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(71) Applicant: **MEDIATEK SINGAPORE PTE. LTD.** [SG/SG]; #03-01 Solaris, No. 1 Fusionopolis Walk, Singapore 138628 (SG).

(72) Inventors; and

(71) Applicants *(for AO only)*: **CHEN, Tao** [CN/CN]; No. 6 Park, Jiuxianqiao Road, Building 1-B, Chaoyang District, Beijing 100016 (CN). **HWANG, Chien-Hwa** [CN/CN]; No. 1, Dusing Rd. 1st, Science-Based Industrial Park, Hsin-Chu, Taiwan 300 (CN). **WANG, Chien-Yi** [CN/CN]; No. 1, Dusing Rd. 1st, Science-Based Industrial Park, Hsin-Chu, Taiwan 300 (CN). **CHEN, Ju-Ya** [CN/CN]; No. 1, Dusing Rd. 1st, Science-Based Industrial Park, Hsin-Chu, Taiwan 300 (CN). **LIAO, Pei-Kai** [CN/CN]; No. 1, Dusing Rd. 1st, Science-Based Industrial Park, Hsin-Chu, Taiwan 300 (CN).

(74) Agent: **BEIJING SANYOU INTELLECTUAL PROPERTY AGENCY LTD.**; 16th Fl., Block A, Corporate Square, No. 35 Jinrong Street, Beijing 100033 (CN).

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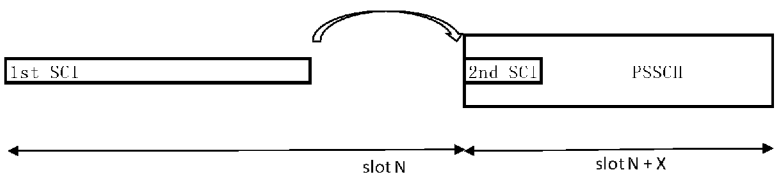

FIG. 2

(57) **Abstract:** For V2X sidelink communication, the sidelink physical data channel (PSSCH) can be scheduled by sidlelink control information (SCI) carried in sidelink physical control channel (PSCCH). 2-stage SCI can be used for such scheduling with the 1st SCI decodable for all UEs to carry Dest ID information, time-frequency resource allocation and priority information, etc. for sensing purpose and 2nd SCI decodable for the intended UEs to carry source ID information and others (e.g., RV, new data indicator, MCS) for detailed demodulation of PSSCH. Src ID can be implicitly carried via CRC scrambling in 2nd SCI to avoid overhead. Moreover, to support both the single SCI and 2-stage SCI, the format indicator of different RNTI can be used for differentiation. Further, for interference cancellation, the port information (port number) and/or DMRS pattern information can be carried in the SCI (e.g., 1st SCI). Single SCI may be used for broadcast communication with a common RNTI or L1-ID for identification, whereas the 2-stage SCI may be used for the unicast/groupcast communication with its own L1-ID or RNTI for differentiation.

WO 2020/168452 A1

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CONTROL CHANNEL DESIGN FOR V2X COMMUNICATION

TECHNICAL FIELD

This disclosure relates generally to wireless communications, and, more particularly, to methods and apparatus for the control channel design for V2X communications.

BACKGROUND

In 5G new radio, V2X sidelink(SL) communication may be supported by the unicast, groupcast and broadcast communications. However, there are several issues to be addressed for control channels considering the complexity, channel sensing and flexibility.

SUMMARY

This disclosure relates generally to wireless communications, and, more particularly, to methods and apparatus for the control channel design for V2X communications.

Since unicast, groupcast, and broadcast have very different characteristics, content of SCI should be tailored for each traffic type. All traffic types can occur simultaneously as a time, so an indicator of SCI format should be introduced to NR V2X.

The physical layer of LTE V2X only supports broadcast and the destinations cannot be identified in the physical layer. Since NR V2X would support unicast and groupcast in the physical layer, it is desirable that only the intended UEs decode PSSCH. The unintended UEs can power down for the rest of TTI. Such requirement can be fulfilled by conveying destination ID in SCI.

Conveying destination ID in SCI is straightforward but increases control overhead. By contrast, UE-specific RNTI (for unicast) and group RNTI (for groupcast) can be RRC configured and do not occupy control resource. However, CRC scrambling by RNTI has the issue that other UEs cannot decode PSCCH and thus has no knowledge about the resource allocation of PSSCH. For autonomous resource selection, which will be supported in NR V2X, it is important to learn the resource locations occupied by other UEs.

To resolve the drawbacks of the mentioned two solutions, the two-stage SCI can be used as such: SCI is split into two parts, where SCI part 1 (1^{st} SCI) may include the location of time-frequency resource used by PSSCH, resource reservation, priority, destination UE/group ID and SCI part 2 (2^{nd} SCI) contains the rest of SCI. the 1^{st} SCI and then 2^{nd} SCI are encoded separately. No CRC scrambling is performed on the 1^{st} SCI so that all UEs can decode the 1^{st} SCI for sensing purpose. Besides, the destination ID included in 1^{st} SCI can indicate the intended receiver so that the unintended receivers can avoid 2^{nd} SCI decoding. The 2^{nd} SCI can be CRC scrambled by source UE/group ID (or UE-specific/group RNTI) so that only the intended UEs can learn the 2^{nd} SCI and further decode PSSCH. The 1^{st} SCI is carried by PSCCH and the 2^{nd} SCI can be either piggybacked on PSSCH or carried in PSCCH.

One more benefit for 2-stage SCI against single SCI is the coverage enhancement due to the smaller SCI size. As shown in **Table 1**, the single SCI will require up to 104 bits including 24 bits of CRC, whereas the 2-stage SCI will require up to 60 bits for the first SCI and 44 bits for the 2^{nd} SCI including CRC bits. In total, there is no increase on the information bits for 2-stage SCI compared to single SCI because of saving from source ID carried implicitly by CRC scrambling in 2^{nd} SCI. To be noted, in LTE V2X the SCI format 1 with 48 bits is applied for LTE V2X which is much smaller than the estimated single SCI payload size. So the large payload size for the single SCI may cause the worse (coverage) performance compared to LTE V2X, which is not desirable.

Table 1. Overhead for Single SCI vs. 2-Stage SCI (example)

Single SCI vs. 2-stage SCI			
Parameters	Single SCI	2-stage SCI	
		1st SCI	2nd SCI
SRC ID	24	0	(24) (CRC scrambled)
Dest ID (up to 24) [1]	24	24	0
Other SCI payload[2]	32	12	20
CRC bits (for NR DCI)	24	24	24
sub-total	104	60	44
Total	104	104	

Note:
1. 16 or 24 bits are assumed for L2 Dest ID as defined in TS36.321.
2. 32 bits are assumed based on LTE V2X SCI format 1.

The simulation results for SCI based on 60 bits (1^{st} SCI), 42 bits (2^{nd} SCI) and 104bits (single SCI) including 24 bits CRC are provided in **Table 2** to show the performance enhancement between the 2-stage SCI and single SCI with different aggregation level. It can be noted that at least 2~7dB gain can be achieved by 2-stage SCI. The simulation assumptions are provided in the appendix. The practical gain may also depend on the size of the other SCI payload, and the aggregation levels.

Table 2. Performance gain of 2-stage SCI vs. Single SCI

SNR@1 % BLER	TDL-C DS=30ns					TDL-C DS=300ns				
Aggregation Level	1st SCI (60bits)	2nd SCI (~44bits)	Single SCI (104bits)	2-stage vs Single SCI Gain (dB)		1st SCI (60bits)	2nd SCI (~44bits)	Single SCI (104bits)	2-stage vs Single SCI Gain (dB)	
				1st SCI gain	2nd SCI gain				1st SCI gain	2nd SCI gain
AL2	3.5	1.3	8.2	**4.7**	**6.9**	4.5	1.6	8.8	**4.3**	**7.2**
AL4	-1.5	-3.2	1.2	**2.7**	**4.4**	-2.2	-4.1	0.5	**2.7**	**4.6**
AL8	-4.6	-5.9	-2.3	**2.3**	**3.6**	-5.8	-7.2	-3.5	**2.3**	**3.7**
AL16	-6.8	-8.1	-4.8	**2**	**3.3**	-8.4	-9.7	-6.5	**1.9**	**3.2**

Alternatively, the split on the information between the 1^{st} SCI and the 2^{nd} SCI can be illustrated in Table 3 as below. The purpose is to have the equal size between the 1^{st} SCI and the 2^{nd} SCI by using one format indicator for differentiation between 1^{st} SCI and 2^{nd} SCI. In this case, both the source ID and the destination ID may be carried in the 2^{nd} SCI with CRC scrambled by Dest and/or source ID to reduce the total overhead.

In particular, if the single SCI is used for broadcast transmission without dest ID, the size can be reduced. So it could be possible to share the same SCI size for the single SCI, the 1^{st} SCI and the 2^{nd} SCI but with the different information fields by using the reserved bits in each format to achieve the same size. In this case, 2 bits of format indicator may be introduced in SCI to differentiate whether it is 1^{st} SCI (broadcast), 2^{nd} SCI or single SCI.

Table 3. the equal split of 1^{st} SCI and 2^{nd} SCI

Single SCI vs. 2-stage SCI			
Parameters	Single SCI	2-stage SCI	
		1st SCI	2nd SCI
Format indicator	0	1	1
SRC ID	24	0	24
Dest ID (16 or 24)	24	0	0 (CRC scrambled)
Other SCI payload	32	28	4
CRC	24	24	24
sub-total (bits)	104	53	53
Total (bits)	104	106	
Note: 1. 32 bits for SCI payload are assumed based on LTE V2X			

As one embodiment, both the 1^{st} SCI and single SCI can be supported by having the same SCI size with the different information fields (but the different size than the 2^{nd} SCI). An indicator can be introduced to differentiate whether it is the first SCI or the single SCI. Besides, if the 2-stage SCI is only used for the unicast/groupcast communication whereas single SCI is used for broadcast communication, then an indicator can indicate whether it is unicast/groupcast or broadcast and implicitly determine the corresponding SCI format (single SCI or 2-stage SCI).

As another embodiment, the same information fields are used for the 1^{st} SCI and single SCI by having an indicator for the presence of the 2^{nd} SCI to differentiate the single SCI and 2-stage SCI. For example, the 1st SCI carries the format indicator, time-frequency resource allocation, priority information, resource reservation, time gap between initial tx and retx, or MCS, etc. The 2nd SCI carries Source ID, RV, new data indicator, HARQ process number, or Dest ID, etc. the format indicator to indicate whether there is the 2^{nd} SCI. To share the same size for 1^{st} SCI and single SCI (mainly for broadcast), CRC in the 2^{nd} SCI can be scrambled by Dest ID rather than in the 1^{st} SCI. In this case, all UEs should decode 1st SCI. Only the unicast/groupcast UEs have to decode 2nd SCI and broadcast UEs need not to decode the 2^{nd} SCI.

As one embodiment, the 2^{nd} SCI in 2-SCI can be implemented similarly to E-PDCCH in LTE by occupying the time/frequency resources as the data channel (PDSCH) resources. The 2^{nd} SCI can be transmitted together with the data channel without occupying the dedicated control channel resources.

As one embodiment, for the 2-stage SCI, the first SCI can have the fixed size, the aggregation level and the pre-defined time/frequency location(s) via broadcast transmission to be sensed by all UEs without any blind detection for decoding. The 2^{nd} SCI can have the fixed size but the adaptive aggregation levels for control channel link adaption in the unicast/groupcast links. To avoid blind detection for 2^{nd} SCI decoding, the adaptive aggregation level (and/or the time/frequency location) can be indicated by first SCI to avoid any blind detection. However, the single SCI solution may have a tradeoff between the link adaption and blind decoding complexity so that it can't have the both benefits as 2-stage SCI.

As one embodiment, for scheduling of 2-stage and single SCI, both same-slot (same-symbol or cross-symbol) and cross-slot scheduling can be supported. The purpose of the cross-slot scheduling is to ensure the other UEs can have the sufficient time to decode SCI for sensing and apply the results for resource selection. For the same-slot scheduling, it may be beneficial to reduce the transmission latency but with the drawback that the other UEs can't have the enough time to decode SCI (for cross-symbol same-slot scheduling, it may depend on UE hardware processing capability) and apply the sensing results especially for the aperiodic traffic case. In case of presence of both the same-slot and cross-slot scheduling, it is beneficial to differentiate them by have some indicators carried in DMRS to avoid any control channel decoding. For example, the initialization value for DMRS sequence generation can be a function of the indicator(s) for indication of the same-slot (even differentiation for the same-symbol or cross-symbol scheduling) or cross-slot scheduling. It may also imply or indicate the processing time requirement to apply the sensing results for UE. By detecting the DMRS to obtain the feasibility indicator, UE can know whether the decoded SCI results is feasible to be applied for resource selection according to its own processing capability. If not feasible, it will give up decoding of such SCI for power and computing resource saving. If feasible, it will further decode such SCI for the sensing results.

As one embodiment, 2-stagge SCI can be used to enable interference cancellation at UE. For example, the port information (the port number and/or the number of port) and/or DMRS pattern information can be carried in the SCI (e.g., 1st SCI or single SCI). UE can decode the 1st SCI (of the other UEs) to know whether/how to do the channel estimation for its own channel via the cancellation of the other transmissions. Furthermore, the MCS information can be used for data part interference cancellation.

As one embodiment, the single SCI may be used for broadcast communication with a common RNTI or L1-ID for identification, whereas the 2-stage SCI may be used for the unicast/groupcast communication with its own L1-ID or RNTI for differentiation. Whether to use the L1-ID or RNTI may depend on whether UEs are in the coverage or out-of-coverage.

BRIEF DESCRIPTION OF DRAWINGS

The invention can be more fully understood by reading the subsequent detailed description and examples with references made to the accompanying drawings, wherein:

Fig.1 shows that the 1st SCI in PSCCH can schedule the data channel (PSSCH) and/or the 1st SCI in PSCCH by cross-symbol scheduling in the same slot.

Fig.2 shows that the 1st SCI in PSCCH can schedule the data channel (PSSCH) and/or the 1st SCI in PSCCH by cross-slot scheduling.

FIG. 3 shows an exemplary block diagram of a UE (a.k.a device) according to an embodiment of the disclosure.

DETAILED DESCRIPTION

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.

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.

Since unicast, groupcast, and broadcast have very different characteristics, content of SCI should be tailored for each traffic type. All traffic types can occur simultaneously as a time, so an indicator of SCI format should be introduced to NR V2X.

The physical layer of LTE V2X only supports broadcast and the destinations cannot be identified in the physical layer. Since NR V2X would support unicast and groupcast in the physical layer, it is desirable that only the intended UEs decode PSSCH. The unintended UEs can power down for the rest of TTI. Such requirement can be fulfilled by conveying destination ID in SCI.

Conveying destination ID in SCI is straightforward but increases control overhead. By contrast, UE-specific RNTI (for unicast) and group RNTI (for groupcast) can be RRC configured and do not occupy control resource. However, CRC scrambling by RNTI has the issue that other UEs cannot decode PSCCH and thus has no knowledge about the resource allocation of PSSCH. For autonomous resource selection, which will be supported in NR V2X, it is important to learn the resource locations occupied by other UEs.

To resolve the drawbacks of the mentioned two solutions, the two-stage SCI can be used as such: SCI is split into two parts, where SCI part 1 (1^{st} SCI) may include the location of time-frequency resource used by PSSCH, resource reservation, priority, destination UE/group ID and SCI part 2 (2^{nd} SCI) contains the rest of SCI. the 1^{st} SCI and then 2^{nd} SCI are encoded separately. No CRC scrambling is performed on the 1^{st} SCI so that all UEs can decode the 1^{st} SCI for sensing purpose. Besides, the destination ID included in 1^{st} SCI can indicate the intended receiver so that the unintended receivers can avoid 2nd SCI decoding. The 2nd SCI can be CRC scrambled by source UE/group ID (or UE-specific/group RNTI) so that only the intended UEs can learn the 2nd SCI and further decode PSSCH. The 1st SCI is carried by PSCCH and the 2nd SCI can be either piggybacked on PSSCH or carried in PSCCH (by sharing the same time/frequency resources as data channel).

Alternatively, the split on the information between the 1st SCI and the 2nd SCI can be illustrated in Table 2 as below. The purpose is to have the equal size between the 1st SCI and the 2nd SCI by using one format indicator for differentiation between 1st SCI and 2nd SCI. In this case, both the source ID and the destination ID may be carried in the 2nd SCI with CRC scrambled by Dest and/or source ID to reduce the total overhead.

In particular, if the single SCI is used for broadcast transmission without dest ID, the size can be reduced. So it could be possible to share the same SCI size for the single SCI, the 1st SCI and the 2nd SCI but with the different information fields by using the reserved bits in each format to achieve the same size. In this case, 2 bits of format indicator may be introduced in SCI to differentiate whether it is 1st SCI (broadcast), 2nd SCI or single SCI.

As one embodiment, both the 1st SCI and single SCI can be supported by having the same SCI size with the different information fields (but the different size than the 2nd SCI). An indicator can be introduced to differentiate whether it is the first SCI or the single SCI. Besides, if the 2-stage SCI is only used for the unicast/groupcast communication whereas single SCI is used for broadcast communication, then an indicator can indicate whether it is unicast/groupcast or broadcast and implicitly determine the corresponding SCI format (single SCI or 2-stage SCI).

As another embodiment, the same information fields are used for the 1st SCI and single SCI by having an indicator for the presence of the 2nd SCI to differentiate the single SCI and 2-stage SCI. For example, the 1st SCI carries the format indicator, time-frequency resource allocation, priority information, resource reservation, time gap between initial tx and retx, or MCS, etc. The 2nd SCI carries Source ID, RV, new data indicator, HARQ process number, or Dest ID, etc. the format indicator to indicate whether there is the 2nd SCI. To share the same size for 1st SCI and single SCI (mainly for broadcast), CRC in the 2nd SCI can be scrambled by Dest ID rather than in the 1st SCI. In this case, all UEs should decode 1st SCI. Only the unicast/groupcast UEs have to decode 2nd SCI and broadcast UEs need not to decode the 2nd SCI.

As one embodiment, the 2nd SCI in 2-SCI can be implemented similarly to E-PDCCH in LTE by occupying the time/frequency resources as the data channel (PDSCH) resources. The 2nd SCI can be transmitted together with the data channel without occupying the dedicated control channel resources.

As one embodiment, for the 2-stage SCI, the first SCI can have the fixed size, the aggregation level and the pre-defined time/frequency location(s) via broadcast transmission to be sensed by all UEs without any blind detection for decoding. The 2nd SCI can have the fixed size but the adaptive aggregation levels for control channel link adaption in the unicast/groupcast links. To avoid blind detection for 2nd SCI decoding, the adaptive aggregation level (and/or the time/frequency location) can be indicated by first SCI to avoid any blind detection. However, the single SCI solution may have a tradeoff between the link adaption and blind decoding complexity so that it can't have the both benefits as 2-stage SCI.

As one embodiment, for scheduling of 2-stage and single SCI, both same-slot (same-symbol or cross-symbol) and cross-slot scheduling can be supported. The purpose of the cross-slot scheduling is to ensure the other UEs can have the sufficient time to decode SCI for sensing and apply the results for resource selection. For the same-slot scheduling, it may be beneficial to reduce the transmission latency but with the drawback that the other UEs can't have the enough time to decode SCI (for cross-symbol same-slot scheduling, it may depend on UE hardware processing capability) and apply the sensing results especially for the aperiodic traffic case. In case of presence of both the same-slot and cross-slot scheduling, it is beneficial to differentiate them by have some indicators carried in DMRS to avoid any control channel decoding. For example, the initialization value for DMRS sequence generation can be a function of the indicator(s) for indication of the same-slot (even differentiation for the same-symbol or cross-symbol scheduling) or cross-slot scheduling. It may also imply or indicate the processing time requirement to apply the sensing results for UE. By detecting the DMRS to obtain the feasibility indicator, UE can know whether the decoded SCI results is feasible to be applied for resource selection according to its own processing capability. If not feasible, it will give up decoding of such SCI for power and computing resource saving. If feasible, it will further decode such SCI for the sensing results.

As one embodiment, 2-stagge SCI can be used to enable interference cancellation at UE. For example, the port information (the port number and/or the number of port) and/or DMRS pattern information can be carried in the SCI (e.g., 1st SCI or single SCI). UE can decode the 1st SCI (of the other UEs) to know whether/how to do the channel estimation for its own channel via the cancellation of the other transmissions. Furthermore, the MCS information can be used for data part interference cancellation.

As one embodiment, the single SCI may be used for broadcast communication with a common RNTI or L1-ID for identification, whereas the 2-stage SCI may be used for the unicast/groupcast communication with its own L1-ID or RNTI for differentiation. Whether to use the L1-ID or RNTI may depend on whether UEs are in the coverage or out-of-coverage.

Fig.1 shows that the 1st SCI in PSCCH can schedule the data channel (PSSCH) and/or the 1st

SCI in PSCCH by cross-symbol scheduling in the same slot. The 1st SCI can carry the time-frequency location of the data channel (and the aggregation level/time-frequency location for the associated 2nd SCI). The time gap between the 1st SCI and PSSCH/2nd SCI are one or a few symbols. Based on the SCI decoding results in the same slot, the other UEs can determine whether/how to do the resource selection in the remaining symbols of the slot. It is also possible to have no gap in between. However, it may not be feasible for other UEs to use the sensing results for resource selection.

Fig.2 shows that the 1st SCI in PSCCH can schedule the data channel (PSSCH) and/or the 1st SCI in PSCCH by cross-slot scheduling. In this case, the other UEs can decode this SCI of the UE at slot N and determine whether/how to do the resource selection based on the sensing results (SCI decoding results) in slot N+X.

If the resources scheduled by 1st SCI are a group of resources or resource following a pattern, the other UEs may do the resource selection according to such resource pool or pattern.

Whether/how to use the 2-stage SCI or the single SCI can be up to network configuration or pre-configuration at UE (e.g., UICC). Switching between 2-stage SCI and single SCI can be supported by RRC, MAC and/or physical layer signaling.

Fig. 3 shows an exemplary block diagram of a UE 800 according to an embodiment of the disclosure. The UE 800 can be configured to implement various embodiments of the disclosure described herein. The UE 800 can include a processor 810, a memory 820, and a radio frequency (RF) module 830 that are coupled together as shown in Fig. 8. In different examples, the UE 800 can be a mobile phone, a tablet computer, a desktop computer, a vehicle carried device, and the like.

The processor 810 can be configured to perform various functions of the UE 120 described above with reference to Figs. 1a-1b. 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.

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.

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.

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.

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.

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.

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, comprising:

receiving a configuration or pre-configuration for 2-stage SCI;

performing 1st SCI decoding;

performing 2nd SCI decoding; and

performing data decoding.

2. The method of claim 1, wherein a configuration or pre-configuration for 2-stage SCI is based on configuration from the network or group head device or groupcasting Tx device or stored information at device.

3. The method of claim 1, wherein 1st SCI decoding is to obtain the data channel time-frequency location for data reception by the target receiving UE and sensing by the other UEs to perform resource selection.

4. The method of claim 1, wherein 2nd SCI decoding is to obtain the remaining information about data reception for the target receiving UEs.

5. The method of claim 1, wherein 1st SCI, 2nd SCI and/or the single SCI sharing the same SCI size can be differentiated by the format indicator.

6. The method of claim 1, wherein the SRC ID and/or Dest ID can be either CRC scrambled in the 1st SCI and/or 2nd SCI.

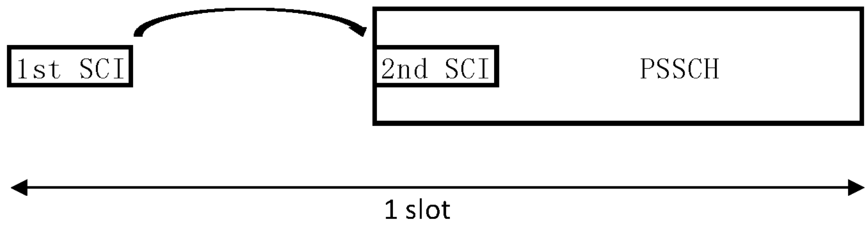
1st SCI
2nd SCI
PSSCH
1 slot

FIG. 1

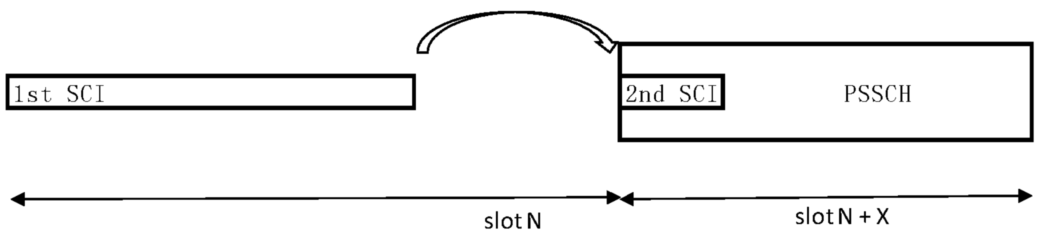
1st SCI
2nd SCI
PSSCH
slot N
slot N + X

FIG. 2

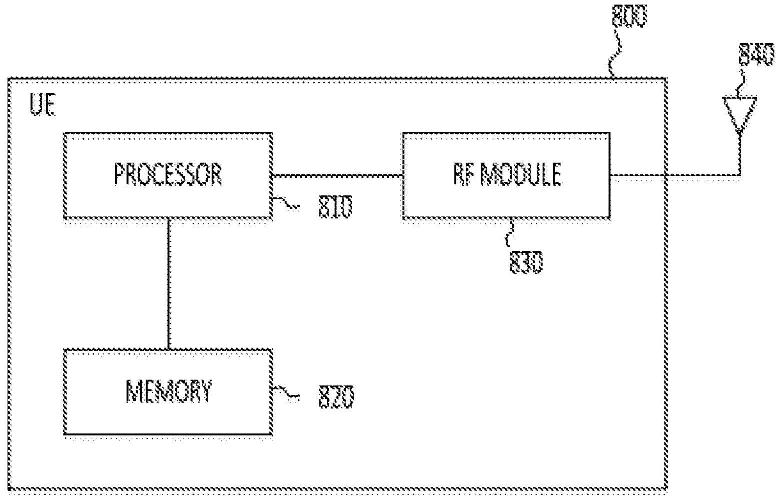

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/075362

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/12(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)

CNABS;CNKI;CNTXT;VEN;WOTXT;USTXT;EPTXT;3GPP: side link, device to device, vehicle to everything, SL, SCI, D2D, V2X, target, ID, identifer

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 107466068 A (ASUSTEK COMPUTER INC.) 12 December 2017 (2017-12-12) description, paragraphs [0099]-[0114], figures 8-13	1-6
X	CN 107615844 A (PANASONIC INTELLECTUAL PROPERTY CORPORATION OF AMERICA) 19 January 2018 (2018-01-19) description, paragraphs [0274]-[0361], figures 1-17	1-6
A	WO 2017171437 A1 (SAMSUNG ELECTRONICS CO., LTD.) 05 October 2017 (2017-10-05) the whole document	1-6

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 May 2019	**29 May 2019**

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**	**XU,Qian**
Facsimile No. **(86-10)62019451**	Telephone No. **86-(010)-62411433**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/075362

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				KR	20170138063	A	14 December 2017
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				WO	2016165124	A1	20 October 2016
				EP	3284299	A1	21 February 2018
				EP	3284299	A4	12 December 2018
				US	2018139724	A1	17 May 2018
WO	2017171437	A1	05 October 2017	EP	3420774	A1	02 January 2019
				KR	20180122373	A	12 November 2018
				US	2017289733	A1	05 October 2017