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(54) **Title:** MULTIPLEXING OF SIDELINK POSITIONING REFERENCE SIGNAL WITH PHYSICAL SIDELINK FEEDBACK CHANNEL

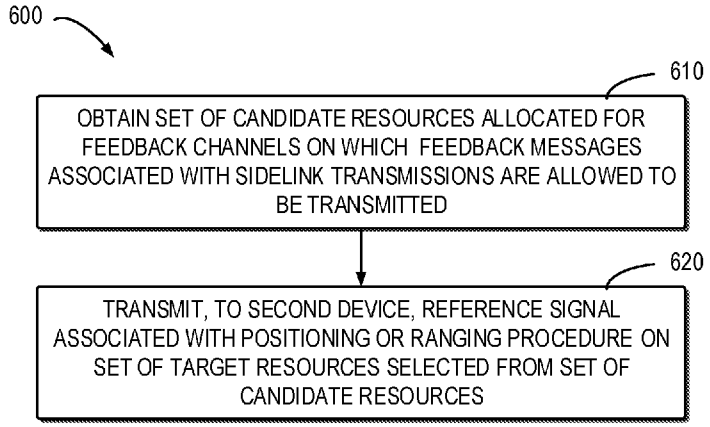


FIG. 6

(57) **Abstract:** Embodiments of the present disclosure relate to devices, methods, apparatuses and computer readable storage media of multiplexing of a PRS with PSFCHs. The method comprises obtaining a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and transmitting, to a second device, a reference signal associated with a positioning or ranging procedure on a set of target resources selected from the set of candidate resources. In this way, the unused PSFCH resources can be dynamically exploited for supporting a transmission of sidelink PRS and therefore the system efficiency can be increased.

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MULTIPLEXING OF SIDELINK POSITIONING REFERENCE SIGNAL WITH PHYSICAL SIDELINK FEEDBACK CHANNEL

FIELD

[0001] Embodiments of the present disclosure generally relate to the field of telecommunication and in particular to a method, device, apparatus and computer readable storage medium of multiplexing of a sidelink Positioning Reference Signal (PRS) with Physical Sidelink Feedback Channels (PSFCHs).

BACKGROUND

[0002] In Release 16, Physical Sidelink Feedback Channel (PSFCH) for sidelink communication was specified to carry HARQ feedback over the sidelink from a User Equipment (UE) which is an intended recipient of a Physical Sidelink Shared Channel (PSSCH) transmission to the UE which performed the transmission. The time resources for PSFCH are (pre-)configured. The HARQ feedback resource can be derived from the resource location of Physical Sidelink Control Channel (PSCCH)/PSSCH.

[0003] Further, as the sidelink communication continues to be enhanced in Release 17 and future Releases, many sidelink use cases may require a positioning or ranging procedure for a UE. Thus, a transmission of PRS may need to be performed for the positioning or ranging procedure.

SUMMARY

[0004] In general, example embodiments of the present disclosure provide a solution of multiplexing of a PRS with PSFCHs.

[0005] In a first aspect, there is provided a first device. The first device comprises at least one processor; and at least one memory including computer program codes; the at least one memory and the computer program codes are configured to, with the at least one processor, cause the first device at least to obtain a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and transmit, to a second device, a reference signal associated with a positioning or ranging procedure on a set of target resources selected from the set of candidate resources.

[0006] In a second aspect, there is provided a second device. The second device comprises at least one processor; and at least one memory including computer program codes; the at least one memory and the computer program codes are configured to, with the at least one processor, cause the second device at least to receive, from a first device, a reference signal associated with a positioning or ranging procedure on a set of target resources, the set of target resources selected from a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and perform the positioning or ranging procedure based on the reference signal.

[0007] In a third aspect, there is provided a method. The method comprises obtaining a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and transmitting, to a second device, a reference signal associated with a positioning or ranging procedure on a set of target resources selected from the set of candidate resources.

[0008] In a fourth aspect, there is provided a method. The method comprises receiving, from a first device, a reference signal associated with a positioning or ranging procedure on a set of target resources, the set of target resources selected from a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and performing the positioning or ranging procedure based on the reference signal.

[0009] In a fifth aspect, there is provided an apparatus comprising means for obtaining a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and means for transmitting, to a second device, a reference signal associated with a positioning or ranging procedure on a set of target resources selected from the set of candidate resources.

[0010] In a sixth aspect, there is provided an apparatus comprising means for receiving, from a first device, a reference signal associated with a positioning or ranging procedure on a set of target resources, the set of target resources selected from a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and means for performing the positioning or ranging procedure based on the reference signal.

[0011] In a seventh aspect, there is provided a computer readable medium having a

computer program stored thereon which, when executed by at least one processor of a device, causes the device to carry out the method according to the third aspect.

[0012] In an eighth aspect, there is provided a computer readable medium having a computer program stored thereon which, when executed by at least one processor of a device, causes the device to carry out the method according to the fourth aspect.

[0013] Other features and advantages of the embodiments of the present disclosure will also be apparent from the following description of specific embodiments when read in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of embodiments of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Embodiments of the disclosure are presented in the sense of examples and their advantages are explained in greater detail below, with reference to the accompanying drawings, where

[0015] FIG. 1 illustrates an example environment in which example embodiments of the present disclosure can be implemented;

[0016] FIG. 2 shows a signaling chart illustrating a process of multiplexing of a PRS with PSFCHs according to some example embodiments of the present disclosure;

[0017] FIG. 3 shows an example of multiplexing of a PRS with PSFCHs according to some example embodiments of the present disclosure;

[0018] FIG. 4 shows an example of multiplexing of a PRS with PSFCHs according to some example embodiments of the present disclosure;

[0019] FIG. 5 shows an example of multiplexing of a PRS with PSFCHs according to some example embodiments of the present disclosure;

[0020] FIG. 6 shows a flowchart of an example method of multiplexing of a PRS with PSFCHs according to some example embodiments of the present disclosure;

[0021] FIG. 7 shows a flowchart of an example method of multiplexing of a PRS with PSFCHs according to some example embodiments of the present disclosure;

[0022] FIG. 8 shows a simplified block diagram of a device that is suitable for implementing example embodiments of the present disclosure; and

[0023] FIG. 9 shows a block diagram of an example computer readable medium in accordance with some embodiments of the present disclosure.

[0024] Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

[0025] Principle of the present disclosure will now be described with reference to some example embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure. The disclosure described herein can be implemented in various manners other than the ones described below.

[0026] In the following description and claims, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

[0027] References in the present disclosure to "one embodiment," "an embodiment," "an example embodiment," and the like indicate that the embodiment described may include a particular feature, structure, or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an example embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

[0028] It shall be understood that although the terms "first" and "second" etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish functionalities of various elements. As used herein, the term "and/or" includes any and all combinations of one or more of the listed terms.

[0029] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example embodiments. As used

herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises", "comprising", "has", "having", "includes" and/or "including", when used herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/ or combinations thereof.

[0030] As used in this application, the term "circuitry" may refer to one or more or all of the following:

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

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

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

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

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

[0031] This definition of circuitry applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term circuitry also covers an implementation of merely a hardware circuit or processor (or multiple processors) or portion of a hardware circuit or processor and its (or their) accompanying software and/or firmware. The term circuitry also covers, for example and if applicable to the particular claim element, a baseband integrated circuit or processor integrated circuit for a mobile device or a similar integrated circuit in server, a cellular network device, or other computing or network device.

[0032] As used herein, the term "communication network" refers to a network following any suitable communication standards, such as fifth generation (5G) systems, Long Term Evolution (LTE), LTE-Advanced (LTE-A), Wideband Code Division Multiple Access

(WCDMA), High-Speed Packet Access (HSPA), Narrow Band Internet of Things (NB-IoT) and so on. Furthermore, the communications between a terminal device and a network device in the communication network may be performed according to any suitable generation communication protocols, including, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the future fifth generation (5G) new radio (NR) communication protocols, and/or any other protocols either currently known or to be developed in the future. Embodiments of the present disclosure may be applied in various communication systems. Given the rapid development in communications, there will of course also be future type communication technologies and systems with which the present disclosure may be embodied. It should not be seen as limiting the scope of the present disclosure to only the aforementioned system.

[0033] As used herein, the term "network device" refers to a node in a communication network via which a terminal device accesses the network and receives services therefrom. The network device may refer to a base station (BS) or an access point (AP), for example, a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a NR Next Generation NodeB (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, depending on the applied terminology and technology. A RAN split architecture comprises a gNB-CU (Centralized unit, hosting RRC, SDAP and PDCP) controlling a plurality of gNB-DUs (Distributed unit, hosting RLC, MAC and PHY). A relay node may correspond to DU part of the IAB node.

[0034] The term "terminal device" refers to any end device that may be capable of wireless communication. By way of example rather than limitation, a terminal device may also be referred to as a communication device, user equipment (UE), a subscriber station (SS), a portable subscriber station, a mobile station (MS), or an access terminal (AT). The terminal device may include, but not limited to, a mobile phone, a cellular phone, a smart phone, voice over IP (VoIP) phones, wireless local loop phones, a tablet, a wearable terminal device, a personal digital assistant (PDA), portable computers, desktop computer, image capture terminal devices such as digital cameras, gaming terminal devices, music storage and playback appliances, vehicle-mounted wireless terminal devices, wireless endpoints, mobile stations, laptop-embedded equipment (LEE), laptop-mounted equipment (LME), USB dongles, smart devices, wireless customer-premises equipment (CPE), an

Internet of Things (IoT) device, a watch or other wearable, a head-mounted display (HMD), a vehicle, a drone, a medical device and applications (e.g., remote surgery), an industrial device and applications (e.g., a robot and/or other wireless devices operating in an industrial and/or an automated processing chain contexts), a consumer electronics device, a device operating on commercial and/or industrial wireless networks, and the like. The terminal device may also correspond to Mobile Termination (MT) part of the integrated access and backhaul (IAB) node (a.k.a. a relay node). In the following description, the terms "terminal device", "communication device", "terminal", "user equipment" and "UE" may be used interchangeably.

[0035] Although functionalities described herein can be performed, in various example embodiments, in a fixed and/or a wireless network node, in other example embodiments, functionalities may be implemented in a user equipment apparatus (such as a cell phone or tablet computer or laptop computer or desktop computer or mobile IoT device or fixed IoT device). This user equipment apparatus can, for example, be furnished with corresponding capabilities as described in connection with the fixed and/or the wireless network node(s), as appropriate. The user equipment apparatus may be the user equipment and/or or a control device, such as a chipset or processor, configured to control the user equipment when installed therein. Examples of such functionalities include the bootstrapping server function and/or the home subscriber server, which may be implemented in the user equipment apparatus by providing the user equipment apparatus with software configured to cause the user equipment apparatus to perform from the point of view of these functions/nodes.

[0036] FIG. 1 shows an example communication network 100 in which embodiments of the present disclosure can be implemented. As shown in FIG. 1, the communication system 100 comprises a network device 120 (hereinafter may also be referred to as a gNB 120 or a third device 120). The network device 120 is associated with one or more serving areas, i.e. a land area called "cells". As shown in FIG. 1, the network device 120 may serve a cell 121.

[0037] The communication system 100 can also comprise a terminal device 110-1 (hereinafter may also be referred to as a first device 110-1 or a UE 110-1) and a terminal device 110-2 (hereinafter may also be referred to as a second device 110-2 or a UE 110-2). The network device 120 and the terminal devices 110-1 and 110-2 can communicate data and control information to each other. It is to be understood that the number of network

devices, terminal devices and/or cells is provided for illustration purpose only without suggesting any limitation to the scope of the present disclosure. The communication system 100 may include any suitable number of network devices, terminal devices and/or cells adapted for implementing the present disclosure.

[0038] The communication between the terminal device 110-1 and the terminal device 110-2 can be referred to as the sidelink communication. For example, if a sidelink transmission between the terminal device 110-1 and the terminal device 110-2 is initiated from the terminal device 110-1, the terminal device 110-1 may be considered as a TX sidelink UE and the terminal device 110-2 may be considered as a RX sidelink UE. The sidelink transmission between the terminal device 110-1 and the terminal device 110-2 can be performed via a Physical Sidelink Control Channel (PSCCH) and a Physical Sidelink Shared Channel (PSSCH). Furthermore, a PSFCH between the terminal device 110-1 and the terminal device 110-2 can be defined to convey sidelink feedback control information (SFCI).

[0039] Depending on the communication technologies, the network 100 may be a Code Division Multiple Access (CDMA) network, a Time Division Multiple Address (TDMA) network, a Frequency Division Multiple Access (FDMA) network, an Orthogonal Frequency-Division Multiple Access (OFDMA) network, a Single Carrier-Frequency Division Multiple Access (SC-FDMA) network or any others. Communications discussed in the network 100 may conform to any suitable standards including, but not limited to, New Radio Access (NR), Long Term Evolution (LTE), LTE-Evolution, LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), Code Division Multiple Access (CDMA), cdma2000, and Global System for Mobile Communications (GSM) and the like. Furthermore, the communications may be performed according to any generation communication protocols either currently known or to be developed in the future. Examples of the communication protocols include, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G) communication protocols. The techniques described herein may be used for the wireless networks and radio technologies mentioned above as well as other wireless networks and radio technologies. For clarity, certain aspects of the techniques are described below for 5G NR, and 5G NR terminology is used in much of the description below.

[0040] The PSFCH for sidelink communication was specified to carry HARQ feedback

over the sidelink from a receiving UE (Rx UE) to a transmitting UE (Tx UE) which performed a PSSCH transmission. For example, the PSFCH may transmit a Zadoff-Chu sequence in one Physical Resource Block (PRB) repeated over two Orthogonal Frequency Division Multiplexing (OFDM) symbols, the first of which can be used for Automatic Gain Control (AGC), near the end of the sidelink resource in a slot. The Zadoff-Chu sequence as base sequence is (pre-)configured per sidelink resource pool.

[0041] The time resources for PSFCH are (pre-)configured. The HARQ feedback resource can be derived from the resource location of PSCCH/PSSCH. For PSSCH-to-HARQ timing, the gNB may configure a parameter K with the unit of slot. The time occasion for PSFCH is determined from K. For a PSSCH transmission with its last symbol in slot n, HARQ feedback is in slot n+a where a is the smallest integer larger than or equal to K with the condition that slot n+a contains PSFCH resources.

[0042] However, the pre-allocated PSFCH resources may not be used for actual PSFCH transmissions. The PSFCHs are associated with or determined by PSSCHs. There is fixed timing/frequency relationship between a PSFCH and a data subchannel. The Subchannel occupying multiple PRBs is the minimum granularity of a PSSCH, i.e., a PSSCH may occupy one or multiple subchannels continuously in frequency domain in a slot. When a PSSCH occupies multiple subchannels, the corresponding PSFCH is determined by the starting subchannel of the PSSCH. The PSFCH resources corresponding to other subchannels will not be used.

[0043] The Sidelink Control Information (SCI) can indicate resources for a PSSCH. The SCI in PSCCH/PSSCH also indicates whether there will be a PSFCH transmission in the pre-allocated PSFCH resource.

[0044] There are different cast types of data traffic conveyed at PSSCH, namely unicast, groupcast and broadcast. The HARQ feedback via PSFCH can be enabled or disabled with indication in SCI for unicast and groupcast. The HARQ feedback may not be needed for the broadcast. The PSFCH resources corresponding to PSSCHs for broadcast and unicast/groupcast with HARQ feedback disabled will not be used.

[0045] Since the PSFCH resources are pre-allocated densely in sidelink resource pool, and those pre-allocated PSFCH resources may be wasted if they are not used for PSFCH transmissions.

[0046] Therefore, the present disclosure provides solutions of multiplexing of a PRS with

PSFCHs. In this solution, the UE may obtain a set of candidate resources allocated for PSFCHs. The HARQ feedback associated with a sidelink transmission may be allowed to be transmitted on a PSFCH. The UE may transmit a reference signal associated with a positioning or ranging procedure on a set of target resources selected from the set of candidate resources. In this way, the unused PSFCH resources can be dynamically exploited for supporting a transmission of sidelink PRS and therefore the system efficiency can be increased.

[0047] Principle and implementations of the present disclosure will be described in detail below with reference to FIG. 2, which shows a signaling chart illustrating a process of multiplexing of a PRS with PSFCHs according to some example embodiments of the present disclosure. For the purpose of discussion, the process 200 will be described with reference to FIG. 1. The process 200 may involve the UE 110-1 and the UE 110-2 as illustrated in FIG. 1.

[0048] As shown in FIG. 2, if the UE 110-1 is involved in a positioning or ranging procedure, the UE 110-1 may obtain a set of candidate resources. The set of candidate resources can be the resources allocated for PFSCHs, on which HARQ feedbacks associated with sidelink transmissions can be transmitted. In general, the time resources for PSFCHs can be configured or pre-configured and therefore the resources allocated for PFSCHs can be derived from the resource locations of PSCCHs/PSSCHs.

[0049] Then the UE 110-1 may select 205, from the set of candidate resources, a set of target resources for transmitting a reference signal associated with the positioning or ranging procedure. Hereinafter the reference signal associated with the positioning or ranging procedure can be referred to as the sidelink Positioning Reference Signal (PRS). It is to be understood that other suitable reference signal can also be used as the reference signal associated with the positioning or ranging procedure.

[0050] A sidelink PRS can be configured as a wide band signal with comb structure, i.e., a sidelink PRS can occupy multiple PRBs with only some subcarriers in each PRB are used. On the contrary, a PSFCH may occupy all subcarriers of a PRB. Therefore, the set of target resources for transmitting the reference signal can be overlapped with the set of candidate resources allocated for PFSCHs and mutual interference between PRS and PSFCHs can be reduced or randomized.

[0051] For determining the set of target resources from the set of candidate resources, the

UE 110-1 may determine a distribution mode of the set of target resources on the set of candidate resources.

[0052] In some example embodiments, the UE 110-1 may determine a number of subcarriers included in the set of the target resources and a comb size for the comb structure of the PRS, i.e., an offset between a first subcarrier and a second subcarrier in the subcarriers included in the set of the target resources on the frequency domain. The comb size can be selected or configured by the gNB 120. The UE 110-1 may receive an indication of comb size from the gNB 120.

[0053] Furthermore, the UE 110-1 may also determine a comb offset for PRS. The comb offset can be configured by the gNB 120. Alternatively, the comb offset can also be selected by the UE 110-1 itself.

[0054] In some example embodiments, the UE 110-1 may also determine the number of PRBs included in the set of candidate resources allocated for PFSCHs. The sidelink PRS can be spread over whole bandwidth of PSFCH resources. Accordingly, lower Power Spectral Density (PSD) can be employed to reduce interference to PSFCH transmissions.

[0055] Alternatively, the sidelink PRS can be spread over partial bandwidth of PSFCH resources.

[0056] FIG. 3 shows an example of multiplexing of a PRS with PSFCHs according to some example embodiments of the present disclosure. As shown in FIG. 3, there are multiple PRBs, namely PRB 310-1 to PRB 310-N, allocated for the PSFCHs. For simplicity, FIG. 3 only shows the two ends of frequency resources for the PSFCHs for illustration. The PRB 310-3 and PRB 310-N are actually used to transmit a HARQ feedback on the PSFCH. The set of target resources 320-1 to 320-N can be spread over whole bandwidth of PSFCH resources. 12 (the number of subcarriers for a PSFCH) can be selected as the comb size for the sidelink PRS.

[0057] Based on the number of subcarriers included in the set of the target resources, the comb size and the number of PRBs included in the set of candidate resources, the UE 110-1 may determine the distribution mode of the set of target resources on the set of candidate resources. Based on the distribution mode, the UE 110-1 may determine the set of target resources from the set of candidate resources.

[0058] Furthermore, the gNB 120 may dynamically change the multiplexing strategy based on the traffic load in the system and the expected PSFCH transmissions. For

example, the gNB 120 may configure comb size 6 for the PRS multiplexed with PSFCHs when the traffic load is low and then increase the comb size to 12 when the traffic load increases.

[0059] In some example embodiments, a dynamic multiplexing mechanism can be adopted. That is, only if the UE 110-1 determines that occupation ratio of the set of candidate resources allocated for PSFCHs is low, the UE 110-1 may select the set of target resources for transmitting the PRS from the set of candidate resources.

[0060] For mode 2 sidelink communication, the UE 110-1 can continuously perform sensing of SCIs in PSCCHs/PSSCHs from other UEs for resource selection. Hence the UE 110-1 can determine which PSFCH resources (PRBs) will have actual PSFCH transmissions. Based on the collected information, the UE 110-1 determines whether it can transmit sidelink PRS in a coming slot with PSFCH resources.

[0061] The collected information may comprise a PSFCH occupation ratio, i.e., the number of PRBs to be occupied for PSFCH transmissions versus the total number of PRBs pre-allocated for PSFCHs. In some example embodiments, if the UE 110-1 determines that the occupation ratio is less than a threshold ratio, the UE 110-1 may select the set of target resources for transmitting the PRS from the set of candidate resources. This dynamic multiplexing mechanism can guarantee the quality of timing (or angle) estimation based on PRS to some extent.

[0062] Now referring back to FIG. 2, the UE 110-1 may transmit 210 the sidelink PRS to the UE 110-2 on the set of target resources.

[0063] In some example embodiments, the UE 110-1 may transmit the sidelink PRS only on the resources on which no actual PSFCH transmission occurs and mute the sidelink PRS transmission on the resources having the actual PSFCH transmission. For example, the UE 110-1 may dynamically apply this muting when transmitting the PRS depending on the total number of PFSCH transmissions and/or a pre-configured setting.

[0064] FIG. 4 shows an example of multiplexing of a PRS with PSFCHs according to some example embodiments of the present disclosure. As shown in FIG. 4, there are multiple PRBs, namely PRB 410-1 to PRB 410-N, allocated for the PSFCHs. For simplicity, FIG. 4 only shows the two ends of frequency resources for the PSFCHs for illustration. The PRB 410-3 and PRB 410-N are actually used to transmit a HARQ feedback on the PSFCH. The set of target resources 420-1, 420-2, ..., 420-N-2 and 420-N-1 can be selected for

transmitting the sidelink PRS. The transmission of the sidelink PRS are muted on the PRB 410-3 and PRB 410-N having the actual PSFCH transmission.

[0065] In some example embodiments, the UE 110-1 may transmit an indication of a muting on the resources having the actual PSFCH transmission.

[0066] The subcarrier muting may also be applied based on the expected quality of the received PRS at the other UEs. For example, if the UE 110-1 believes it has a high quality link with the receiving UE 110-2 (e.g., from past measurements or communication) it may mute the subcarriers in the PSFCHs as it is less critical for PRS to have all the subcarriers at that receiving UE 110-2.

[0067] Alternatively, the UE 110-1 may reduce the transmit power of the PRS based on the determined PSFCH resources with actual transmissions.

[0068] The Sidelink PRS subcarrier muting can reduce interference to PSFCH transmissions and provide back compatibility with R16 UEs of sidelink capability.

[0069] For mode 2 sidelink communication, the UE 110-2 can also continuously perform sensing of SCIs of PSCCHs/PSSCHs from other UEs for resource selection. Hence the UE 110-2 can determine which PSFCH resources (PRBs) will have actual PSFCH transmissions. Thus, the UE 110-2 can also determine the set of target resources on which the sidelink PRS is transmitted. As shown in FIG. 2, the UE 110-2 then may perform 215 the positioning or ranging procedure based on the received sidelink PRS.

[0070] In some example embodiments, for correlation for the timing (or angle) estimation based on the received sidelink PRS in the positioning or ranging procedure, the UE 110-2 can choose to ignore the subcarriers overlapped with actual PFSCH transmissions. That is, the UE 110-2 can perform the timing (or angle) estimation by excluding the sidelink PRS received on the PRS resources overlapped with PSFCH resources having actual PSFCH transmissions, which can improve performance of timing (or angle) estimation based on received sidelink PRS.

[0071] Furthermore, the UE 110-2 may receive, from the UE 110-1, an indication of a muting on the resources having the actual PSFCH transmission. The UE 110-2 then may skip the reception of the sidelink PRS on the the resources having the actual PSFCH transmission.

[0072] When the UE 110-2 performs the positioning or ranging procedure, the UE 110-2

obtains a set of parameters associated with the sidelink PRS to process the received sidelink PRS, for example, for timing (or angle) estimation based on a correlation process. As an example, the set of parameters can be set as the sidelink PRS, and the received sidelink PRS may contain the sidelink PRS plus noise and interference. When the UE 110-2 receives the indication of a muting on the resources having the actual PSFCH transmissions, the UE 110-2 may perform the positioning or ranging procedure by using a portion of parameters in the set of parameters associated with the sidelink PRS. The portion of parameters may correspond to the sidelink PRS received on the resources for transmitting the sidelink PRS excluding the resources overlapped with PSFCH resources having actual PSFCH transmissions.

[0073] Moreover, as known, a PSFCH can be repeated over two OFDM symbols near the end of the sidelink resources in a slot. The first of the two OFDM symbols can be used for AGC. As an option, a PRS can also be repeated over two OFDM symbols when a PRS reuses resources for PSFCHs.

[0074] FIG. 5 shows an example of multiplexing of a PRS with PSFCHs according to some example embodiments of the present disclosure. As shown in FIG. 5, there are multiple PRBs, namely PRB 510-1 to PRB 510-N, allocated for the PSFCHs. [-1, 1]*PRS are used in two OFDM symbols, such as 520-1 and 520-1' in the PRB 510-1, i.e., the PRS in the first symbol is the multiplication of -1 with the PRS in the second symbol.

[0075] In this way, at the receiver detecting a PSFCH, the addition of received first and second OFDM symbols can remove the impact of a PRS reusing the PSFCH resources. Thus, PFSCH detection performance can be improved with slightly more complicated operations.

[0076] FIG. 6 shows a flowchart of an example method 600 of multiplexing of a PRS with PSFCHs according to some example embodiments of the present disclosure. The method 600 can be implemented at a first device 110-1 as shown in FIG. 1. For the purpose of discussion, the method 600 will be described with reference to FIG. 1.

[0077] At 610, the first device obtains a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted.

[0078] In some example embodiments, the first device may determine a distribution mode of the set of target resources on the set of candidate resources; and select the set of target

resources from the set of candidate resources based on the distribution mode.

[0079] In some example embodiments, the first device may determine the number of subcarriers included in the set of the target resources and a comb size of the set of the target resources having a comb structure; determine the number of physical resource blocks included in the set of candidate resources; and determine the distribution mode based on the number of a plurality of subcarriers, the comb size and the number of physical resource blocks.

[0080] In some example embodiments, the first device may obtain an indication associated with the number of subcarriers and the comb size from a third device; and determine the number of subcarriers and the comb size based on the indication.

[0081] At 620, the first device transmits, to a second device, a reference signal associated with a positioning or ranging procedure on a set of target resources selected from the set of candidate resources.

[0082] In some example embodiments, the first device may determine, based on sidelink control information, an occupation ratio of the set of candidate resources, the occupation ratio indicating an amount of resources used to transmit the feedback messages on the set of candidate resources. If the first device determines that the occupation ratio is less than a threshold ratio, the first device may transmit the reference signal on the set of target resources.

[0083] In some example embodiments, the first device may determine, based on sidelink control information, a set of reference resources used to transmit the feedback messages. If the first device determines that at least one subset of target resources in the set of target resources overlaps with the set of reference resources, the first device may mute the reference signal transmission on the at least one subset of target resources.

[0084] In some example embodiments, the first device may transmit, to the second device, an indication of a muting on the at least one subset of target resources.

[0085] In some example embodiments, the first device may determine, based on sidelink control information, a set of reference resources used to transmit the feedback messages. If the first device determines that at least one subset of target resources in the set of target resources overlaps with the set of reference resources, the first device may reduce a transmission power for transmitting the reference signal on the at least one subset of target resources.

[0086] In some example embodiments, the first device may comprise a sidelink terminal device and the second device may comprise a sidelink terminal device.

[0087] In some example embodiments, the third device may comprise a network device.

[0088] FIG. 7 shows a flowchart of an example method 700 of multiplexing of a PRS with PSFCHs according to some example embodiments of the present disclosure. The method 700 can be implemented at a second device 110-2 as shown in FIG. 1. For the purpose of discussion, the method 700 will be described with reference to FIG. 1.

[0089] At 710, the second device receives, from a first device, a reference signal associated with a positioning or ranging procedure on a set of target resources, the set of target resources selected from a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted.

[0090] In some example embodiments, the second device may determine, from the set of candidate resources based on sidelink control information, a set of reference resources used to transmit the feedback messages; and determine the set of target resources based on the set of reference resources.

[0091] In some example embodiments, the second device may receive, from the first device, an indication of a muting on at least one subset of target resources in the set of target resources, the at least one subset of target resources overlapping with a set of reference resources used to transmit the feedback messages; and cause a reception of the reference signal on the at least one subset of target resources to be skipped.

[0092] In some example embodiments, the second device may obtain a set of reference parameters associated with the reference signal and perform the positioning or ranging procedure based on a portion of reference parameters in the set of reference parameters, the portion of reference parameters corresponding to the reference signal received on the set of target resources excluding the at least one subset of target resources.

[0093] In some example embodiments, the first device may comprise a sidelink terminal device and the second device may comprise a sidelink terminal device.

[0094] In some example embodiments, an apparatus capable of performing the method 600 (for example, implemented at the UE 110-1) may comprise means for performing the respective steps of the method 600. The means may be implemented in any suitable form.

For example, the means may be implemented in a circuitry or software module.

[0095] In some example embodiments, the apparatus comprises means for obtaining a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and means for transmitting, to a second device, a reference signal associated with a positioning or ranging procedure on a set of target resources selected from the set of candidate resources.

[0096] In some example embodiments, the apparatus further comprises means for determining a distribution mode of the set of target resources on the set of candidate resources; and means for selecting the set of target resources from the set of candidate resources based on the distribution mode.

[0097] In some example embodiments, the means for determining the distribution mode comprises means for determining the number of subcarriers included in the set of the target resources and a comb size of the set of the target resources having a comb structure; means for determining a number of physical resource blocks included in the set of candidate resources; and means for determining the distribution mode based on the number of a plurality of subcarriers, the comb size and the number of physical resource blocks.

[0098] In some example embodiments, the means for determining the number of subcarriers and the comb size comprises means for obtaining an indication associated with the number of subcarriers and the comb size from a third device; and means for determining the number of subcarriers and the comb size based on the indication.

[0099] In some example embodiments, the means for transmitting the reference signal comprises means for determining, based on sidelink control information, an occupation ratio of the set of candidate resources, the occupation ratio indicating an amount of resources used to transmit the feedback messages on the set of candidate resources; and means for in accordance with a determination that the occupation ratio is less than a threshold ratio, transmitting the reference signal on the set of target resources.

[00100] In some example embodiments, the apparatus further comprises means for determining, from the set of candidate resources based on sidelink control information, a set of reference resources used to transmit the feedback messages; and means for in accordance with a determination that at least one subset of target resources in the set of target resources overlaps with the set of reference resources, muting the reference signal transmission on the at least one subset of target resources.

[00101] In some example embodiments, the apparatus further comprises means for transmitting, to the second device, an indication of a muting on the at least one subset of target resources.

[00102] In some example embodiments, the apparatus further comprises means for determining, from the set of candidate resources, a set of reference resources used to transmit the feedback messages; and means for in accordance with a determination that at least one subset of target resources in the set of target resources overlaps with the set of reference resources, reducing a transmission power for transmitting the reference signal on the at least one subset of target resources.

[00103] In some example embodiments, the first device comprises a sidelink terminal device and the second device comprises a sidelink terminal device.

[00104] In some example embodiments, the third device comprises a network device.

[00105] In some example embodiments, an apparatus capable of performing the method 700 (for example, implemented at the UE 110-2) may comprise means for performing the respective steps of the method 700. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module.

[00106] In some example embodiments, the apparatus comprises means for receiving, from a first device, a reference signal associated with a positioning or ranging procedure on a set of target resources, the set of target resources selected from a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and means for performing the positioning or ranging procedure based on the reference signal.

[00107] In some example embodiments, the apparatus further comprises means for determining, from the set of candidate resources based on sidelink control information, a set of reference resources used to transmit the feedback messages; and means for determining the set of target resources based on the set of reference resources.

[00108] In some example embodiments, the means for performing the positioning or ranging procedure comprises means for receiving, from the first device, an indication of a muting on at least one subset of target resources in the set of target resources, the at least one subset of target resources overlapping with a set of reference resources used to transmit the feedback messages; and means for performing the positioning or ranging procedure by excluding the reference signal received on the at least one subset of target resources.

[00109] In some example embodiments, the apparatus further comprises means for obtaining a set of reference parameters associated with the reference signal; and means for performing the positioning or ranging procedure based on a portion of reference parameters in the set of reference parameters, the portion of reference parameters corresponding to the reference signal received on the set of target resources excluding the at least one subset of target resources.

[00110] In some example embodiments, the first device comprises a sidelink terminal device and the second device comprises a sidelink terminal device.

[00111] FIG. 8 is a simplified block diagram of a device 800 that is suitable for implementing embodiments of the present disclosure. The device 800 may be provided to implement the communication device, for example the UE 110-1 and the UE 110-2 as shown in FIG. 1. As shown, the device 800 includes one or more processors 810, one or more memories 840 coupled to the processor 810, and one or more transmitters and/or receivers (TX/RX) 840 coupled to the processor 810.

[00112] The TX/RX 840 is for bidirectional communications. The TX/RX 840 has at least one antenna to facilitate communication. The communication interface may represent any interface that is necessary for communication with other network elements.

[00113] The processor 810 may be of any type suitable to the local technical network and may include one or more of the following: general purpose computers, special purpose computers, microprocessors, digital reference signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 800 may have multiple processors, such as an application specific integrated circuit chip that is slaved in time to a clock which synchronizes the main processor.

[00114] The memory 820 may include one or more non-volatile memories and one or more volatile memories. Examples of the non-volatile memories include, but are not limited to, a Read Only Memory (ROM) 824, an electrically programmable read only memory (EPROM), a flash memory, a hard disk, a compact disc (CD), a digital video disk (DVD), and other magnetic storage and/or optical storage. Examples of the volatile memories include, but are not limited to, a random access memory (RAM) 822 and other volatile memories that will not last in the power-down duration.

[00115] A computer program 830 includes computer executable instructions that are executed by the associated processor 810. The program 830 may be stored in the ROM

820. The processor 810 may perform any suitable actions and processing by loading the program 830 into the RAM 820.

[00116] The embodiments of the present disclosure may be implemented by means of the program 830 so that the device 800 may perform any process of the disclosure as discussed with reference to FIGs. 2 to 7. The embodiments of the present disclosure may also be implemented by hardware or by a combination of software and hardware.

[00117] In some embodiments, the program 830 may be tangibly contained in a computer readable medium which may be included in the device 800 (such as in the memory 820) or other storage devices that are accessible by the device 800. The device 800 may load the program 830 from the computer readable medium to the RAM 822 for execution. The computer readable medium may include any types of tangible non-volatile storage, such as ROM, EPROM, a flash memory, a hard disk, CD, DVD, and the like. FIG. 9 shows an example of the computer readable medium 900 in form of CD or DVD. The computer readable medium has the program 830 stored thereon.

[00118] Generally, various embodiments of the present disclosure may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. 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. While various aspects of embodiments of the present disclosure are illustrated and described as block diagrams, flowcharts, or using some other pictorial representations, it is to be understood that the block, device, system, technique or method 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.

[00119] The present disclosure also provides at least one computer program product tangibly stored on a non-transitory computer readable storage medium. The computer program product includes computer-executable instructions, such as those included in program modules, being executed in a device on a target real or virtual processor, to carry out the methods 600-700 as described above with reference to FIGs. 6-7. Generally, program modules include routines, programs, libraries, objects, classes, components, data structures, or the like that perform particular tasks or implement particular abstract data types. The functionality of the program modules may be combined or split between

program modules as desired in various embodiments. Machine-executable instructions for program modules may be executed within a local or distributed device. In a distributed device, program modules may be located in both local and remote storage media.

[00120] Program code for carrying out methods of the present disclosure may be written in any combination of one or more programming languages. These program codes may be provided to a processor or controller of a general purpose computer, special purpose computer, or other programmable data processing device, such that the program codes, when executed by the processor or controller, cause the functions/operations specified in the flowcharts and/or block diagrams to be implemented. The program code may execute entirely on a machine, partly on the machine, as a stand-alone software package, partly on the machine and partly on a remote machine or entirely on the remote machine or server.

[00121] In the context of the present disclosure, the computer program codes or related data may be carried by any suitable carrier to enable the device, device or processor to perform various processes and operations as described above. Examples of the carrier include a reference signal, computer readable medium, and the like.

[00122] The computer readable medium may be a computer readable reference signal medium or a computer readable storage medium. A computer readable medium may include but not limited to an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, device, or device, or any suitable combination of the foregoing. More specific examples of the computer readable storage medium would include an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing.

[00123] Further, while operations are depicted in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Likewise, while several specific implementation details are contained in the above discussions, these should not be construed as limitations on the scope of the present disclosure, but rather as descriptions of features that may be specific to particular

embodiments. Certain features that are described in the context of separate embodiments may also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment may also be implemented in multiple embodiments separately or in any suitable sub-combination.

[00124] Although the present disclosure has been described in languages specific to structural features and/or methodological acts, it is to be understood that the present disclosure defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

WHAT IS CLAIMED IS:

1. A first device comprising:

at least one processor; and

at least one memory including computer program codes;

the at least one memory and the computer program codes are configured to, with the at least one processor, cause the first device at least to:

obtain a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and

transmit, to a second device, a reference signal associated with a positioning or ranging procedure on a set of target resources selected from the set of candidate resources.

2. The first device of Claim 1, wherein the first device is further caused to:

determine a distribution mode of the set of target resources on the set of candidate resources; and

select the set of target resources from the set of candidate resources based on the distribution mode.

3. The first device of Claim 2, wherein the first device is caused to determine the distribution mode by:

determining the number of subcarriers included in the set of the target resources;

determining a comb size of the set of the target resources having a comb structure;

determining the number of physical resource blocks included in the set of candidate resources; and

determining the distribution mode based on the number of a plurality of subcarriers, the comb size and the number of physical resource blocks.

4. The first device of Claim 3, wherein the first device is caused to determine the number of subcarriers and the comb size by:

obtaining an indication associated with the number of subcarriers and the comb size from a third device; and

determining the number of subcarriers and the comb size based on the indication.

5. The first device of Claim 1, wherein the first device is caused to transmit the reference signal on the set of target resources by:

determining, based on sidelink control information, an occupation ratio of the set of candidate resources, the occupation ratio indicating an amount of resources used to transmit the feedback messages on the set of candidate resources; and

in accordance with a determination that the occupation ratio is less than a threshold ratio, transmitting the reference signal on the set of target resources.

6. The first device of Claim 1, wherein the first device is further caused to:

determine, from the set of candidate resources based on sidelink control information, a set of reference resources used to transmit the feedback messages; and

in accordance with a determination that at least one subset of target resources in the set of target resources overlaps with the set of reference resources, mute the reference signal transmission on the at least one subset of target resources.

7. The first device of Claim 6, wherein the first device is further caused to:

transmit, to the second device, an indication of a muting on the at least one subset of target resources.

8. The first device of Claim 1, wherein the first device is further caused to:

determine, from the set of candidate resources, a set of reference resources used to transmit the feedback messages; and

in accordance with a determination that at least one subset of target resources in the set of target resources overlaps with the set of reference resources, reduce a transmission power for transmitting the reference signal on the at least one subset of target resources.

9. The first device of Claim 1, wherein the first device comprises a sidelink terminal device and the second device comprises a sidelink terminal device.

10. The first device of Claim 4, wherein the third device comprises a network device.

11. A second device comprising:

at least one processor; and

at least one memory including computer program codes;

the at least one memory and the computer program codes are configured to, with the at least one processor, cause the second device at least to:

receive, from a first device, a reference signal associated with a positioning or ranging procedure on a set of target resources, the set of target resources selected from a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and

perform the positioning or ranging procedure based on the reference signal.

12. The second device of Claim 10, wherein the second device is further caused to:

determine, from the set of candidate resources based on sidelink control information, a set of reference resources used to transmit the feedback messages; and

determine the set of target resources based on the set of reference resources.

13. The second device of Claim 10, wherein the second device is caused to perform the positioning or ranging procedure by:

receiving, from the first device, an indication of a muting on at least one subset of target resources in the set of target resources, the at least one subset of target resources overlapping with a set of reference resources used to transmit the feedback messages; and

causing a reception of the reference signal on the at least one subset of target resources to be skipped.

14. The second device of Claim 10, wherein the second device is further caused to:

obtain a set of reference parameters associated with the reference signal; and

perform the positioning or ranging procedure based on a portion of reference parameters in the set of reference parameters, the portion of reference parameters corresponding to the reference signal received on the set of target resources excluding the at least one subset of target resources.

15. The second device of Claim 10, wherein the first device comprises a sidelink terminal device and the second device comprises a sidelink terminal device.

16. A method comprising:

obtaining a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and

transmitting, to a second device, a reference signal associated with a positioning or ranging procedure on a set of target resources selected from the set of candidate resources.

17. The method of Claim 16, further comprising:

determining a distribution mode of the set of target resources on the set of candidate resources; and

selecting the set of target resources from the set of candidate resources based on the distribution mode.

18. The method of Claim 17, wherein determining the distribution mode comprises:

determining the number of subcarriers included in the set of the target resources;

determining a comb size of the set of the target resources having a comb structure;

determining a number of physical resource blocks included in the set of candidate resources; and

determining the distribution mode based on the number of a plurality of subcarriers, the comb size and the number of physical resource blocks.

19. The method of Claim 18, wherein determining the number of subcarriers and the comb size comprises:

obtaining an indication associated with the number of subcarriers and the comb size from a third device; and

determining the number of subcarriers and the comb size based on the indication.

20. The method of Claim 16, wherein transmitting the reference signal on the set of target resources comprises:

determining, based on sidelink control information, an occupation ratio of the set of candidate resources, the occupation ratio indicating an amount of resources used to transmit the feedback messages on the set of candidate resources; and

in accordance with a determination that the occupation ratio is less than a threshold ratio, transmitting the reference signal on the set of target resources.

21. The method of Claim 16, further comprising:

determining, from the set of candidate resources based on sidelink control information, a set of reference resources used to transmit the feedback messages; and

in accordance with a determination that at least one subset of target resources in the set of target resources overlaps with the set of reference resources, muting the reference signal transmission on the at least one subset of target resources.

22. The method of Claim 21, further comprising:

transmitting, to the second device, an indication of a muting on the at least one subset of target resources.

23. The method of Claim 16, further comprising:

determining, from the set of candidate resources, a set of reference resources used to transmit the feedback messages; and

in accordance with a determination that at least one subset of target resources in the set of target resources overlaps with the set of reference resources, reducing a transmission power for transmitting the reference signal on the at least one subset of target resources.

24. The method of Claim 16, wherein the first device comprises a sidelink terminal device and the second device comprises a sidelink terminal device.

25. The method of Claim 19, wherein the third device comprises a network device.

26. A method comprising:

receiving, from a first device, a reference signal associated with a positioning or ranging procedure on a set of target resources, the set of target resources selected from a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and

performing the positioning or ranging procedure based on the reference signal.

27. The method of Claim 26, further comprising:

determining, from the set of candidate resources based on sidelink control information, a set of reference resources used to transmit the feedback messages; and

determining the set of target resources based on the set of reference resources.

28. The method of Claim 26, wherein performing the positioning or ranging procedure comprises:

receiving, from the first device, an indication of a muting on at least one subset of target resources in the set of target resources, the at least one subset of target resources overlapping with a set of reference resources used to transmit the feedback messages; and

causing a reception of the reference signal on the at least one subset of target resources to be skipped.

29. The method of Claim 28, further comprising:

obtaining a set of reference parameters associated with the reference signal; and

performing the positioning or ranging procedure based on a portion of reference parameters in the set of reference parameters, the portion of reference parameters corresponding to the reference signal received on the set of target resources excluding the at least one subset of target resources.

30. The method of Claim 26, wherein the first device comprises a sidelink terminal device and the second device comprises a sidelink terminal device.

31. An apparatus comprising:

means for obtaining a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and

means for transmitting, to a second device, a reference signal associated with a positioning or ranging procedure on a set of target resources selected from the set of candidate resources.

32. An apparatus comprising:

means for receiving, from a first device, a reference signal associated with a positioning or ranging procedure on a set of target resources, the set of target resources

selected from a set of candidate resources allocated for feedback channels on which feedback messages associated with sidelink transmissions are allowed to be transmitted; and

means for performing the positioning or ranging procedure based on the reference signal.

33. A non-transitory computer readable medium comprising program instructions for causing an apparatus to perform at least the method of any of claims 16-25.

34. A non-transitory computer readable medium comprising program instructions for causing an apparatus to perform at least the method of any of claims 26-30.

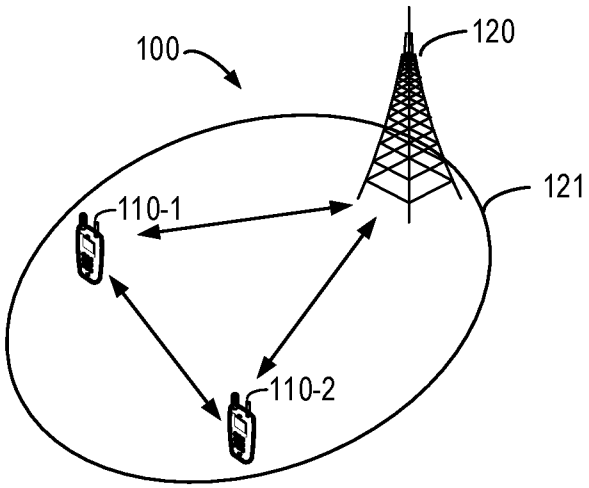


FIG. 1

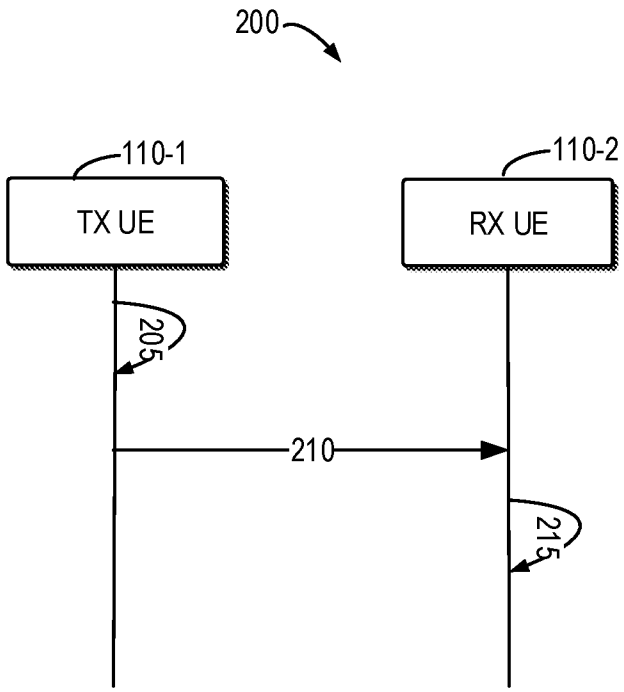


FIG. 2

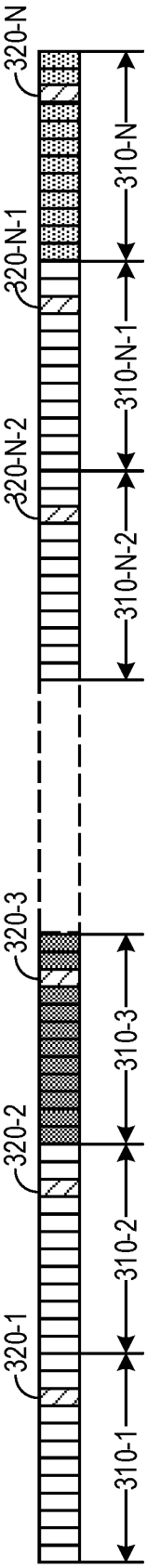

320-N
320-N-1
320-N-2
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320-2
320-1
310-N
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310-N-2
310-3
310-2
310-1

FIG. 3

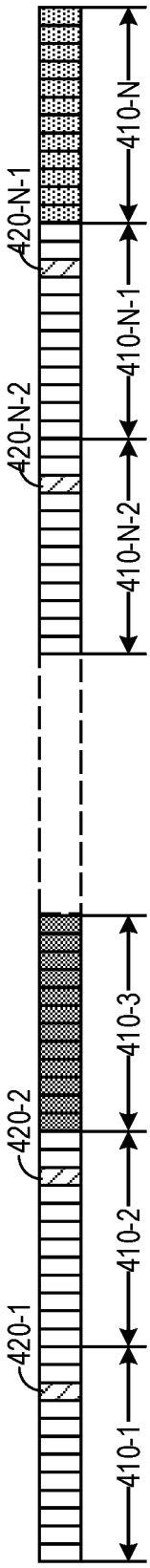

420-N-1
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420-2
420-1
410-N
410-N-1
410-N-2
410-3
410-2
410-1

FIG. 4

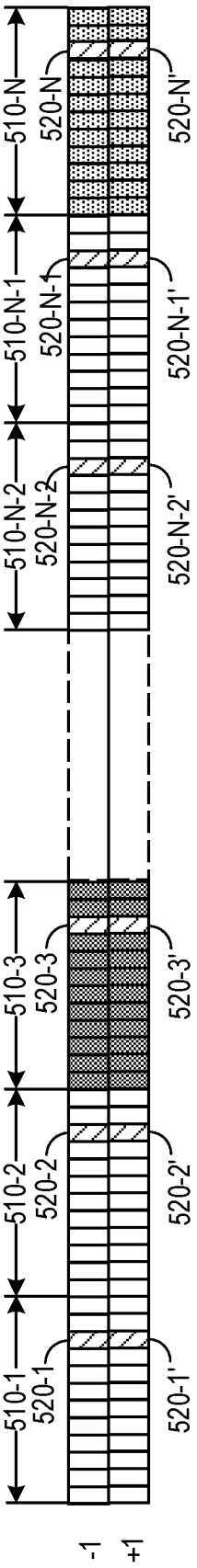

510-N
520-N
520-N'
510-N-1
520-N-1
520-N-1'
510-N-2
520-N-2
520-N-2'
510-3
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510-1
520-1
520-1'
-1
+1

FIG. 5

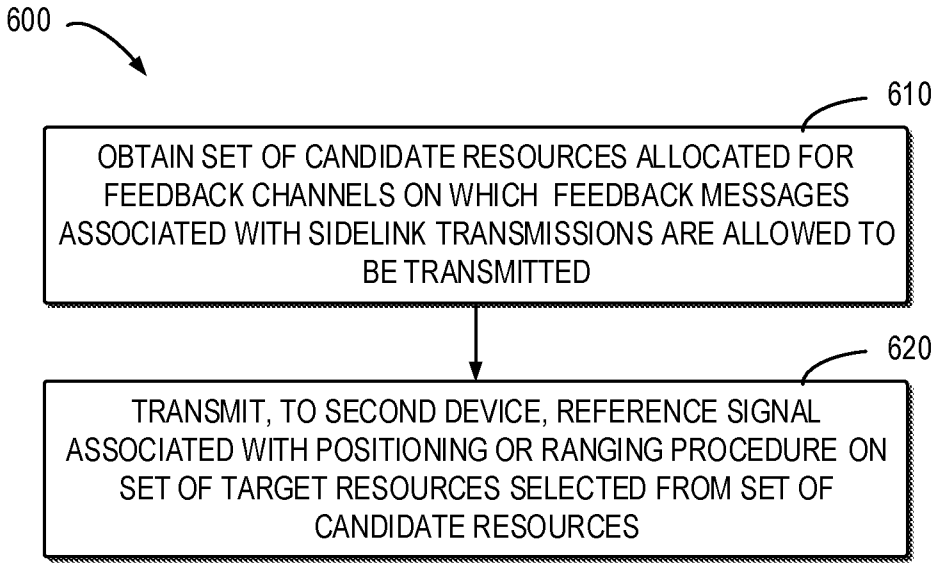

600
610
OBTAIN SET OF CANDIDATE RESOURCES ALLOCATED FOR FEEDBACK CHANNELS ON WHICH FEEDBACK MESSAGES ASSOCIATED WITH SIDELINK TRANSMISSIONS ARE ALLOWED TO BE TRANSMITTED
620
TRANSMIT, TO SECOND DEVICE, REFERENCE SIGNAL ASSOCIATED WITH POSITIONING OR RANGING PROCEDURE ON SET OF TARGET RESOURCES SELECTED FROM SET OF CANDIDATE RESOURCES

FIG. 6

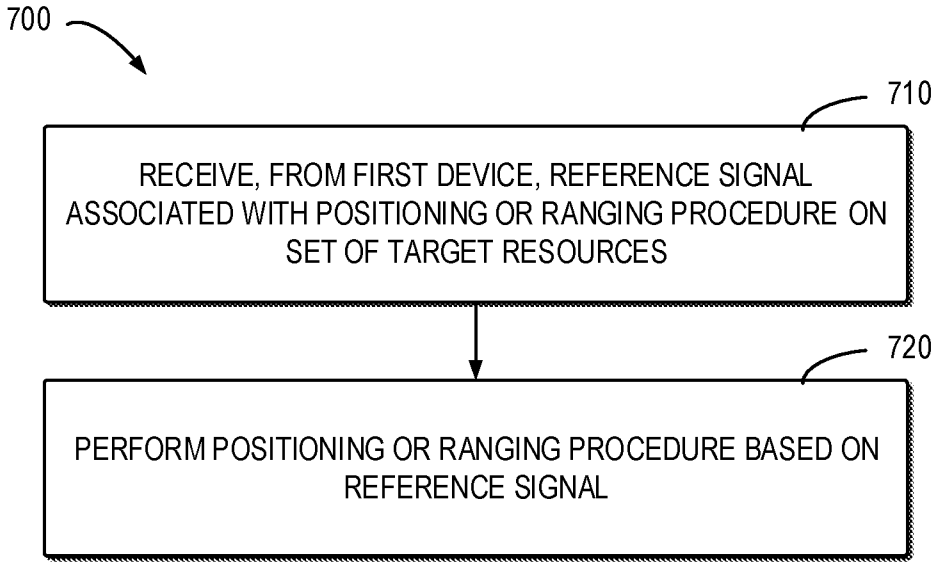

700
710
RECEIVE, FROM FIRST DEVICE, REFERENCE SIGNAL ASSOCIATED WITH POSITIONING OR RANGING PROCEDURE ON SET OF TARGET RESOURCES
720
PERFORM POSITIONING OR RANGING PROCEDURE BASED ON REFERENCE SIGNAL

FIG. 7

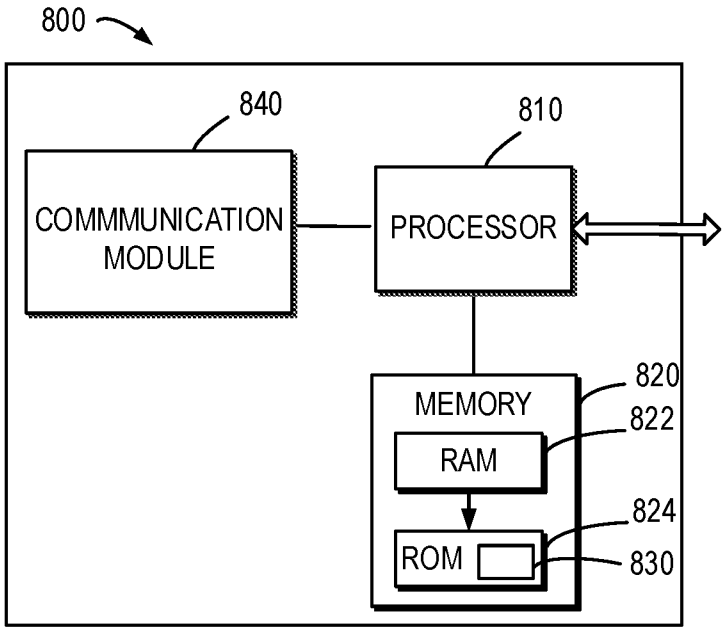

800
840
810
COMMMUNICATION MODULE
PROCESSOR
820
MEMORY
822
RAM
824
ROM
830

FIG. 8

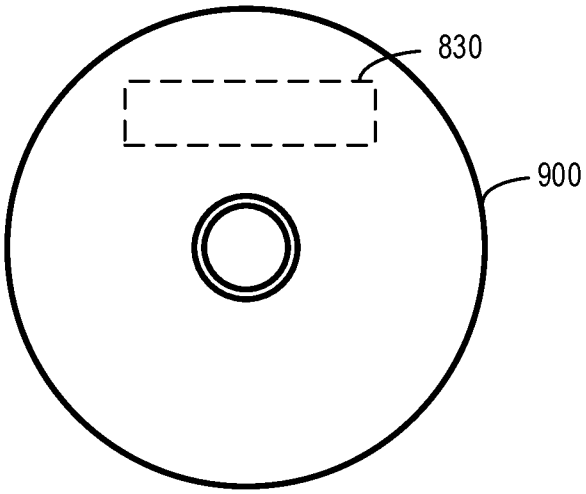

830
900

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/076346

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/02(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; H04L

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: PRS, PSFCH, multiplex, set, group, overlapped, mute, comb, positioning, position, ranging, locating, location, feedback, resourse, reference signal, HARQ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 112119607 A (BEIJING XIAOMI MOBILE SOFTWARE CO., LTD.) 22 December 2020 (2020-12-22) description, paragraphs[0066]-[0153], fig.3	1-34
A	WO 2020210333 A1 (IDAC HOLDINGS, INC.) 15 October 2020 (2020-10-15) the whole document	1-34
A	LG ELECTRONICS. "Discussion on physical layer procedure for NR sidelink" *3GPP TSG RAN WG1 Meeting #98bis, R1-1910783*, 07 October 2019 (2019-10-07), the whole document	1-34
A	MEDIATEK INC. "Physical layer procedures for sidelink" *3GPP TSG RAN WG1 #98, R1-1908401*, 17 August 2019 (2019-08-17), the whole document	1-34
A	US 2020344722 A1 (SAMSUNG ELECTRONICS CO., LTD.) 29 October 2020 (2020-10-29) the whole document	1-34
A	CN 111726211 A (HUAWEI TECHNOLOGIES CO., LTD.) 29 September 2020 (2020-09-29) the whole document	1-34

☐ 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
19 October 2021	**01 November 2021**
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 **LIAO,Ran** Telephone No. **86-(10)-53961767**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/076346

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 112119607 A	22 December 2020	None	
WO 2020210333 A1	15 October 2020	TW 202102032 A	01 January 2021
US 2020344722 A1	29 October 2020	WO 2020218892 A1	29 October 2020
CN 111726211 A	29 September 2020	None	