs as a group for SRS transmission. For example, taking the advantage of the grouped SRS transmission makes the gNB be able to trigger SRS transmissions of multiple UEs by a single trigger message, which may save the overhead of triggering multiple SRS transmissions for different UEs. On the other hand, there may be a high probability for the gNB to get some channel sounding results of the candidate UEs for UL MU-MIMO scheduling in a short time. Besides, the UEs in one group can perform an aligned LBT procedure (for example, a short LBT procedure or a LBT procedure according to the same backoff window size indicated by the gNB) for their SRS transmissions. Optionally, the trigger message according to some exemplary embodiments could also schedule the grouped SRS transmission potentially spanning multiple slots, which may further reduce the signaling overhead for triggering SRS transmissions. In accordance with some exemplary embodiments, a LBT procedure may be avoided from multiple UEs before SRS transmissions, for example, by configuring the trigger message or DL data at a specified resource position.

[0093] The various blocks shown in Fig.3 and Figs.8-10 may be viewed as method steps, and/or as operations that result from operation of computer program code, and/or as a plurality of coupled logic circuit elements constructed to carry out the associated function(s). The schematic flow chart diagrams described above are generally set forth as logical flow chart diagrams. As such, the depicted order and labeled steps are indicative of specific embodiments of the presented methods. Other steps and methods may be conceived that are equivalent in function, logic, or effect to one or more steps, or portions thereof, of the illustrated methods. Additionally, the order in which a particular method occurs may or may not strictly adhere to the order

of the corresponding steps shown.

[0094] Fig.11 is a block diagram illustrating an apparatus 1100 according to various embodiments of the present disclosure. As shown in Fig.11, the apparatus 1100 may comprise one or more processors such as processor 1101 and one or more memories such as memory 1102 storing computer program codes 1103. The memory 1102 may be non-transitory machine/processor/computer readable storage medium. In some implementations, the one or more memories 1102 and the computer program codes 1103 may be configured to, with the one or more processors 1101, cause the apparatus 1100 at least to perform any operation of the method as described in connection with Fig.3. In other implementations, the one or more memories 1102 and the computer program codes 1103 may be configured to, with the one or more processors 1101, cause the apparatus 1100 at least to perform any operation of the method as described in connection with Fig.8.

[0095] Alternatively or additionally, the one or more memories 1102 and the computer program codes 1103 may be configured to, with the one or more processors 1101, cause the apparatus 1100 at least to perform more or less operations to implement the proposed methods according to the exemplary embodiments of the present disclosure.

[0096] Fig.12 is a block diagram illustrating an apparatus 1200 according to another embodiment of the present disclosure. As shown in Fig.12, the apparatus 1200 may comprise a receiving unit 1201 and a determining unit 1202. In an exemplary embodiment, the apparatus 1200 may be implemented at a terminal device such as a UE. The receiving unit 1201 may be operable to carry out the operation in block 802, and the determining unit 1202 may be operable to carry out the operation in block 804. Optionally, the receiving unit 1201 and/or the determining unit 1202 may be operable to carry out more or less operations to implement the proposed

methods according to the exemplary embodiments of the present disclosure.

[0097] Fig.13 is a block diagram illustrating an apparatus 1300 according to a further embodiment of the present disclosure. As shown in Fig.13, the apparatus 1300 may comprise a determining unit 1301 and a transmitting unit 1302. In an exemplary embodiment, the apparatus 1300 may be implemented at a network node such as a gNB. The determining unit 1301 may be operable to carry out the operation in block 302, and the transmitting unit 1302 may be operable to carry out the operation in block 304. Optionally, the determining unit 1301 and/or the transmitting unit 1302 may be operable to carry out more or less operations to implement the proposed methods according to the exemplary embodiments of the present disclosure.

[0098] In general, the various exemplary embodiments may be implemented in hardware or special purpose chips, circuits, software, logic or any combination thereof. For example, some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device, although the disclosure is not limited thereto. While various aspects of the exemplary embodiments of this disclosure may be illustrated and described as block diagrams, flow charts, or using some other pictorial representation, it is well understood that these blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[0099] As such, it should be appreciated that at least some aspects of the exemplary embodiments of the disclosure may be practiced in various components such as integrated circuit chips and modules. It should thus be appreciated that the exemplary embodiments of this disclosure may be realized in an apparatus that is

embodied as an integrated circuit, where the integrated circuit may comprise circuitry (as well as possibly firmware) for embodying at least one or more of a data processor, a digital signal processor, baseband circuitry and radio frequency circuitry that are configurable so as to operate in accordance with the exemplary embodiments of this disclosure.

[00100] It should be appreciated that at least some aspects of the exemplary embodiments of the disclosure may be embodied in computer-executable instructions, such as in one or more program modules, executed by one or more computers or other devices. Generally, program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract data types when executed by a processor in a computer or other device. The computer executable instructions may be stored on a computer readable medium such as a hard disk, optical disk, removable storage media, solid state memory, random access memory (RAM), etc. As will be appreciated by one of skill in the art, the function of the program modules may be combined or distributed as desired in various embodiments. In addition, the function may be embodied in whole or partly in firmware or hardware equivalents such as integrated circuits, field programmable gate arrays (FPGA), and the like.

[00101] The present disclosure includes any novel feature or combination of features disclosed herein either explicitly or any generalization thereof. Various modifications and adaptations to the foregoing exemplary embodiments of this disclosure may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings. However, any and all modifications will still fall within the scope of the non-Limiting and exemplary embodiments of this disclosure.

CLAIMS

What is claimed is:

1. A method (800) implemented at a terminal device, comprising:

receiving (802) configuration information from a network node, wherein the configuration information indicates a resource allocation for a sounding reference signal transmission of the terminal device; and

determining (804) a group identifier associated with a sounding reference signal transmission of a device group, based at least in part on the configuration information, wherein the terminal device is a member of the device group.

2. The method according to claim 1, wherein the sounding reference signal transmission of the device group comprises respective sounding reference signal transmissions from members of the device group.

3. The method according to claim 1 or 2, further comprising:

detecting a trigger message for triggering the sounding reference signal transmission of the device group, based at least in part on the group identifier.

4. The method according to any of claims 1-3, wherein the group identifier comprises a radio network temporary identifier for the device group.

5. The method according to claim 3 or 4, wherein the trigger message comprises downlink control information scrambled by the group identifier.

6. The method according to any of claims 3-5, wherein the trigger message indicates that a listen-before-talk procedure is needed for the sounding reference

signal transmission of the device group.

7. The method according to claim 6, wherein the trigger message indicates a type of the listen-before-talk procedure.

8. The method according to claim 6 or 7, wherein the listen-before-talk procedure comprises a short listen-before-talk procedure.

9. The method according to claim 6 or 7, wherein the trigger message indicates a backoff window size for the listen-before-talk procedure.

10. The method according to any of claims 3-5, wherein the trigger message indicates that no listen-before-talk procedure is needed for the sounding reference signal transmission of the device group.

11. The method according to claim 3, 4 or 10, wherein there is an interval between the detection of the trigger message and the sounding reference signal transmission of the device group, and wherein the interval is less than a predefined threshold.

12. The method according to any of claims 3-11, wherein the trigger message indicates that the sounding reference signal transmission of the device group is allowable to span multiple slots.

13. The method according to claim 12, further comprising:

performing a listen-before-talk procedure one or more times prior to the sounding reference signal transmission of the terminal device, in response to the trigger message indicating that the listen-before-talk procedure is needed for the sounding reference signal transmission of the device group.

14. The method according to any of claims 3-13, wherein the trigger message is detected within a search space specified by the network node.

15. The method according to any of claims 2-14, wherein the members of the device group are configured to perform uplink multi-user multiple-input multiple-output transmissions.

16. An apparatus (1100), comprising:

one or more processors (1101); and

one or more memories (1102) comprising computer program codes (1103),

the one or more memories (1102) and the computer program codes (1103) configured to, with the one or more processors (1101), cause the apparatus (1100) at least to:

receive configuration information from a network node, wherein the configuration information indicates a resource allocation for a sounding reference signal transmission of the apparatus; and

determine a group identifier associated with a sounding reference signal transmission of a device group, based at least in part on the configuration information, wherein the apparatus is a member of the device group.

17. The apparatus according to claim 16, wherein the sounding reference signal transmission of the device group comprises respective sounding reference signal transmissions from members of the device group.

18. The apparatus according to claim 16 or 17, wherein the one or more memories and the computer program codes are configured to, with the one or more processors, cause the apparatus at least further to:

detect a trigger message for triggering the sounding reference signal transmission of the device group, based at least in part on the group identifier.

19. The apparatus according to any of claims 16-18, wherein the group identifier comprises a radio network temporary identifier for the device group.

20. The apparatus according to claim 18 or 19, wherein the trigger message comprises downlink control information scrambled by the group identifier.

21. The apparatus according to any of claims 18-20, wherein the trigger message indicates that a listen-before-talk procedure is needed for the sounding reference signal transmission of the device group.

22. The apparatus according to claim 21, wherein the trigger message indicates a type of the listen-before-talk procedure.

23. The apparatus according to claim 21 or 22, wherein the listen-before-talk procedure comprises a short listen-before-talk procedure.

24. The apparatus according to claim 21 or 22, wherein the trigger message indicates a backoff window size for the listen-before-talk procedure.

25. The apparatus according to any of claims 18-20, wherein the trigger message indicates that no listen-before-talk procedure is needed for the sounding reference signal transmission of the device group.

26. The apparatus according to claim 18, 19 or 25, wherein there is an interval between the detection of the trigger message and the sounding reference signal

transmission of the device group, and wherein the interval is less than a predefined threshold.

27. The apparatus according to any of claims 18-26, wherein the trigger message indicates that the sounding reference signal transmission of the device group is allowable to span multiple slots.

28. The apparatus according to claim 27, wherein the one or more memories and the computer program codes are configured to, with the one or more processors, cause the apparatus at least further to:

perform a listen-before-talk procedure one or more times prior to the sounding reference signal transmission of the apparatus, in response to the trigger message indicating that the listen-before-talk procedure is needed for the sounding reference signal transmission of the device group.

29. The apparatus according to any of claims 18-28, wherein the trigger message is detected within a search space specified by the network node.

30. The apparatus according to any of claims 17-29, wherein the members of the device group are configured to perform uplink multi-user multiple-input multiple-output transmissions.

31. A method (300) implemented at a network node, comprising:

determining (302) configuration information which comprises a group identifier associated with a sounding reference signal transmission of a device group; and

transmitting (304) the configuration information to a terminal device which is a member of the device group, wherein the configuration information indicates a

resource allocation for a sounding reference signal transmission of the terminal device.

32. The method according to claim 31, wherein the sounding reference signal transmission of the device group comprises respective sounding reference signal transmissions from members of the device group.

33. The method according to claim 31 or 32, further comprising:

transmitting a trigger message for triggering the sounding reference signal transmission of the device group, based at least in part on the group identifier.

34. The method according to any of claims 31-33, wherein the group identifier comprises a radio network temporary identifier for the device group.

35. The method according to claim 33 or 34, wherein the trigger message comprises downlink control information scrambled by the group identifier.

36. The method according to any of claims 33-35, wherein the trigger message indicates that a listen-before-talk procedure is needed for the sounding reference signal transmission of the device group.

37. The method according to claim 36, wherein the trigger message indicates a type of the listen-before-talk procedure.

38. The method according to claim 36 or 37, wherein the listen-before-talk procedure comprises a short listen-before-talk procedure.

39. The method according to claim 36 or 37, wherein the trigger message indicates a

backoff window size for the listen-before-talk procedure.

40. The method according to any of claims 33-35, wherein the trigger message indicates that no listen-before-talk procedure is needed for the sounding reference signal transmission of the device group.

41. The method according to claim 33, 34 or 40, wherein there is an interval between the transmission of the trigger message and the sounding reference signal transmission of the device group, and wherein the interval is less than a predefined threshold.

42. The method according to any of claims 33-41, wherein the trigger message indicates that the sounding reference signal transmission of the device group is allowable to span multiple slots.

43. The method according to claim 42, further comprising:

detecting the sounding reference signal transmission of the device group in at least one of the multiple slots.

44. The method according to any of claims 33-43, further comprising:

specifying a search space for the trigger message to the terminal device.

45. The method according to any of claims 32-44, wherein the members of the device group are configured to perform uplink multi-user multiple-input multiple-output transmissions.

46. An apparatus (1100), comprising:

one or more processors (1101); and

one or more memories (1102) comprising computer program codes (1103),

the one or more memories (1102) and the computer program codes (1103) configured to, with the one or more processors (1101), cause the apparatus (1100) at least to perform the method according to any of claims 31-45.

47. A computer-readable medium having computer program codes (1103) embodied thereon for use with a computer, wherein the computer program codes (1103) comprise codes for performing the method according to any one of claims 1-15.

48. A computer-readable medium having computer program codes (1103) embodied thereon for use with a computer, wherein the computer program codes (1103) comprise codes for performing the method according to any one of claims 31-45.

49. An apparatus (1200), comprising:

a receiving unit (1201) configured to receive configuration information from a network node, wherein the configuration information indicates a resource allocation for a sounding reference signal transmission of the apparatus; and

a determining unit (1202) configured to determine a group identifier associated with a sounding reference signal transmission of a device group, based at least in part on the configuration information, wherein the apparatus is a member of the device group.

50. An apparatus (1300), comprising:

a determining unit (1301) configured to determine configuration information which comprises a group identifier associated with a sounding reference signal transmission of a device group; and

a transmitting unit (1302) configured to transmit the configuration information to a terminal device which is a member of the device group, wherein the

configuration information indicates a resource allocation for a sounding reference signal transmission of the terminal device.

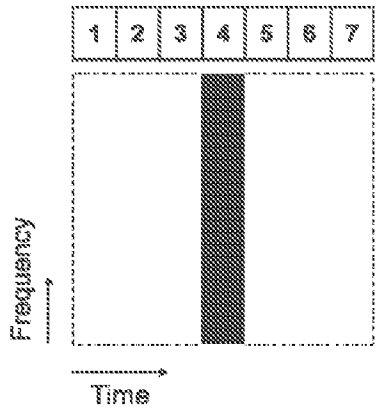

Fig.1A

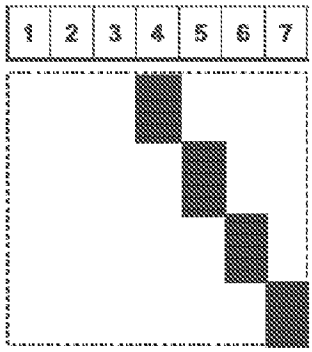

Fig.1B

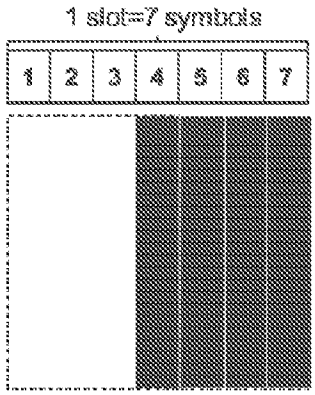

Fig.1C

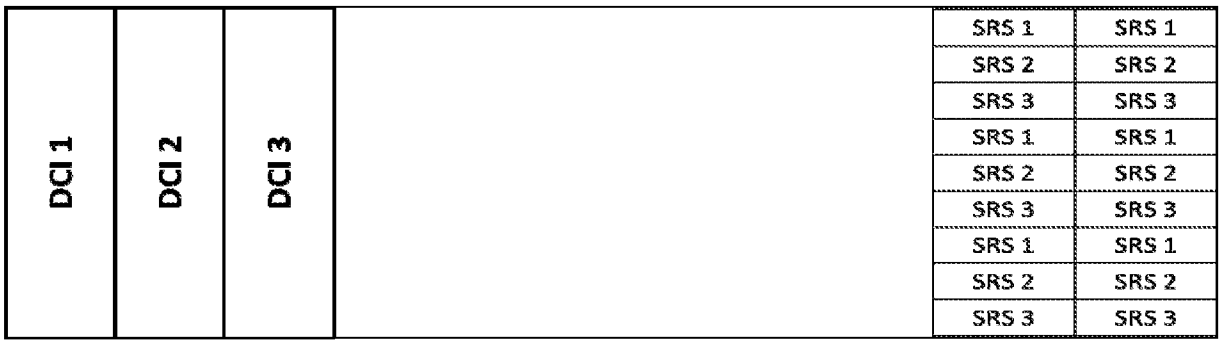

Fig.2

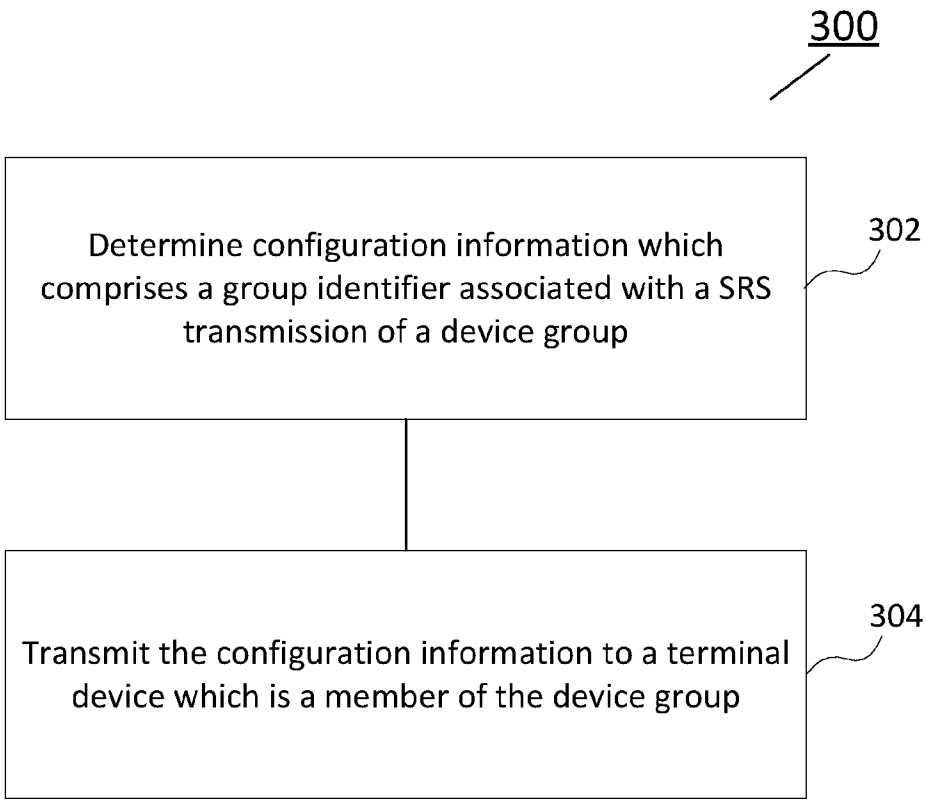
300
Determine configuration information which comprises a group identifier associated with a SRS transmission of a device group
302
Transmit the configuration information to a terminal device which is a member of the device group
304

Fig.3

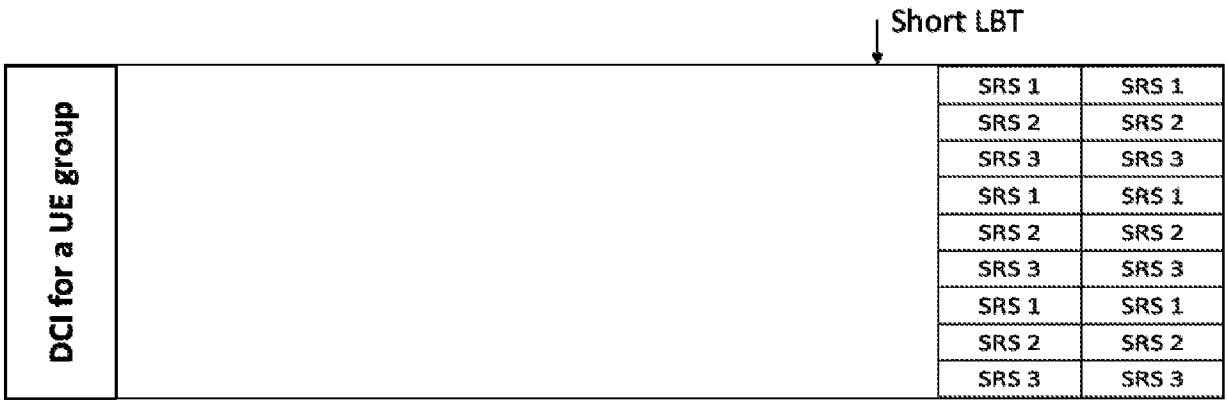
Short LBT
DCI for a UE group
SRS 1
SRS 2
SRS 3
SRS 1
SRS 2
SRS 3
SRS 1
SRS 2
SRS 3
SRS 1
SRS 2
SRS 3
SRS 1
SRS 2
SRS 3

Fig.4

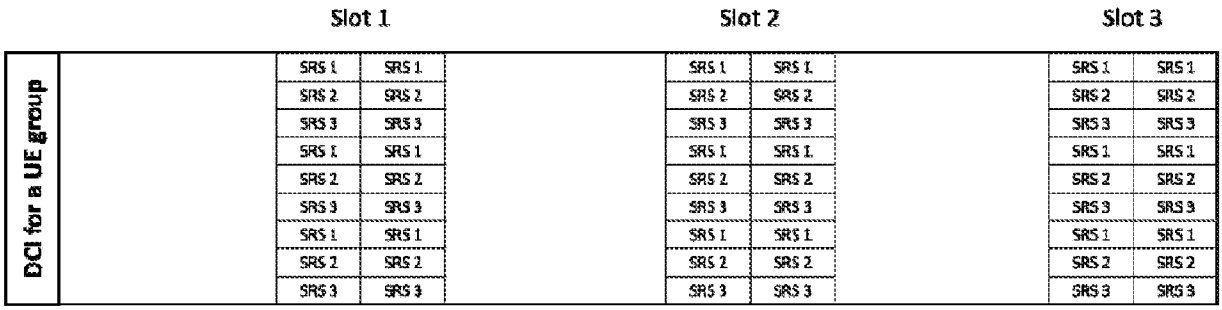
Slot 1
Slot 2
Slot 3
DCI for a UE group
SRS 1
SRS 2
SRS 3

Fig.5

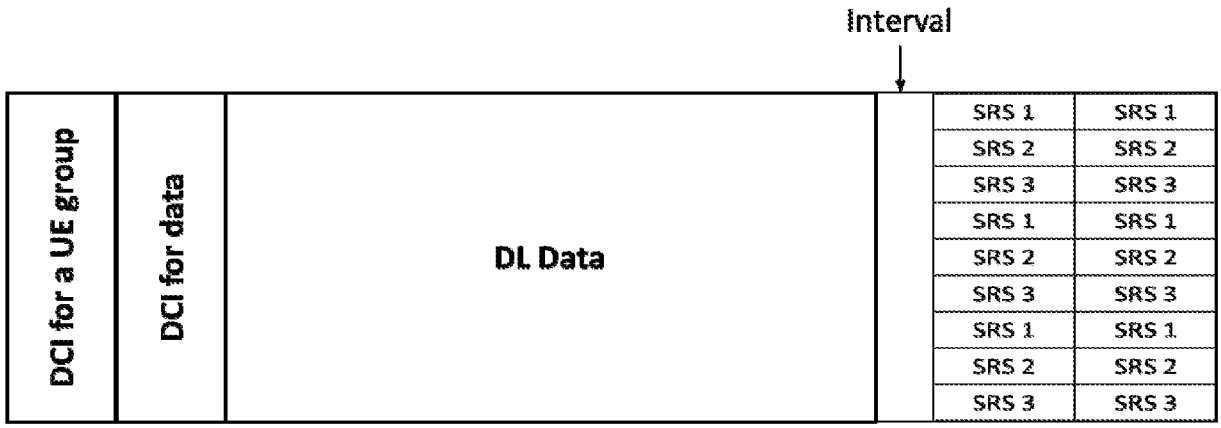
Interval
DCI for a UE group
DCI for data
DL Data
SRS 1
SRS 2
SRS 3

Fig.6

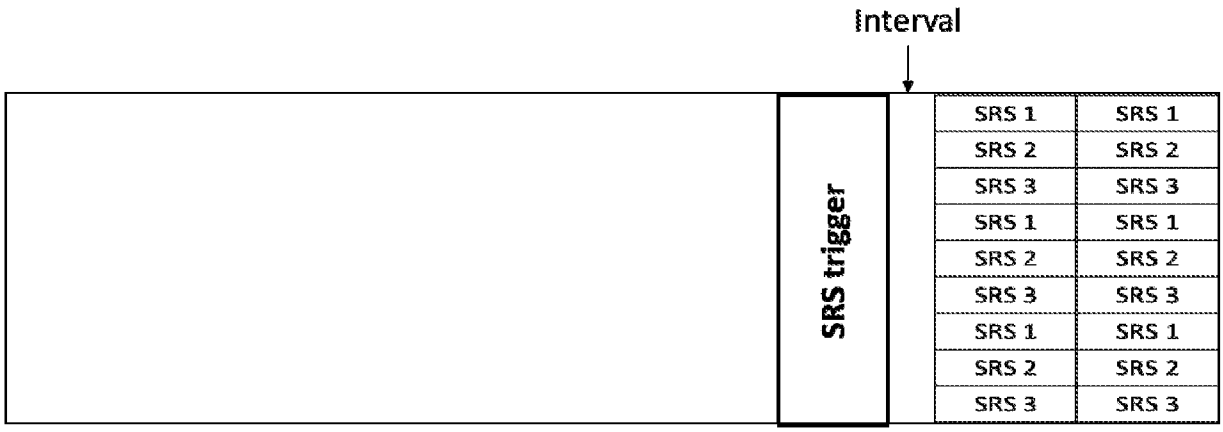
Interval
SRS trigger
SRS 1
SRS 2
SRS 3
SRS 1
SRS 2
SRS 3
SRS 1
SRS 2
SRS 3
SRS 1
SRS 2
SRS 3
SRS 1
SRS 2
SRS 3

Fig.7

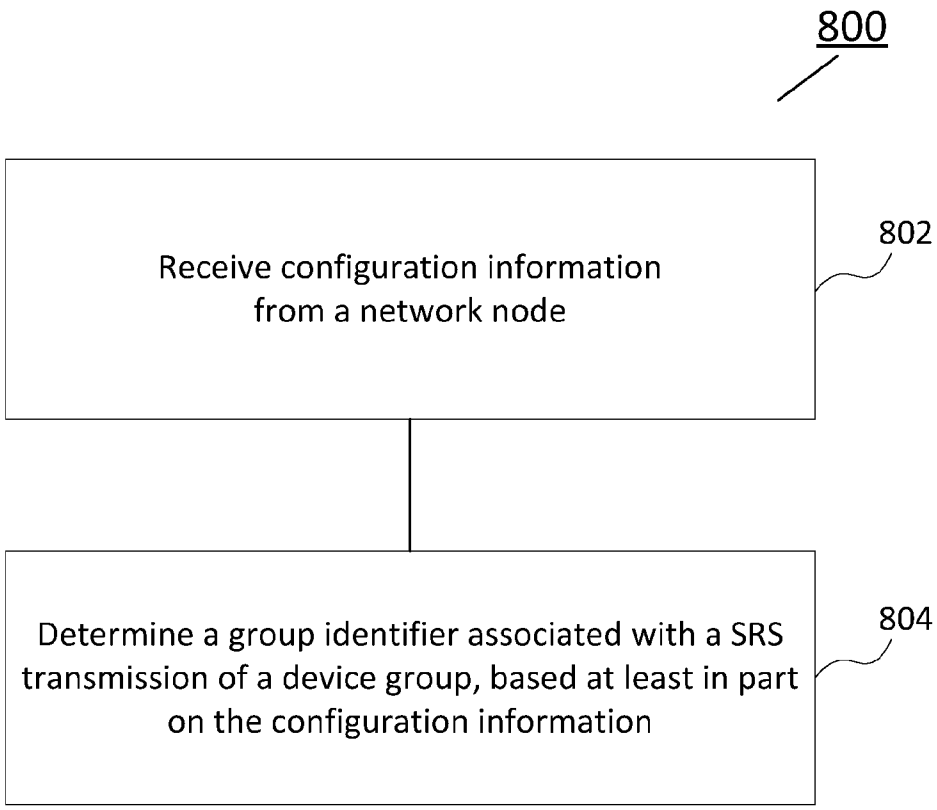
800
Receive configuration information from a network node
802
Determine a group identifier associated with a SRS transmission of a device group, based at least in part on the configuration information
804

Fig.8

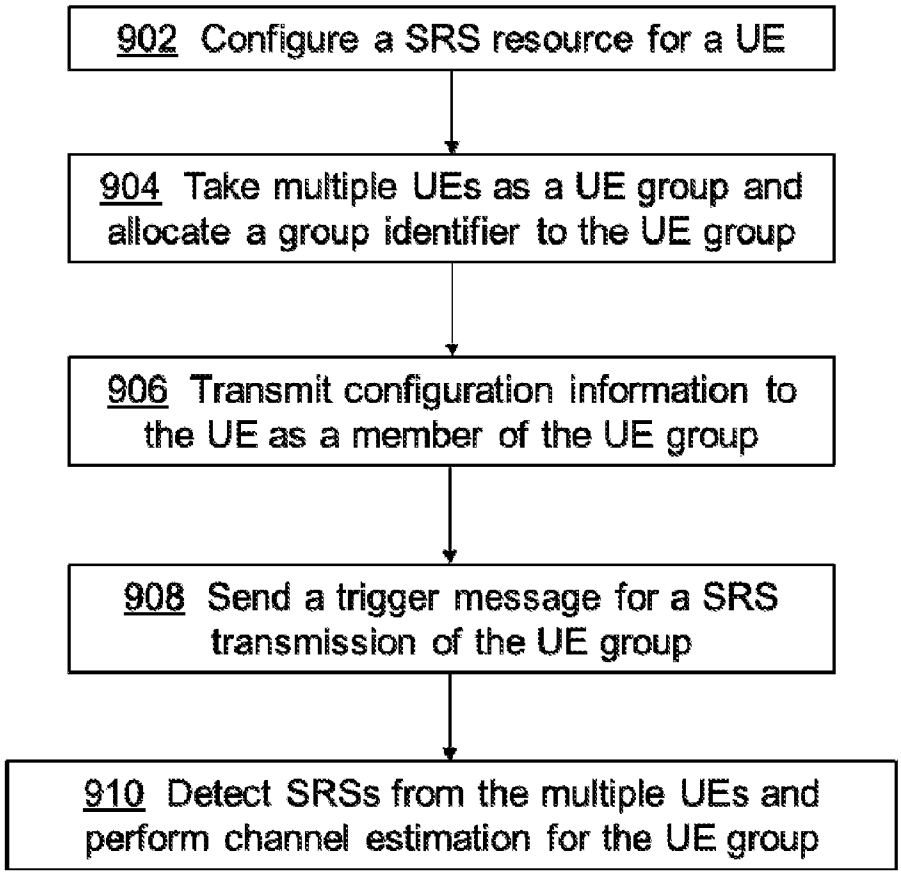
902 Configure a SRS resource for a UE
904 Take multiple UEs as a UE group and allocate a group identifier to the UE group
906 Transmit configuration information to the UE as a member of the UE group
908 Send a trigger message for a SRS transmission of the UE group
910 Detect SRSs from the multiple UEs and perform channel estimation for the UE group

Fig.9

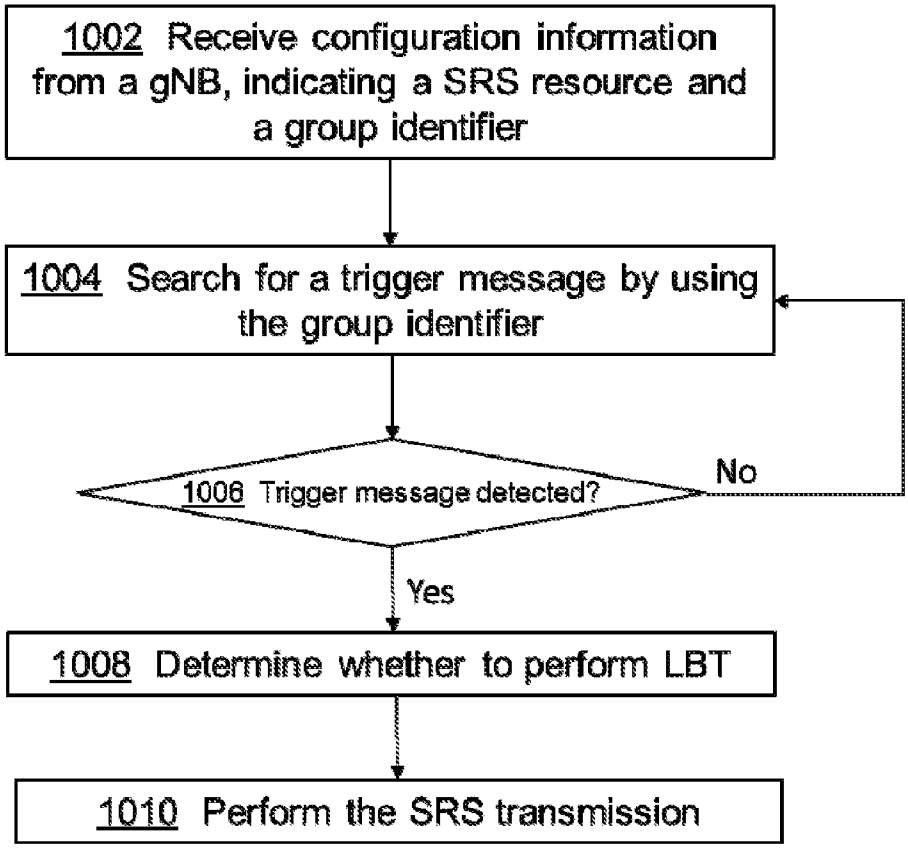
1002 Receive configuration information from a gNB, indicating a SRS resource and a group identifier
1004 Search for a trigger message by using the group identifier
1006 Trigger message detected?
No
Yes
1008 Determine whether to perform LBT
1010 Perform the SRS transmission

Fig.10

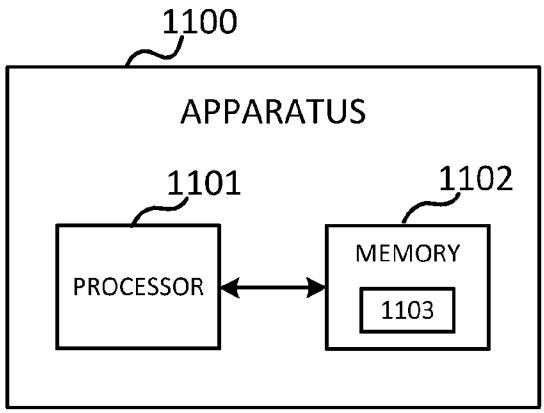
1100
APPARATUS
1101
1102
PROCESSOR
MEMORY
1103

Fig.11

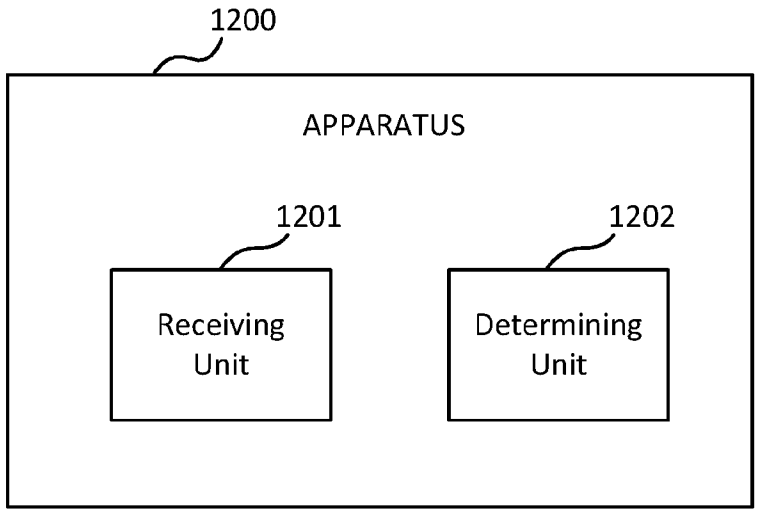
1200
APPARATUS
1201
Receiving Unit
1202
Determining Unit

Fig.12

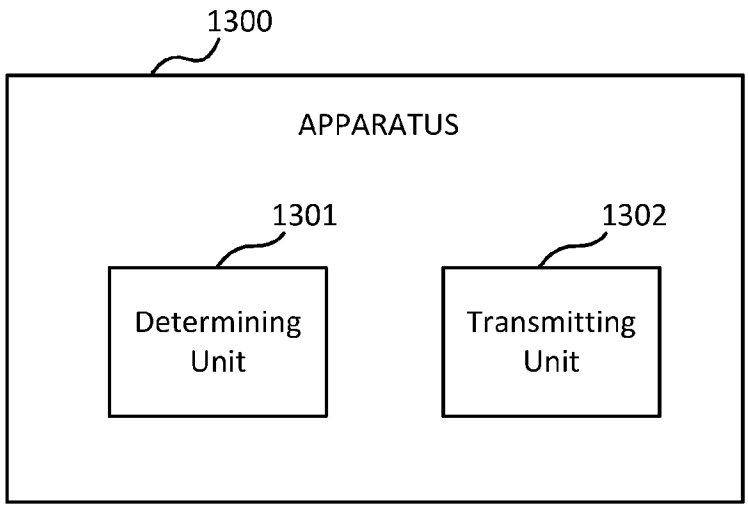
1300
APPARATUS
1301
Determining Unit
1302
Transmitting Unit

Fig.13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/104240

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04(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)

H04L; H04W; H04Q

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,WPI,EPODOC,3GPP,GOOGLE: sounding reference signal, sounding, SRS, group, ID, trigger, signaling, configuration, information, indicate, resource, allocation

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012044906 A1 (MEDIATEK INC.) 23 February 2012 (2012-02-23) description, paragraphs[0035]-[0042], figures 6-7	1-50
A	CN 106304366 A (CHINA ACADEMY TELECOMMUNICATIONS TECHNOLOGY) 04 January 2017 (2017-01-04) the whole document	1-50
A	CN 103582085 A (HUAWEI TECHNOLOGIES CO., LTD.) 12 February 2014 (2014-02-12) the whole document	1-50

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 June 2018	**28 June 2018**

Name and mailing address of the ISA/CN	Authorized officer
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/104240

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2012044906	A1	23 February 2012	CN	102986275	A	20 March 2013
				US	2014341167	A1	20 November 2014
				CN	105049164	A	11 November 2015
				JP	2013541922	A	14 November 2013
				EP	2520118	A1	07 November 2012
				WO	2012059064	A1	10 May 2012
				TW	201225715	A	16 June 2012
CN	106304366	A	04 January 2017	WO	2016184309	A1	24 November 2016
CN	103582085	A	12 February 2014	US	2015163730	A1	11 June 2015
				WO	2014023266	A1	13 February 2014