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(54) Title: METHODS AND APPARATUS FOR RECEIVER ASSISTANCE INFORMATION-BASED RESOURCE ALLOCATION

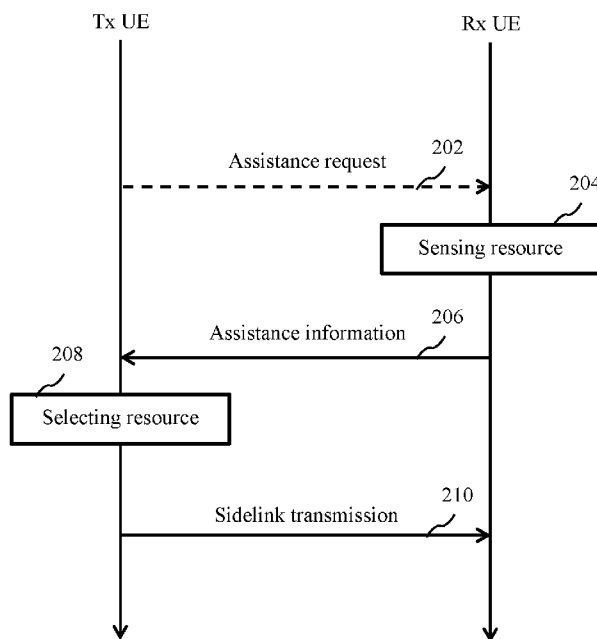


FIG. 2

(57) Abstract: Embodiments of the present disclosure relate to methods and apparatus for receiver assistance information-based resource allocation. According to an embodiment of the present disclosure, a method performed by a user equipment (UE) for wireless communication, comprising: receiving assistance information from a second UE; and selecting, based at least in part on the assistance information, a resource for performing sidelink transmission to the second UE.

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METHODS AND APPARATUS FOR RECEIVER ASSISTANCE INFORMATION-BASED RESOURCE ALLOCATION

TECHNICAL FIELD

[0001] Embodiments of the present disclosure are related to wireless communication technology, and more particularly, related to methods and apparatuses for receiver assistance information-based resource allocation for sidelink communications.

BACKGROUND

[0002] In a wireless communication system, a user equipment (UE), e.g. mobile device, may communicate with another UE via a data path supported by an operator's network, e.g. a cellular or a Wi-Fi network infrastructure. The data path supported by the operator's network may include a base station (BS) and multiple gateways.

[0003] In the case that both UEs are relatively close to each other, a radio link or a sidelink can be established between both UEs to provide Device-to-Device (D2D) communication and without going through a direct link to the BS. The term "sidelink" may refer to a direct radio link established for communicating among devices, e.g. UEs, as opposed to communicating via the cellular infrastructure (uplink and downlink) as discussed above. In this case, the "sidelink" is also referred to as a D2D communication link. The D2D communication link may be used in any suitable telecommunication network in accordance with various standards, where the telecommunication network may configure a resource pool to be used by UEs during such D2D communication.

[0004] D2D communication has evolved into a vehicle-to-everything (V2X) communication in the Long Term Evolution (LTE) sidelink standard. The V2X communication technology encompasses communication involving vehicles as

message sources or destinations. In a new radio (NR) communication system, a transmitting UE (hereinafter referred to as "Tx UE") may send a sidelink transmission to a specific receiving UE (hereinafter referred to as "Rx UE") in a unicast mode, to a group of Rx UEs in a groupcast mode, or to Rx UEs within a range in a broadcast mode.

[0005] At present, NR V2X communication supports two resource allocation modes: 1) mode 1: a base station (e.g., gNB) indicates sidelink resource(s) to a Tx UE for performing a sidelink transmission to an Rx UE; and 2) mode 2: a Tx UE selects sidelink resource(s) for performing a sidelink transmission from a resource pool which contains sidelink resource(s) configured by a base station or pre-configured in standards. The resource allocation modes of a Tx UE can be configured by a base station or pre-configured in standards.

[0006] For a Tx UE operating in mode 2, it normally performs a resource sensing procedure and a resource selecting procedure before performing a sidelink transmission to an Rx UE. In the resource sensing procedure, the Tx UE senses time-frequency resource(s) occupied or reserved by surrounding UE(s). An occupied resource refers to a resource that is currently used by a surrounding UE, and a reserved resource refers to a resource that will be used by a surrounding UE in the future. In the resource selecting procedure, the Tx UE selects resource(s) from a configured or pre-configured resource pool for the sidelink transmission by taking into account a result of the resource sensing procedure, for example, excluding the occupied or reserved resource(s) from the resource pool.

[0007] However, since the Rx UE may be exposed to interference source(s) undetectable by the Tx UE, the resource(s) selected by the Tx UE may be inappropriate from the Rx UE's perspective. There is a need to improve resource allocation or selection performed by a Tx UE by utilizing assistance information from an Rx UE.

SUMMARY OF THE DISCLOSURE

[0008] According to an embodiment of the present disclosure, a method performed by a UE for wireless communication may include: receiving assistance information from a second UE; and selecting, based at least in part on the assistance information, a resource for performing sidelink transmission to the second UE.

[0009] According to another embodiment of the present disclosure, a method performed by a UE for wireless communication may include: transmitting assistance information to a second UE; and receiving sidelink transmission from the second UE using a resource based at least in part on the assistance information.

[0010] According to yet another embodiment of the present disclosure, a method performed by a base station for wireless communication may include: transmitting a configuration message to a UE to configure at least one of: a period of transmission of assistance information from the UE to a second UE; or a condition in which the UE transmits the assistance information to the second UE, wherein the assistance information is used by the second UE to select a resource for performing sidelink transmission to the UE.

[0011] According to still another embodiment of the present disclosure, an apparatus may include: at least one non-transitory computer-readable medium having stored thereon computer executable instructions; at least one receiving circuitry; at least one transmitting circuitry; and at least one processor coupled to the at least one non-transitory computer-readable medium, the at least one receiving circuitry and the at least one transmitting circuitry. The computer executable instructions may cause the at least processor to implement a method according to any embodiment of the present disclosure.

[0012] The details of one or more examples are set forth in the accompanying drawings and the description below. Other features, objects, and advantages will be

apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] In order to describe the manner in which advantages and features of the present disclosure can be obtained, a description of the present disclosure is rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. These drawings depict only exemplary embodiments of the present disclosure and are not therefore intended to limit the scope of the present disclosure.

[0014] FIG. 1 illustrates a schematic diagram of a wireless communication system according to some embodiments of the present application;

[0015] FIG. 2 illustrates a flow chart of an exemplary procedure for receiver assistance information-based resource allocation according to some embodiments of the present disclosure;

[0016] FIG. 3 illustrates an exemplary block diagram of an apparatus according to some embodiments of the present disclosure;

[0017] FIG. 4 illustrates an exemplary block diagram of another apparatus according to some embodiments of the present disclosure; and

[0018] FIG. 5 illustrates an exemplary block diagram of yet another apparatus according to some embodiments of the present disclosure.

DETAILED DESCRIPTION

[0019] The detailed description of the appended drawings is intended as a description of the currently preferred embodiments of the present disclosure and is not intended to represent the only form in which the present disclosure may be practiced.

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

[0020] Reference will now be made in detail to some embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings. To facilitate understanding, embodiments are provided under specific network architecture and new service scenarios, such as 3rd Generation Partnership Project (3GPP) 5G, 3GPP LTE and so on. Persons skilled in the art know very well that, with the development of network architecture and new service scenarios, the embodiments in the present disclosure are also applicable to similar technical problems; and moreover, the terminologies recited in the present disclosure may change, which should not affect the principle of the present disclosure.

[0021] FIG. 1 illustrates a schematic diagram of a wireless communication system 100 according to some embodiments of the present application.

[0022] As shown in FIG. 1, a wireless communication system 100 may include a base station, e.g., BS 120, and some UEs, e.g., UE 110a, UE 110b, and UE 110c (collectively referred to as UEs 110). Although a specific number of UEs 110 and one BS 120 are depicted in FIG. 1, it is contemplated that wireless communication system 100 may also include more BSs and more or fewer UEs in and outside of the coverage of the BSs.

[0023] The UEs and the base station may support communication based on, for example, 3G, LTE, LTE-advanced (LTE-A), NR, or other suitable protocol(s). For example, the BS 120 may include an eNB or a gNB. The UE 110a, UE 110b, or UE 110c may include, for example, but is not limited to, a computing device, a wearable device, a mobile device, an IoT (Internet of Things) device, a vehicle, etc. Persons skilled in the art should understand that as technology develops and advances, the terminologies described in the present disclosure may change, but should not affect or

limit the principles and spirit of the present disclosure.

[0024] The BS 120 may define one or more cells, and each cell may have a coverage area 130. In the exemplary wireless communication system 100, some UEs (e.g., UE 110a and UE 110b) are within the coverage of the BS 120, which may not be a specific base station 120 shown in FIG. 1 and can be any one of the base stations 120 in a wireless communication system, and some UEs (e.g., UE 110c) are outside of the coverage of the BS 120. For example, in the case that the wireless communication system includes two base stations 120, UE 110a being within the coverage of any one of the two base stations 120 means that UE 110a is within the coverage of a base station 120 (i.e., in-coverage) in the wireless communication system; and UE 110a being outside of the coverage of both base stations 120 means that UE 110a is outside of the coverage of a base station 120 (i.e., out-of-coverage) in the wireless communication system.

[0025] Still referring to FIG. 1, the UE 110a and UE 110b may communicate with the BS 120 via, for example, a Uu link (denoted by dotted arrow in FIG. 1). The UEs 110 may communicate with each other (e.g., UE 110a may communicate with UE 110b, or UE 110a may communicate with UE 110c) via a sidelink (denoted by solid arrow in FIG. 1). During a sidelink communication, a Tx UE may transmit signaling, data, or both to an Rx UE. For example, referring to FIG. 1, a Tx UE (e.g., UE 110a) may transmit data to an Rx UE (e.g., UE 110b or UE 110c).

[0026] As described above, there are two resource allocation modes for sidelink transmissions. In mode 1, sidelink resource(s) is(are) assigned by a network (e.g., by a base station), for example, via dynamic scheduling or configured grant. In mode 2, sidelink resource(s) is(are) selected from a configured or pre-configured resource pool by a Tx UE itself. Either for mode 1 or for mode 2, after sidelink resource(s) to be used or reserved is(are) determined, the Tx UE may transmit sidelink control information (SCI) on a physical sidelink control channel (PSCCH) which includes information indicating the determined sidelink resource(s). The SCI can be sensed

by surrounding UE(s) such that the surrounding UE(s) can avoid using the sidelink resource(s) indicated by the SCI (which the surrounding UE(s) may deem unavailable resource(s)) to avoid collision or interference.

[0027] A UE can sense SCI from other UE(s) within a sensing range and cannot sense SCI from UE(s) outside the sensing range. In other words, the UE(s) outside the sensing range is(are) undetectable. For example, referring to FIG. 1, in a case where UEs 110a, 110b, and 110c are all in mode 2, UE 110b is within a sensing range of UE 110a and can be sensed by UE 110a, while it is outside a sensing range of UE 110c and cannot be sensed by UE 110c. Before a Tx UE (e.g., UE 110c) performs a sidelink transmission to an Rx UE (e.g., UE 110a), it may perform a resource sensing procedure to sense sidelink resource(s) occupied or reserved by surrounding UE(s) within its sensing range, and then select resource(s) for the sidelink transmission based at least in part on a result of the resource sensing procedure. Since UE 110c cannot sense UE 110b, it may possibly select sidelink resource(s) occupied or reserved by UE 110b. However, for the Rx UE, i.e., UE 110a, UE 110b is an interference source, and thus the sidelink transmission using the sidelink resource(s) occupied or reserved by UE 110b may be subject to collision or interference at UE 110a. That is, the resource(s) selected by the Tx UE based solely on its own sensing may be inappropriate from the Rx UE's perspective.

[0028] The above problem can be solved by taking into account receiver-side sensing, e.g., by providing assistance information from an Rx UE to a Tx UE. In the above example, UE 110a can sense sidelink resource(s) occupied or reserved by UE 110b and provide assistance information indicating the sensed sidelink resource(s) to UE 110c, such that UE 110c will exclude the sidelink resource(s) occupied or reserved by UE 110b from its resource pool when selecting resource(s) for performing a sidelink transmission to UE 110a. In this way, resource allocation performance for sidelink communications can be improved.

[0029] FIG. 2 illustrates a flow chart of an exemplary procedure for receiver

assistance information-based resource allocation according to some embodiments of the present disclosure.

[0030] As described above, a Tx UE, which may be any UE described herein (e.g., UE 110a, 110b, or 110c in FIG. 1), can be configured or pre-configured with a resource pool, from which the Tx UE may select time-frequency resource(s) for performing a sidelink transmission to an Rx UE, which may be any UE described herein other than the Tx UE. Under some conditions, the Tx UE may need assistance information from the Rx UE to assist resource selection at the Tx UE, and thus transmits an assistance request to the Rx UE (202).

[0031] According to some embodiments of the present disclosure, the Tx UE may transmit an assistance request to the Rx UE when any one of the following conditions is met:

(1) when a quality requirement of an incoming service (e.g., the service associated with the sidelink transmission between the Tx UE and the Rx UE) is higher than a threshold, or

(2) when a quality of a channel between the Tx UE and the Rx UE is lower than a threshold.

[0032] The quality requirement of the incoming service may include requirements for reliability or latency, such as packet error rate or packet delay budget. When the transmission of assistance request is triggered by the quality requirement of the incoming service, the assistance request can be transmitted along with (or referred to as "carried in") a message for establishing a sidelink radio resource control (RRC) connection between the Tx UE and the Rx UE. For example, the assistance request can be transmitted along with an *RRCReconfigurationSidelink* message. As such, there is no need to transmit the assistance request via an additional signaling, and the sidelink latency can be reduced.

[0033] The quality of the channel between the Tx UE and the Rx UE may be reflected by several measurements, such as a number of non-acknowledgement (NACK) messages received by the Tx UE from the Rx UE, a value of a channel state information (CSI) feedback (e.g., channel quality indicator (CQI) or rank indication (RI) value) received by the Tx UE from the Rx UE, or a value of a sidelink reference signal receiving power (RSRP) measurement received by the Tx UE from the Rx UE. In other words, the Tx UE may transmit an assistance request to the Rx UE when any one of the following conditions is met:

- (1) when a number of NACK messages from the Rx UE reaches a threshold,
- (2) when a value of a CSI feedback from the Rx UE is lower than a threshold within a time window, or
- (3) when a value of an RSRP measurement from the Rx UE is higher than a threshold within a time window.

[0034] The condition(s) which may trigger the Tx UE to transmit an assistance request to the Rx UE can be configured by a network (e.g., by a base station) or pre-configured in standards. Any one or any combination of the aforementioned conditions as well as any of the aforementioned thresholds related to the conditions may be configured or pre-configured.

[0035] According to some embodiments of the present disclosure, the assistance request transmitted from the Tx UE to the Rx UE includes, but is not limited to, at least one of the following elements, and which element(s) is(are) included in the assistance request can be configured by a network (e.g., a base station) or pre-configured in standards:

- (1) an indication (e.g., a 1-bit or empty indication) to inform the Rx UE to transmit assistance information to the Tx UE;

- (2) information of a transmission resource pool (e.g., an identifier (ID) of the transmission resource pool) of the Tx UE;
- (3) information indicating intended resource(s) for performing a sidelink transmission from the Tx UE's perspective;
- (4) information indicating intended resource(s) for the Rx UE to transmit assistance information, which is considered optimal from the Tx UE's perspective;
- (5) information indicating a result obtained from a resource sensing procedure (not shown in FIG. 2) of the Tx UE, which includes time-frequency resource(s) sensed by the Tx UE as being occupied or reserved by other UE(s);
- (6) information configuring the Rx UE to transmit assistance information aperiodically, periodically, or in response to an event (e.g., in response to the Rx UE detecting a bad channel condition); or
- (7) information indicating traffic characteristic(s) of an incoming service (e.g., buffer state, traffic size, etc.).

[0036] According to some embodiments of the present disclosure, the Tx UE may transmit an assistance request in an SCI or an RRC message (e.g., PC5-RRC message). The Tx UE may transmit the assistance request using PSCCH resource(s) in its resource pool.

[0037] Upon transmission of an assistance request, the Tx UE may start a timer, which can also be configured by a network (e.g., a base station) or pre-configured in standards. The timer may stop upon receipt of assistance information from the Rx UE. According to some embodiments of the present disclosure, the Tx UE stops transmitting a new assistance request to the same Rx UE when the timer is running. In other words, the Rx UE only needs to respond to one assistance request from the same Tx UE during a running period of the time. In the case where the Tx UE fails

to receive assistance information from the Rx UE before the timer expires, the Tx UE may take one of the following actions:

(1) The Tx UE transmits a new assistance request to the Rx UE. The timer is re-started upon transmission of the new assistance request.

(2) The Tx UE selects resource(s) for performing the sidelink transmission from its resource pool by excluding unavailable resource(s) (i.e., resource(s) occupied or reserved by other UE(s)) sensed by the Tx UE. In some embodiments of the present disclosure, the Tx UE may also exclude unavailable resource(s) previously sensed and reported to the Tx UE by the Rx UE.

(3) The Tx UE transmits a request to a base station (e.g., a gNB) for allocating resource(s) for performing the sidelink transmission. For example, a Tx UE in an RRC-idle or inactive mode may transmit an RRC establishment request to a gNB.

[0038] Referring again to FIG. 2, in response to receiving an assistance request from the Tx UE, the Rx UE performs a resource sensing procedure (204) and transmits assistance information to the Tx UE (206) based at least in part on a result of the resource sensing procedure. However, according to some other embodiments of the present disclosure, the resource sensing procedure can be performed before receipt of the assistance request, and the assistance request is not necessary. For example, the Rx UE may transmit assistance information to the Tx UE in response to receiving an indication from a base station (e.g., a gNB). Alternatively or additionally, the Rx UE may perform a resource sensing procedure and transmit assistance information to the Tx UE periodically, and a period of the assistance information is configured by a base station or the Tx UE or is pre-configured. Alternatively or additionally, the Rx UE may transmit assistance information to the Tx UE when a sidelink unicast communication is established between the Tx UE and the Rx UE, i.e., when a sidelink RRC connection is established between the Tx UE and the Rx UE. In such cases, the assistance information can be transmitted along with (or referred to as "carried in")

a message indicating that the sidelink RRC connection is established, for example, an *RRCReconfigurationcompleteSidelink* message.

[0039] Alternatively or additionally, the Rx UE may transmit assistance information to the Tx UE when a quality of a channel between the Tx UE and the Rx UE is lower than a threshold. The quality of the channel between the Tx UE and the Rx UE may be reflected by several measurements, such as a number of decoding failures at the Rx UE, a number of NACK messages transmitted from the Rx UE to the Tx UE, a value of a CSI feedback (e.g., CQI or RI value) transmitted from the Rx UE to the Tx UE, or a value of a sidelink RSRP measurement transmitted from the Rx UE to the Tx UE. In other words, the Rx UE may transmit assistance information to the Tx UE when any one of the following conditions is met:

- (1) when a number of decoding failures at the Rx UE reaches a threshold;
- (2) when a number of NACK messages transmitted from the Rx UE to the Tx UE reaches a threshold,
- (3) when a value of a CSI feedback transmitted from the Rx UE to the Tx UE is lower than a threshold within a time window, or
- (4) when a value of an RSRP measurement transmitted from the Rx UE to the Tx UE is higher than a threshold within a time window.

[0040] When the transmission of assistance information is triggered under the above condition (4), assistance information can be transmitted along with (or referred to as "carried in") a message carrying a sidelink RSRP measurement, for example, a *MeasurementReport* message.

[0041] The condition(s) which may trigger the Rx UE to transmit assistance information to the Tx UE (including whether to transmit assistance information periodically, or in response to receiving an assistance request from the Tx UE or an

indication from a base station, or in response to establishment of a sidelink RRC connection, or when any one of the above conditions (1)-(4) is met) can be configured by a network (e.g., by a base station) or the Tx UE or pre-configured in standards. Any one or any combination of the aforementioned conditions as well as any of the aforementioned thresholds related to the conditions may be configured or pre-configured.

[0042] According to some embodiments of the present disclosure, the assistance information transmitted from the Rx UE to the Tx UE includes, but is not limited to, information indicating at least one of available resource(s) or unavailable resource(s) sensed by the Rx UE. An available resource sensed by the Rx UE refers to a resource which is not used when detected by the Rx UE in a resource sensing procedure, i.e., not occupied or reserved by other UE(s). An unavailable resource sensed by the Rx UE refers to a resource which is used when detected by the Rx UE in a resource sensing procedure, i.e., occupied or reserved by other UE(s). In some embodiments of the present disclosure, the assistance information includes the Rx UE's sensing result for a specific resource pool (e.g., the transmission resource pool indicated in an assistance request from the Tx UE).

[0043] In some embodiments of the present disclosure, in response to an assistance request from the Tx UE indicating traffic characteristic(s) of an incoming service, the Rx UE may determine recommended resource(s) from its perspective based on the traffic characteristic(s), and transmit assistance information indicating the recommended resource(s). For example, the assistance information may include at least an index of the recommended resource.

[0044] In some embodiments of the present disclosure, in response to an assistance request from the Tx UE indicating intended resource(s) for performing a sidelink transmission from the Tx UE's perspective, the Rx UE may transmit assistance information overwriting or confirming the intended resource(s). For example, when the Rx UE senses that an intended resource is occupied or reserved by another UE, the

Rx UE may determine a different resource that is not occupied or reserved by other UE(s) and indicate the different resource in the assistance information; when the Rx UE senses that an intended resource is not occupied or reserved by other UE(s), the Rx UE may confirm the intended resource indicated by the assistance request in the assistance information. According to other embodiments of the present disclosure, the assistance information may include other element(s) based on the assistance request from the Tx UE, or configuration by a network or the Tx UE, or pre-configuration.

[0045] According to some embodiments of the present disclosure, the Rx UE may transmit assistance information in a medium access control (MAC) control element (CE) or an RRC message (e.g., PC5-RRC message). The Rx UE may transmit the assistance information using PSCCH resource(s) in its resource pool. Alternatively or additionally, in response to an assistance request indicating intended resource(s) for the Rx UE to transmit assistance information, the Rx UE may transmit the assistance information using the intended resource(s) indicated by the assistance request.

[0046] Referring again to FIG. 2, after receiving assistance information from the Rx UE, the Tx UE selects resource(s) for performing sidelink transmission to the Rx UE based at least in part on the assistance information (208). According to some embodiments of the present disclosure, when the assistance information includes the Rx UE's sensing result, the Tx UE may select resource(s) from a resource pool by excluding both unavailable resource(s) sensed by the Tx UE and unavailable resource(s) sensed by the Rx UE. For example, the Tx UE may determine an available resource set by excluding unavailable resource(s) sensed by the Tx UE and unavailable resource(s) sensed by the Rx UE in the resource pool, and randomly select resource(s) for performing sidelink transmission from the available resource set.

[0047] According to some embodiments of the present disclosure, when the assistance information indicates recommended resource(s) from the Rx UE's

perspective, the Tx UE may select resource(s) by taking into account the recommended resource(s) from the Rx UE. However, the Tx UE does not necessarily select the recommended resource(s).

[0048] According to some embodiments of the present disclosure, when the assistance information overwrites or confirms intended resource(s) for performing sidelink transmission indicated by an assistance request, the Tx UE may select the resource(s) indicated or confirmed by the assistance information for performing sidelink transmission.

[0049] As shown in FIG. 2, after selecting resource(s) for performing sidelink transmission, the Tx UE performs the sidelink transmission to the Rx UE using the selected resource(s) (210).

[0050] FIG. 3 illustrates an exemplary block diagram of an apparatus 300 according to some embodiments of the present disclosure. In some embodiments of the present disclosure, the apparatus 300 may be a UE (e.g., any UE described herein) acting as a Tx UE or other devices having similar functionalities, which can at least perform the method illustrated in FIG. 2.

[0051] As shown in FIG. 3, the apparatus 300 may include at least one receiving circuitry 302, at least one transmitting circuitry 304, at least one non-transitory computer-readable medium 306, and at least one processor 308 coupled to the at least one receiving circuitry 302, the at least one transmitting circuitry 304, the at least one non-transitory computer-readable medium 306.

[0052] Although in FIG. 3, elements such as receiving circuitry 302, transmitting circuitry 304, non-transitory computer-readable medium 306, and processor 308 are described in the singular, the plural is contemplated unless limitation to the singular is explicitly stated. In some embodiments of the present disclosure, the at least one receiving circuitry 302 and the at least one transmitting circuitry 304 are combined

into a single device, such as a transceiver. In certain embodiments of the present disclosure, the apparatus 300 may further include an input device, a memory, and/or other components.

[0053] In some embodiments of the present disclosure, the at least one non-transitory computer-readable medium 306 may have stored thereon computer-executable instructions which are programmed to cause the at least one processor 308 to implement the steps of the methods, for example as described in view of FIG. 2, with the at least one receiving circuitry 302 and the at least one transmitting circuitry 304. For example, when executed, the instructions may cause the at least one processor 308 to receive assistance information from a second UE (e.g. an Rx UE) with the at least one receiving circuitry 302. The instructions may further cause the at least one processor 308 to select, based at least in part on the assistance information, a resource for performing sidelink transmission to the second UE. In some embodiments of the present disclosure, the instructions may further cause the at least one processor 308 to transmit an assistance request to the second UE with the at least one transmitting circuitry 304.

[0054] FIG. 4 illustrates an exemplary block diagram of an apparatus 400 according to some embodiments of the present disclosure. In some embodiments of the present disclosure, the apparatus 400 may be a UE (e.g., any UE described herein) acting as an Rx UE or other devices having similar functionalities, which can at least perform the method illustrated in FIG. 2.

[0055] As shown in FIG. 4, the apparatus 400 may include at least one receiving circuitry 402, at least one transmitting circuitry 404, at least one non-transitory computer-readable medium 406, and at least one processor 408 coupled to the at least one receiving circuitry 402, the at least one transmitting circuitry 404, the at least one non-transitory computer-readable medium 406.

[0056] Although in FIG. 4, elements such as receiving circuitry 402, transmitting

circuitry 404, non-transitory computer-readable medium 406, and processor 408 are described in the singular, the plural is contemplated unless limitation to the singular is explicitly stated. In some embodiments of the present disclosure, the at least one receiving circuitry 402 and the at least one transmitting circuitry 404 are combined into a single device, such as a transceiver. In certain embodiments of the present disclosure, the apparatus 400 may further include an input device, a memory, and/or other components.

[0057] In some embodiments of the present disclosure, the at least one non-transitory computer-readable medium 406 may have stored thereon computer-executable instructions which are programmed to cause the at least one processor 408 to implement the steps of the methods, for example as described in view of FIG. 2, with the at least one receiving circuitry 402 and the at least one transmitting circuitry 404. For example, when executed, the instructions may cause the at least one processor 408 to transmit assistance information to a second UE (e.g., a Tx UE) with the at least one transmitting circuitry 404. The instructions may further cause the at least one processor 408 to receive sidelink transmission from the second UE using a resource based at least in part on the assistance information with the at least one receiving circuitry 402. In some embodiments of the present disclosure, the instructions may further cause the at least one processor 408 to receive an assistance request from the second UE with the at least one receiving circuitry 402.

[0058] FIG. 5 illustrates an exemplary block diagram of an apparatus 500 according to some embodiments of the present disclosure. In some embodiments of the present disclosure, the apparatus 500 may be a base station or other devices having similar functionalities.

[0059] As shown in FIG. 5, the apparatus 500 may include at least one receiving circuitry 502, at least one transmitting circuitry 504, at least one non-transitory computer-readable medium 506, and at least one processor 508 coupled to the at least one receiving circuitry 502, the at least one transmitting circuitry 504, the at least one

non-transitory computer-readable medium 506.

[0060] Although in FIG. 5, elements such as receiving circuitry 502, transmitting circuitry 504, non-transitory computer-readable medium 506, and processor 508 are described in the singular, the plural is contemplated unless limitation to the singular is explicitly stated. In some embodiments of the present disclosure, the at least one receiving circuitry 502 and the at least one transmitting circuitry 504 are combined into a single device, such as a transceiver. In certain embodiments of the present disclosure, the apparatus 500 may further include a memory and/or other components.

[0061] In some embodiments of the present disclosure, the at least one non-transitory computer-readable medium 506 may have stored thereon computer-executable instructions which are programmed to cause the at least one processor 508 to implement the steps of the methods described herein with the at least one receiving circuitry 502 and the at least one transmitting circuitry 504. For example, when executed, the instructions may cause the at least one processor 508 to transmit, with the at least one transmitting circuitry 504, a configuration message to a UE (e.g., an Rx UE) to configure at least one of: a period of transmission of assistance information from the UE to a second UE (e.g., a Tx UE); or a condition in which the UE transmits the assistance information to the second UE, wherein the assistance information is used by the second UE to select a resource for performing sidelink transmission to the UE.

[0062] Those having ordinary skills in the art would understand that the steps of a method described in connection with the aspects disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module may reside in RAM memory, flash memory, ROM memory, EPROM memory, EEPROM memory, registers, a hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. Additionally, in some aspects, the steps of a method may reside as one or any combination or set of codes and/or instructions on a non-transitory computer-readable

medium, which may be incorporated into a computer program product.

[0063] While this disclosure has been described with specific embodiments thereof, it is evident that many alternatives, modifications, and variations may be apparent to those skilled in the art. For example, various components of the embodiments may be interchanged, added, or substituted in the other embodiments. Also, all of the elements of each figure are not necessary for operation of the disclosed embodiments. For example, those having ordinary skills in the art would be enabled to make and use the teachings of the disclosure by simply employing the elements of the independent claims. Accordingly, embodiments of the disclosure as set forth herein are intended to be illustrative, not limiting. Various changes may be made without departing from the spirit and scope of the disclosure.

[0064] In this document, the terms "includes," "including," or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that includes a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element preceded by "a," "an," or the like does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that includes the element. Also, the term "another" is defined as at least a second or more. The term "having" and the like, as used herein, are defined as "including."

WHAT IS CLAIMED:

1. A method performed by a user equipment (UE) for wireless communication, comprising:
 - receiving assistance information from a second UE; and
 - selecting, based at least in part on the assistance information, a resource for performing sidelink transmission to the second UE.
2. The method of claim 1, wherein the assistance information indicates at least one of an available resource or an unavailable resource sensed by the second UE.
3. The method of claim 1, wherein the assistance information is received periodically, and a period of the assistance information is configured by a base station or the UE or is pre-configured.
4. The method of claim 1, wherein the assistance information is received when a sidelink radio resource control (RRC) connection is established between the UE and the second UE.
5. The method of claim 4, wherein the assistance information is received along with a message indicating that the sidelink RRC connection is established.
6. The method of claim 1, wherein the assistance information is received along with a message carrying a sidelink reference signal receiving power (RSRP) measurement from the second UE.
7. The method of claim 1, further comprising:
 - transmitting an assistance request to the second UE.
8. The method of claim 7, wherein the assistance request comprises an indication to inform the second UE to transmit the assistance information.

9. The method of claim 8, wherein the indication is a 1-bit or empty indication.
10. The method of claim 7, wherein the assistance request comprises information of a transmission resource pool.
11. The method of claim 10, wherein the information of the transmission resource pool comprises an identifier of the transmission resource pool.
12. The method of claim 7, wherein the assistance request indicates an intended resource for performing the sidelink transmission.
13. The method of claim 7, wherein the assistance request indicates an intended resource for the second UE to transmit the assistance information.
14. The method of claim 7, wherein the assistance request indicates a result obtained from a resource sensing procedure of the UE.
15. The method of claim 7, wherein the assistance request comprises information configuring the second UE to transmit the assistance information aperiodically, periodically, or in response to an event.
16. The method of claim 7, wherein the assistance request indicates one or more traffic characteristics of an incoming service.
17. The method of claim 7, wherein the assistance request is transmitted when a quality requirement of an incoming service is higher than a threshold.
18. The method of claim 17, wherein the assistance request is transmitted along with a message for establishing a sidelink radio resource control (RRC) connection between the UE and the second UE.

19. The method of claim 7, wherein the assistance request is transmitted when a quality of a channel between the UE and the second UE is lower than a threshold.

20. The method of claim 19, wherein the assistance request is transmitted when a number of non-acknowledgement (NACK) messages from the second UE reaches a threshold.

21. The method of claim 19, wherein the assistance request is transmitted when a value of a channel state information (CSI) feedback from the second UE is lower than a threshold within a time window.

22. The method of claim 19, wherein the assistance request is transmitted when a value of a sidelink reference signal receiving power (RSRP) measurement from the second UE is higher than a threshold within a time window.

23. The method of claim 7, further comprising:
starting a timer in response to transmission of the assistance request.

24. The method of claim 23, further comprising:
stopping transmitting a new assistance request to the second UE when the timer is running.

25. The method of claim 23, further comprising:
in response to failing to receive assistance information from the second UE before the timer expires, transmitting a new assistance request to the second UE.

26. The method of claim 23, further comprising:
in response to failing to receive assistance information from the second UE before the timer expires, selecting a resource for performing sidelink transmission to the second UE based on a resource sensing procedure of the UE.

27. The method of claim 23, further comprising:
in response to failing to receive assistance information from the second UE before the timer expires, transmitting a request to a base station for allocating a resource for performing sidelink transmission to the second UE.
28. The method of claim 12, wherein the assistance information indicates a resource different from the intended resource or confirms the intended resource for performing sidelink transmission to the second UE.
29. The method of claim 28, wherein selecting the resource for performing sidelink transmission to the second UE comprises selecting the resource indicated or confirmed by the assistance information.
30. The method of claim 16, wherein the assistance information indicates a recommended resource based on the one or more traffic characteristics.
31. The method of claim 30, wherein selecting the resource for performing sidelink transmission to the second UE comprises selecting the resource by taking into account the recommended resource.
32. The method of claim 2, wherein selecting the resource for performing sidelink transmission to the second UE comprises excluding the unavailable resource sensed by the second UE and an unavailable resource sensed by the UE.
33. The method of claim 7, wherein the assistance request is transmitted in a sidelink control information (SCI) or radio resource control (RRC) message.
34. The method of claim 7, wherein the assistance request is transmitted using a physical sidelink control channel (PSCCH) resource.

35. The method of claim 1, wherein the assistance information is received in a medium access control (MAC) control element (CE) or radio resource control (RRC) message.

36. A method performed by a user equipment (UE) for wireless communication, comprising:

transmitting assistance information to a second UE; and

receiving sidelink transmission from the second UE using a resource based at least in part on the assistance information.

37. The method of claim 36, wherein the assistance information indicates at least one of an available resource or an unavailable resource sensed by the UE.

38. The method of claim 36, wherein the assistance information is transmitted periodically, and a period of the assistance information is configured by a base station or the second UE or is pre-configured.

39. The method of claim 36, wherein the assistance information is transmitted when a sidelink radio resource control (RRC) connection is established between the UE and the second UE.

40. The method of claim 39, wherein the assistance information is transmitted along with a message indicating that the sidelink RRC connection is established.

41. The method of claim 36, wherein the assistance information is transmitted when a quality of a channel between the UE and the second UE is lower than a threshold.

42. The method of claim 41, wherein the assistance information is transmitted when a number of decoding failures at the UE or a number of non-acknowledgement (NACK) messages transmitted from the UE to the second UE reaches a threshold.

43. The method of claim 41, wherein the assistance information is transmitted when a value of a channel state information (CSI) feedback from the UE to the second UE is lower than a threshold within a time window.

44. The method of claim 41, wherein the assistance information is transmitted when a value of a sidelink reference signal receiving power (RSRP) measurement from the UE to the second UE is higher than a threshold within a time window.

45. The method of claim 44, wherein the assistance information is transmitted along with a message carrying the sidelink RSRP measurement.

46. The method of claim 36, further comprising:
receiving an assistance request from the second UE.

47. The method of claim 46, wherein the assistance request comprises an indication to inform the UE to transmit the assistance information.

48. The method of claim 47, wherein the indication is a 1-bit or empty indication.

49. The method of claim 46, wherein the assistance request comprises information of a transmission resource pool of the second UE.

50. The method of claim 49, wherein the information of the transmission resource pool comprises an identifier of the transmission resource pool.

51. The method of claim 46, wherein the assistance request indicates an intended resource for performing the sidelink transmission.

52. The method of claim 46, wherein the assistance request indicates an intended resource for the UE to transmit the assistance information.

53. The method of claim 46, wherein the assistance request indicates a result obtained from a resource sensing procedure of the second UE.

54. The method of claim 46, wherein the assistance request comprises information configuring the UE to transmit the assistance information aperiodically, periodically, or in response to an event.

55. The method of claim 46, wherein the assistance request indicates one or more traffic characteristics of an incoming service.

56. The method of claim 51, wherein the assistance information indicates a resource different from the intended resource or confirms the intended resource for performing sidelink transmission to the UE.

57. The method of claim 56, wherein the sidelink transmission is received using the resource indicated or confirmed by the assistance information.

58. The method of claim 55, further comprising determining a recommended resource based on the one or more traffic characteristics, wherein the assistance information indicates the recommended resource.

59. The method of claim 36, wherein the assistance information is transmitted in a medium access control (MAC) control element (CE) or radio resource control (RRC) message.

60. The method of claim 36, wherein the assistance information is transmitted using a physical sidelink control channel (PSCCH) resource.

61. The method of claim 52, wherein the assistance information is transmitted using the intended resource indicated by the assistance request.

62. The method of claim 36, wherein the assistance information is transmitted based on a configuration from a base station or the second UE or based on a pre-configuration.

63. A method performed by a base station for wireless communication, comprising:

transmitting a configuration message to a user equipment (UE) to configure at least one of:

a period of transmission of assistance information from the UE to a second UE; or

a condition in which the UE transmits the assistance information to the second UE,

wherein the assistance information is used by the second UE to select a resource for performing sidelink transmission to the UE.

64. The method of claim 63, wherein the condition comprises at least one of:
when the UE receives an assistance request from the second UE or an indication from the base station;

when a sidelink radio resource control (RRC) connection is established between the UE and the second UE; or

when a quality of a channel between the UE and the second UE is lower than a threshold.

65. The method of claim 63, wherein the assistance information indicates at least one of an available resource or an unavailable resource sensed by the UE.

66. An apparatus, comprising:

at least one non-transitory computer-readable medium having stored thereon computer-executable instructions;

at least one receiving circuitry;

at least one transmitting circuitry; and

at least one processor coupled to the at least one non-transitory computer-readable medium, the at least one receiving circuitry and the at least one transmitting circuitry,

wherein the computer-executable instructions cause the at least one processor to implement the method according to any of claims 1-35.

67. An apparatus, comprising:

at least one non-transitory computer-readable medium having stored thereon computer-executable instructions;

at least one receiving circuitry;

at least one transmitting circuitry; and

at least one processor coupled to the at least one non-transitory computer-readable medium, the at least one receiving circuitry and the at least one transmitting circuitry,

wherein the computer-executable instructions cause the at least one processor to implement the method according to any of claims 36-62.

68. An apparatus, comprising:

at least one non-transitory computer-readable medium having stored thereon computer-executable instructions;

at least one receiving circuitry;

at least one transmitting circuitry; and

at least one processor coupled to the at least one non-transitory computer-readable medium, the at least one receiving circuitry and the at least one transmitting circuitry,

wherein the computer-executable instructions cause the at least one processor to implement the method according to any of claims 63-65.

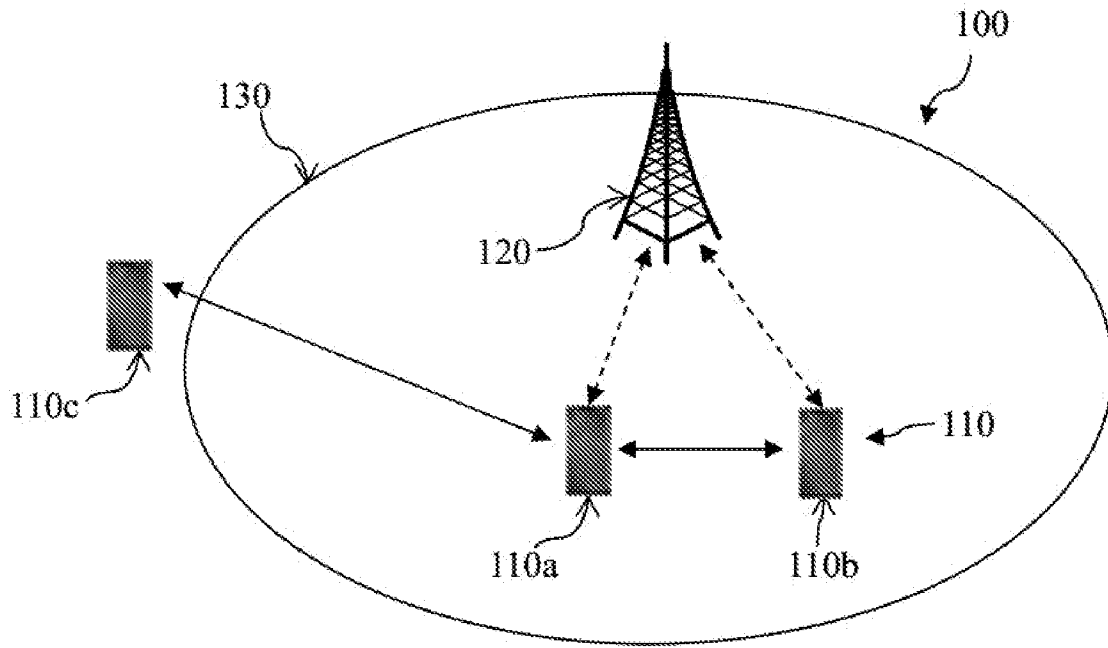


FIG. 1

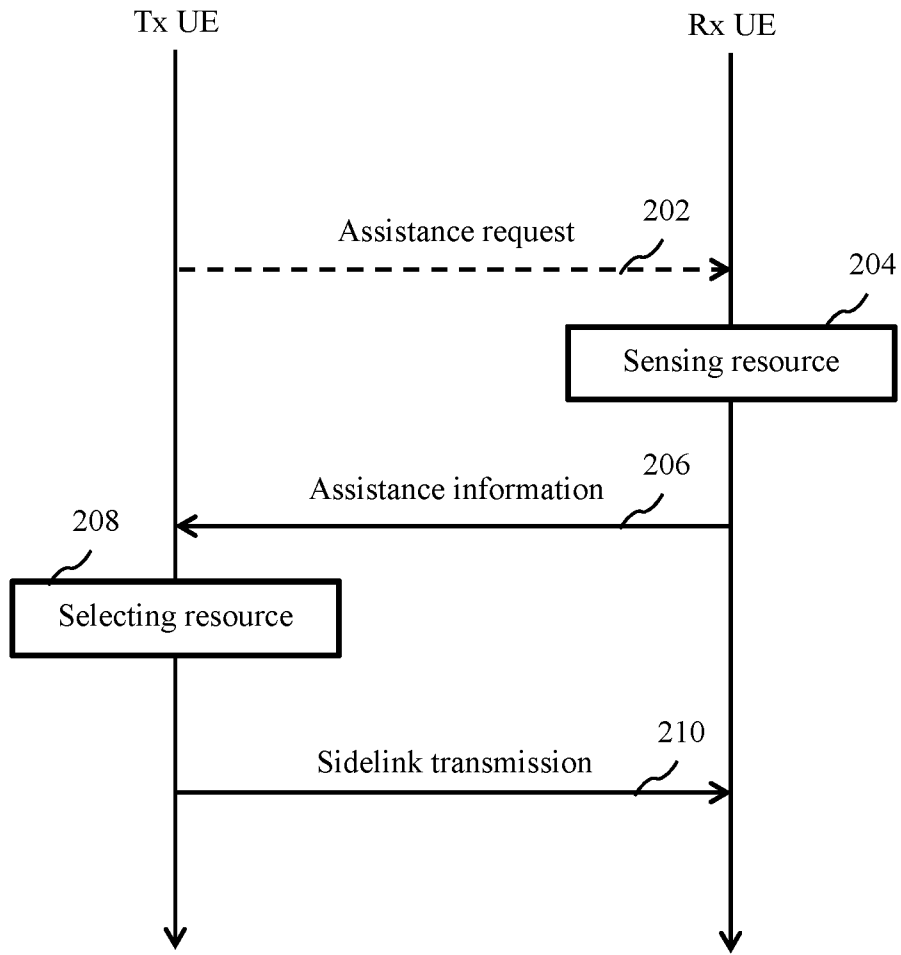


FIG. 2

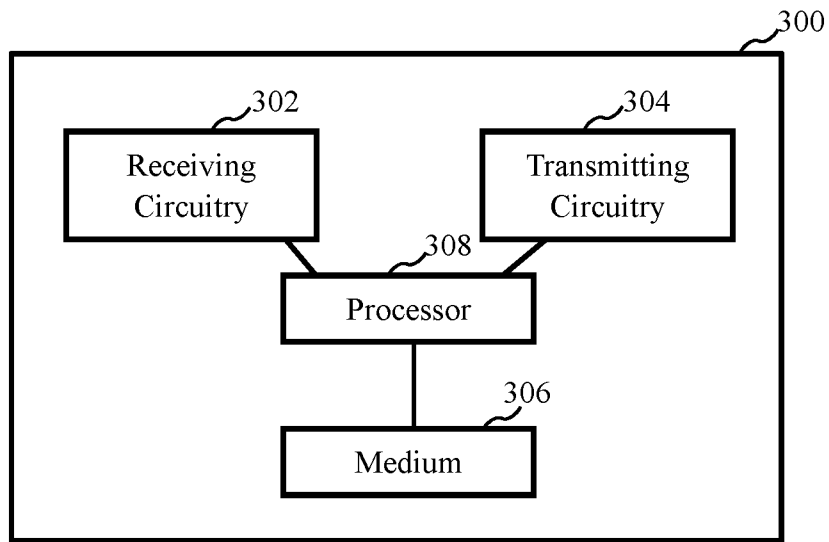


FIG. 3

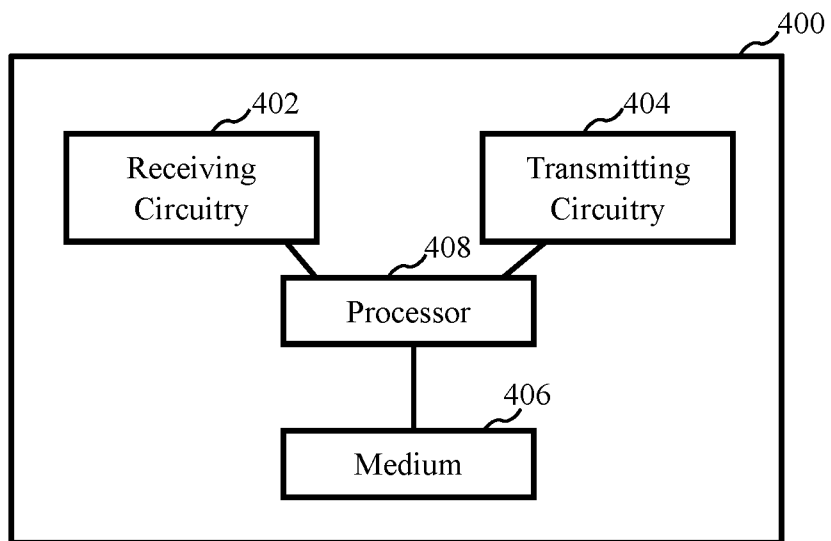


FIG. 4

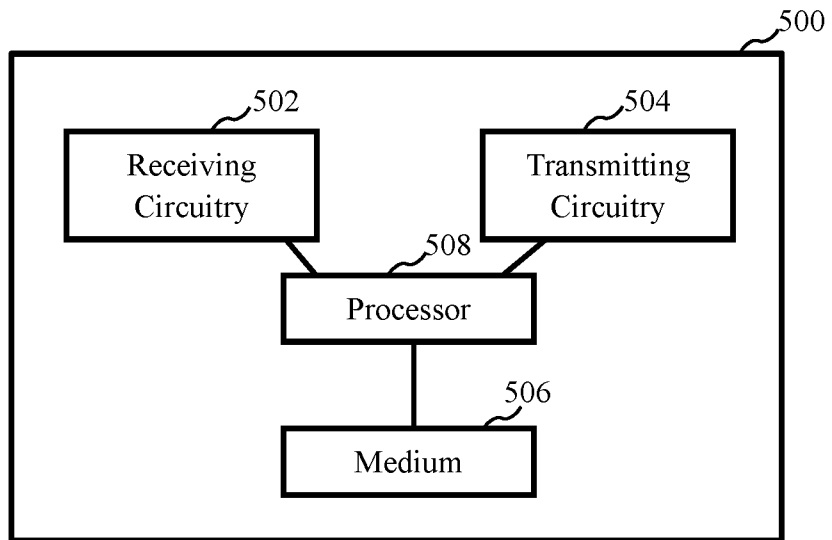


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/093216

A. CLASSIFICATION OF SUBJECT MATTER		
H04W 72/02(2009.01)i; H04W 92/18(2009.01)i		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
H04W		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
CNKI;CNTXT;CNABS;VEN;WOTXT;EPTXT;USTXT;3GPP;SIDELINK, RESOURCE CONFIGURATION, ASSISTANCE, N2X, SIDELINK RRC, RSRP, RESOURCE SENSING, SCI		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2020008030 A1 (LG ELECTRONICS INC) 02 January 2020 (2020-01-02) description, paragraphs [0188]-[0197], [0301]-[0310], figure 11	1-6, 32, 35-45, 59, 60, 62-68
X	CN 109644434 A (QUALCOMM INC.) 16 April 2019 (2019-04-16) description, paragraphs [0045]-[0050], [0073]-[0079], figures 4 and 8	1-6, 32, 35-45, 59, 60, 62-68
X	WO 2020092939 A1 (INTEL CORP.) 07 May 2020 (2020-05-07) description, paragraphs [0070]-[0079]	1-6, 32, 35-45, 59, 60, 62-68
A	US 2020137769 A1 (HUAWEI TECH CO., LTD.) 30 April 2020 (2020-04-30) the whole description	1-68
A	LG Electronics Inc. "Sidelink resource configuration for NR Sidelink" 3GPP TSG-RAN WG2 #104 R2-1818423, 12 November 2018 (2018-11-12), the whole text	1-68
A	LG Electronics Inc. "Support of unicast and groupcast for NR sidelink mode 1" 3GPP TSG-RAN WG2 Meeting #104 R2-1818296, 12 November 2018 (2018-11-12), the whole text	1-68
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
29 January 2021		08 February 2021
Name and mailing address of the ISA/CN		Authorized officer
National Intellectual Property Administration, PRC 6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088 China		LIU, Shiru
Facsimile No. (86-10)62019451		Telephone No. 86-(010)-62411317

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2020/093216

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
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				JP	2020506630	A	27 February 2020
				CN	110495231	A	22 November 2019
				EP	3579633	A1	11 December 2019
				KR	20190096435	A	19 August 2019
CN	109644434	A	16 April 2019	EP	3504915	A1	03 July 2019
				US	2020229146	A1	16 July 2020
				US	2018063816	A1	01 March 2018
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				BR	112019003373	A2	21 May 2019
				WO	2018039079	A1	01 March 2018
				JP	2019531640	A	31 October 2019
				CA	3031676	A1	01 March 2018
				KR	20190039721	A	15 April 2019
WO	2020092939	A1	07 May 2020	None			
US	2020137769	A1	30 April 2020	CN	109219024	A	15 January 2019
				EP	3634058	A4	17 June 2020
				EP	3634058	A1	08 April 2020
				WO	2019001286	A1	03 January 2019