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(54) **RESOURCE ALLOCATION IN PRESENCE OF IN-BAND EMISSION FOR NR V2X MOBILE COMMUNICATIONS**

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(52) **U.S. Cl.**

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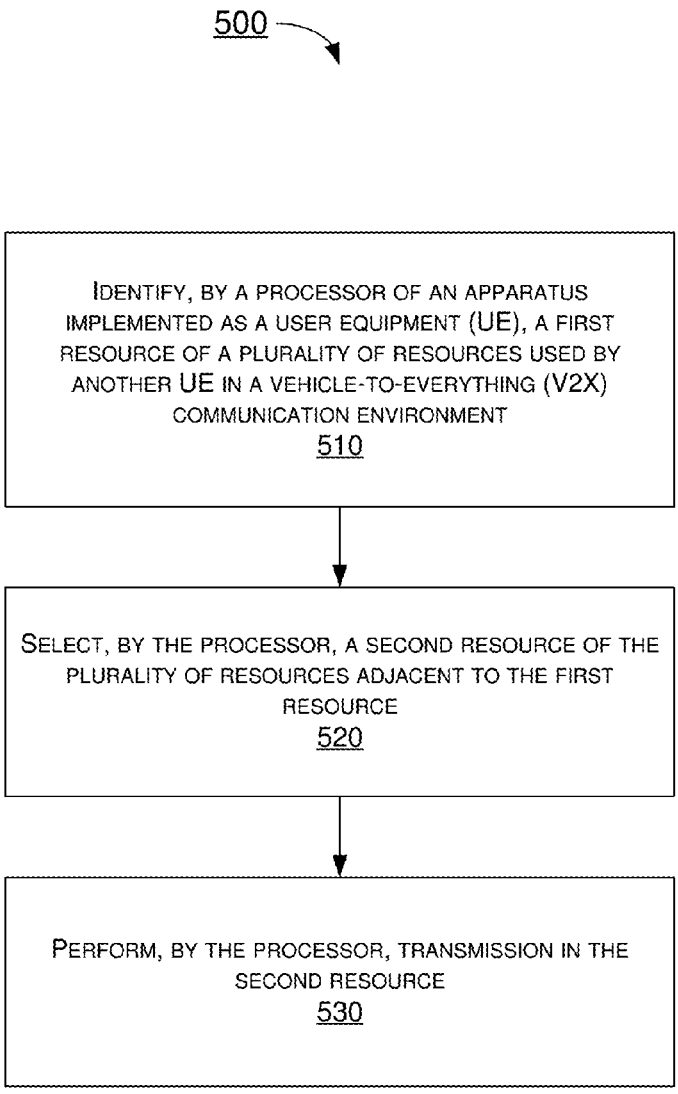
(57) **ABSTRACT**

Various examples and schemes pertaining to resource allocation in presence of in-band emission (IBE) for New Radio (NR) vehicle-to-everything (V2X) mobile communications are described. An apparatus implemented in a user equipment (UE) identifies a first resource of a plurality of resources used by another UE in a vehicle-to-everything (V2X) communication environment. The apparatus selects a second resource of the plurality of resources adjacent to the first resource. Then, the apparatus performs transmission in the second resource.



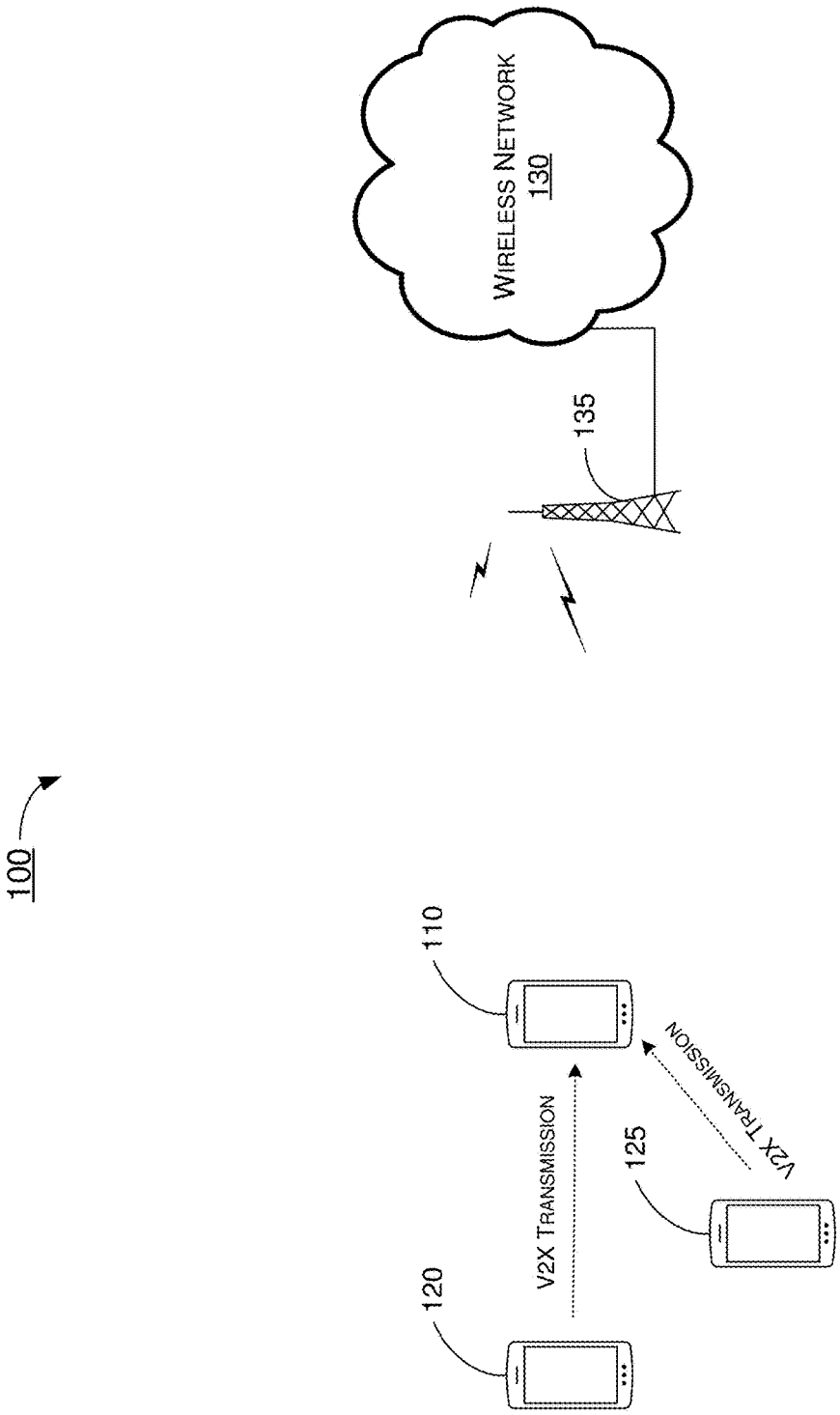

100
WIRELESS NETWORK
130
135
110
120
125
V2X TRANSMISSION
V2X TRANSMISSION

FIG. 1

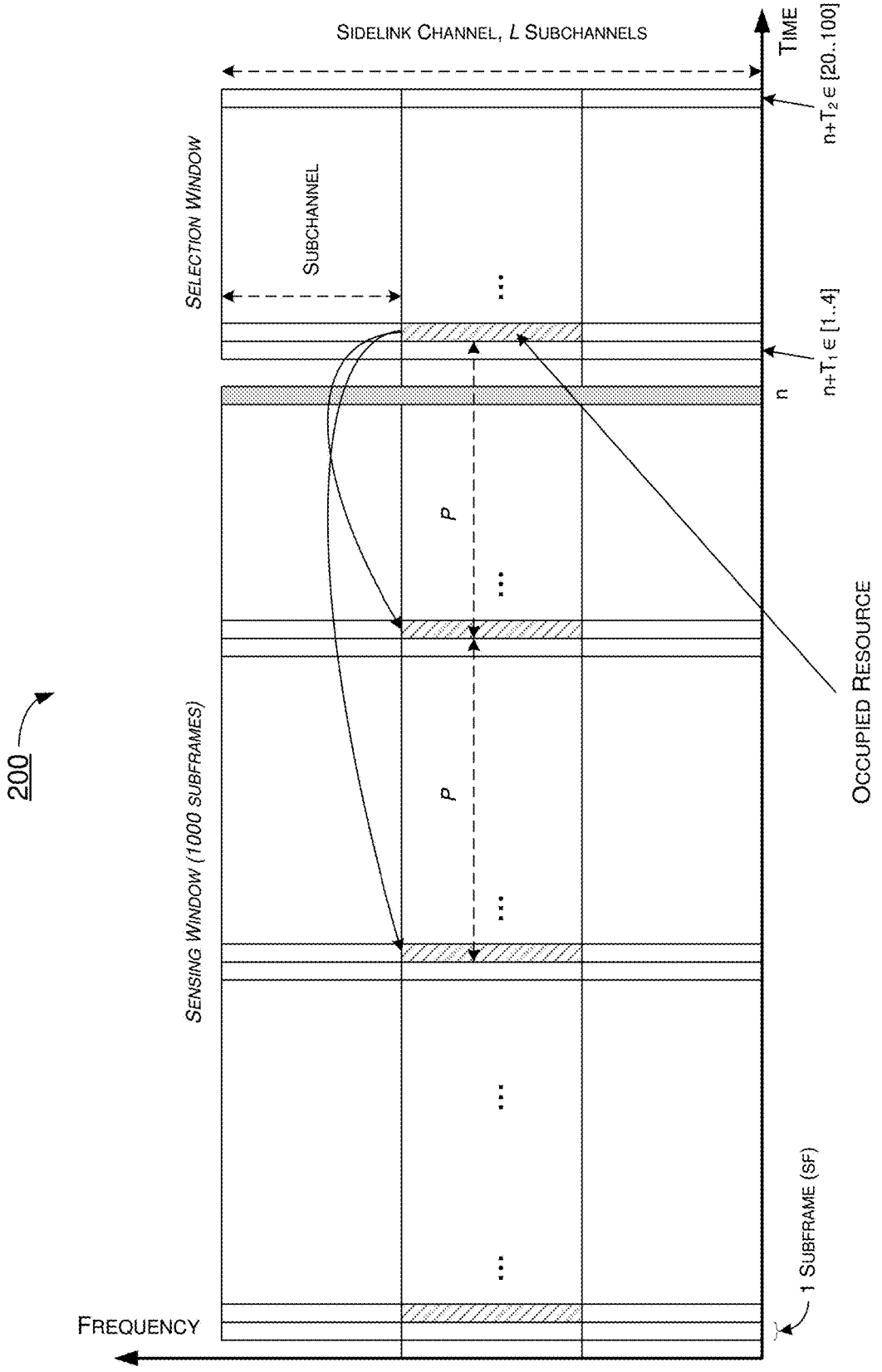

200
SIDELINK CHANNEL, L SUBCHANNELS
TIME
n+T2 ∈ [20..100]
SELECTION WINDOW
SUBCHANNEL
n+T1 ∈ [1..4]
n
P
P
OCCUPIED RESOURCE
SENSING WINDOW (1000 SUBFRAMES)
1 SUBFRAME (SF)
FREQUENCY

FIG. 2

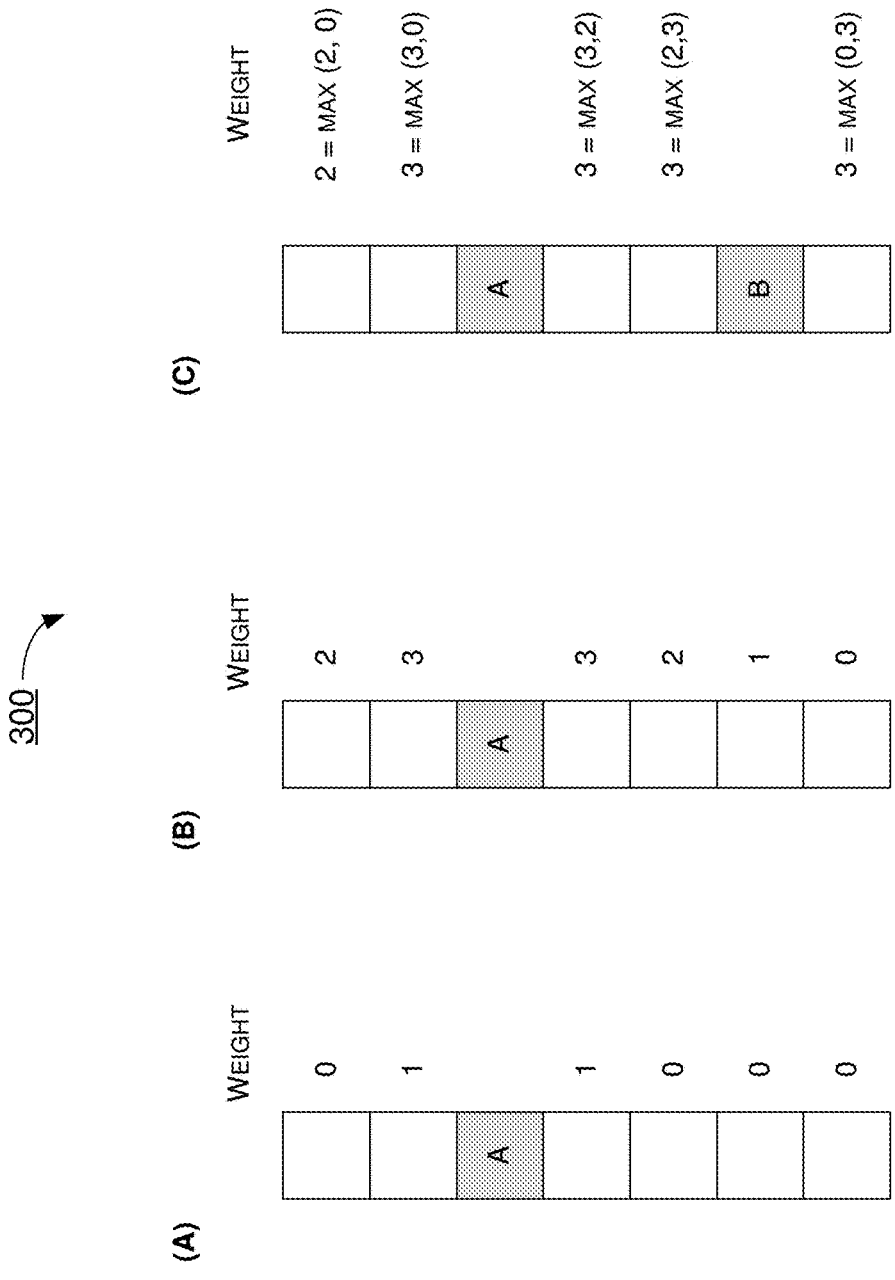

300
(A)
WEIGHT
0
1
A
1
0
0
0
(B)
WEIGHT
2
3
A
3
2
1
0
(C)
WEIGHT
2 = MAX (2, 0)
3 = MAX (3,0)
A
3 = MAX (3,2)
3 = MAX (2,3)
B
3 = MAX (0,3)
NOTE: A AND B ARE SUBCHANNELS WITH POWER GREATER THAN THRESHOLD P_h

FIG. 3

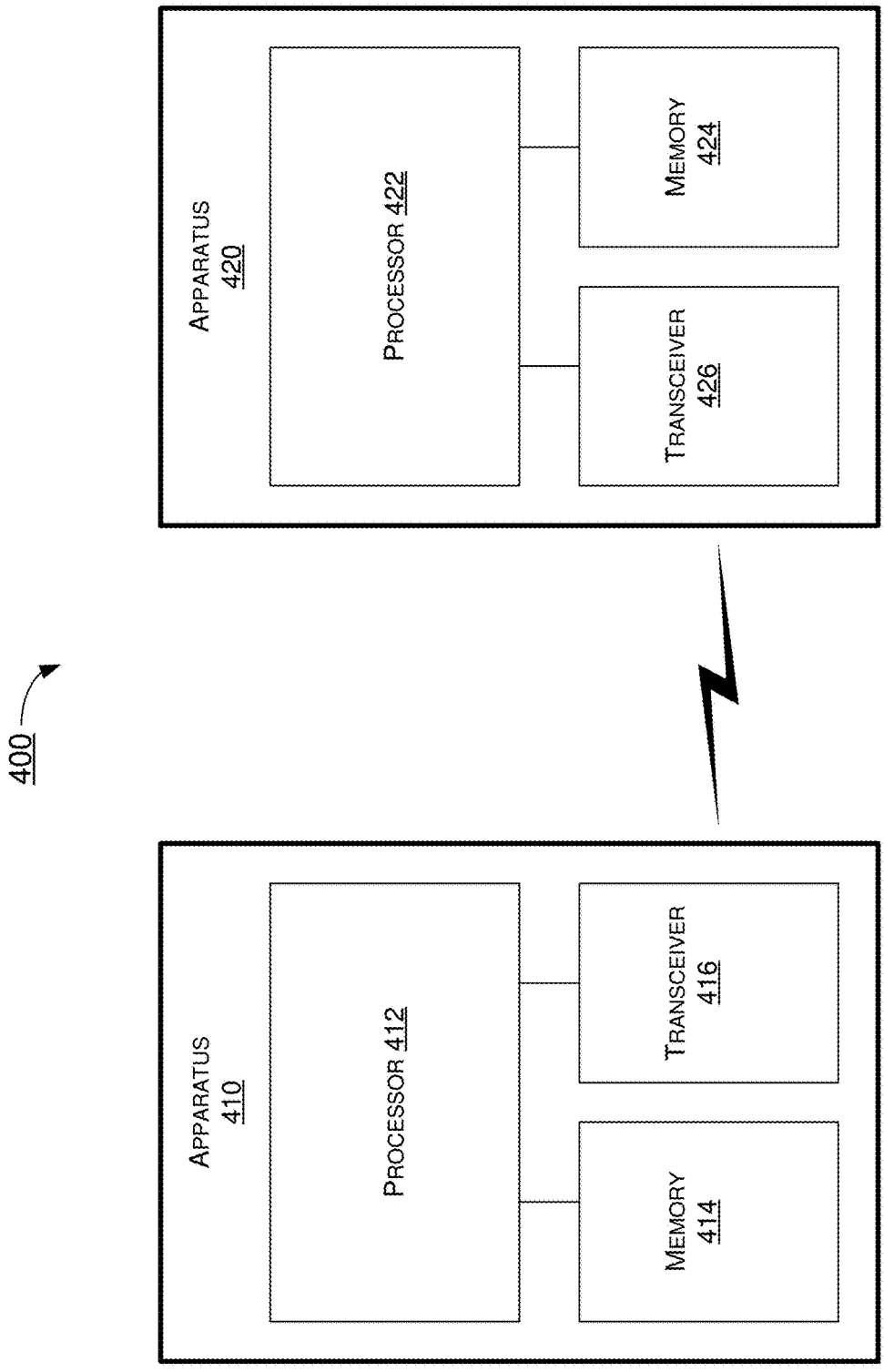

400
APPARATUS 420
PROCESSOR 422
MEMORY 424
TRANSCEIVER 426
APPARATUS 410
PROCESSOR 412
TRANSCEIVER 416
MEMORY 414

FIG. 4

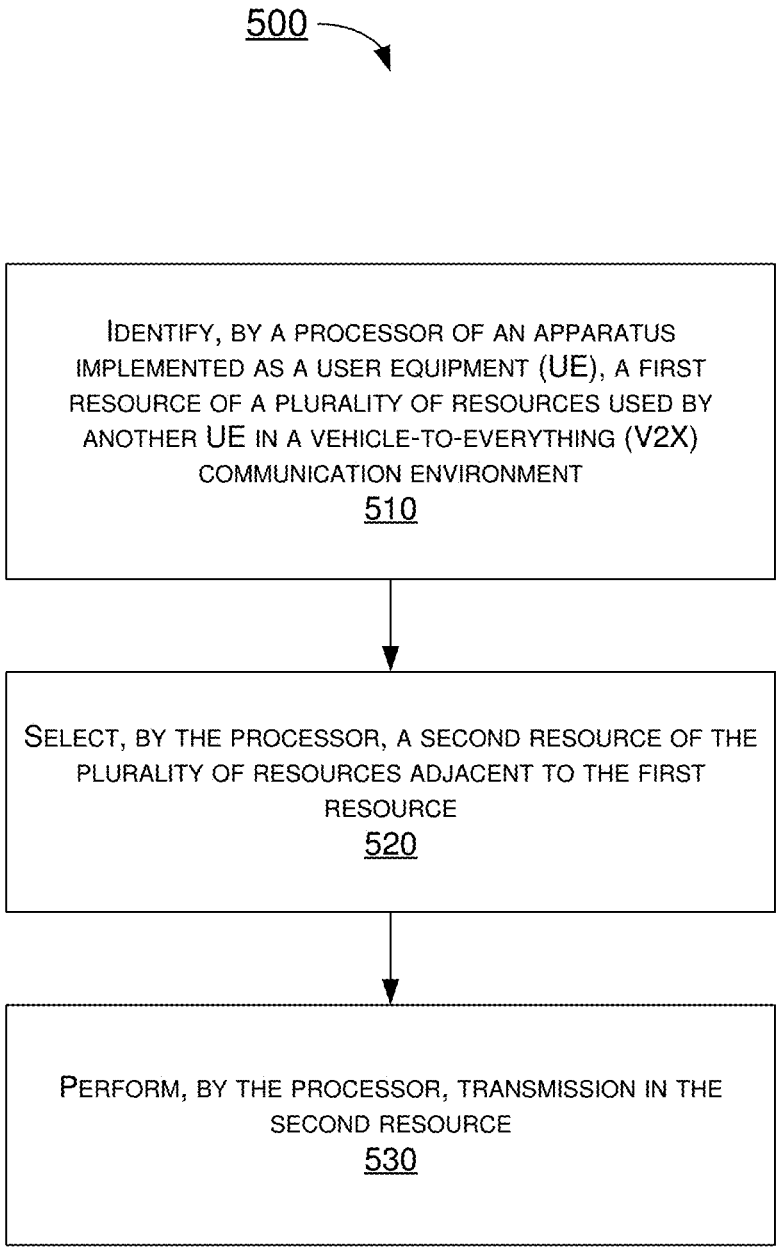

500
IDENTIFY, BY A PROCESSOR OF AN APPARATUS IMPLEMENTED AS A USER EQUIPMENT (UE), A FIRST RESOURCE OF A PLURALITY OF RESOURCES USED BY ANOTHER UE IN A VEHICLE-TO-EVERYTHING (V2X) COMMUNICATION ENVIRONMENT
510
SELECT, BY THE PROCESSOR, A SECOND RESOURCE OF THE PLURALITY OF RESOURCES ADJACENT TO THE FIRST RESOURCE
520
PERFORM, BY THE PROCESSOR, TRANSMISSION IN THE SECOND RESOURCE
530

FIG. 5

RESOURCE ALLOCATION IN PRESENCE OF IN-BAND EMISSION FOR NR V2X MOBILE COMMUNICATIONS

CROSS REFERENCE TO RELATED PATENT APPLICATION(S)

[0001] The present disclosure is part of a non-provisional application claiming the priority benefit of U.S. Patent Application No. 62/791,117, filed on 11 Jan. 2019, the content of which being incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure is generally related to wireless communications and, more particularly, to techniques pertaining to resource allocation in presence of in-band emission (IBE) for New Radio (NR) vehicle-to-everything (V2X) mobile communications.

BACKGROUND

[0003] Unless otherwise indicated herein, approaches described in this section are not prior art to the claims listed below and are not admitted as prior art by inclusion in this section.

[0004] In general, the transmission power in a broadcasting system is nearly constant from one user equipment (UE) to another. Consequently, the received power of a signal from a near UE tends to be greater than the received power of a signal from a distant UE. In enhanced mobile broadband (eMBB), a base station (BS) can use power control to adjust the transmission power of a given UE so that signals received by the BS from different UEs can be received at similar received power levels. However, power control is not suitable in the context of V2X mobile communications. For instance, with IBE, a signal from a distant UE may be interfered by a signal from a near UE when adjacent time-frequency resources are used by the distant UE and the near UE. Consequently, IBE can negatively impact system performance in V2X mobile communications.

SUMMARY

[0005] The following summary is illustrative only and is not intended to be limiting in any way. That is, the following summary is provided to introduce concepts, highlights, benefits and advantages of the novel and non-obvious techniques described herein. Select implementations are further described below in the detailed description. Thus, the following summary is not intended to identify essential features of the claimed subject matter, nor is it intended for use in determining the scope of the claimed subject matter.

[0006] The present disclosure aims to propose concepts, solutions, schemes, techniques, designs, methods and apparatus pertaining to resource allocation in presence of IBE for NR V2X mobile communications. In particular, various proposed schemes in accordance with the present disclosure may allocate adjacent time-frequency resources for nearby UEs in a V2X network.

[0007] In one aspect, a method may involve a processor of an apparatus implemented in a UE, identifying a first resource of a plurality of resources used by another UE in a V2X communication environment. The method may also involve the processor selecting a second resource of the plurality of resources adjacent to the first resource. The method may further involve the processor performing transmission in the second resource.

[0008] In another aspect, an apparatus implemented as a UE may include a communication device and a processor coupled to the communication device. The communication device may be configured to communicate wirelessly in a V2X communication environment. The processor may be configured to identify a first resource of a plurality of resources used by another UE. The processor may also be configured to select a second resource of the plurality of resources adjacent to the first resource. The processor may further be configured to performing, via the communication device, transmission in the second resource.

[0009] It is noteworthy that, although description provided herein may be in the context of certain radio access technologies, networks and network topologies such as NR V2X, the proposed concepts, schemes and any variation(s)/derivative(s) thereof may be implemented in, for and by other types of radio access technologies, networks and network topologies such as, for example and without limitation, 5^{th} Generation (5G), Long-Term Evolution (LTE), LTE-Advanced, LTE-Advanced Pro and any future-developed networks and technologies. Thus, the scope of the present disclosure is not limited to the examples described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The accompanying drawings are included to provide a further understanding of the disclosure and are incorporated in and constitute a part of the present disclosure. The drawings illustrate implementations of the disclosure and, together with the description, serve to explain the principles of the disclosure. It is appreciable that the drawings are not necessarily in scale as some components may be shown to be out of proportion than the size in actual implementation in order to clearly illustrate the concept of the present disclosure.

[0011] FIG. **1** is a diagram of an example network environment in which various solutions and schemes in accordance with the present disclosure may be implemented.

[0012] FIG. **2** is a diagram of an example scenario in accordance with an implementation of the present disclosure may be implemented.

[0013] FIG. **3** is a diagram of an example scenario in accordance with an implementation of the present disclosure may be implemented.

[0014] FIG. **4** is a block diagram of an example communication system in accordance with an implementation of the present disclosure.

[0015] FIG. **5** is a flowchart of an example process in accordance with an implementation of the present disclosure.

DETAILED DESCRIPTION OF PREFERRED IMPLEMENTATIONS

[0016] Detailed embodiments and implementations of the claimed subject matters are disclosed herein. However, it shall be understood that the disclosed embodiments and implementations are merely illustrative of the claimed subject matters which may be embodied in various forms. The present disclosure may, however, be embodied in many different forms and should not be construed as limited to the exemplary embodiments and implementations set forth

herein. Rather, these exemplary embodiments and implementations are provided so that description of the present disclosure is thorough and complete and will fully convey the scope of the present disclosure to those skilled in the art. In the description below, details of well-known features and techniques may be omitted to avoid unnecessarily obscuring the presented embodiments and implementations.

Overview

[0017] Implementations in accordance with the present disclosure relate to various techniques, methods, schemes and/or solutions pertaining to resource allocation in presence of IBE for NR V2X mobile communications. According to the present disclosure, a number of possible solutions may be implemented separately or jointly. That is, although these possible solutions may be described below separately, two or more of these possible solutions may be implemented in one combination or another.

[0018] FIG. **1** illustrates an example network environment **100** in which various solutions and schemes in accordance with the present disclosure may be implemented. FIG. **2** illustrates an example scenario **200** in accordance with an implementation of the present disclosure may be implemented. FIG. **3** illustrates an example scenario **300** in accordance with an implementation of the present disclosure may be implemented. Each of scenario **200** and scenario **300** may be implemented in network environment **100**.

[0019] Referring to FIG. **1**, network environment **100** may be an NR V2X communication environment involving a first UE **110**, a second UE **120**, a third UE **125**. Optionally, network environment **100** may also involve and a wireless network **130**. Wireless network **130** may be in wireless communication with one or more of first UE **110**, second UE **120** and third UE **125** via a base station **135** (e.g., an eNB, gNB or transmit/receive point (TRP)). First UE **110** may be in wireless communication with second UE **120** and third UE **125** via a first NR sidelink and a second NR sidelink, respectively. Each of first UE **110**, second UE **120** and third UE **125** may be in or as a part of, for example and without limitation, a portable apparatus (e.g., smartphone), a vehicle or a component thereof, a roadside unit (RSU) (e.g., a traffic signal, a street lamp, a roadside sensor or a roadside structure) or an Internet of Thing (IoT) device (e.g., a sensor). In network environment **100**, first UE **110**, second UE **120**, third UE **125** and wireless network **130** (via base station **135**) may implement various schemes pertaining to resource allocation in presence of IBE for NR V2X mobile communications in accordance with the present disclosure, as described below. It is noteworthy that, although FIG. **1** shows first UE **110** simultaneously in communication with second UE **120** and third UE **125** via NR sidelinks, in various scenarios first UE **110** may be simultaneously in communication with a different number (e.g., more than two) UEs via NR sidelinks while implementing one or more proposed schemes in accordance with the present disclosure.

[0020] Referring to FIG. **2**, in NR V2X in network environment **100**, first UE **110** may identify one or more occupied time-frequency resources by performing a sensing procedure, as shown in FIG. **2**, and then select all or part of the available time-frequency resources that can fit within a size of a transmission of sidelink control information (SCI) and data payload(s). First UE **110** may then pass this information to its medium access control (MAC) layer to perform resource selection/allocation. In scenario **200**, there may be a quantity of L of subchannels in a sidelink channel. As shown in FIG. **2**, a given time-frequency resource within a certain subchannel and during a certain subframe may be identified by first UE **110** as occupied (e.g., used for transmission by second UE **120** and/or third UE **125**). First UE **110** may then perform resource selection based on a result of the sensing as described below with reference to FIG. **2**.

[0021] Under a proposed scheme in accordance with the present disclosure, first UE **110** may set a selection window as $[n+T_1, n+T_2]$ and continuously monitor decoded SCI within the selection window. From the decoded SCI, first UE **110** may identify occupied time-frequency resource(s) and reserved time-frequency resource(s). First UE **110** may also set a signal power threshold to be P_{Th} and initialize sets S_A and S_B as complete and empty sets, respectively. First UE **110** may exclude all single-slot candidate resources in case first UE **110** has not monitored corresponding resources in the selection window. Out of all remaining single-slot candidate resources, first UE **110** may exclude those that are reserved or those in which a Physical Sidelink Shared Channel (PSSCH) and/or Physical Sidelink Control Channel (PSCCH) reference signal received power (RSRP) measurement is higher than P_{Th}. In an event that the remaining single-slot candidate resources are less than a predetermined percentage (e.g., 20%) of total resources, first UE **110** may increase the power threshold P_{Th} by a predetermined amount (e.g., 3 dB) and repeat the exclusion process. Under the proposed scheme, first UE **110** may move the resultant predetermined percentage (e.g., 20%) of single-slot candidate resources in set S_A to set S_B which is reported to higher layer(s). Moreover, under the proposed scheme, the MAC layer of first UE **110** may select a candidate resource from set S_B to be used for transmission.

[0022] Under the proposed scheme, in reporting to higher layer(s) the resultant predetermined percentage (e.g., 20%) of single-slot candidate resources that are moved from set S_A to set S_B, first UE **110** may report those single-slot candidate resources each with a respective weighting function or weighting value w^f_i. This may be achieved under one of several options. Under a first option (or option **1**), the MAC layer may select a candidate resource of set S_B with a non-zero weighting value for transmission. Under a second option (or option **2**), the MAC layer may select a candidate resource of set S_B based on the respective weighting value of each resource in set S_B being proportional to a probability for transmission (e.g., the higher probability for transmission the higher the likelihood of selection).

[0023] With respect to resource selection in the presence of IBE, first UE **110** may perform certain operations in accordance with the present disclosure. Description below is provided with reference to FIG. **3**. For instance, first UE **110** may set a power threshold P_{Th}, which may be dynamically configured by wireless network **130** (via base station **135**), pre-configured by wireless network **130** (via base station **135**) or determined by first UE **110** based on its transmission power. First UE **110** may initialize or otherwise set the weighting value of all subchannels in set S_B to a predetermined value (e.g., 0 or 1). In an event that PSSCH or PSCCH of a subchannel i is greater than P_{Th}, first UE **110** may take either of two actions.

[0024] For instance, first UE **110** may set the weighting values $w_{i,\,i-1}$ and $w_{i,\,i+1}$ of neighboring subchannels i−1 and i+1 (which are adjacent to and on two opposite sides of subchannel i) as a predetermined value (e.g., 1 or X),

respectively. Referring to the example shown in part (A) of FIG. **3**, first UE **110** may, upon sensing a power level in subchannel A being greater than P_{Th}, determine subchannel A as an occupied resource. Accordingly, first UE **110** may increment the weighting values of the two neighboring subchannels (subchannels A−1 and A+1) that are adjacent to and on two opposite sides of subchannel A from 0 to 1, assuming the respective weighting value of each subchannel was initially set to an initial value of 0.

[0025] Alternatively, first UE **110** may set the weighting values of neighboring subchannels such that, on each of the two opposite sides of subchannel i, the respective weighting value of an adjacent resource is increased by a first amount and a next adjacent resource is increased by a second amount smaller than the first amount. For instance, first UE **110** may set the weighting values of neighboring subchannels in a cascading fashion (e.g., $w_{i,\ i-1}$=a, $w_{i,\ i-2}$=a−1, $w_{i,\ i-3}$=a−2, and so on). Referring to the example shown in part (B) of FIG. **3**, first UE **110** may, upon sensing a power level in subchannel A being greater than P_{Th}, determine subchannel A as an occupied resource. Accordingly, first UE **110** may set the weighting values of neighboring subchannels of subchannel A in a cascading fashion. Specifically, for each of the two neighboring subchannels (subchannels A−1 and A+1) that are adjacent to and on two opposite sides of subchannel A, first UE **110** may set the respective weighting value to 3, assuming the respective weighting value of each subchannel was initially set to 0. Additionally, for the next adjacent subchannels on the two opposite sides (subchannels A−2 and A+2), first UE **110** may set the respective weighting value to 2, assuming the respective weighting value of each subchannel was initially set to 0. Moreover, for the still next adjacent subchannels on the two opposite sides (subchannels A−3 and A+3), first UE **110** may set the respective weighting value to 1, assuming the respective weighting value of each subchannel was initially set to 0.

[0026] Referring to the example shown in part (C) of FIG. **3**, first UE **110** may, upon sensing a respective power level in each of subchannel A and subchannel B being greater than P_{Th}, determine each of subchannel A and subchannel B as an occupied resource. In this example, first UE **110** may set the weighting values of neighboring subchannels of each of subchannel A and subchannel B in a cascading fashion as described above respective to each of subchannel A and subchannel B. Then, first UE **110** may calculate a combined weighting value of each subchannel. For instance, first UE **110** may calculate a combined weighting value of each subchannel by using a maximum function (e.g., $w^{f}_{i}=\max_{j}(w_{j,\ i})$). Alternatively, first UE **110** may calculate a combined weighting value of each subchannel by using linear combination.

[0027] Under the proposed scheme, with respect to resource selection in the presence of IBE, first UE **110** may perform resource selection by one of multiple approaches upon having identified one or more occupied subchannels in set S_B and having determined the combined weighting value of neighboring subchannels of the occupied subchannel(s). Under a first approach, first UE **110** may form a set of subchannels with weighting values greater than the initial value (e.g., 0), and first UE **110** may, at the MAC layer, select a candidate subchannel from the set. Under a second approach, first UE **110** may sort the subchannels in set S_B by their weighting values (e.g., in a descending order from high to low). First UE **110** may then pick a top predetermined percentage (e.g., top Y %) of the sorted subchannels for random selection. Alternatively, first UE **110** may select the subchannel with the largest weighting value or select the subchannel from a group of subchannels with the largest weighting value (when there are more than one subchannel with the same largest weighting value). Under a third approach, first UE **110** may, at the MAC layer, select the subchannel based on the respective weighting value of each subchannel being proportional to a probability value. As an example, given ten subchannels with subchannels 2 and 4 having a weighting value of X=5, which is higher than that of other subchannels, first UE **110** may select subchannels 2 and 4, as each of subchannels 2 and 4 has a probability of 5/18 while each of the remaining eight subchannels has a probability of 1/18.

Illustrative Implementations

[0028] FIG. **4** illustrates an example communication system **400** having an example apparatus **410** and an example apparatus **420** in accordance with an implementation of the present disclosure. Each of apparatus **410** and apparatus **420** may perform various functions to implement schemes, techniques, processes and methods described herein pertaining to resource allocation in presence of IBE for NR V2X mobile communications, including various schemes described above as well as processes described below.

[0029] Each of apparatus **410** and apparatus **420** may be a part of an electronic apparatus, which may be a UE such as a vehicle, a portable or mobile apparatus, a wearable apparatus, a wireless communication apparatus or a computing apparatus. For instance, each of apparatus **410** and apparatus **420** may be implemented in an electronic control unit (ECU) of a vehicle, a smartphone, a smartwatch, a personal digital assistant, a digital camera, or a computing equipment such as a tablet computer, a laptop computer or a notebook computer. Each of apparatus **410** and apparatus **420** may also be a part of a machine type apparatus, which may be an IoT or NB-IoT apparatus such as an immobile or a stationary apparatus, a home apparatus, a wire communication apparatus or a computing apparatus. For instance, each of apparatus **410** and apparatus **420** may be implemented in a smart thermostat, a smart fridge, a smart door lock, a wireless speaker or a home control center. Alternatively, each of apparatus **410** and apparatus **420** may be implemented in the form of one or more integrated-circuit (IC) chips such as, for example and without limitation, one or more single-core processors, one or more multi-core processors, one or more multi-core processors, one or more reduced-instruction set computing (RISC) processors, or one or more complex-instruction-set-computing (CISC) processors. Each of apparatus **410** and apparatus **420** may include at least some of those components shown in FIG. **4** such as a processor **412** and a processor **422**, respectively. Each of apparatus **410** and apparatus **420** may further include one or more other components not pertinent to the proposed scheme of the present disclosure (e.g., internal power supply, display device and/or user interface device), and, thus, such component(s) of each of apparatus **410** and apparatus **420** are neither shown in FIG. **4** nor described below in the interest of simplicity and brevity.

[0030] In some implementations, at least one of apparatus **410** and apparatus **420** may be a part of an electronic apparatus, which may be a vehicle, a roadside unit (RSU), network node or base station (e.g., eNB, gNB or TRP), a

small cell, a router or a gateway. For instance, at least one of apparatus **410** and apparatus **420** may be implemented in a vehicle in a vehicle-to-vehicle (V2V) or V2X network, an eNodeB in an LTE, LTE-Advanced or LTE-Advanced Pro network or in a gNB in a 5G, NR, IoT or NB-IoT network. Alternatively, at least one of apparatus **410** and apparatus **420** may be implemented in the form of one or more IC chips such as, for example and without limitation, one or more single-core processors, one or more multi-core processors, or one or more RISC or CISC processors.

[0031] In one aspect, each of processor **412** and processor **422** may be implemented in the form of one or more single-core processors, one or more multi-core processors, or one or more RISC or CISC processors. That is, even though a singular term "a processor" is used herein to refer to processor **412** and processor **422**, each of processor **412** and processor **422** may include multiple processors in some implementations and a single processor in other implementations in accordance with the present disclosure. In another aspect, each of processor **412** and processor **422** may be implemented in the form of hardware (and, optionally, firmware) with electronic components including, for example and without limitation, one or more transistors, one or more diodes, one or more capacitors, one or more resistors, one or more inductors, one or more memristors and/or one or more varactors that are configured and arranged to achieve specific purposes in accordance with the present disclosure. In other words, in at least some implementations, each of processor **412** and processor **422** is a special-purpose machine specifically designed, arranged and configured to perform specific tasks including resource allocation in presence of IBE for NR V2X mobile communications in accordance with various implementations of the present disclosure.

[0032] In some implementations, apparatus **410** may also include a transceiver **416**, as a communication device, coupled to processor **412** and capable of wirelessly transmitting and receiving data. In some implementations, apparatus **410** may further include a memory **414** coupled to processor **412** and capable of being accessed by processor **412** and storing data therein. In some implementations, apparatus **420** may also include a transceiver **426**, as a communication device, coupled to processor **422** and capable of wirelessly transmitting and receiving data. In some implementations, apparatus **420** may further include a memory **424** coupled to processor **422** and capable of being accessed by processor **422** and storing data therein. Accordingly, apparatus **410** and apparatus **420** may wirelessly communicate with each other via transceiver **416** and transceiver **426**, respectively.

[0033] To aid better understanding, the following description of the operations, functionalities and capabilities of each of apparatus **410** and apparatus **420** is provided in the context of an NR V2X communication environment in which apparatus **410** is implemented in or as a wireless communication device, a communication apparatus or a UE (e.g., first UE **110**) and apparatus **420** is implemented in or as another UE (e.g., second UE **120** or third UE **125**) in network environment **100**.

[0034] In one aspect of resource allocation in presence of IBE for NR V2X mobile communications in accordance with the present disclosure, processor **412** of apparatus **410** identify, via transceiver **416**, a first resource of a plurality of resources used by another UE in a V2X communication environment. Additionally, processor **412** may select a second resource of the plurality of resources adjacent to the first resource. Moreover, processor **412** may perform, via transceiver **416**, transmission in the second resource.

[0035] In some implementations, each of the plurality of resources may include subchannels. In such cases, the second resource may be adjacent the first resource in a frequency domain.

[0036] In some implementations, in identifying the first resource of the plurality of resources, processor **412** may perform certain operations. For instance, processor **412** may exclude, from the plurality of resources, a first subset of one or more resources and a second subset of one or more resources to result in a remaining subset of resources of the plurality of resources, with the first subset of one or more resources not having been monitored and with each resource of the second subset of one or more resources being reserved or having a respective measured PSSCH or PSCCH reference signal received power (RSRP) higher than a power threshold. In an event that the remaining subset of resources comprise less than a predetermined percentage (e.g., 20% or 25%) of the plurality of resources, processor **412** may increase the power threshold by a predefined amount to exclude the second subset of one or more resources from the plurality of resources. Additionally, processor **412** may report the remaining subset of resources, which includes the first resource, to a higher layer with each resource of the remaining subset of resources associated a respective weighting value.

[0037] In some implementations, in selecting the second resource of the plurality of resources, processor **412** may perform certain operations. For instance, processor **412** may select the second resource from one or more resources of the remaining subset of resources each of which being associated with a non-zero weighting value. Alternatively, processor **412** may select the second resource based on the respective weighting value of each resource of the remaining subset of resources.

[0038] In some implementations, in identifying the first resource of the plurality of resources, processor **412** may perform additional operations. For instance, processor **412** may set the power threshold based on a configuration received from a network, based on preconfigured information, or based on a transmission power of first UE **110**. Moreover, processor **412** may initialize the respective weighting values of each resource of the remaining subset of resources to an initial value.

[0039] In some implementations, in selecting the second resource of the plurality of resources, processor **412** may increase the weighting values of adjacent resources on two opposite sides in a frequency domain of each resource having the respective measured PSSCH or PSCCH RSRP higher than the power threshold.

[0040] In some implementations, in increasing the weighting values of the adjacent resources, processor **412** may increase the respective weighting value of each of two adjacent resources on the two opposite sides by a predefined amount. Alternatively, in increasing the weighting values of the adjacent resources, processor **412** may increase weighting values of one or more resources on each of the two opposite sides such that, on each of the two sides, the respective weighting value of an adjacent resource is increased by a first amount and a next adjacent resource is increased by a second amount smaller than the first amount.

[0041] In some implementations, in selecting the second resource of the plurality of resources, processor **412** may perform additional operations. For instance, processor **412** may calculate a respective combined weighting value of each resource of the remaining subset of resources. Furthermore, processor **412** may select the second resource based on the combined weighing values of the remaining subset of resources.

[0042] In some implementations, in calculating the respective combined weighting value of each resource of the remaining subset of resources, processor **412** may calculate the respective combined weighting value of each resource of the remaining subset of resources using a maximum function or linear combination. In such cases, in selecting the second resource based on the combined weighing values of the remaining subset of resources, processor **412** may take one of multiple approaches.

[0043] Under a first approach, processor **412** may perform a first selection procedure. For instance, processor **412** may identify one or more resources from the remaining subset of resources with each having the respective combined weighting value greater than 0. Additionally, processor **412** may select the second resource from the one or more resources.

[0044] Under a second approach, processor **412** may perform a second selection procedure. For instance, processor **412** may sort the remaining subset of resources in a descending order by the combined weighting values. Moreover, processor **412** may select the second resource from the remaining subset of resources by performing one of: (a) selecting the second resource from a top predetermined percentile of resources of the sorted one or more resources; (b) selecting the second resource responsive to the second resource having the largest respective combined weighting value than that of other resources of the remaining subset of resources; and (c) selecting the second resource from one or more resources having the respective combined weighting values larger than that of other resources of the remaining subset of resources.

[0045] Under a third approach, processor **412** may perform a third selection procedure. For instance, processor **412** may select the second resource based on the respective combined weighting value of each resource of the remaining subset of resources. For instance, each respective combined weighting value may be representative of a probability and, accordingly, the higher the combined weighting value the higher the probability it is for selection for transmission.

Illustrative Processes

[0046] FIG. **5** illustrates an example process **500** in accordance with an implementation of the present disclosure. Process **500** may be an example implementation of the proposed schemes described above with respect to resource allocation in presence of IBE for NR V2X mobile communications in accordance with the present disclosure. Process **500** may represent an aspect of implementation of features of apparatus **410** and apparatus **420**. Process **500** may include one or more operations, actions, or functions as illustrated by one or more of blocks **510**, **520** and **530**. Although illustrated as discrete blocks, various blocks of process **500** may be divided into additional blocks, combined into fewer blocks, or eliminated, depending on the desired implementation. Moreover, the blocks of process **500** may executed in the order shown in FIG. **5** or, alternatively, in a different order. Process **500** may also be repeated partially or entirely. Process **500** may be implemented by apparatus **410**, apparatus **420** and/or any suitable wireless communication device, UE, RSU, base station or machine type devices. Solely for illustrative purposes and without limitation, process **500** is described below in the context of apparatus **410** as a UE (e.g., first UE **110**) and apparatus **420** as another UE (e.g., second UE **120** or third UE **125**) in an NR V2X mobile communication environment (e.g., network environment **100**). Process **500** may begin at block **510**.

[0047] At **510**, process **500** may involve processor **412** of apparatus **410** (e.g., implemented in first UE **110**) identifying, via transceiver **416**, a first resource of a plurality of resources used by another UE in a V2X communication environment. Process **500** may proceed from **510** to **520**.

[0048] At **520**, process **500** may involve processor **412** selecting a second resource of the plurality of resources adjacent to the first resource. Process **500** may proceed from **520** to **530**.

[0049] At **530**, process **500** may involve processor **412** performing, via transceiver **416**, transmission in the second resource.

[0050] In some implementations, each of the plurality of resources may include subchannels. In such cases, the second resource may be adjacent the first resource in a frequency domain.

[0051] In some implementations, in identifying the first resource of the plurality of resources, process **500** may involve processor **412** performing certain operations. For instance, process **500** may involve processor **412** excluding, from the plurality of resources, a first subset of one or more resources and a second subset of one or more resources to result in a remaining subset of resources of the plurality of resources, with the first subset of one or more resources not having been monitored and with each resource of the second subset of one or more resources being reserved or having a respective measured PSSCH or PSCCH reference signal received power (RSRP) higher than a power threshold. In an event that the remaining subset of resources comprise less than a predetermined percentage (e.g., 20% or 25%) of the plurality of resources, process **500** may involve processor **412** increasing the power threshold by a predefined amount to exclude the second subset of one or more resources from the plurality of resources. Additionally, process **500** may involve processor **412** reporting the remaining subset of resources, which includes the first resource, to a higher layer with each resource of the remaining subset of resources associated a respective weighting value.

[0052] In some implementations, in selecting the second resource of the plurality of resources, process **500** may involve processor **412** performing certain operations. For instance, process **500** may involve processor **412** selecting the second resource from one or more resources of the remaining subset of resources each of which being associated with a non-zero weighting value. Alternatively, process **500** may involve processor **412** selecting the second resource based on the respective weighting value of each resource of the remaining subset of resources.

[0053] In some implementations, in identifying the first resource of the plurality of resources, process **500** may involve processor **412** performing additional operations. For instance, process **500** may involve processor **412** setting the power threshold based on a configuration received from a network, based on preconfigured information, or based on a transmission power of first UE **110**. Moreover, process **500**

may involve processor **412** initializing the respective weighting values of each resource of the remaining subset of resources to an initial value.

[0054] In some implementations, in selecting the second resource of the plurality of resources, process **500** may also involve processor **412** increasing the weighting values of adjacent resources on two opposite sides in a frequency domain of each resource having the respective measured PSSCH or PSCCH RSRP higher than the power threshold.

[0055] In some implementations, in increasing the weighting values of the adjacent resources, process **500** may involve processor **412** increasing the respective weighting value of each of two adjacent resources on the two opposite sides by a predefined amount. Alternatively, in increasing the weighting values of the adjacent resources, process **500** may involve processor **412** increasing weighting values of one or more resources on each of the two opposite sides such that, on each of the two sides, the respective weighting value of an adjacent resource is increased by a first amount and a next adjacent resource is increased by a second amount smaller than the first amount.

[0056] In some implementations, in selecting the second resource of the plurality of resources, process **500** may involve processor **412** performing additional operations. For instance, process **500** may involve processor **412** calculating a respective combined weighting value of each resource of the remaining subset of resources. Furthermore, process **500** may involve processor **412** selecting the second resource based on the combined weighing values of the remaining subset of resources.

[0057] In some implementations, in calculating the respective combined weighting value of each resource of the remaining subset of resources, process **500** may involve processor **412** calculating the respective combined weighting value of each resource of the remaining subset of resources using a maximum function or linear combination. In such cases, in selecting the second resource based on the combined weighing values of the remaining subset of resources, process **500** may involve processor **412** taking one of multiple approaches.

[0058] Under a first approach, process **500** may involve processor **412** performing a first selection procedure. For instance, process **500** may involve processor **412** identifying one or more resources from the remaining subset of resources with each having the respective combined weighting value greater than 0. Additionally, process **500** may involve processor **412** selecting the second resource from the one or more resources.

[0059] Under a second approach, process **500** may involve processor **412** performing a second selection procedure. For instance, process **500** may involve processor **412** sorting the remaining subset of resources in a descending order by the combined weighting values. Moreover, process **500** may involve processor **412** selecting the second resource from the remaining subset of resources by performing one of: (a) selecting the second resource from a top predetermined percentile of resources of the sorted one or more resources; (b) selecting the second resource responsive to the second resource having the largest respective combined weighting value than that of other resources of the remaining subset of resources; and (c) selecting the second resource from one or more resources having the respective combined weighting values larger than that of other resources of the remaining subset of resources.

[0060] Under a third approach, process **500** may involve processor **412** performing a third selection procedure. For instance, process **500** may involve processor **412** selecting the second resource based on the respective combined weighting value of each resource of the remaining subset of resources. For instance, each respective combined weighting value may be representative of a probability and, accordingly, the higher the combined weighting value the higher the probability it is for selection for transmission.

Additional Notes

[0061] The herein-described subject matter sometimes illustrates different components contained within, or connected with, different other components. It is to be understood that such depicted architectures are merely examples, and that in fact many other architectures can be implemented which achieve the same functionality. In a conceptual sense, any arrangement of components to achieve the same functionality is effectively "associated" such that the desired functionality is achieved. Hence, any two components herein combined to achieve a particular functionality can be seen as "associated with" each other such that the desired functionality is achieved, irrespective of architectures or intermedial components. Likewise, any two components so associated can also be viewed as being "operably connected", or "operably coupled", to each other to achieve the desired functionality, and any two components capable of being so associated can also be viewed as being "operably couplable", to each other to achieve the desired functionality. Specific examples of operably couplable include but are not limited to physically mateable and/or physically interacting components and/or wirelessly interactable and/or wirelessly interacting components and/or logically interacting and/or logically interactable components.

[0062] Further, with respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

[0063] Moreover, it will be understood by those skilled in the art that, in general, terms used herein, and especially in the appended claims, e.g., bodies of the appended claims, are generally intended as "open" terms, e.g., the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc. It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to implementations containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an," e.g., "a" and/or "an" should be interpreted to mean "at least one" or "one or more;" the same holds true for the use of definite articles used to introduce

claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should be interpreted to mean at least the recited number, e.g., the bare recitation of "two recitations," without other modifiers, means at least two recitations, or two or more recitations. Furthermore, in those instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention, e.g., "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc. In those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention, e.g., "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc. It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

[0064] From the foregoing, it will be appreciated that various implementations of the present disclosure have been described herein for purposes of illustration, and that various modifications may be made without departing from the scope and spirit of the present disclosure. Accordingly, the various implementations disclosed herein are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

What is claimed is:

1. A method, comprising:

identifying, by a processor of an apparatus implemented as a user equipment (UE), a first resource of a plurality of resources used by another UE in a vehicle-to-everything (V2X) communication environment;

selecting, by the processor, a second resource of the plurality of resources adjacent to the first resource; and

performing, by the processor, transmission in the second resource.

2. The method of claim **1**, wherein each of the plurality of resources comprise subchannels, and wherein the second resource is adjacent the first resource in a frequency domain.

3. The method of claim **1**, wherein the identifying of the first resource of the plurality of resources comprises:

excluding, from the plurality of resources, a first subset of one or more resources and a second subset of one or more resources to result in a remaining subset of resources of the plurality of resources, with the first subset of one or more resources not having been monitored and with each resource of the second subset of one or more resources being reserved or having a respective measured Physical Sidelink Shared Channel (PSSCH) or Physical Sidelink Control Channel (PSCCH) reference signal received power (RSRP) higher than a power threshold;

in an event that the remaining subset of resources comprise less than a predetermined percentage of the plurality of resources, increasing the power threshold by a predefined amount to exclude the second subset of one or more resources from the plurality of resources; and

reporting the remaining subset of resources, which includes the first resource, to a higher layer with each resource of the remaining subset of resources associated a respective weighting value.

4. The method of claim **3**, wherein the selecting of the second resource of the plurality of resources comprises:

selecting the second resource from one or more resources of the remaining subset of resources each of which being associated with a non-zero weighting value; or

selecting the second resource based on the respective weighting value of each resource of the remaining subset of resources.

5. The method of claim **3**, wherein the identifying of the first resource of the plurality of resources further comprises:

setting the power threshold based on a configuration received from a network, based on preconfigured information, or based on a transmission power of the UE; and

initializing the respective weighting values of each resource of the remaining subset of resources to an initial value.

6. The method of claim **5**, wherein the selecting of the second resource of the plurality of resources comprises increasing the weighting values of adjacent resources on two opposite sides in a frequency domain of each resource having the respective measured PSSCH or PSCCH RSRP higher than the power threshold.

7. The method of claim **6**, wherein the increasing of the weighting values of the adjacent resources comprises increasing the respective weighting value of each of two adjacent resources on the two opposite sides by a predefined amount.

8. The method of claim **6**, wherein the increasing of the weighting values of the adjacent resources comprises increasing weighting values of one or more resources on each of the two opposite sides such that, on each of the two sides, the respective weighting value of an adjacent resource is increased by a first amount and a next adjacent resource is increased by a second amount smaller than the first amount.

9. The method of claim **6**, wherein the selecting of the second resource of the plurality of resources further comprises:

calculating a respective combined weighting value of each resource of the remaining subset of resources; and

selecting the second resource based on the combined weighing values of the remaining subset of resources.

10. The method of claim **9**, wherein the calculating of the respective combined weighting value of each resource of the remaining subset of resources comprises calculating the respective combined weighting value of each resource of the remaining subset of resources using a maximum function or linear combination.

11. The method of claim **9**, wherein the selecting of the second resource based on the combined weighing values of the remaining subset of resources comprises:

identifying one or more resources from the remaining subset of resources with each having the respective combined weighting value greater than 0; and

selecting the second resource from the one or more resources.

12. The method of claim 9, wherein the selecting of the second resource based on the combined weighing values of the remaining subset of resources comprises:
- sorting the remaining subset of resources in a descending order by the combined weighting values; and
- selecting the second resource from the remaining subset of resources by performing one of:
  - selecting the second resource from a top predetermined percentile of resources of the sorted one or more resources;
  - selecting the second resource responsive to the second resource having the largest respective combined weighting value than that of other resources of the remaining subset of resources; and
  - selecting the second resource from one or more resources having the respective combined weighting values larger than that of other resources of the remaining subset of resources.

13. The method of claim 9, wherein the selecting of the second resource based on the combined weighing values of the remaining subset of resources comprises selecting the second resource based on the respective combined weighting value of each resource of the remaining subset of resources.

14. An apparatus implemented as a user equipment (UE), comprising:
- a communication device configured to communicate wirelessly in a vehicle-to-everything (V2X) communication environment; and
- a processor coupled to the communication device such that the processor performs operations comprising:
  - identifying a first resource of a plurality of resources used by another UE;
  - selecting a second resource of the plurality of resources adjacent to the first resource; and
  - performing, via the communication device, transmission in the second resource.

15. The apparatus of claim 14, wherein, in identifying the first resource of the plurality of resources, the processor performs operations comprising:
- excluding, from the plurality of resources, a first subset of one or more resources and a second subset of one or more resources to result in a remaining subset of resources of the plurality of resources, with the first subset of one or more resources not having been monitored and with each resource of the second subset of one or more resources being reserved or having a respective measured Physical Sidelink Shared Channel (PSSCH) or Physical Sidelink Control Channel (PSCCH) reference signal received power (RSRP) higher than a power threshold;
- in an event that the remaining subset of resources comprise less than a predetermined percentage of the plurality of resources, increasing the power threshold by a predefined amount to exclude the second subset of one or more resources from the plurality of resources; and
- reporting the remaining subset of resources, which includes the first resource, to a higher layer with each resource of the remaining subset of resources associated a respective weighting value.

16. The apparatus of claim 15, wherein, in identifying the first resource of the plurality of resources, the processor further performs operations comprising:
- setting the power threshold based on a configuration received from a network, based on preconfigured information, or based on a transmission power of the UE; and
- initializing the respective weighting values of each resource of the remaining subset of resources to an initial value.

17. The apparatus of claim 16, wherein, in selecting the second resource of the plurality of resources, the processor increases the weighting values of adjacent resources on two opposite sides in a frequency domain of each resource having the respective measured PSSCH or PSCCH RSRP higher than the power threshold.

18. The apparatus of claim 17, wherein, in increasing the weighting values of the adjacent resources, the processor performs either of:
- increasing the respective weighting value of each of two adjacent resources on the two opposite sides by a predefined amount; and
- increasing weighting values of one or more resources on each of the two opposite sides such that, on each of the two sides, the respective weighting value of an adjacent resource is increased by a first amount and a next adjacent resource is increased by a second amount smaller than the first amount.

19. The apparatus of claim 17, wherein, in selecting the second resource of the plurality of resources, the processor further performs operations comprising:
- calculating a respective combined weighting value of each resource of the remaining subset of resources; and
- selecting the second resource based on the combined weighing values of the remaining subset of resources by performing a first selection procedure, a second selection procedure, or a third selection procedure,
- wherein the first selection procedure comprises:
  - identifying one or more resources from the remaining subset of resources with each having the respective combined weighting value greater than 0; and
  - selecting the second resource from the one or more resources, wherein the second selection procedure comprises:
  - sorting the remaining subset of resources in a descending order by the combined weighting values; and
  - selecting the second resource from the remaining subset of resources by performing one of:
    - selecting the second resource from a top predetermined percentile of resources of the sorted one or more resources;
    - selecting the second resource responsive to the second resource having the largest respective combined weighting value than that of other resources of the remaining subset of resources; and
    - selecting the second resource from one or more resources having the respective combined weighting values larger than that of other resources of the remaining subset of resources, and
- wherein the third selection procedure comprises selecting the second resource based on the respective combined weighting value of each resource of the remaining subset of resources being proportional to a probability for transmission.

20. The apparatus of claim 19, wherein, in calculating the respective combined weighting value of each resource of the remaining subset of resources, the processor calculates the

respective combined weighting value of each resource of the remaining subset of resources using a maximum function or linear combination.

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