



(51) International Patent Classification:

H04W 72/04 (2009.01) H04W 76/34 (2018.01)
H04W 76/28 (2018.01)

(21) International Application Number:

PCT/CN2019/088981

(22) International Filing Date:

29 May 2019 (29.05.2019)

(25) Filing Language:

English

(26) Publication Language:

English

(71) Applicants (for CN only): **NOKIA SHANGHAI BELL CO., LTD.** [CN/CN]; No. 388, Ningqiao Road, Pudong Jin-qiao, Shanghai 201206 (CN). **NOKIA SOLUTIONS AND NETWORKS OY** [FI/FI]; Karakaari 7, 02610 Espoo (FI).

(71) Applicant (for all designated States except CN): **NOKIA TECHNOLOGIES OY** [FI/FI]; Karakaari 7, 02610 Espoo (FI).

(72) Inventors: **LIU, Yong**; No. 388 Ningqiao Road, Pudong Jinqiao, Shanghai 201206 (CN). **LI, Dong**; No. 388 Ningqiao Road, Pudong Jinqiao, Shanghai 201206 (CN).

(74) Agent: **KING & WOOD MALLESONS**; 20th Floor, East Tower, World Financial Centre, No. 1 Dongsanhuan Zhonglu, Chaoyang District, Beijing 100020 (CN).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,

(54) Title: RESOURCE MANAGEMENT IN SIDELINK COMMUNICATION

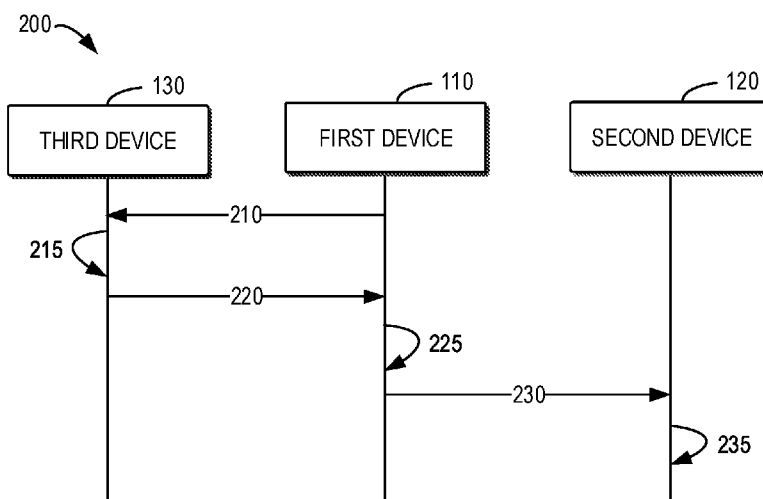


Fig. 2

(57) Abstract: Embodiments of the present disclosure relate to resource management in sidelink communication. According to one aspect of the present disclosure, a third device serving a first device may receive information on traffic characteristic parameters from the first device, the traffic characteristic parameters at least comprising a transport block size range, and assign a periodic resource to the first device based on an upper limit in the transport block size range. The first device may determine whether a resource assigned to the first device can be released and in response to a determination that the resource can be released, transmit a message from the first device to a second device over a direct communication link between the first and second devices, the message indicating availability of the resource for use by the second device. Upon receiving the message, the second device uses the released resource for transport block transmission. The resource management as provided in the present disclosure achieves a low latency, a high reliability and an increased efficiency of sidelink resource usage.

UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

RESOURCE MANAGEMENT IN SIDELINK COMMUNICATION

FIELD

5 [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 for resource management in a sidelink communication.

BACKGROUND

10 [0002] Vehicle to everything (V2X) communications are enabled in 5G New Radio (NR). A sidelink transmission via a physical sidelink control channel (PSCCH) and a physical sidelink share channel (PSSCH) has been studied to enable communication between terminal devices. NR V2X sidelink supports two resource allocation modes: mode 1 where sidelink resource is allocated by a network device dynamically or semi-statically, and
15 mode 2 where a terminal device autonomously selects the sidelink resource. However, in NR V2X communications, diverse data traffic needs to be supported, e.g. periodic traffic with large packet size variation. Hence an improved solution for resource management in mode 1 needs to be designed accordingly.

20 SUMMARY

[0003] In general, example embodiments of the present disclosure provide a solution for resource management in a sidelink communication.

[0004] In a first aspect, there is provided a method. The method comprises determining, by a first device, whether a resource assigned to the first device can be released; and in
25 response to a determination that the resource can be released, transmitting a message from the first device to a second device over a direct communication link between the first and second devices, the message indicating availability of the resource for use by the second device.

[0005] In a second aspect, there is provided a method. The method comprises receiving,
30 by a second device, a message from a first device over a direct communication link between the first and second devices, the message indicating availability of a resource assigned to the first device for use by the second device; and using the resource for

aperiodic transmission.

[0006] In a third aspect, there is provided a method. The method comprises receiving, by a third device serving a first device, information on traffic characteristic parameters from the first device, the traffic characteristic parameters at least comprising a transport
5 block size range; and assigning a periodic resource to the first device based on an upper limit in the transport block size range.

[0007] In a fourth aspect, there is provided a method. The method comprises determining, by a first device, whether a resource assigned to the first device can be released; and in response to a determination that the resource can be released, transmitting,
10 to a third device serving the first device, a message indicating availability of the resource for use by a second device.

[0008] In a fifth aspect, there is provided a method. The method comprises receiving, by a third device serving a first device, a message from the first device, the message indicating availability of a resource assigned to the first device for use by a second device; and
15 assigning the resource to the second device for use in transmission.

[0009] In a sixth aspect, there is provided a device. The 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 device to: determine, by a first device, whether a resource assigned to the first
20 device can be released; and in response to a determination that the resource can be released, transmit a message from the first device to a second device over a direct communication link between the first and second devices, the message indicating availability of the resource for use by the second device.

[0010] In a seventh aspect, there is provided a device. The device comprises at least one processor; and at least one memory including computer program codes; the at least one
25 memory and the computer program codes are configured to, with the at least one processor, cause the device to: receive, by a second device, a message from a first device over a direct communication link between the first and second devices, the message indicating availability of a resource assigned to the first device for use by the second device; and use
30 the resource for aperiodic transmission.

[0011] In an eighth aspect, there is provided a device. The 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 device to: receive, by a third device serving a first device, information on traffic characteristic parameters from the first device, the traffic characteristic parameters at least comprising a transport block size range; and assign a periodic resource to the first device
5 based on an upper limit in the transport block size range.

[0012] In a ninth aspect, there is provided a device. The 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 device to: determine, by a first device, whether a resource assigned to the first
10 device can be released; and in response to a determination that the resource can be released, transmit, to a third device serving the first device, a message indicating availability of the resource for use by a second device.

[0013] In a tenth aspect, there is provided a device. The device comprises at least one processor; and at least one memory including computer program codes; the at least one
15 memory and the computer program codes are configured to, with the at least one processor, cause the device to: receive, by a third device serving a first device, a message from the first device, the message indicating availability of a resource assigned to the first device for use by a second device; and assign the resource to the second device for use in transmission.

[0014] In an eleventh aspect, there is provided an apparatus comprising means for determining, by a first device, whether a resource assigned to the first device can be released; and means for transmitting, in response to a determination that the resource can be released, a message from the first device to a second device over a direct communication
20 link between the first and second devices, the message indicating availability of the resource for use by the second device.

[0015] In a twelfth aspect, there is provided an apparatus comprising means for receiving, by a second device, a message from a first device over a direct communication link between the first and second devices, the message indicating availability of a resource assigned to the first device for use by the second device; and means for using the resource
30 for aperiodic transmission.

[0016] In a thirteenth aspect, there is provided an apparatus comprising means for receiving, by a third device serving a first device, information on traffic characteristic

parameters from the first device, the traffic characteristic parameters at least comprising a transport block size range; and means for assigning a periodic resource to the first device based on an upper limit in the transport block size range.

[0017] In a fourteenth aspect, there is provided an apparatus comprising means for determining, by a first device, whether a resource assigned to the first device can be released; and means for transmitting, in response to a determination that the resource can be released, a message to a third device serving the first device, the message indicating availability of the resource for use by a second device.

[0018] In a fifteenth aspect, there is provided an apparatus comprising means for receiving, by a third device serving a first device, a message from the first device, the message indicating availability of a resource assigned to the first device for use by a second device; and means for assigning the resource to the second device for use in transmission.

[0019] In a sixteenth aspect, there is provided a non-transitory computer readable medium comprising program instructions for causing an apparatus to perform at least the method according to any one of the above first to fifth aspects.

[0020] It is to be understood that the summary section is not intended to identify key or essential features of embodiments of the present disclosure, nor is it intended to be used to limit the scope of the present disclosure. Other features of the present disclosure will become easily comprehensible through the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Some example embodiments will now be described with reference to the accompanying drawings, where:

[0022] Fig. 1 illustrates an example communication network in which embodiments of the present disclosure may be implemented;

[0023] Fig. 2 illustrates a flowchart illustrating a process for resource management according to a first example embodiment of the present disclosure;

[0024] Fig. 3 illustrates a flowchart of a method implemented at a first device according to the first example embodiment of the present disclosure;

[0025] Fig. 4 illustrates a flowchart of a method implemented at a second device according to the first example embodiment of the present disclosure;

[0026] Fig. 5 illustrates a flowchart of a method implemented at a third device according to the first example embodiment of the present disclosure;

[0027] Fig. 6 illustrates a flowchart illustrating a process for resource management according to a second example embodiment of the present disclosure;

5 [0028] Fig. 7 illustrates a flowchart of a method implemented at a first device according to the second example embodiment of the present disclosure;

[0029] Fig. 8 illustrates a flowchart of a method implemented at a third device according to the second example embodiment of the present disclosure;

10 [0030] Fig. 9 illustrates a flowchart illustrating a process for resource management according to a third example embodiment of the present disclosure;

[0031] Fig. 10 illustrates a flowchart of a method implemented at a first device according to the third example embodiment of the present disclosure;

[0032] Fig. 11 illustrates a flowchart of a method implemented at a third device according to the third example embodiment of the present disclosure;

15 [0033] Fig. 12 illustrates a simplified block diagram of an apparatus that is suitable for implementing embodiments of the present disclosure; and

[0034] Fig. 13 illustrates a block diagram of an example computer readable medium in accordance with some example embodiments of the present disclosure.

20 [0035] Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

25 [0036] 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.

30 [0037] 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.

[0038] 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 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.

[0039] 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 one element from another. For example, a first element could be termed a second element, and similarly, a second element could be termed a first element, without departing from the scope of example embodiments. As used herein, the term “and/or” includes any and all combinations of one or more of the listed terms.

[0040] 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.

[0041] As used in this application, the term “circuitry” may refer to one or more or all of the following:

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

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

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

(ii) any portions of hardware processor(s) with software (including digital signal processor(s)), software, and memory(ies) that work together to cause an

apparatus, such as a mobile phone or server, to perform various functions) and

(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.

5 **[0042]** 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
10 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.

[0043] As used herein, the term “communication network” refers to a network following any suitable communication standards, such as Long Term Evolution (LTE),
15 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
20 generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the future fifth generation (5G) 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
25 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.

[0044] 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
30 node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a NR next generation NodeB (also referred to as a 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. An 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).

[0045] 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. In the following description, the terms “terminal device”, “communication device”, “terminal”, “user equipment” and “UE” may be used interchangeably.

[0046] 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.

[0047] As described above, in NR V2X communications, diverse data traffic needs to be supported: periodic or aperiodic traffic and fixed or varying packet sizes, e.g. periodic traffic with large packet size variation. For mode 1 where sidelink resource is allocated by a network device dynamically or semi-statically, there are two resource allocation schemes currently. One scheme is configuring a periodic resource enough to accommodate maximal packet size. In this scheme, resources may be wasted for smaller packets. The other scheme is using dynamic scheduling for each arrived packet. Dynamic resource allocation includes the following tedious steps of signaling exchange at a Uu interface before sidelink transmissions. Upon a packet arrives at a transmitting device in sidelink communication, the transmitting device transmits a schedule request (SR) to a network device serving the transmitting device and the network device responds with an uplink grant to the transmitting device. Then the transmitting device transmits a buffer status report (BSR) to the network device. After performing scheduling, the network device transmits resource allocation information to the transmitting device via downlink control information (DCI). This procedure of signaling may not be suitable for advanced use cases with a stringent latency requirement in NR V2X.

[0048] Embodiments of the present disclosure provide an improved solution for resource management, so as to solve the above problems and one or more of other potential problems. According to embodiments of the present disclosure, a transmitting device in sidelink communication determines a surplus or lack of a resource assigned to the transmitting device and informs the surplus or lack of the resource to other devices so that the surplus resource can be reused by the other devices or the lack resource can be reassigned to the transmitting device. In this way, periodic sidelink data traffic with large packet size variations can be better supported, and resource utilization can be enhanced. Principles and implementations of the present disclosure will be described in detail below with reference to the figures.

[0049] FIG. 1 illustrates a schematic diagram of an example communication system 100 in which embodiments of the present disclosure can be implemented. As shown in FIG. 1, the communication system 100 may include a first device 110, a second device 120 and a third device 130 that can communicate with each other. In this example, the first device 110 and the second device 120 are illustrated as terminal devices, and the third device 130 is illustrated as a network device serving the terminal devices. Thus, the serving area of

the third device 130 is called as a cell as shown in dash line. It is to be understood that the number of network devices and terminal devices is only for the purpose of illustration without suggesting any limitations. The system 100 may include any suitable number of network devices and terminal devices adapted for implementing embodiments of the present disclosure. Although not shown, it would be appreciated that more terminal devices may be located in the cell and served by the third device 130.

[0050] As shown in FIG. 1, the third device 130 may communicate with the first and second devices 110 and 120 via channels (such as, wireless communication channels) 111 and 121, respectively. In the case where the first and second devices 110 and 120 are the terminal devices and the third device 130 is the network device, the channels 111 and 121 may be a physical uplink control channel (PUCCH)/physical uplink share channel (PUSCH) in a link from the first and second device 110 and 120 to the third device 130 or a physical downlink control channel (PDCCH)/physical downlink share channel (PDSCH) in a link from the third device 130 to the first and second device 110 and 120.

[0051] The first and second devices 110 and 120 are shown in FIG. 1 as mobile phones which enable V2X communications. It is to be understood that embodiments of the present disclosure are also applicable to other devices than mobile phones, such as vehicles, sensors and so on. The first device 110 may communicate with the second device 120 via a sidelink. For example, the first device 110 may transmit information to the second device 120 via a PSSCH/PSCCH 131.

[0052] In an example embodiment, the third device 130 may perform resource allocation for sidelink transmission between the first and second devices 110 and 120, and transmit an assigned resource to the first and second devices 110 and 120 via the channels 111 and 121. The first and second devices 110 and 120 may directly communicate with each other over the assigned resource. In some example embodiments, for periodic traffic from the first device 110 to the second device 120, the third device 130 may schedule a periodic resource for transmission of the periodic traffic. In some example embodiments, the periodic resource may be fixed in size.

[0053] Communications in the communication system 100 may be implemented according to any proper communication protocol(s), comprising, but not limited to, cellular communication protocols of the first generation (1G), the second generation (2G), the third generation (3G), the fourth generation (4G) and the fifth generation (5G) and on the like,

wireless local network communication protocols such as Institute for Electrical and Electronics Engineers (IEEE) 802.11 and the like, and/or any other protocols currently known or to be developed in the future. Moreover, the communication may utilize any proper wireless communication technology, comprising but not limited to: Code Division
5 Multiple Access (CDMA), Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Frequency Division Duplex (FDD), Time Division Duplex (TDD), Multiple-Input Multiple-Output (MIMO), Orthogonal Frequency Division Multiple (OFDM), Discrete Fourier Transform spread OFDM (DFT-s-OFDM) and/or any other technologies currently known or to be developed in the future.

10 **[0054]** Below first to third example embodiments according to the present disclosure will be described in details with reference to figures. Assuming that a transmitting device (for example, the first device 110) has periodic packets to be transmitted over a sidelink, packet sizes of periodic data traffic have a large variation, and mode 1 resource allocation is considered.

15 **[0055]** First Example Embodiment

[0056] In this example embodiment, considering stringent QoS requirement, e.g. very low latency and high reliability, a periodic sidelink resource for maximal TB size is assigned, and for each arrived packet, a sidelink signaling is transmitted from a device to release unused sidelink resource to other devices promptly.

20 **[0057]** Fig. 2 illustrates a flowchart illustrating a process 200 for resource management according to a first example embodiment 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 first, second and third devices 110, 120 and 130 as illustrated in Fig. 1. It would be appreciated that although the process 200 for link has been described in the
25 communication system 100 of Fig. 1, this process may be likewise applied to other communication scenarios where different network devices are jointly deployed to provide respective serving cells.

[0058] In the process 200, before sidelink traffic transmission, the first device 110 may transmit 210 information (also referred as assistant information below) on traffic
30 characteristic parameters to the third device 130, for example, via a radio resource control (RRC) signaling. In an example embodiment of the present disclosure, the traffic characteristic parameters may be used for describing the periodic sidelink data traffic. In

some example embodiments, the traffic characteristic parameters may include at least one or more of the following: a preferred/expected semi-persistent scheduling (SPS) interval, a transport block (TB) size range, and quality of service (QoS). For example, the traffic characteristic parameters may include a TB size range [a, b], wherein a and b are integers, and b is larger than a.

[0059] It should be noted that the traffic characteristic parameters are not limited by the above examples, and it may include any other suitable parameters. As more information on transport block size is reported as traffic characteristic parameters, it facilitates a better resource allocation at the third device 130.

[0060] Upon receiving the information on traffic characteristic parameters, the third device 130 may perform sidelink SPS for the first device so as to assign a resource to the first device 110. In some example embodiments, the third device 130 may assign a periodic resource (also referred as SPS configured resource below) to the first device 110. In some example embodiments, the third device 130 may assign the periodic resource based on QoS requirement information reported in the information on traffic characteristic parameters. In this example embodiment, the third device 130 may determine the periodic resource based on an upper limit of the TB size range, for example, maximum TB size in the traffic. It can result in stringent low latency and high reliability.

[0061] Accordingly, the third device 130 transmits a message on the periodic resource to the first device 110. In some example embodiments, the third device 130 may send a configured grant including the SPS configured resource to the first device 110 via a RRC signaling. In some example embodiments, for type-2 configured grant, the third device 130 may send a DCI to the first device 110 to activate periodic transmissions.

[0062] As packet sizes vary randomly, the periodic resource may be surplus for periodic traffic transmission. Upon a packet arrives at the first device 110, the first device 110 may determine whether a resource assigned to the first device 110 can be released. In some example embodiments, the first device 110 may determine the size of a resource required for transmission of the packet, and if the required resource size is smaller than the size of the periodic resource, the first device 110 may determine that unused resource can be released. In some example embodiments, the resource may comprise at least a portion of the periodic resource assigned to the first device 110. In some example embodiments, the resource may be all of the periodic resource. In some example alternative

embodiments, the resource may be zero.

[0063] In some example embodiments, the first device 110 may only release the resource for current SPS occasion, and continue using configured resource for subsequent SPS occasions. In some example embodiments, the first device 110 may determine whether there is a packet arriving in the current SPS occasion, and if no packet arrives, release all SPS configured resource.

[0064] Upon determining that the resource assigned to the first device 110 can be released, the first device 110 may transmit 230 a message to a second device (also referred as other devices), the message indicating availability of the resource for use by other devices. In some example embodiments, the other devices may be the second device 120. In some alternative embodiments, the other devices may be any devices other than the second device 120 in the cell of the third device 130. For convenience, the other devices are shown in Fig. 2 as the second device 120.

[0065] For each arrived packet, the first device 110 may transmit a sidelink signaling to release unused sidelink resource to other devices promptly. In this example embodiment, the first device 110 may transmit 230 the message to the second device 120 over a direct communication link between the first and second devices. In some example embodiments, the first device 110 may transmit the message in a sidelink control information (SCI) over a stand-alone PSCCH. In this way, the PSCCH can be sent as early as possible to leave more time for other devices to sense and then use the released resource. In some example alternative embodiments, the first device 110 may transmit the message over a PSCCH transmitted in the same slot as a PSSCH associated with the PSCCH.

[0066] Upon receiving the message, the second device 120 may use 235 the released resource in transport block transmission. In an example embodiment in which the second device 120 may operate in mode 2, that is, autonomously select a sidelink resource, the second device 120 may perform persistent sensing and identify the released resource by decoding the PSCCH. In some example embodiments, the second device 120 may use the released resource for transmissions of aperiodic packets. Thereby, mode 1/mode 2 resource sharing is achieved. It should be noted that the second device 120 may also use the released resource for any suitable packet transmissions.

[0067] The process 200 as shown in Fig. 2 is merely an example, and may have additional operations. For example, the first device 110 may transmit the TB at sidelink over the

configured periodic resource.

[0068] In the first example embodiment described above, it is suitable for the use case requiring stringent low latency and high reliability. In one hand, as the message on the unused resource is transmitted to other devices over a direct communication link, a low latency and increased efficiency of sidelink resource usage can be achieved. In the other hand, as the periodic resource is determined based on an upper limit of a TB size range, high reliability can be achieved.

[0069] Example embodiments of the present disclosure also provide the corresponding methods. Fig. 3 illustrates a flowchart of a method 300 implemented at a first device according to the first example embodiment of the present disclosure. For the purpose of discussion, the method 300 will be described from the perspective of the first device 110 with reference to Fig. 1.

[0070] At block 310, the first device 110 determines whether a resource assigned to the first device 110 can be released. In some example embodiments, the first device 110 may transmit information on traffic characteristic parameters, to the third device 130 serving the first device 110, the traffic characteristic parameters at least comprising a transport block size range, and receive, from the third device 130, a periodic resource assigned to the first device 110 based on an upper limit in the transport block size range.

[0071] In some example embodiments, the first device 110 may determine the size of a resource required for transmission of a current transport block, and if the required resource size is smaller than the size of a periodic resource assigned to the first device, determine that the resource can be released. In some example embodiments, the released resource may comprise at least a portion of a periodic resource assigned to the first device 110. In some example embodiments, the released resource may be all of the periodic resource. In some example alternative embodiments, the released resource may be zero.

[0072] If the first device 110 determines that a resource assigned to the first device 110 can be released, at block 320, the first device 110 transmits a message from the first device to a second device (e.g. the second device 120) over a direct communication link between the first and second devices 110 and 120, the message indicating availability of the released resource for use by the second device 120. In some example embodiments, the first device 110 may transmit the message over a stand-alone PSCCH. In some example embodiments, the first device 110 may transmit the message over a PSCCH transmitted in

the same slot as a PSSCH associated with the PSCCH.

[0073] The processing at blocks 310 and 320 may correspond to that described at 225 and 230 in Fig. 2, and its other details are not repeated here. With the method 300, the message on the unused resource is transmitted to other devices over a direct communication link, and thus a low latency and an increased efficiency of sidelink resource usage can be achieved.

[0074] Fig. 4 illustrates a flowchart of a method 400 implemented at a second device according to the first example embodiment of the present disclosure. For the purpose of discussion, the method 400 will be described from the perspective of the second device 120 with reference to Fig. 1.

[0075] At block 410, the second device 120 receives a message from the first device 110 over a direct communication link between the first and second devices 110 and 120. The message indicates availability of the released resource for use by the second device 120. In some example embodiments, the second device 120 may receive the message over a stand-alone PSCCH. In some example embodiments, the second device 120 may receive the message over a PSCCH transmitted in the same slot as a PSSCH associated with the PSCCH.

[0076] At block 420, the second device 120 uses the released resource for transport block transmission. In some embodiments, the second device 120 may perform persistent sensing and identify the released resource by decoding the PSCCH. Upon receiving the message, the second device 120 may use the released resource in transport block transmission. In an example embodiment in which the second device 120 may operate in mode 2, that is, may autonomously select a sidelink resource, the second device 120 may use the released resource for transmissions of aperiodic packets.

[0077] The processing at blocks 410 and 420 may correspond to that described at 235 in Fig. 2, and its other details are not repeated here. With the method 400, the message on the released resource from a first device is received directly by a second device over a direct communication link, and thus a low latency and increased efficiency of sidelink resource usage can be achieved.

[0078] Fig. 5 illustrates a flowchart of a method 500 implemented at a third device according to the first example embodiment of the present disclosure. For the purpose of discussion, the method 500 will be described from the perspective of the third device 130

with reference to Fig. 1.

[0079] At block 510, the third device 130 receives information on traffic characteristic parameters from the first device. The traffic characteristic parameters at least comprise a transport block size range. In some example embodiments, the traffic characteristic parameters may include at least one or more of the following: a preferred/expected semi-persistent scheduling (SPS) interval, a transport block (TB) size range, and quality of service (QoS). It facilitates a better resource allocation at the third device 130.

[0080] At block 520, the third device 130 assigns a periodic resource to the first device based on an upper limit in the transport block size range, for example, maximum TB size in the traffic. The processing at blocks 510 and 520 may correspond to that described at 210, 215 and 220 in Fig. 2, and its other details are not repeated here.

[0081] With the method 500, the periodic resource is determined based on an upper limit of a TB size range, high reliability can be achieved.

[0082] Second Example Embodiment

[0083] This example embodiment is similar with the first example embodiment except that a message indicating the released resource is transmitted from a first device to a third device serving the first device at a Uu interface, rather than transmitting the message to a second device over a sidelink.

[0084] Fig. 6 illustrates a flowchart illustrating a process 600 for resource management according to a second example embodiment of the present disclosure. For the purpose of discussion, the process 600 will be described with reference to Fig. 1. The process 600 may involve the first, second and third devices 110, 120 and 130 as illustrated in Fig. 1. It would be appreciated that although the process 600 for link has been described in the communication system 100 of Fig. 1, this process may be likewise applied to other communication scenarios where different network devices are jointly deployed to provide respective serving cells.

[0085] In the process 600, before sidelink traffic transmission, the first device 110 may transmit 610 information on traffic characteristic parameters to the third device 130. In an example embodiment of the present disclosure, the traffic characteristic parameters may be used for describing the periodic sidelink data traffic. In some example embodiments, the traffic characteristic parameters may include at least one or more of the following: a preferred/expected semi-persistent scheduling (SPS) interval, a transport block (TB) size

range, and quality of service (QoS). It should be noted that the traffic characteristic parameters are not limited by the above examples, and it may include any other suitable parameters. As more information on transport block size is reported as traffic characteristic parameters, it facilitates a better resource allocation at the third device 130.

5 [0086] Upon receiving the information on traffic characteristic parameters, the third device 130 may perform sidelink SPS for the first device so as to assign 615 a resource to the first device 110. In this example embodiment, the third device 130 may determine the periodic resource based on an upper limit of the TB size range, for example, maximum TB size in the traffic.

10 [0087] Additionally, the third device 130 may configure for the first device 110 a resource for transmission of a schedule request (SR). In some example embodiments, the third device 130 may configure a periodic SR resource for use by the first device 110 to release the unused sidelink resource to the third device 130.

[0088] Accordingly, the third device 130 transmits 620 a configured grant including
15 sidelink SPS resource and SR resource to the first device 110 over a Uu interface. In some example embodiments, the third device 130 may send the configured grant to the first device 110 via a RRC signaling. In some example embodiments, for type-2 configured grant, the third device 130 may send a DCI to the first device 110 to activate periodic transmissions.

20 [0089] Upon a packet arrives at the first device 110, the first device 110 may determine 625 whether a resource assigned to the first device 110 can be released. In some example embodiments, the first device 110 may determine the size of a resource required for transmission of the packet, and if the required resource size is smaller than the size of the periodic resource, the first device 110 may determine that unused resource can be released.
25 In some example embodiments, the resource may comprise at least a portion of the periodic resource assigned to the first device 110. In some example embodiments, the resource may be all of the periodic resource. In some example alternative embodiments, the resource may be zero.

[0090] In some example embodiments, the first device 110 may only release the resource
30 for current SPS occasion, and continue using configured resource for subsequent SPS occasions. In some example embodiments, the first device 110 may determine whether there is a packet arriving in the current SPS occasion, and if no packet arrives, release all

SPS configured resource.

[0091] Upon determining that the resource assigned to the first device 110 can be released, the first device 110 may transmit 630 a message to the third device 130, e.g. over the configured SR resource. The message indicates availability of the resource for use by a second device such as the second device 120. In some example embodiments, the first device 110 may determine bit information corresponding to the size of the resource, and transmit the bit information in the message to the third device 130. In this way, signalling overhead can be saved.

[0092] In some example embodiments, the first device 110 may determine the bit information based on a predetermined mapping between the bit information and the size of the released resource. In some example embodiments, the mapping may be configured by the third device 130. In some example embodiments, the first device 110 may determine a value of bits based on the size of the released resource, a predetermined number of bits, and a TB size range, and determine the value of bits as the bit information. For example, the mapping may be implicitly derived from the following equation (1):

$$n=m(b-a)/(N-1) \quad (1)$$

where n is the TB size which the size of the released resource can accommodate, m is the value of bits conveyed by the PUCCH, N is the number of bits conveyed by the PUCCH, and a and b is a lower limit and an upper limit of the TB size range.

[0093] For example, for the TB size range [30000, 60000] bytes, 2 information bits are conveyed by a PUCCH using configured SR resource. The mapping between the value of bits conveyed by the PUCCH and the size of the released resource can be set as follows:

1: released resource for 10000 bytes,

2: released resource for 20000 bytes,

3: released resource for 30000 bytes,

0: no packet.

[0094] It should be noted that there is a trade-off between signalling overhead and a granularity of released resource size. The more information bits a PUCCH conveys, the finer released resource size granularity is. With the implicitly derived mapping, the save of the signalling overhead can be further enhanced.

[0095] Accordingly, upon receiving the message, the third device 130 determines 635 the

released resource. In some example embodiments, the third device 130 may receive bit information corresponding to the size of the released resource, and determine the released resource based on the bit information. In some example embodiments, the determination of the released resource may be made based on a predetermined mapping between the bit information and the size of the released resource. In some example embodiments, the third device 130 may determine the number of bits and a value of bits comprised in the bit information, and determine the size of the released resource based on the number of bits, the value of bits, and a transport block size range. For example, the size of the released resource may be derived from the above equation (1). In the case that the first device 110 uses the assigned resource in a predetermined order, the released resource may be determined based on information on the size of the released resource.

[0096] Upon determining the released resource, the third device 130 assigns the released resource to other devices (in this example, the second device 120) for use in transmission. The process 600 as shown in Fig. 6 is merely an example, and may have additional operations. For example, the first device 110 may transmit the TB at a sidelink over the configured periodic resource.

[0097] In the second example embodiment described above, it is also suitable for the use case requiring stringent low latency and high reliability. In one hand, as the message on the released resource is transmitted to the third device as a serving node in a low signaling overhead, a low latency and increased efficiency of sidelink resource usage can be achieved. In the other hand, as the periodic resource is determined based on an upper limit of a TB size range, high reliability can be achieved.

[0098] Example embodiments of the present disclosure also provide the corresponding methods. Fig. 7 illustrates a flowchart of a method 700 implemented at a first device according to the second example embodiment of the present disclosure. For the purpose of discussion, the method 700 will be described from the perspective of the first device 110 with reference to Fig. 1.

[0099] At block 710, the first device 110 determines whether a resource assigned to the first device 110 can be released. The processing at block 710 is similar with that at block 310.

[00100] In some example embodiments, the first device 110 may transmit information on traffic characteristic parameters, to the third device 130 serving the first device 110, the

traffic characteristic parameters at least comprising a transport block size range, and receive, from the third device 130, a periodic resource assigned to the first device 110 based on an upper limit in the transport block size range. Additionally, the first device 110 may receive, from the third device 130, a resource assigned to the first device 110 for transmission of a SR.

[00101] In some example embodiments, the first device 110 may determine the size of a resource required for transmission of a current transport block, and if the required resource size is smaller than the size of a periodic resource assigned to the first device, determine that the resource can be released. In some example embodiments, the released resource may comprise at least a portion of a periodic resource assigned to the first device 110. In some example embodiments, the released resource may be all of the periodic resource. In some example alternative embodiments, the released resource may be zero.

[00102] If the first device 110 determines that a resource assigned to the first device 110 can be released, at block 720, the first device 110 transmits a message from the first device to the third device 130, the message indicating availability of the resource for use by other devices such as the second device 120. In some example embodiments, the first device 110 may transmit the message over a configured SR resource. In some example embodiments, the first device 110 may transmit the message over a configured periodic SR resource.

[00103] In some example embodiments, the first device 110 may determine bit information corresponding to the size of the released resource, and transmit the bit information to the third device 130. In this way, signalling overhead can be saved.

[00104] In some example embodiments, the first device 110 may determine the bit information based on a predetermined mapping between the bit information and the size of the released resource. In some example embodiments, the first device 110 may determine a value of bits based on the size of the released resource, a predetermined number of bits, and a TB size range, and determine the value of bits as the bit information. For example, the mapping may be implicitly derived from the above equation (1). The processing at blocks 710 and 720 may correspond to that described at 625 and 630 in Fig. 6, and thus other details are not repeated here.

[00105] With the method 700, the message on the unused resource is transmitted to the third device as a serving node in a low signaling overhead, and thus a low latency and

increased efficiency of sidelink resource usage can be achieved.

[00106] Fig. 8 illustrates a flowchart of a method 800 implemented at a third device according to the second example embodiment of the present disclosure. For the purpose of discussion, the method 800 will be described from the perspective of the third device 130 with reference to Fig. 1.

[00107] At block 810, the third device 130 receives a message from the first device 110, the message indicating availability of the resource assigned to the first device 110 for use by other devices such as the second device 120. In some example embodiments, the third device 130 may configure a resource for transmission of a SR to the first device 110, and receive the message over the configured SR resource. In some example embodiments, the third device 130 may configure periodic SR resource for the first device 110 and receive the message over the configured periodic SR resource.

[00108] In some example embodiments, the third device 130 may receive bit information corresponding to the size of the released resource in the message, and determine the released resource based on the bit information. In this way, signalling overhead can be saved.

[00109] In some example embodiments, the third device 130 may determine the size of the released resource based on a predetermined mapping between the bit information and the size of the released resource. In some example embodiments, the third device 130 may determine the size of the released resource based on a value of bits, a predetermined number of bits, and a TB size range. For example, the size of the released resource may be derived from the above equation (1). In the case that the first device 110 uses the assigned resource in a predetermined order, the released resource may be determined based on information on the size of the released resource.

[00110] In some example embodiments, the third device 130 may receive information on traffic characteristic parameters from the first device 110, the traffic characteristic parameters at least comprising a transport block size range, and assign a periodic resource to the first device 110 based on an upper limit in the transport block size range.

[00111] At block 820, the third device 130 assigns the released resource to other devices such as the second device 120. The processing at blocks 810 and 820 may correspond to that described at 635 and 640 in Fig. 6, and thus other details are not repeated here.

[00112] With the method 800, the message on the unused resource is received in a low

signaling overhead, and thus a low latency and increased efficiency of sidelink resource usage can be achieved.

[00113] Third Example Embodiment

[00114] Unlike that in the first and second example embodiments, in this example embodiment, a periodic resource is assigned to accommodate a basis packet size, e.g. minimal packet size, and a PUCCH is sent to a device as a serving node to request sidelink resources to accommodate an extra TB size beyond the basis packet size. It is suitable for a user case having less stringent latency requirement.

[00115] Fig. 9 illustrates a flowchart illustrating a process 900 for resource management according to a third example embodiment of the present disclosure. For the purpose of discussion, the process 900 will be described with reference to Fig. 1. The process 900 may involve the first device 110 and the third device 130 as illustrated in Fig. 1. It would be appreciated that although the process 900 for link has been described in the communication system 100 of Fig. 1, this process may be likewise applied to other communication scenarios where different network devices are jointly deployed to provide respective serving cells.

[00116] In the process 900, before sidelink traffic transmission, the first device 110 may transmit 910 information on traffic characteristic parameters to the third device 130. In an example embodiment of the present disclosure, the traffic characteristic parameters may be used for describing the periodic sidelink data traffic. In some example embodiments, the traffic characteristic parameters may include at least one or more of the following: a preferred/expected semi-persistent scheduling (SPS) interval, a transport block (TB) size range, and quality of service (QoS). It should be noted that the traffic characteristic parameters are not limited by the above examples, and it may include any other suitable parameters. As more information on transport block size is reported as traffic characteristic parameters, it facilitates a better resource allocation at the third device 130.

[00117] Upon receiving the information on traffic characteristic parameters, the third device 130 may perform sidelink SPS for the first device so as to assign 915 a resource to the first device 110. In this example embodiment, the third device 130 may determine the periodic resource based on a lower limit of the TB size range, for example, minimum TB size in the traffic.

[00118] Additionally, the third device 130 may configure for the first device 110 a resource

for transmission of a SR. In some example embodiments, the third device 130 may configure a periodic SR resource for use by the first device 110 to transmit a SR to the third device 130 for packet transmission.

[00119] Accordingly, the third device 130 transmits 920 a configured grant including sidelink SPS resource and SR resource to the first device 110 at a Uu interface. In some example embodiments, the third device 130 may send the configured grant to the first device 110 via a RRC signaling. In some example embodiments, for type-2 configured grant, the third device 130 may send a DCI to the first device 110 to activate periodic transmissions. The processing at 910, 915 and 920 is similar with that at 610, 615 and 620.

[00120] Upon a packet arrives at the first device 110, the first device 110 may determine 925 whether a resource other than a periodic resource assigned to the first device 110 is required to be assigned to the first device. In some example embodiments, the first device 110 may determine the size of a resource required for transmission of a current transport block, and if the required resource size is larger than the size of a periodic resource assigned to the first device, determine that the resource other than the periodic resource assigned to the first device is required. That is, an extra resource is required to be reassigned to the first device.

[00121] Upon determining that the resource other than the periodic resource is required, the first device 110 transmits 930 a message to the third device 130, the message indicating that the resource other than the periodic resource is required. In some example embodiments, the first device 110 may transmit the message over a configured SR resource. In some example embodiments, the first device 110 may transmit the message over a configured periodic SR resource.

[00122] In some example embodiments, the first device 110 may determine bit information corresponding to the size of the required resource, and transmit the bit information in the SR. In some example embodiments, the first device 110 may determine the bit information based on a predetermined mapping between the bit information and the size of the released resource. In some example embodiments, the mapping may be configured by the third device 130. In some example embodiments, the first device 110 may determine a value of bits based on the size of the resource, a predetermined number of bits, and a transport block size range, and determine the value of bits as the bit information. For example, the value

of bits may be derived based on the above equation (1).

[00123] Accordingly, upon receiving the message, the third device 130 determines 935 the required resource. In some example embodiments, the third device 130 may receive bit information corresponding to the size of the required extra resource, and determine the required resource based on the bit information. In some example embodiments, the determination of the required resource may be made based on a predetermined mapping between the bit information and the size of the required resource. In some example embodiments, the third device 130 may determine the number of bits and a value of bits included in the bit information, and determine the size of the required resource based on the number of bits, the value of bits, and a transport block size range. For example, the size of the required resource may be derived from the above equation (1).

[00124] Upon determining the size of the required resource, the third device 130 assigns 940 the required resource to the first device 110 for transport block transmission. In some example embodiments, the third device 130 may perform dynamic resource allocation for the SR and use a DCI to dynamically grant the required resource.

[00125] In the third example embodiment described above, it is suitable for the use case requiring less stringent low latency and high reliability. In one hand, the message on the required resource is transmitted to the third device as a serving node in a low signaling overhead. In the other hand, as the periodic resource is determined based on a lower limit of a TB size range, and dynamic resource request and allocation are performed for an extra resource beyond the periodic resource, an increased efficiency of sidelink resource usage can be achieved.

[00126] Example embodiments of the present disclosure also provide the corresponding methods. Fig. 10 illustrates a flowchart of a method 1000 implemented at a first device according to the third example embodiment of the present disclosure. For the purpose of discussion, the method 1000 will be described from the perspective of the first device 110 with reference to Fig. 1.

[00127] At block 1010, the first device 110 determine whether a resource other than a periodic resource assigned to the first device 110 is required to be assigned to the first device 110. In some example embodiments, the first device 110 may determine the size of a resource required for transmission of a current transport block, and if the required resource size is larger than the size of a periodic resource assigned to the first device,

determine that the resource other than the periodic resource assigned to the first device is required.

[00128] In some example embodiments, the first device 110 may transmit information on traffic characteristic parameters, to the third device 130 serving the first device 110, the traffic characteristic parameters at least comprising a transport block size range, and receive, from the third device 130, a periodic resource assigned to the first device 110 based on a lower limit in the transport block size range. Additionally, the first device 110 may receive, from the third device 130, a resource assigned to the first device 110 for transmission of a SR.

[00129] If the first device 110 determines that the resource other than the periodic resource is required, at block 1020, the first device 110 transmits a message to the third device 130, the message indicating the resource other than the periodic resource is required. In some example embodiments, the first device 110 may transmit the message over a configured SR resource. In some example embodiments, the first device 110 may transmit the message over a configured periodic SR resource.

[00130] In some example embodiments, the first device 110 may determine bit information corresponding to the size of the required resource, and transmit the bit information to the third device 130. In this way, signalling overhead can be saved.

[00131] In some example embodiments, the first device 110 may determine the bit information based on a predetermined mapping between the bit information and the size of the required resource. In some example embodiments, the first device 110 may determine a value of bits based on the size of the required resource, a predetermined number of bits, and a TB size range, and determine the value of bits as the bit information. For example, the value of bits may be derived from the above equation (1). The processing at blocks 1010 and 1020 may correspond to that described at 925 and 930 in Fig. 9, and thus other details are not repeated here.

[00132] Fig. 11 illustrates a flowchart of a method 1100 implemented at a third device according to the third example embodiment of the present disclosure. For the purpose of discussion, the method 1100 will be described from the perspective of the third device 130 with reference to Fig. 1.

[00133] At block 1110, the third device 130 receive a message from the first device 110, the message indicating that a resource other than a periodic resource assigned to the first

device 110 is required. In some example embodiments, the third device 130 may receive bit information corresponding to the size of the required resource, and determine the required resource based on the bit information. In some example embodiments, the determination of the required resource may be made based on a predetermined mapping
5 between the bit information and the size of the required resource. In some example embodiments, the third device 130 may determine the number of bits and a value of bits included in the bit information, and determine the size of the required resource based on the number of bits, the value of bits, and a transport block size range. For example, the size of the required resource may be derived from the above equation (1).

10 **[00134]** At block 1120, the third device 130 assigns the required resource to the first device for TB transmission. In some example embodiments, the third device 130 may perform dynamic resource allocation for the SR and use a DCI to dynamically grant the required resource. The processing at blocks 1110 and 1120 may correspond to that described at 935 and 940 in Fig. 9, and thus other details is not repeated here.

15 **[00135]** Example embodiments of the present disclosure also provide the following solutions.

[00136] Clause 1. A method, comprising:

determining, by a first device, whether a resource other than a periodic resource assigned to the first device is required to be assigned to the first device; and

20 in response to a determination that the resource is required, transmitting, to a third device serving the first device, a message indicating that the resource is required.

[00137] Clause 2. The method of clause 1, further comprising:

transmitting, by the first device, information on traffic characteristic parameters, to the third device, the traffic characteristic parameters at least comprising a transport block
25 size range; and

receiving, from the third device, the periodic resource assigned to the first device based on a lower limit in the transport block size range.

[00138] Clause 3. The method of any of clauses 1-2, wherein the determining comprising:

30 determining the size of a resource required for transmission of a current transport block; and

in response to the required resource size being larger than the size of a periodic resource assigned to the first device, determining that the resource other than the periodic resource assigned to the first device is required.

[00139] Clause 4. The method of any of clauses 1-3, wherein transmitting the message comprising:

determining bit information corresponding to the size of the resource; and

transmitting the bit information in a scheduling request.

[00140] Clause 5. The method of clause 4, wherein determining the bit information comprising:

determining a value of bits based on the size of the resource, a predetermined number of bits, and a transport block size range; and

determining the value of bits as the bit information.

[00141] Clause 6. The method of any of clauses 1-5, further comprising: receiving, from the third device, information on a resource assigned to the first device for transmission of a schedule request, and

wherein transmitting the message comprises: transmitting the message over the resource assigned to the first device for transmission of a schedule request.

[00142] Clause 7. The method of any of clauses 1-6, wherein the first device is a terminal device, and the third device is a network device.

[00143] Clause 8. A method, comprising:

receiving, by a third device serving a first device, a message from the first device, the message indicating that a resource other than a periodic resource assigned to the first device is required; and

assigning the resource to the first device for transport block transmission.

[00144] Clause 9. The method of clause 8, further comprising:

receiving, by the third device, information on traffic characteristic parameters, from the first device, the traffic characteristic parameters at least comprising a transport block size range; and

assigning a periodic resource to the first device based on a lower limit in the transport block size range.

[00145] Clause 10. The method of any of clauses 8-9, wherein receiving the message comprising:

receiving bit information corresponding to the size of the resource; and

determining the resource based on the bit information.

5 [00146] Clause 11. The method of clause 10, wherein determining the resource comprising:

determining the number of bits and a value of bits in the bit information; and

determining the resource based on the number of bits, the value of bits, and a transport block size range.

10 [00147] Example embodiments of the present disclosure also provide the corresponding apparatus. In some embodiments, an apparatus capable of performing any of the method 300 (for example, the first device 110) may comprise means for performing the respective steps of the method 300. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module.

15 [00148] In some embodiments, the apparatus comprises means for transmitting, in response to a determination that the resource can be released, a message from the first device to a second device over a direct communication link between the first and second devices, the message indicating availability of the resource for use by the second device.

[00149] In some embodiments, the apparatus further comprises means for performing other
20 steps in some embodiments of the method 300. In some embodiments, the means comprises at least one processor; and at least one memory including computer program code, the at least one memory and computer program code configured to, with the at least one processor, cause the performance of the apparatus.

[00150] In some embodiments, an apparatus capable of performing any of the method 400
25 (for example, the second device 120) may comprise means for performing the respective steps of the method 400. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module.

[00151] In some embodiments, the apparatus comprises: means for receiving, by a second device, a message from a first device over a direct communication link between the first
30 and second devices, the message indicating availability of a resource assigned to the first device for use by the second device; and means for using the resource for transport block

transmission.

[00152] In some embodiments, the apparatus further comprises means for performing other steps in some embodiments of the method 400. In some embodiments, the means comprises at least one processor; and at least one memory including computer program code, the at least one memory and computer program code configured to, with the at least one processor, cause the performance of the apparatus.

[00153] In some embodiments, an apparatus capable of performing any of the method 500 (for example, the third device 130) may comprise means for performing the respective steps of the method 500. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module.

[00154] In some embodiments, the apparatus comprises: means for receiving, by a third device serving a first device, information on traffic characteristic parameters from the first device, the traffic characteristic parameters at least comprising a transport block size range; and means for assigning a periodic resource to the first device based on an upper limit in the transport block size range.

[00155] In some embodiments, the apparatus further comprises means for performing other steps in some embodiments of the method 500. In some embodiments, the means comprises at least one processor; and at least one memory including computer program code, the at least one memory and computer program code configured to, with the at least one processor, cause the performance of the apparatus.

[00156] In some embodiments, an apparatus capable of performing any of the method 700 (for example, the first device 110) 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.

[00157] In some embodiments, the apparatus comprises: means for determining, by a first device, whether a resource assigned to the first device can be released; and means for transmitting, in response to a determination that the resource can be released, a message to a third device serving the first device, the message indicating availability of the resource for use by a second device.

[00158] In some embodiments, the apparatus further comprises means for performing other steps in some embodiments of the method 700. In some embodiments, the means comprises at least one processor; and at least one memory including computer program

code, the at least one memory and computer program code configured to, with the at least one processor, cause the performance of the apparatus.

[00159] In some embodiments, an apparatus capable of performing any of the method 800 (for example, the third device 130) may comprise means for performing the respective steps of the method 800. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module.

[00160] In some embodiments, the apparatus comprises: means for receiving, by a third device serving a first device, a message from the first device, the message indicating availability of a resource assigned to the first device for use by a second device; and means for assigning the resource to the second device for use in transmission.

[00161] In some embodiments, the apparatus further comprises means for performing other steps in some embodiments of the method 800. In some embodiments, the means comprises at least one processor; and at least one memory including computer program code, the at least one memory and computer program code configured to, with the at least one processor, cause the performance of the apparatus.

[00162] In some embodiments, an apparatus capable of performing any of the method 1000 (for example, the first device 110) may comprise means for performing the respective steps of the method 1000. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module.

[00163] In some embodiments, the apparatus comprises: means for determining, by a first device, whether a resource other than a periodic resource assigned to the first device is required to be assigned to the first device; and means for transmitting, in response to a determination that the resource is required, a message to a third device serving the first device, the message indicating that the resource is required.

[00164] In some embodiments, the apparatus further comprises means for performing other steps in some embodiments of the method 1000. In some embodiments, the means comprises at least one processor; and at least one memory including computer program code, the at least one memory and computer program code configured to, with the at least one processor, cause the performance of the apparatus.

[00165] In some embodiments, an apparatus capable of performing any of the method 1100 (for example, the third device 130) may comprise means for performing the respective steps of the method 1100. The means may be implemented in any suitable form. For example,

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

[00166] In some embodiments, the apparatus comprises: means for receiving, by a third device serving a first device, a message from the first device, the message indicating that a resource other than a periodic resource assigned to the first device is required; and means
5 for assigning the resource to the first device for transport block transmission.

[00167] In some embodiments, the apparatus further comprises means for performing other steps in some embodiments of the method 1100. In some embodiments, the means comprises at least one processor; and at least one memory including computer program code, the at least one memory and computer program code configured to, with the at least
10 one processor, cause the performance of the apparatus.

[00168] Fig. 12 is a simplified block diagram of a device 1200 that is suitable for implementing embodiments of the present disclosure. The device 1200 may be provided to implement the communication device, for example the first device 110, the second device 120 or the third device 130 as shown in Fig. 1. As shown, the device 1200
15 includes one or more processors 1210, one or more memories 1220 coupled to the processor 1210, and one or more communication modules 1240 coupled to the processor 1210.

[00169] The communication module 1240 is for bidirectional communications. The communication module 1240 has at least one antenna to facilitate communication. The
20 communication interface may represent any interface that is necessary for communication with other network elements.

[00170] The processor 1210 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 signal processors (DSPs) and processors based on
25 multicore processor architecture, as non-limiting examples. The device 1200 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.

[00171] The memory 1220 may include one or more non-volatile memories and one or more volatile memories. Examples of the non-volatile memories include, but are not
30 limited to, a Read Only Memory (ROM) 1224, 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) 1222 and other volatile memories that will not last in the power-down duration.

[00172] A computer program 1230 includes computer executable instructions that are executed by the associated processor 1210. The program 1230 may be stored in the ROM 1220. The processor 1210 may perform any suitable actions and processing by loading the program 1230 into the RAM 1220.

[00173] The embodiments of the present disclosure may be implemented by means of the program 1230 so that the device 1200 may perform any process of the disclosure as discussed with reference to Figs. 2 to 11. The embodiments of the present disclosure may also be implemented by hardware or by a combination of software and hardware.

[00174] In some embodiments, the program 1230 may be tangibly contained in a computer readable medium which may be included in the device 1200 (such as in the memory 1220) or other storage devices that are accessible by the device 1200. The device 1200 may load the program 1230 from the computer readable medium to the RAM 1222 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. 13 shows an example of the computer readable medium 1300 in form of CD or DVD. The computer readable medium has the program 1230 stored thereon.

[00175] 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, apparatus, 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.

[00176] 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 method 300, 400, 500, 700, 800, 1000 or 1100 as described above with reference to Figs. 2-11. 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
5 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.

[00177] Program code for carrying out methods of the present disclosure may be written in
10 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 apparatus, 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
15 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.

[00178] 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, apparatus or processor to perform various processes and operations as described above. Examples of the carrier
20 include a signal, computer readable medium, and the like.

[00179] The computer readable medium may be a computer readable 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, apparatus, or device, or any suitable combination of the foregoing. More specific
25 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
30 combination of the foregoing.

[00180] 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.

10 **[00181]** 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 method, comprising:

determining, by a first device, whether a resource assigned to the first device can be released; and

in response to a determination that the resource can be released, transmitting a message from the first device to a second device over a direct communication link between the first and second devices, the message indicating availability of the resource for use by the second device.

2. The method of claim 1, wherein the resource comprises at least a portion of a periodic resource assigned to the first device.

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

transmitting, by the first device, information on traffic characteristic parameters, to a third device serving the first device, the traffic characteristic parameters at least comprising a transport block size range; and

receiving, from the third device, a periodic resource assigned to the first device based on an upper limit in the transport block size range.

4. The method of any of claims 1-3, wherein the determining comprises:

determining the size of a resource required for transmission of a current transport block; and

in response to the required resource size being smaller than the size of a periodic resource assigned to the first device, determining that the resource can be released.

5. The method of any of claims 1-4, wherein the transmitting comprises:

transmitting the message over a stand-alone physical sidelink control channel (PSCCH).

6. The method of any of claims 1-4, wherein the transmitting comprises:

transmitting the message over a physical sidelink control channel (PSCCH) transmitted in the same slot as a physical sidelink share channel (PSSCH) associated with the PSCCH.

7. The method of any of claims 1-6, wherein the first and second devices are terminal devices, and the third device is a network device.

5 8. A method, comprising:
receiving, by a second device, a message from a first device over a direct communication link between the first and second devices, the message indicating availability of a resource assigned to the first device for use by the second device; and
using the resource for transport block transmission.

10 9. The method of claim 8, wherein using the resource comprises:
using the resource for aperiodic transmission.

15 10. The method of claim 8 or claim 9, wherein receiving the message comprises:
receiving the message over a stand-alone physical sidelink control channel (PSCCH).

20 11. The method of claim 8 or claim 9, wherein receiving the message comprises:
receiving the message over a physical sidelink control channel (PSCCH) transmitted
in the same slot as a physical sidelink share channel (PSSCH) associated with the PSCCH.

12. The method of any of claims 8-11, wherein the first and second devices are terminal device.

25 13. A method, comprising:
receiving, by a third device serving a first device, information on traffic characteristic parameters from the first device, the traffic characteristic parameters at least comprising a transport block size range; and
assigning a periodic resource to the first device based on an upper limit in the
30 transport block size range.

14. A method, comprising:
determining, by a first device, whether a resource assigned to the first device can be released; and

in response to a determination that the resource can be released, transmitting, to a third device serving the first device, a message indicating availability of the resource for use by a second device.

5 15. The method of claim 14, wherein the resource comprises at least a portion of a periodic resource assigned to the first device.

16. The method of claim 14 or claim 15, further comprising:
transmitting, by the first device, information on traffic characteristic parameters, to
10 the third device, the traffic characteristic parameters at least comprising a transport block size range; and
receiving, from the third device, a periodic resource assigned to the first device based on an upper limit in the transport block size range.

15 17. The method of any of claims 14-16, wherein the determining comprises:
determining the size of a resource required for transmission of a current transport block; and
in response to the required resource size being smaller than the size of a periodic resource assigned to the first device, determining that the resource can be released.

20 18. The method of any of claims 14-17, wherein the transmitting comprises:
determining bit information corresponding to the size of the resource; and
transmitting the bit information to the third device.

25 19. The method of any of claims 14-18, further comprising: receiving, from the third device, information on a resource assigned to the first device for transmission of a schedule request, and
wherein the transmitting comprises: transmitting the message over the resource assigned to the first device for transmission of a schedule request.

30 20. The method of any of claims 14-18, wherein the first and second devices are terminal devices, and the third device is a network device.

21. A method, comprising:

receiving, by a third device serving a first device, a message from the first device, the message indicating availability of a resource assigned to the first device for use by a second device; and

assigning the resource to the second device for use in transmission.

5

22. The method of claim 21, further comprising:

receiving, by the third device, information on traffic characteristic parameters from the first device, the traffic characteristic parameters at least comprising a transport block size range; and

10

assigning a periodic resource to the first device based on an upper limit in the transport block size range.

23. The method of claim 21 or claim 22, wherein the resource comprises at least a portion of a periodic resource assigned to the first device.

15

24. The method of any of claims 21-23, further comprising: assigning, from the third device, a resource for transmission of a schedule request to the first device, and

wherein receiving the message comprises: receiving the message transmitted over the assigned resource from the first device.

20

25. The method of any of claims 21-24, wherein receiving the message comprising:

receiving bit information corresponding to the size of the resource; and

determining the resource based on the bit information.

25

26. The method of any of claims 21-25, wherein the first and second devices are terminal devices, and the third device is a network device.

27. A device, comprising:

30

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 device to:

determine, by a first device, whether a resource assigned to the first device

can be released; and

in response to a determination that the resource can be released, transmit a message from the first device to a second device over a direct communication link between the first and second devices, the message indicating availability of the resource for use by the second device.

28. A 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 device to:

receive, by a second device, a message from a first device over a direct communication link between the first and second devices, the message indicating availability of a resource assigned to the first device for use by the second device; and

use the resource for transport block transmission.

29. A 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 device to:

receive, by a third device serving a first device, information on traffic characteristic parameters from the first device, the traffic characteristic parameters at least comprising a transport block size range; and

assign a periodic resource to the first device based on an upper limit in the transport block size range.

30. A 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 device to:

determine, by a first device, whether a resource assigned to the first device can be released; and

in response to a determination that the resource can be released, transmit, to a third device serving the first device, a message indicating availability of the resource for use by a second device.

- 5 31. A 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 device to:
10 receive, by a third device serving a first device, a message from the first
device, the message indicating availability of a resource assigned to the first device for use
by a second device; and
assign the resource to the second device for use in transmission.

- 15 32. An apparatus, comprising:
means for determining, by a first device, whether a resource assigned to the first
device can be released; and
means for transmitting, in response to a determination that the resource can be
released, a message from the first device to a second device over a direct communication
20 link between the first and second devices, the message indicating availability of the
resource for use by the second device.

33. The apparatus of claim 32, wherein the resource comprises at least a portion of
a periodic resource assigned to the first device.

- 25 34. The apparatus of claim 32 or claim 33, further comprising:
means for transmitting, by the first device, information on traffic characteristic
parameters, to a third device serving the first device, the traffic characteristic parameters at
least comprising a transport block size range; and
30 means for receiving, from the third device, a periodic resource assigned to the first
device based on an upper limit in the transport block size range.

35. The apparatus of any of claims 32-34, wherein the means for determining
comprises:

means for determining the size of a resource required for transmission of a current transport block; and

means for determining, in response to the required resource size being smaller than the size of a periodic resource assigned to the first device, that the resource can be released.

5

36. The apparatus of any of claims 32-35, wherein the means for transmitting comprises:

means for transmitting the message over a stand-alone physical sidelink control channel (PSCCH).

10

37. The apparatus of any of claims 32-35, wherein the means for transmitting comprises:

means for transmitting the message over a physical sidelink control channel (PSCCH) transmitted in the same slot as a physical sidelink share channel (PSSCH) associated with the PSCCH.

15

38. The apparatus of any of claims 32-37, wherein the first and second devices are terminal devices, and the third device is a network device.

20

39. An apparatus, comprising:

means for receiving, by a second device, a message from a first device over a direct communication link between the first and second devices, the message indicating availability of a resource assigned to the first device for use by the second device; and

means for using the resource for transport block transmission.

25

40. An apparatus, comprising:

means for receiving, by a third device serving a first device, information on traffic characteristic parameters from the first device, the traffic characteristic parameters at least comprising a transport block size range; and

30

means for assigning a periodic resource to the first device based on an upper limit in the transport block size range.

41. An apparatus, comprising:

means for determining, by a first device, whether a resource assigned to the first

device can be released; and

means for transmitting, in response to a determination that the resource can be released, a message to a third device serving the first device, the message indicating availability of the resource for use by a second device.

5

42. An apparatus, comprising:

means for receiving, by a third device serving a first device, a message from the first device, the message indicating availability of a resource assigned to the first device for use by a second device; and

10

means for assigning the resource to the second device for use in transmission.

43. A non-transitory computer readable medium comprising program instructions for causing an apparatus to perform at least the method of claim 1, 8, 13, 14 or 21.

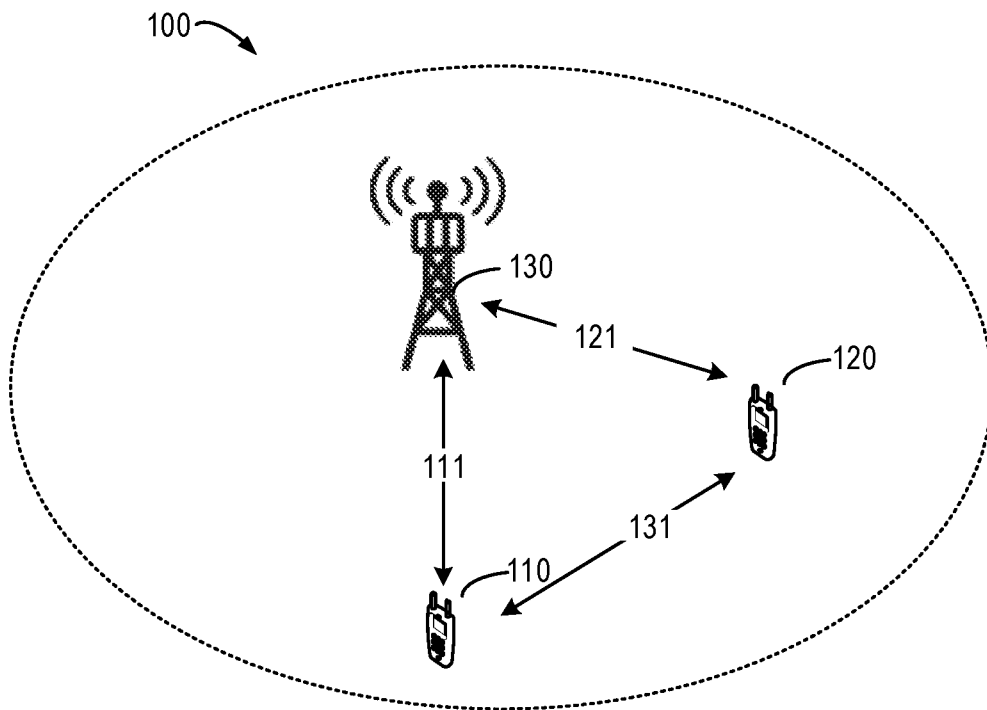


Fig. 1

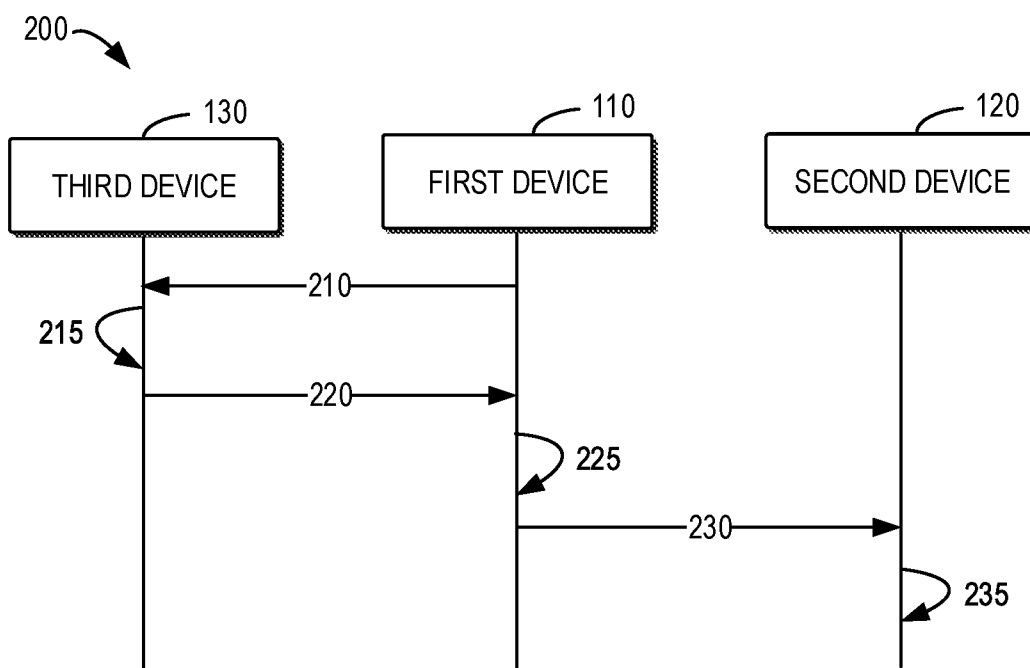


Fig. 2

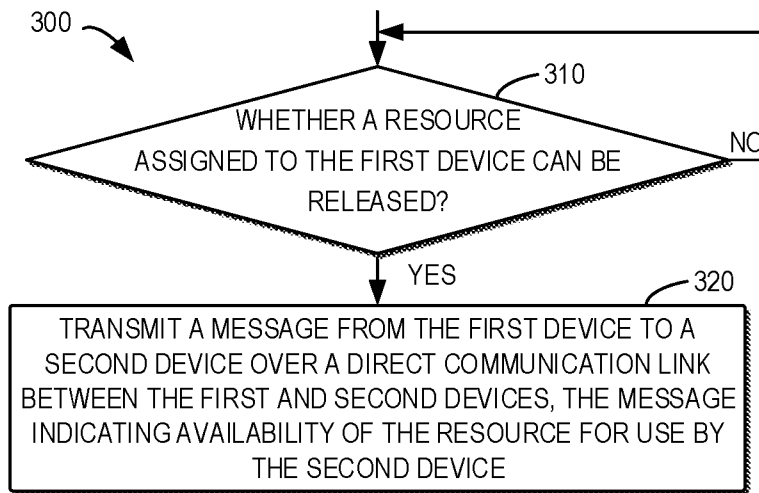


Fig. 3

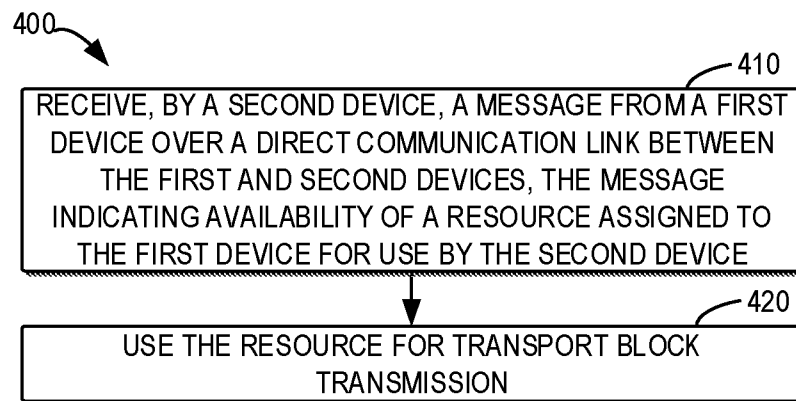


Fig. 4

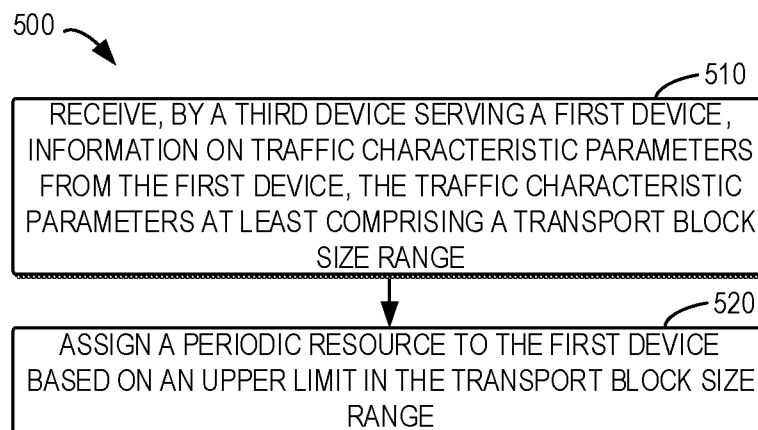


Fig. 5

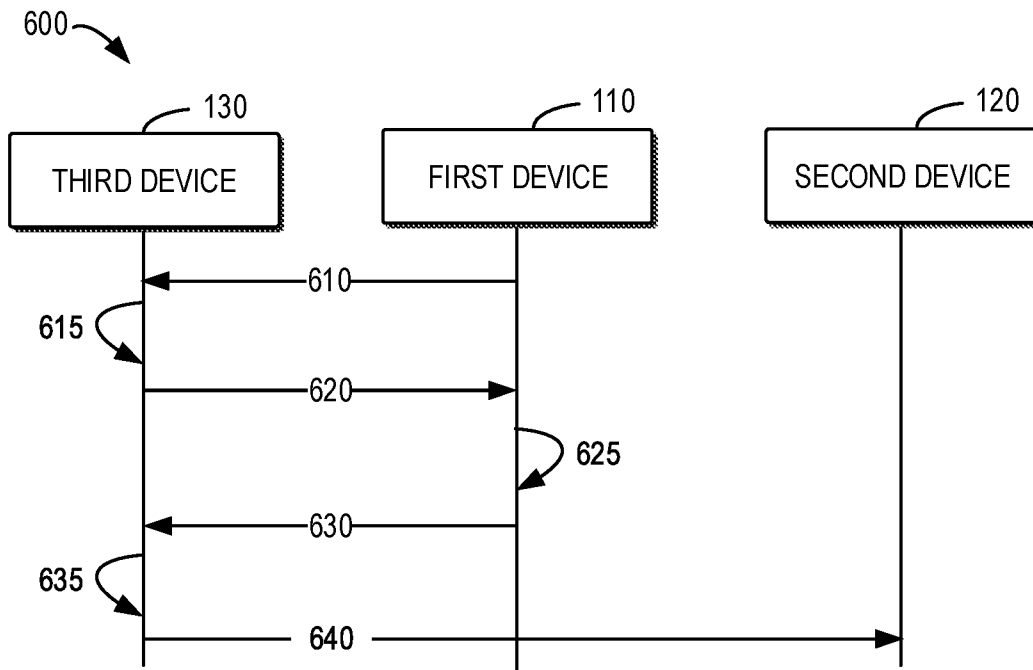


Fig. 6

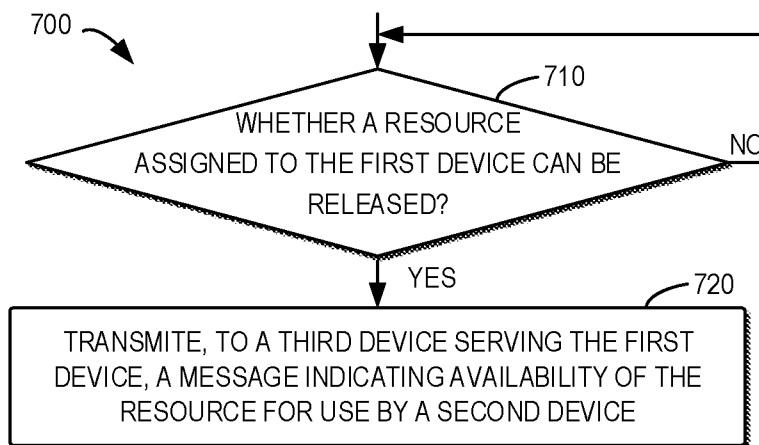


Fig. 7

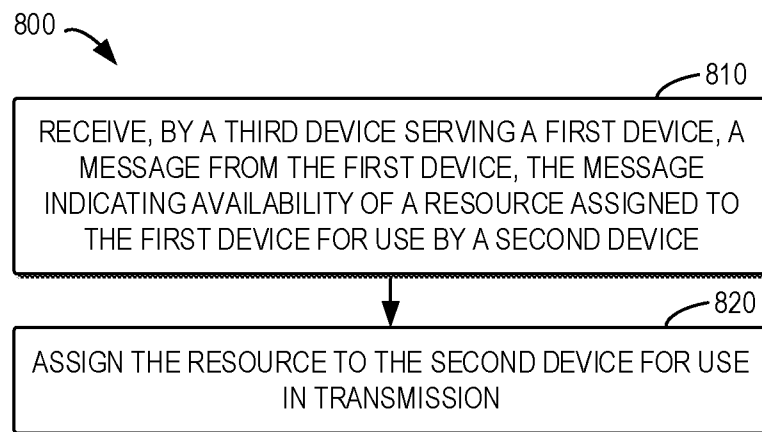


Fig. 8

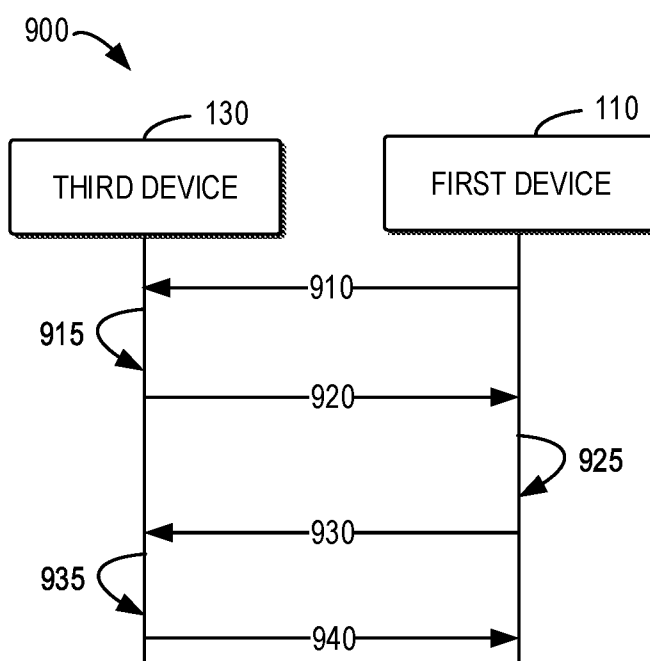


Fig. 9

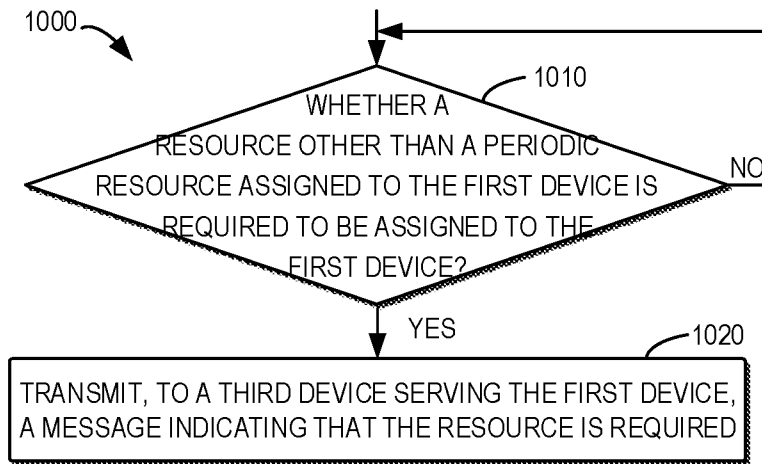


Fig. 10

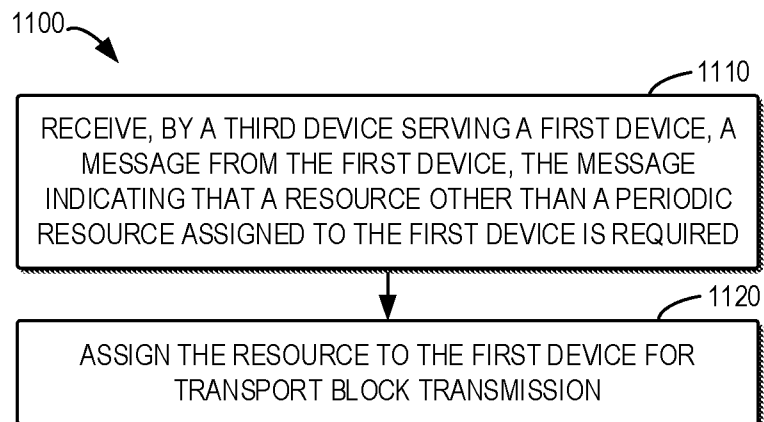


Fig. 11

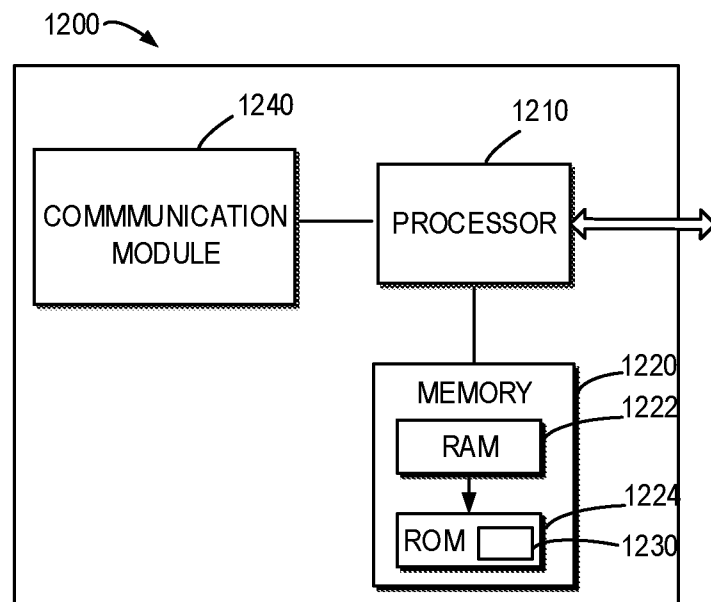


Fig. 12

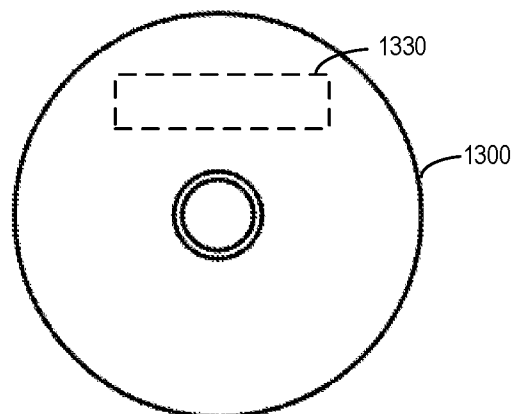


Fig. 13

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/088981

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04(2009.01)i; H04W 76/28(2018.01)n; H04W 76/34(2018.01)n

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)

CNABS,CNTXT,CNKI,VEN,USTXT,WOTXT,EPTXT,3GPP:D2D, SPS, sidelink, release, resource, portion, part, size

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016345381 A1 (NOKIA SOLUTIONS & NETWORKS OY) 24 November 2016 (2016-11-24) paragraphs 0031-0092, and figures 1-6	1, 5-12, 27-28, 32, 36-39, 43
Y	US 2016345381 A1 (NOKIA SOLUTIONS & NETWORKS OY) 24 November 2016 (2016-11-24) paragraphs 0031-0092, and figures 1-6	2-4, 33-35
X	WO 2018118341 A1 (QUALCOMM INC.) 28 June 2018 (2018-06-28) paragraphs 0014-0015, 0053-0112, and figures 1-8	13-26, 29-31, 40-43
Y	WO 2018118341 A1 (QUALCOMM INC.) 28 June 2018 (2018-06-28) paragraphs 0014-0015, 0053-0112, and figures 1-8	2-4, 33-35
A	CN 105309038 A (HUAWEI TECHNOLOGIES CO., LTD.) 03 February 2016 (2016-02-03) the whole document	1-43
A	US 2018070367 A1 (KYOCERA CORP.) 08 March 2018 (2018-03-08) the whole document	1-43
A	US 2018184443 A1 (QUALCOMM INC.) 28 June 2018 (2018-06-28) the whole document	1-43



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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

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

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

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

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

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

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

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

“&” document member of the same patent family

Date of the actual completion of the international search

16 February 2020

Date of mailing of the international search report

02 March 2020

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

FU, Qi

Telephone No. 86-(010)-62411842

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2019/088981

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2016345381	A1	24 November 2016	WO	2015113620	A1	06 August 2015
				EP	3100549	A1	07 December 2016
WO	2018118341	A1	28 June 2018	CN	110169180	A	23 August 2019
				TW	201826760	A	16 July 2018
				US	2018184444	A1	28 June 2018
				EP	3560262	A1	30 October 2019
				IN201947017785	A		31 May 2019
CN	105309038	A	03 February 2016	EP	3113573	A4	12 April 2017
				KR	20160130300	A	10 November 2016
				CN	105309038	B	28 May 2019
				US	2017019881	A1	19 January 2017
				CN	110191511	A	30 August 2019
				RU	2016140937	A	20 April 2018
				RU	2672186	C2	12 November 2018
				RU	2016140937	A3	26 April 2018
				MX	2016012063	A	27 April 2017
				KR	102023144	B1	19 September 2019
				WO	2015139245	A1	24 September 2015
				EP	3113573	A1	04 January 2017
				ZA	201606414	B	27 September 2017
				ID201707873	A		28 July 2017
				IN201637032611	A		03 March 2017
				BR112016021437	A2		15 August 2017
				VN50112	A		26 December 2016
US	2018070367	A1	08 March 2018	JP	6313525	B2	18 April 2018
				EP	3285535	A1	21 February 2018
				WO	2016185923	A1	24 November 2016
				JP	6510700	B2	08 May 2019
				EP	3285535	A4	25 April 2018
				JP	2018137776	A	30 August 2018
				JP	WO2016185923	A1	15 March 2018
US	2018184443	A1	28 June 2018	CN	110115089	A	09 August 2019
				EP	3560264	A1	30 October 2019
				KR	20190097035	A	20 August 2019
				US	10349432	B2	09 July 2019
				CA	3042556	A1	28 June 2018
				TW	201826858	A	16 July 2018
				WO	2018118342	A1	28 June 2018
				IN201947017561	A		31 May 2019