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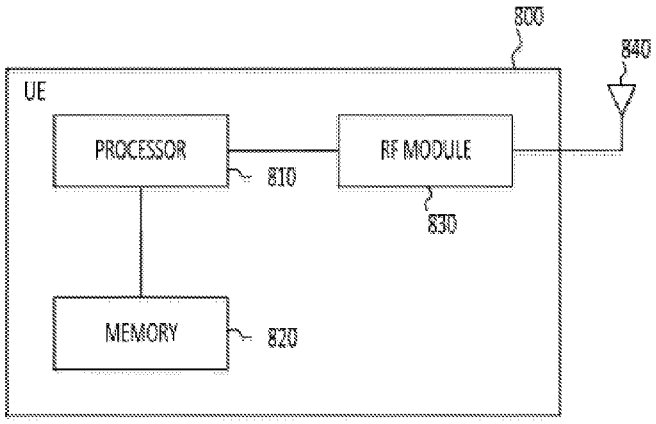


FIG. 1

(57) Abstract: For SL resource allocation, the Rx UE assisted resource allocation mechanism can be applied to improve the reliability and reduce the overall latency for SL communication, which can work independently or jointly with Tx UE based sensing and resource allocation mechanism. Rx UE can be triggered to send the feedback information upon reception of the SCI and/or data from the Tx UE. The feedback information can carry Rx UE's resource sensing information, CSI info, observed Doppler/delay/moving speed related information and MIMO related feedback information to assist the resource/MCS/MIMO/DMRS pattern selection at Tx UE. It is desirable for Rx UE to feedback such assistance information (just) before the reserved resources by Tx UE to be transmitted. So the Tx UE can take into account the feedback information to assist resource re-selection and/or resource utilization.

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SL RESOURCE ALLOCATION ENHANCEMENTS

FIELD OF INVENTION

[0001]This disclosure relates generally to wireless communications, and, more particularly, to methods and apparatus about SL resource allocation enhancement.

BACKGROUND OF THE INVENTION

[0002]In 5G new radio, V2X sidelink (SL) communication can be supported by the unicast, groupcast and broadcast communications. However, there are some issues to be addressed for SL resource allocation to improve the reliability and reduce the latency of SL communications.

SUMMARY OF THE INVENTION

[0003]This disclosure relates generally to wireless communications, and, more particularly, to methods and apparatus about SL resource allocation enhancement.

[0004]For SL resource allocation, the Rx UE assisted resource allocation mechanism can be applied to improve the reliability and reduce the overall latency for SL communication, which can work independently or jointly with Tx UE based sensing and resource allocation mechanism. Rx UE can be triggered to send the assistance information upon a certain of conditions that may include: 1) reception of SCI and/or data from a peer Tx UE who sends data intended to the Rx UE, and/or 2) the SCI from other Tx UEs who may cause interference to the Rx UE. The assistance information can carry Rx UE's resource sensing information that reflects situations/quality of reception of SCIs/data sent from other Tx UEs and/or the peer Tx UEs, when the SCIs/data from other Tx UEs may 1) collide with the SCI sent by the peer Tx UE so that the SCI sent by the peer Tx UE is not decodable; 2) have higher priority than the data to be sent by the peer Tx UE so that the peer Tx UE may need to avoid from using the resource occupied by the SCI sent from other Tx UEs. It is desirable for Rx UE to send such assistance information (just) before the reserved resources by the peer or other Tx UE to be transmitted so that the Tx UE can take into account the assistance information to assist resource re-selection and/or resource utilization.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005]FIG.1 shows an exemplary block diagram of a UE (a.k.a device) according to an embodiment of the disclosure.

DETAILED DESCRIPTION

[0006]Certain terms are used throughout the description and following claims to refer to particular components. As one skilled in the art will appreciate, manufacturers may refer to a component by different names. This document does not intend to distinguish between components that differ in name but not function. In the following description and in the claims, the terms "include" and "comprise" are used in an open-ended fashion, and thus should be interpreted to mean "include, but not limited to ...". Also, the term "couple" is intended to mean either an indirect or direct electrical connection. Accordingly, if one device is

coupled to another device, that connection may be through a direct electrical connection, or through an indirect electrical connection via other devices and connections. The making and using of the embodiments of the disclosure are discussed in detail below. It should be appreciated, however, that the embodiments can be embodied in a wide variety of specific contexts. The specific embodiments discussed are merely illustrative, and do not limit the scope of the disclosure. Some variations of the embodiments are described. Throughout the various views and illustrative embodiments, like reference numbers are used to designate like elements.

[0007]The following description is of the best-contemplated mode of carrying out the invention. This description is made for the purpose of illustrating the general principles of the invention and should not be taken in a limiting sense. Note that the 3GPP specifications described herein are used to teach the spirit of the invention, and the invention is not limited thereto.

[0008]For SL resource allocation, the Rx UE assisted resource allocation mechanism can be applied to improve the reliability and reduce the overall latency for SL communication, which can work independently or jointly with Tx UE based sensing and resource allocation mechanism.

[0009]The Rx UE assisted resource allocation mechanism needs assistance information from Rx UE. For example, an Rx UE performs sensing (similar to the sensing at Tx UE) on the resource pools for reception (or the Tx pool of the peer Tx UE) by measuring RSRP over PSCCH-DMRS or PSSCH-DMRS according to the detected SCI from the other Tx UEs and/or the peer Tx UE. To be noted, Tx UE may need to inform Rx UE the resource pool for sensing (or the pool for transmission by Tx UE) via signaling so that the Rx UE can provide the sensing results to assist the Tx UE's resource (re-)selection. Alternatively, such resource pool(s) can be (pre-)configured. The assistance information from Rx UE could be defined by several interpretations, according to received signal quality of and priority of PSCCH (SCI) and/or PSSCH. It can carry Rx UE's resource sensing information that reflects situations/quality of reception of SCIs sent from other Tx UEs and/or the peer Tx UE, when the SCIs from other Tx UEs may 1) collide with the SCI sent by the peer Tx UE so that the SCI sent by the peer Tx UE is not decodable; 2) have higher priority than the data to be sent by the peer Tx UE so that the peer Tx UE may need to avoid from using the resource occupied by the SCI sent from other Tx UEs.

[0010]In general the assistance information is derived based on the measured RSRP, whether SCI (from peer Tx UE and/or other Tx UEs) is decodable or not, the priority of the peer Tx UE's transmission, the priority of the sensed UEs, and/or the corresponding resources reserved by SCI from the peer Tx UE and/or the other Tx UEs. The Rx UE can determine whether the resources (and/or the resources reserved by the peer Tx UE) is preferred or not from the Rx UE perspective, which may avoid the hidden node problem. Here, the priority of the peer Tx UE's transmission can be determined according to the priority indicated in SCI or a (pre-)configured priority for the MAC flow, the link pair, logical channel priority, the session or the UE. The priority of the sensed UE can be obtained from the detected SCI by the Rx UE when perform sensing.

[0011]To facilitate the decision at Rx UE, the RSRP threshold can be set according to the combination of the priority of the peer Tx UE's transmission and the priority of the sensed UE' transmission. Rx UE will compare the measured RSRP of the sensed Tx UE's control and/or data DMRS transmission with the RSRP threshold to determine whether the preferred resources are preferred or not. For example, if the measured

RSRP is lower than the threshold, the reserved resources may be determined as acceptable or preferred. Otherwise, the reserved resources may be determined as unacceptable or un-preferred.

[0012]Alternatively or additionally, the RSRP offset or the relative value between the measured RSRP for the sensed Tx UE(s) and the RSRP measured or (pre-)configured for the peer Tx UE. Such RSRP offset or relative value setting can be related to the combination of the priority levels of the peer Tx UE's transmission and the priority of the sensed UE' transmission. Rx UE will compare the measured RSRP of the sensed Tx UE's control and/or data channel DMRS transmission with the RSRP of the peer Tx UE to check whether the difference is higher or lower than the (pre-)configured RSRP offset, the resources (and/or the resources reserved by the peer Tx UE) may be determined as acceptable or preferred. Otherwise, the resources may be determined as unacceptable or un-preferred. Herein, the RSRP offset or the relative value may be (pre-)configured according to the priority levels of the other Tx UE's transmission priority and the peer Tx UE's priority.

[0013]To be noted, instead of RSRP, SINR can be used as the measurement metric.

[0014]To save overhead for reporting, instead of keeping sending assistance information, Rx UE can be triggered by a certain of conditions to send/report the assistance information upon reception of the transmission from the peer Tx UE (e.g., SCI and/or data from the peer Tx UE). For example, the triggering condition could be that the Rx UE detects SCIs from other Tx UEs at a resource where it expects to receive SCI from its peer Tx UE. If the triggering condition meets, it is likely that the Rx UE cannot successfully decode the SCI sent by the peer Tx UE. To be more specific, we may consider the following approaches for an Rx UE to report assistance information:

1） Rx UE reports (un-)preferred time/frequency resources based on sensing at Rx UE. The un-preferred time/frequency resource may be defined as the resources where this Rx UE detects SCIs from other Tx UEs with high SNR or with a priority higher than the priority of the transmission that this Rx UE expects to receive from the peer Tx UE. To further save overhead, if the Rx UE does not expect to receive SCI from a peer Tx UE, it does not provide the report for (un-)preferred time/frequency resources.

2） For a Rx UE, given that the Rx UE had successfully received SCI from the peer Tx UE at slot#n and the SCI had indicated a period (denoted by P) for resource reservation, The Rx UE fails to decode the expected SCI (either 1^{st} SCI or 2^{nd} SCI) at slot#(n+P). Then the Rx UE sends an indication to indicate that SCI from the peer Tx UE is not received at slot#(n+P).

3） For a Rx UE, given that the Rx UE had successfully received SCI (either 1^{st} SCI or 2^{nd} SCI) from Tx UE at slot#n and the SCI had indicated a period (denoted by P) for resource reservation, If the Rx UE doesn't decode the expected SCI (either 1^{st} SCI or 2^{nd} SCI) at multiple periodic slots, then the Rx UE sends an indication to indicate that SCI from the Tx UE is not received at slot#(n+m*P) for m= 1, 2,…, K, where K is a predefined integer greater than 1. Compared with 2), this approach aims to have a more conservative report in case that the SCI decoding fail is not a periodic event, which may be due to collision with aperiodic PSCCH/PSSCH or short-term fading.

[0015]Compared to 1), the approaches 2) and 3) require less reporting overhead because the report is specific to the resource that had been reserved; there is no need to further indicate which resource is under consideration.

[0016]In all approaches above, if the Tx UE receives the assistance information, it may avoid adopting the un-preferred resources or avoid using the resources where the Rx UE already indicated SCI is not decodable. Then the Tx UE may perform resource reselection to avoid using the problematic resources. However, if the Tx UE directly performs resource reselection and sends a new SCI carrying information for new allocated resource and new reservation period, all other UEs who can decode the new SCI may avoid using the new resource and meanwhile the previous reserved resource is assumed to be still occupied, because other UEs cannot tell whether this new SCI is based on resource re-selection that releases the past reserved resource, or a new resource allocation with a new reservation period. Another proper way is that the Tx UE first sends a SCI that can indicate the periodic reservation is no longer held, e.g., by setting reservation period to zero, and then information for re-selected resource and reservation period is carried in the next SCI.

[0017]We note that when the Rx UE reports assistance information, the information may be hearable by Tx UEs other than the peer Tx UE, depending on which channel carries the assistance information.

[0018]<u>Definition of assistance information</u>

[0019]In the approaches we presented for an Rx UE to report assistance information. The report assistance information can represent different cases that may degrade PSCCH/PSSCH decoding performance so resource reselection at the peer Tx UE is recommended. From a perspective of signal quality of received SCI, the report assistance information can defined to represent:

1）1st SCI is not decodable but the measured RSRP/RSSI at the resource expected to receive PSCCH from the peer Tx UE is greater than a threshold; in other words, this Rx UE received SCI from other Tx UEs

2）1st SCI is decodable but 2nd SCI is not decodable: Then this Rx UE indicates that PSCCH decoding fails and provides such an assistance information to either the peer TX UE or all potential Tx UEs.

3）1st SCI is decodable and the 1st SCI carries information to indicate that this SCI is not from peer Tx UE or not intended to the Rx UE.

[0020]In this case part of source ID or destination ID needed to be carried in 1st SCI. This ID-related information is implemented by introducing a new field in SCI format with X bits. However because the overhead/bit-width needed to signal source/destination ID is too huge, we may consider to capture only part of the bits representing source/destination ID, for example, X=3. In this case, when an Rx-UE checks the X bits and finds it does not match the ID it expects, it can conclude this SCI is not intended to this Rx UE. For legacy sidelink UEs who are implemented based on early releases and cannot interpret the new field, they could be configured with X reserved bits to ensure SCI bit-width is the same for the same SCI format for all UEs.

[0021]<u>How to send the report</u>

[0022]Rx UE can send the assistance information autonomously to peer Tx UE who intends to send data the Rx UE, or broadcast it to potential Tx UEs. For the report intended to the peer Tx UE, it can be sent via 2nd SCI or PSFCH. For broadcasting like reporting, it can be sent via 1st SCI. Additionally, the assistance information can be carried in the standalone SCI with or without PSSCH. The assistance information can also be carried in PSSCH, especially when there is the traffic for transmission in PSSCH. The 2nd SCI can carry such assistance information with the field to indicate whether the assistance information is carried in the 2nd

SCI and/or whether the assistance information is carried in the 2nd SCI with or without the data channel (i.e., PSSCH).

[0023]For the feedback channel carrying information from Rx UE to Tx UE for assistance of resource selection, we may consider the following aspects:

•N-ID, a parameter to form initial seed for generating DMRS sequence so that this DMRS is specific to this Tx-Rx pair, can be (pre-)configured via PC5-RRC for the DMRS of the feedback channel (PSCCH/2nd SCI).

•Feedback channel is not required to be sensed supposing there is no reservation information.

[0024]We may determine the report is unicast or broadcast according to previous measurement on reserved resources where SCI from peer Tx UE and SCI from other Tx UEs may be present. We define the following terms to facilitate presentation of this invention:

•Own_prio: denotes the priority of the transmission of the peer Tx UE

•Other_prio: denotes the priority of the transmission of the other Tx UE

•Own_RSRP: denotes the measured RSRP (or SINR) corresponding to the transmission of the peer Tx UE

•Other_RSRP: denotes the measured RSRP (or SINR) corresponding to the transmission of the other Tx UE

[0025]If Own_prio > Other_prio & Own_RSRP < Other_RSRP

Then

•Rx UE will send the assistance information to the other Tx UEs or a specific Tx UE via broadcast or unicast. The intention is to ask other Tx UEs or a specific Tx UE (e.g., causing high interference at Rx UE) to avoid using the time/frequency resources indicated in the assistance informationor without indication but implied by the time/frequency resources carrying the assistance information.

•The other UE receiving the broadcast/unicast assistance information may (re-)select the resource to avoid collision/interference at Rx UE with the transmission from its peer Tx UE(s). Whether/how to make (re-)selection in the other UE may depend on one or multiple of the following parameters: the priority of peer Tx UE's transmission carried in the assistance information (or SCI), the priority indicated in SCI of Rx UE's transmission for assistance information, the (pre-)configured priority or the logical channel priority of the own transmission, the RSRP (or RSRQ/SINR) measured over DMRS of PSCCH and/or PSSCH carrying the assistance information, the absolute RSRP threshold (pre-)configured or indicated in the assistance information. additionally, the RSRP threshold setting may be a function of the one or multiple following parameters: the priority of peer Tx UE's transmission carried in the assistance information (or SCI), the priority indicated in SCI of Rx UE's transmission for assistance information, the (pre-)configured priority or the logical channel priority of the own transmission.

•Additionally, the assistance information may carry the partial or full peer Tx UE's ID in the field other than the source ID and destination ID. Upon reception of broadcast assistance information, the peer Tx UE can check the assistance information indicator (carried in SCI, MAC-CE, and/or PSSCH) and/or the peer Tx UE's ID field (carried in SCI, MAC-CE, and/or PSSCH) to know that this broadcast assistance information is targeting the other Tx UE(s) so that it can ignore such assistance information to avoid any (re-)selection by

mistake.

[0026]If Own_prio < Other_prio & Own_RSRP < Other_RSRP

Then

•Rx UE will send unicast feedback to Tx UE. The intention is to ask the peer Tx UE to avoid using this resource associated with the received SCI.

•Tx UE may perform reselection based on Rx UE feedback.

[0027]Peer Tx UE behavior

[0028]When the peer Tx UE receives the assistance information that suggest resource re-selection is needed to overcome PSCCH/PSSCH collision, the following options can be considered:

Option 1: Re-select resource immediately;

Option 2: Still send SCI at the reserved resource (although collision is expected) but set reservation period to '0' to indicate that this is the last PSSCH/PSCCH occupying the reserved resource, and resource re-selection may be performed for the next PSSCH/PSCCH.

[0029]Other Tx UE behavior

[0030]When the other Tx UE(s) receives the assistance information that suggest resource re-selection is needed to overcome PSCCH/PSSCH collision, the following options can be considered:

Option 1': Re-select resource immediately;

Option 2': Still send SCI at the reserved resource (although collision is expected) but set reservation period to '0' to indicate that this is the last PSSCH/PSCCH occupying the reserved resource, and resource re-selection may be performed.

[0031]Receiver based approaches to handle collision problems

[0032]Other than triggering resource reselection to avoid control/data collision, there are other potential solutions to remediate the impact of collision. For example, an Rx UE may decode twice on resources 'potentially carrying SCI': one for sensing (strongest one among all possible OCC patterns) and the other for data reception (based on Tx ID for unicast known via PC5-RRC or own OCC position):

Option 1:

-OCC can't be changed during at least the unicast communication.

-OCC sequence selection is a function of Tx(/Rx) UE ID and/or slot index (at least for unicast), e.g., Mod(x,3) wherein x is determined by Tx(/Rx) UE ID and/or slot index.

Option 2:

-PSCCH can be randomly located in any sub-channel of PSSCH: backward compatibility issue.

[0033]It is possible to have the combination of Option 1 and Option 2.

[0034]To further avoid introducing huge PSCCH decoding complexity, UE may decode SCI for multiple times only on the potential resources where had been indicated as reserved resources by SCI received before.

[0035]FIG.1 shows an exemplary block diagram of a UE (a.k.a device) according to an embodiment of the disclosure. A processor 810 can be configured to perform various functions of embodiments of the invention. The processor 810 can include signal processing circuitry to process received or to be transmitted data according to communication protocols specified in, for example, LTE and NR standards. Additionally,

the processor 810 may execute program instructions, for example, stored in the memory 820, to perform functions related with different communication protocols. The processor 810 can be implemented with suitable hardware, software, or a combination thereof. For example, the processor 810 can be implemented with application specific integrated circuits (ASIC), field programmable gate arrays (FPGA), and the like, that includes circuitry. The circuitry can be configured to perform various functions of the processor 810.

[0036]In one example, the memory 820 can store program instructions that, when executed by the processor 810, cause the processor 810 to perform various functions as described herein. The memory 820 can include a read only memory (ROM), a random access memory (RAM), a flash memory, a solid state memory, a hard disk drive, and the like.

[0037]The RF module 830 can be configured to receive a digital signal from the processor 810 and accordingly transmit a signal to a base station in a wireless communication network via an antenna 840. In addition, the RF module 830 can be configured to receive a wireless signal from a base station and accordingly generate a digital signal which is provided to the processor 810. The RF module 830 can include digital to analog/analog to digital converters (DAC/ADC), frequency down/up converters, filters, and amplifiers for reception and transmission operations. For example, the RF module 830 can include converter circuits, filter circuits, amplification circuits, and the like, for processing signals on different carriers or bandwidth parts.

[0038]The UE 800 can optionally include other components, such as input and output devices, additional CPU or signal processing circuitry, and the like. Accordingly, the UE 800 may be capable of performing other additional functions, such as executing application programs, and processing alternative communication protocols.

[0039]The processes and functions described herein can be implemented as a computer program which, when executed by one or more processors, can cause the one or more processors to perform the respective processes and functions. The computer program may be stored or distributed on a suitable medium, such as an optical storage medium or a solid-state medium supplied together with, or as part of, other hardware. The computer program may also be distributed in other forms, such as via the Internet or other wired or wireless telecommunication systems. For example, the computer program can be obtained and loaded into an apparatus, including obtaining the computer program through physical medium or distributed system, including, for example, from a server connected to the Internet.

[0040]The computer program may be accessible from a computer-readable medium providing program instructions for use by or in connection with a computer or any instruction execution system. A computer readable medium may include any apparatus that stores, communicates, propagates, or transports the computer program for use by or in connection with an instruction execution system, apparatus, or device. The computer-readable medium can be magnetic, optical, electronic, electromagnetic, infrared, or semiconductor system (or apparatus or device) or a propagation medium. The computer-readable medium may include a computer-readable non-transitory storage medium such as a semiconductor or solid state memory, magnetic tape, a removable computer diskette, a random access memory (RAM), a read-only memory (ROM), a magnetic disk and an optical disk, and the like. The computer-readable non-transitory

storage medium can include all types of computer readable medium, including magnetic storage medium, optical storage medium, flash medium and solid state storage medium.

[0041]While aspects of the present disclosure have been described in conjunction with the specific embodiments thereof that are proposed as examples, alternatives, modifications, and variations to the examples may be made. Accordingly, embodiments as set forth herein are intended to be illustrative and not limiting. There are changes that may be made without departing from the scope of the claims set forth below.

CLAIMS

1.A method performed by a UE, comprising:

receiving a first control information in a first slot from a peer Tx UE comprising reservation period information to indicating a reserved resource in a second slot;

measuring and decoding a second control information at the reserved resources in the second slot;

determining assistance information to indicate a state of the measuring and decoding;

transmitting the assistance information.

2. The method of claim 1, wherein the state implies the first control information is not decodable by the UE.

3. The method of claim 1, wherein the first control information comprising 1st SCI and 2nd SCI, and the first control information is not decodable if either 1st SCI or 2nd SCI is not decodable.

4. A method performed by a UE, comprising:

sending a third control information in a third slot to a peer Rx UE comprising reservation period information to indicating a reserved resource in a third slot;

receiving assistance information from the peer Rx UE, wherein the assistance information indicates a state of measuring and decoding the third control information at the peer Rx UE at the reserved resources in the third slot;

determining if resource reselection is performed or not according to the assistance information.

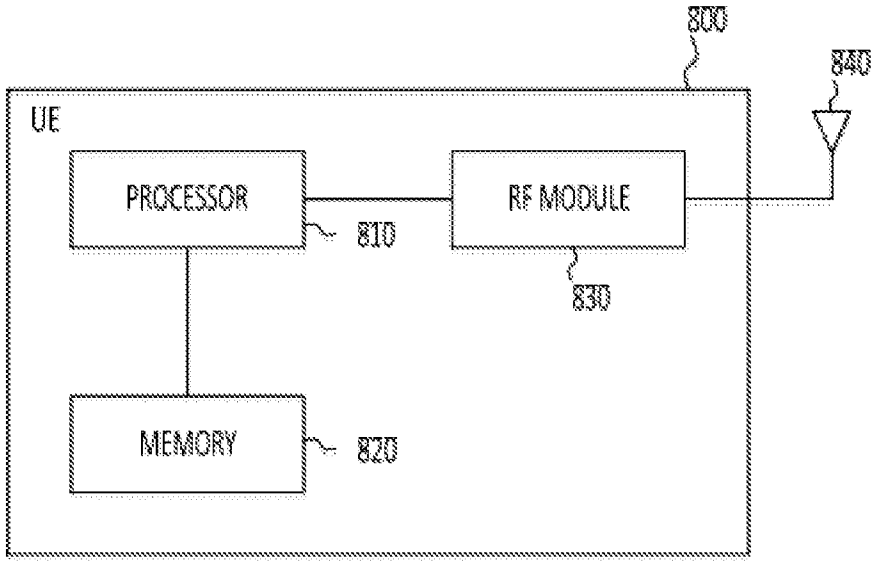


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/120000

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/10(2009.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT,CNKI,WPI,EPODOC,3GPP:SLOT PEER UE V2X SIDELINK SL RESOURCE STATE DECOD+ DECODABLE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2020029340 A1 (SAMSUNG ELECTRONICS CO., LTD.) 23 January 2020 (2020-01-23) abstract, description, paragraphs 0063-0096	1-4
A	CN 108024273 A (BEIJING SAMSUNG COMMUNICATION TECHNOLOGY et al.) 11 May 2018 (2018-05-11) the whole document	1-4
A	WO 2020092939 A1 (INTEL CORPORATION) 07 May 2020 (2020-05-07) the whole document	1-4
A	WO 2018031086 A1 (INTEL CORPORATION) 15 February 2018 (2018-02-15) the whole document	1-4
A	LENOVO et al. "Discussion on Latency Reduction for V2X Phase 2" *3GPP TSG RAN WG1 Meeting #92bis R1-1804206,* 20 April 2018 (2018-04-20), the whole document	1-4

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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"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
28 June 2021	**07 July 2021**
Name and mailing address of the ISA/CN **National Intellectual Property Administration, PRC** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China** Facsimile No. **(86-10)62019451**	Authorized officer **FANG,Ting** Telephone No. **86-010-53961654**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2020029340	A1	23 January 2020	KR	20210024197	A	04 March 2021
				WO	2020017939	A1	23 January 2020
CN	108024273	A	11 May 2018	EP	3530047	A1	28 August 2019
				EP	3530047	A4	30 October 2019
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WO	2020092939	A1	07 May 2020		None		
WO	2018031086	A1	15 February 2018		None		