(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 August 2019 (15.08.2019)

WIPO | PCT

(10) International Publication Number
WO 2019/153147 A1

(51) International Patent Classification:
H04W 72/04 (2009.01)

(21) International Application Number:
PCT/CN2018/075643

(22) International Filing Date:
07 February 2018 (07.02.2018)

(25) Filing Language: English

(26) Publication Language: English

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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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

(54) **Title:** USER EQUIPMENT AND METHOD OF WIRELESS COMMUNICATION OF SAME

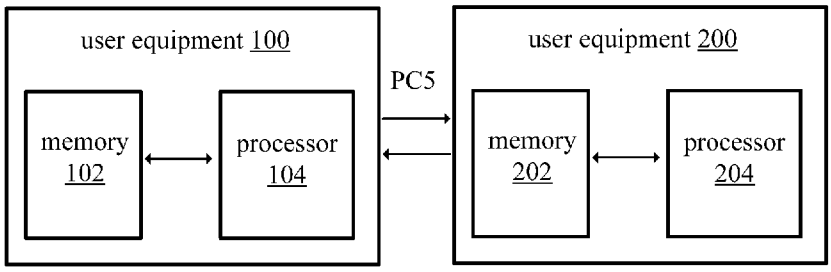


FIG. 1

(57) **Abstract:** A user equipment includes a memory and a processor coupled to the memory. The processor is configured to perform a communication over a sidelink interface to at least one second user equipment and transmit at least one data transport block using at least one sidelink resource of a sidelink resource pool to the at least one second user equipment. The sidelink resource pool includes a dimension of a plurality of slots in a time domain and a plurality of physical resource blocks in a frequency domain. The sidelink resource pool includes at least one transmission time interval (TTI) region each having one slot length, at least one long TTI region each having an integer multiple of one slot length, and at least one short TTI region each having one slot length. The at least one short TTI region includes a plurality of short TTIs each having a length less than one slot length.

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USER EQUIPMENT AND METHOD OF WIRELESS COMMUNICATION OF SAME

BACKGROUND OF DISCLOSURE

1. Field of the Disclosure

[0001] The present disclosure relates to the field of communication systems, and more particularly, to a user equipment and a method of wireless communication of same.

2. Description of the Related Art

[0002] In long term evolution (LTE) radio access technology, layer 1 (L1) transmission of data transport blocks (TBs) in downlink, uplink, and sidelink such as over both air (Uu) and PC5 interfaces is traditionally performed in unit of one subframe, and the subframe has a fixed length of 1ms being only a transmit time interval (TTI) supported in a 4th generation (4G) system. That is, regardless of size of data TBs, each TB is channel encoded, rate matched, resource element (RE) mapped, and transmitted over a 1ms subframe being a TTI duration.

[0003] Due to increasing needs for urgent transmission of data over a sidelink interface such as the PC5 interface to support public safety, road safety, and mission critical communications, data latency requirement for end-to-end communication becomes extremely short. For example, in 3rd generation partnership project (3GPP), SA-WG1 work item has identified and detailed latency requirement for data transfer from end-to-end that can be as short as 10ms in vehicle platooning operation, for which this has to cover all UE signal processing time, inter-layer communication, L1 transmissions, and relays if data needs to go from one end of a platoon to another end. As another example, for fully driverless operation such as autonomous driving, fast and reliable communication between closed-by vehicles is crucial for safe driving and maneuver on the road, and for which the communication latency requirement has been defined to be 5ms or even shorter. From the existing LTE-sidelink technology, it is very difficult to satisfy these requirements and there is no guarantee that it may meet these requirements due to resource selection mechanism and fixed TTI length transmission as described earlier. As the result, this has given the rise to the need to support ultra reliable and low latency communication (URLLC) in a next generation of wireless communication system. In addition, the need for enhanced broadband communication to support high data rate and large data blocks has also been identified as an essential feature to support more advanced vehicle-to-everything (V2X) applications such as vehicle sensor data sharing.

[0004] For the upcoming and recently developed 5th generation new radio (5G-NR) system, which supports longer sub-carrier spacing (SCS) over a previous 4G-LTE, the 5G-NR system allows shorter transmission symbol length and enables the possibility of faster and shorter transmission of data packets in a radio frame and a slot. However, if sidelink data transmission TTI is still associated with one slot of 14 symbols in the 5G-NR system and re-transmissions of data TB are scattered from slot to slot, this again still does not ensure the stringent latency requirements of data exchange over NR-sidelink over PC5 interface can be fulfilled.

SUMMARY

[0005] An object of the present disclosure is to propose a user equipment (UE) and a method of wireless communication of same for providing at least one transmission time interval (TTI) region, at least one long

TTI region, and at least one short TTI region in a same sidelink resource pool for new radio (NR) sidelink communication.

[0006] In a first aspect of the present disclosure, a user equipment for wireless communication includes a memory and a processor coupled to the memory. The processor is configured to perform a communication over a sidelink interface to at least one second user equipment and transmit at least one data transport block using at least one sidelink resource of a sidelink resource pool to the at least one second user equipment. The sidelink resource pool includes a dimension of a plurality of slots in a time domain and a plurality of physical resource blocks (PRBs) in a frequency domain. The sidelink resource pool includes at least one transmission time interval (TTI) region each having one slot length, at least one long TTI region each having an integer multiple of one slot length, and at least one short TTI region each having one slot length. The at least one short TTI region includes a plurality of short TTIs each having a length less than one slot length.

[0007] According to an embodiment in conjunction to the first aspect of the present disclosure, the sidelink resource pool in each slot includes a guard period (GP)/automatic gain control (AGC) region, a control region for transmitting a physical sidelink control channel (PSCCH) carrying sidelink control information (SCI), and a data region for transmitting a physical sidelink shared channel (PSSCH) for transmitting a plurality of sidelink data transport blocks (TBs).

[0008] According to an embodiment in conjunction to the first aspect of the present disclosure, the at least one long TTI region includes a beginning slot and at least one neighboring slot neighboring the beginning slot, and the processor is configured to map and transmit the sidelink data TBs using a corresponding GP/AGC region and a corresponding control region for transmitting the PSSCH in the at least one neighboring slot.

[0009] According to an embodiment in conjunction to the first aspect of the present disclosure, the at least one long TTI region based on a network configuration or a pre-configuration includes a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

[0010] According to an embodiment in conjunction to the first aspect of the present disclosure, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one long TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

[0011] According to an embodiment in conjunction to the first aspect of the present disclosure, the short TTIs have a same length, and the processor is configured to map and transmit the sidelink data TBs using the short TTIs.

[0012] According to an embodiment in conjunction to the first aspect of the present disclosure, the at least one short TTI region based on a network configuration or a pre-configuration includes a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

[0013] According to an embodiment in conjunction to the first aspect of the present disclosure, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one short

TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

[0014] According to an embodiment in conjunction to the first aspect of the present disclosure, the SCI includes at least one of a TTI type, a TTI length, an existence of the GP/AGC region and the PSCCH of the at least one long TTI region, a modulation and coding scheme (MCS) level, a transport block size (TBS), a redundancy version of short TTI transmissions, and a sequence of the short TTI transmissions.

[0015] According to an embodiment in conjunction to the first aspect of the present disclosure, the TTI type is represented by two bits to provide three indications including the at least one TTI region, the at least one long TTI region, and the at least one short TTI region.

[0016] According to an embodiment in conjunction to the first aspect of the present disclosure, the TTI length is a length of the at least one long TTI region and is represented by two bits to provide four indications including 2, 3, 4, and 5 slots.

[0017] According to an embodiment in conjunction to the first aspect of the present disclosure, the TTI length is a length of each short TTI and is represented by two bits to provide four indications including 2, 3, 4, and 5 symbols.

[0018] According to an embodiment in conjunction to the first aspect of the present disclosure, a number of the short TTIs is 5, 3, 2, and 2 when the length of each short TTI is 2, 3, 4, and 5 symbols, correspondingly.

[0019] According to an embodiment in conjunction to the first aspect of the present disclosure, the existence of the GP/AGC region and the PSCCH is represented by 1 bit.

[0020] According to an embodiment in conjunction to the first aspect of the present disclosure, if the bit is on, the at least one long TTI region in another slot other than a beginning slot includes a part of the data region, instead of including the GP/AGC region and the control region.

[0021] According to an embodiment in conjunction to the first aspect of the present disclosure, each slot has a constant length of 14 symbols.

[0022] According to an embodiment in conjunction to the first aspect of the present disclosure, the GP/AGC region has a length of 1 to 2 symbols being allocated at a beginning of the slot.

[0023] According to an embodiment in conjunction to the first aspect of the present disclosure, the control region has a length of 2 symbols.

[0024] According to an embodiment in conjunction to the first aspect of the present disclosure, the data region has a length of 10 to 11 symbols.

[0025] According to an embodiment in conjunction to the first aspect of the present disclosure, the sidelink resource pool includes the at least one TTI region of a slot based transmission and the at least one long TTI region and the at least one short TTI region of a non-slot based transmission.

[0026] In a second aspect of the present disclosure, a user equipment for wireless communication includes a memory and a processor coupled to the memory. The processor is configured to perform a communication over a sidelink interface to at least one second user equipment and receive at least one data transport block using at least one sidelink resource of a sidelink resource pool from the at least one second user equipment. The sidelink resource pool includes a dimension of a plurality of slots in a time domain and a plurality of

physical resource blocks (PRBs) in a frequency domain. The sidelink resource pool includes at least one transmission time interval (TTI) region each having one slot length, at least one long TTI region each having an integer multiple of one slot length, and at least one short TTI region each having one slot length. The at least one short TTI region includes a plurality of short TTIs each having a length less than one slot length.

[0027] According to another embodiment in conjunction to the second aspect of the present disclosure, the sidelink resource pool in each slot includes a guard period (GP)/automatic gain control (AGC) region, a control region for transmitting a physical sidelink control channel (PSCCH) carrying sidelink control information (SCI), and a data region for transmitting a physical sidelink shared channel (PSSCH) for transmitting a plurality of sidelink data transport blocks (TBs).

[0028] According to another embodiment in conjunction to the second aspect of the present disclosure, the at least one long TTI region includes a beginning slot and at least one neighboring slot neighboring the beginning slot, and the processor is configured to receive and decode the sidelink data TBs using a corresponding GP/AGC region and a corresponding control region for receiving the PSSCH in the at least one neighboring slot.

[0029] According to another embodiment in conjunction to the second aspect of the present disclosure, the at least one long TTI region based on a network configuration or a pre-configuration includes a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

[0030] According to another embodiment in conjunction to the second aspect of the present disclosure, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one long TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

[0031] According to another embodiment in conjunction to the second aspect of the present disclosure, the short TTIs have a same length, and the processor is configured to receive and decode the sidelink data TBs using the short TTIs.

[0032] According to another embodiment in conjunction to the second aspect of the present disclosure, the at least one short TTI region based on a network configuration or a pre-configuration includes a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

[0033] According to another embodiment in conjunction to the second aspect of the present disclosure, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one short TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

[0034] According to another embodiment in conjunction to the second aspect of the present disclosure, the SCI includes at least one of a TTI type, a TTI length, an existence of the GP/AGC region and the PSCCH of the at least one long TTI region, a modulation and coding scheme (MCS) level, a transport block size (TBS), a redundancy version of short TTI transmissions, and a sequence of the short TTI transmissions.

[0035] According to another embodiment in conjunction to the second aspect of the present disclosure, the TTI type is represented by two bits to provide three indications including the at least one TTI region, the at least one long TTI region, and the at least one short TTI region.

[0036] According to another embodiment in conjunction to the second aspect of the present disclosure, the TTI length is a length of the at least one long TTI region and is represented by two bits to provide four indications including 2, 3, 4, and 5 slots.

[0037] According to another embodiment in conjunction to the second aspect of the present disclosure, the TTI length is a length of each short TTI and is represented by two bits to provide four indications including 2, 3, 4, and 5 symbols.

[0038] According to another embodiment in conjunction to the second aspect of the present disclosure, a number of the short TTIs is 5, 3, 2, and 2 when the length of each short TTI is 2, 3, 4, and 5 symbols, correspondingly.

[0039] According to another embodiment in conjunction to the second aspect of the present disclosure, the existence of the GP/AGC region and the PSCCH is represented by 1 bit.

[0040] According to another embodiment in conjunction to the second aspect of the present disclosure, if the bit is on, the at least one long TTI region in another slot other than a beginning slot includes a part of the data region, instead of including the GP/AGC region and the control region.

[0041] According to another embodiment in conjunction to the second aspect of the present disclosure, each slot has a constant length of 14 symbols.

[0042] According to another embodiment in conjunction to the second aspect of the present disclosure, the GP/AGC region has a length of 1 to 2 symbols being allocated at a beginning of the slot.

[0043] According to another embodiment in conjunction to the second aspect of the present disclosure, the control region has a length of 2 symbols.

[0044] According to another embodiment in conjunction to the second aspect of the present disclosure, the data region has a length of 10 to 11 symbols.

[0045] According to another embodiment in conjunction to the second aspect of the present disclosure, the sidelink resource pool includes the at least one TTI region of a slot based transmission and the at least one long TTI region and the at least one short TTI region of a non-slot based transmission.

[0046] In a third aspect of the present disclosure, a method of wireless communication of a user equipment includes performing a communication over a sidelink interface to at least one second user equipment and transmitting at least one data transport block using at least one sidelink resource of a sidelink resource pool to the at least one second user equipment. The sidelink resource pool includes a dimension of a plurality of slots in a time domain and a plurality of physical resource blocks (PRBs) in a frequency domain. The sidelink resource pool includes at least one transmission time interval (TTI) region each having one slot length, at least one long TTI region each having an integer multiple of one slot length, and at least one short TTI region each having one slot length. The at least one short TTI region includes a plurality of short TTIs each having a length less than one slot length.

[0047] According to another embodiment in conjunction to the third aspect of the present disclosure, the sidelink resource pool in each slot includes a guard period (GP)/automatic gain control (AGC) region, a control region for transmitting a physical sidelink control channel (PSCCH) carrying sidelink control information (SCI), and a data region for transmitting a physical sidelink shared channel (PSSCH) for transmitting a plurality of sidelink data transport blocks (TBs).

[0048] According to another embodiment in conjunction to the third aspect of the present disclosure, the at least one long TTI region includes a beginning slot and at least one neighboring slot neighboring the beginning slot, and the method further including mapping and transmitting the sidelink data TBs using a corresponding GP/AGC region and a corresponding control region for transmitting the PSSCH in the at least one neighboring slot.

[0049] According to another embodiment in conjunction to the third aspect of the present disclosure, the at least one long TTI region based on a network configuration or a pre-configuration includes a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

[0050] According to another embodiment in conjunction to the third aspect of the present disclosure, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one long TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

[0051] According to another embodiment in conjunction to the third aspect of the present disclosure, the short TTIs have a same length, and the method further including mapping and transmitting the sidelink data TBs using the short TTIs.

[0052] According to another embodiment in conjunction to the third aspect of the present disclosure, the at least one short TTI region based on a network configuration or a pre-configuration includes a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

[0053] According to another embodiment in conjunction to the third aspect of the present disclosure, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one short TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

[0054] According to another embodiment in conjunction to the third aspect of the present disclosure, the SCI includes at least one of a TTI type, a TTI length, an existence of the GP/AGC region and the PSCCH of the at least one long TTI region, a modulation and coding scheme (MCS) level, a transport block size (TBS), a redundancy version of short TTI transmissions, and a sequence of the short TTI transmissions.

[0055] According to another embodiment in conjunction to the third aspect of the present disclosure, the TTI type is represented by two bits to provide three indications including the at least one TTI region, the at least one long TTI region, and the at least one short TTI region.

[0056] According to another embodiment in conjunction to the third aspect of the present disclosure, the TTI length is a length of the at least one long TTI region and is represented by two bits to provide four indications including 2, 3, 4, and 5 slots.

[0057] According to another embodiment in conjunction to the third aspect of the present disclosure, the TTI length is a length of each short TTI and is represented by two bits to provide four indications including 2, 3, 4, and 5 symbols.

[0058] According to another embodiment in conjunction to the third aspect of the present disclosure, a number of the short TTIs is 5, 3, 2, and 2 when the length of each short TTI is 2, 3, 4, and 5 symbols, correspondingly.

[0059] According to another embodiment in conjunction to the third aspect of the present disclosure, the existence of the GP/AGC region and the PSCCH is represented by 1 bit.

[0060] According to another embodiment in conjunction to the third aspect of the present disclosure, if the bit is on, the at least one long TTI region in another slot other than a beginning slot includes a part of the data region, instead of including the GP/AGC region and the control region.

[0061] According to another embodiment in conjunction to the third aspect of the present disclosure, each slot has a constant length of 14 symbols.

[0062] According to another embodiment in conjunction to the third aspect of the present disclosure, the GP/AGC region has a length of 1 to 2 symbols being allocated at a beginning of the slot.

[0063] According to another embodiment in conjunction to the third aspect of the present disclosure, the control region has a length of 2 symbols.

[0064] According to another embodiment in conjunction to the third aspect of the present disclosure, the data region has a length of 10 to 11 symbols.

[0065] According to another embodiment in conjunction to the third aspect of the present disclosure, the sidelink resource pool includes the at least one TTI region of a slot based transmission and the at least one long TTI region and the at least one short TTI region of a non-slot based transmission.

[0066] In a fourth aspect of the present disclosure, a method of wireless communication of a user equipment includes performing a communication over a sidelink interface to at least one second user equipment and receiving at least one data transport block using at least one sidelink resource of a sidelink resource pool from the at least one second user equipment. The sidelink resource pool includes a dimension of a plurality of slots in a time domain and a plurality of physical resource blocks (PRBs) in a frequency domain. The sidelink resource pool includes at least one transmission time interval (TTI) region each having one slot length, at least one long TTI region each having an integer multiple of one slot length, and at least one short TTI region each having one slot length. The at least one short TTI region includes a plurality of short TTIs each having a length less than one slot length.

[0067] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the sidelink resource pool in each slot includes a guard period (GP)/automatic gain control (AGC) region, a control region for transmitting a physical sidelink control channel (PSCCH) carrying sidelink control

information (SCI), and a data region for transmitting a physical sidelink shared channel (PSSCH) for transmitting a plurality of sidelink data transport blocks (TBs).

[0068] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the at least one long TTI region includes a beginning slot and at least one neighboring slot neighboring the beginning slot, and the method further including receiving and decoding the sidelink data TBs using a corresponding GP/AGC region and a corresponding control region for receiving the PSSCH in the at least one neighboring slot.

[0069] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the at least one long TTI region based on a network configuration or a pre-configuration includes a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

[0070] According to another embodiment in conjunction to the fourth aspect of the present disclosure, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one long TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

[0071] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the short TTIs have a same length, and the method further including receiving and decoding the sidelink data TBs using the short TTIs.

[0072] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the at least one short TTI region based on a network configuration or a pre-configuration includes a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

[0073] According to another embodiment in conjunction to the fourth aspect of the present disclosure, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one short TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

[0074] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the SCI includes at least one of a TTI type, a TTI length, an existence of the GP/AGC region and the PSCCH of the at least one long TTI region, a modulation and coding scheme (MCS) level, a transport block size (TBS), a redundancy version of short TTI transmissions, and a sequence of the short TTI transmissions.

[0075] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the TTI type is represented by two bits to provide three indications including the at least one TTI region, the at least one long TTI region, and the at least one short TTI region.

[0076] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the TTI length is a length of the at least one long TTI region and is represented by two bits to provide four indications including 2, 3, 4, and 5 slots.

[0077] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the TTI length is a length of each short TTI and is represented by two bits to provide four indications including 2, 3, 4, and 5 symbols.

[0078] According to another embodiment in conjunction to the fourth aspect of the present disclosure, a number of the short TTIs is 5, 3, 2, and 2 when the length of each short TTI is 2, 3, 4, and 5 symbols, correspondingly.

[0079] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the existence of the GP/AGC region and the PSCCH is represented by 1 bit.

[0080] According to another embodiment in conjunction to the fourth aspect of the present disclosure, if the bit is on, the at least one long TTI region in another slot other than a beginning slot includes a part of the data region, instead of including the GP/AGC region and the control region.

[0081] According to another embodiment in conjunction to the fourth aspect of the present disclosure, each slot has a constant length of 14 symbols.

[0082] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the GP/AGC region has a length of 1 to 2 symbols being allocated at a beginning of the slot.

[0083] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the control region has a length of 2 symbols.

[0084] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the data region has a length of 10 to 11 symbols.

[0085] According to another embodiment in conjunction to the fourth aspect of the present disclosure, the sidelink resource pool includes the at least one TTI region of a slot based transmission and the at least one long TTI region and the at least one short TTI region of a non-slot based transmission.

[0086] In the embodiment of the present disclosure, the user equipment and the method of wireless communication of same for providing at least one transmission time interval (TTI) region, at least one long TTI region, and at least one short TTI region in a same sidelink resource pool for new radio (NR) sidelink communication, so as to provide fast and reliable data transmission for NR-sidelink communication utilizing a short TTI structure and data repetition, perform an enhanced support for data TBs with large size to use a long TTI structure and/or perform a flexible use of a sidelink resource pool with easy co-existence and harmonized operation for all normal TTI, long TTI and short TTI transmissions.

BRIEF DESCRIPTION OF DRAWINGS

[0087] In order to more clearly illustrate the embodiments of the present disclosure or related art, the following figures will be described in the embodiments are briefly introduced. It is obvious that the drawings are merely some embodiments of the present disclosure, a person having ordinary skill in this field can obtain other figures according to these figures without paying the premise.

[0088] FIG. 1 is a block diagram of a user equipment for wireless communication according to an embodiment of the present disclosure.

[0089] FIG. 2 is a diagram of a structure of a sidelink resource pool according to an embodiment of the present disclosure.

[0090] FIG. 3 is a diagram of a structure of at least one long transmission time interval (TTI) region according to an embodiment of the present disclosure.

[0091] FIG. 4 is a diagram of a structure of at least one short TTI region according to an embodiment of the present disclosure.

[0092] FIG. 5 is a scenario of vehicle-to-everything (V2X) communication according to an embodiment of the present disclosure.

[0093] FIG. 6A is a flowchart illustrating a method of wireless communication according to the present disclosure, from an aspect of operation of a user equipment for transmitting signals.

[0094] FIG. 6B is a flowchart illustrating a method of wireless communication according to the present disclosure, from an aspect of operation of a user equipment for transmitting signals.

[0095] FIG. 7A is a flowchart illustrating a method of wireless communication according to the present disclosure, from an aspect of operation of a user equipment for receiving signals.

[0096] FIG. 7B is a flowchart illustrating a method of wireless communication according to the present disclosure, from an aspect of operation of a user equipment for receiving signals.

DETAILED DESCRIPTION OF EMBODIMENTS

[0097] Embodiments of the present disclosure are described in detail with the technical matters, structural features, achieved objects, and effects with reference to the accompanying drawings as follows. Specifically, the terminologies in the embodiments of the present disclosure are merely for describing the purpose of the certain embodiment, but not to limit the disclosure.

[0098] FIG. 1 and FIG. 2 illustrate that, in some embodiments, at least one user equipment (UE) 100 for wireless communication includes a memory 102 and a processor 104 coupled to the memory 102. The processor 104 is configured to perform a communication over a sidelink interface such as a PC5 interface to at least one user equipment 200 and transmit at least one data transport block using at least one sidelink resource of a sidelink resource pool 300 to the at least one second user equipment 200. The sidelink resource pool 300 includes a dimension of a plurality of slots in a time domain and a plurality of physical resource blocks (PRBs) in a frequency domain. The sidelink resource pool 300 includes at least one transmission time interval (TTI) region 310 or 312 each having one slot length, at least one long TTI region 320 or 322 each having an integer multiple of one slot length, and at least one short TTI region (sTTI) 330 each having one slot length. The at least one short TTI region 330 includes a plurality of short TTIs each having a length less than one slot length. The at least one TTI region 310 or 312 is, for example, a normal TTI region.

[0099] In details, in some embodiments, the GP/AGC region 301, the control region 302, and the data region 303 are arranged in order. Each slot has a constant length of 14 symbols. The GP/AGC region 301 has a length of 1 to 2 symbols being allocated at a beginning of the slot for transmission/reception switching and adjusting of input signal power level at the user equipment 200. The control region 302 has a length of 2 symbols. The data region 303 has a length of 10 to 11 symbols for transporting sidelink data transport blocks (TBs). The sidelink resource pool 300 includes the at least one TTI region 310 or 312, such as a normal TTI region, of a slot based transmission and the at least one long TTI region 320 or 322 and the at least one short TTI region 330 of a non-slot based transmission.

[0100] In the embodiment of the present disclosure, the user equipment 100 provides at least one of a transmission time interval (TTI) region, a long TTI region, and a short TTI region in a same sidelink resource pool 300 for new radio (NR) sidelink communication, so as to provide fast and reliable data transmission for NR-sidelink communication utilizing a short TTI structure such as the at least one short TTI region 330 and data repetition, perform an enhanced support for data transport blocks (TBs) with large size to use a long TTI structure and/or perform a flexible use of a sidelink resource pool with easy co-existence and harmonized operation for all normal TTI, long TTI and short TTI transmissions.

[0101] In details, the user equipment 100 may be a user equipment for transmitting signals and the user equipment 200 may be a user equipment for receiving signals. In some embodiments, the communication between the user equipment 100 and the user equipment 200 over the sidelink interface such as the PC5 interface could be based on based on long term evolution (LTE) sidelink technology developed under 3rd generation partnership project (3GPP) and/or 5th generation new radio (5G-NR) radio access technology.

[0102] FIG. 1 and FIG. 2 further illustrate that, in some embodiments, the at least one user equipment 200 for wireless communication includes a memory 202 and a processor 204 coupled to the memory 202. The processor 204 is configured to perform a communication over a sidelink interface such as a PC5 interface to the at least one user equipment 100 and receive the at least one data transport block using the at least one sidelink resource of the sidelink resource pool 300 from the at least one user equipment 100.

[0103] In some embodiments, the memories 102 and 202 each may include read-only memory (ROM), random access memory (RAM), flash memory, memory card, storage medium and/or other storage device. The processors 104 and 204 each may include application-specific integrated circuit (ASIC), other chipset, logic circuit and/or data processing device. The processors 104 and 204 each may also include baseband circuitry to process radio frequency signals. When the embodiments are implemented in software, the techniques described herein can be implemented with modules (e.g., procedures, functions, and so on) that perform the functions described herein. The modules can be stored in memories 102 and 202 and executed by processors 104 and 204. The memories 102 and 202 can be implemented within the processors 104 and 204 or external to the processors 104 and 204 in which case those can be communicatively coupled to the processors 104 and 204 via various means as is known in the art.

[0104] Further, FIG. 1 and FIG. 2 illustrate that, in some embodiments, the sidelink resource pool 300 in each slot includes a guard period (GP)/automatic gain control (AGC) region 301, a control region 302 for transmitting a physical sidelink control channel (PSCCH) carrying sidelink control information (SCI), and a data region 303 for transmitting a physical sidelink shared channel (PSSCH) for transmitting a plurality of sidelink data transport blocks (TBs). As illustrated in FIG. 3, the at least one long TTI region 320 includes a beginning slot and at least one neighboring slot neighboring the beginning slot. The processor 104 is configured to map and transmit the sidelink data TBs using a corresponding GP/AGC region 322 and a corresponding control region 323 for transmitting the PSSCH 321 in the at least one neighboring slot. The processor 204 is configured to receive and decode the sidelink data TBs using a corresponding GP/AGC region 322 and a corresponding control region 323 for receiving the PSSCH 321 in the at least one neighboring slot. The at least one long TTI region 320 includes a last symbol such as a blank/empty reserved

when the sidelink resource pool 300 is allocated on a carrier. The SCI includes at least one of a TTI type, a TTI length, an existence of the GP/AGC region and the PSCCH of the at least one long TTI region 320, a modulation and coding scheme (MCS) level, a transport block size (TBS), a redundancy version of short TTI transmissions, and a sequence of the short TTI transmissions.

[0105] In some embodiment, the TTI length may be a length of the at least one long TTI region and is represented by two bits to provide four indications including 2, 3, 4, and 5 slots. In details, 00 means a total length of the at least one long TTI region is 2 slots. 01 means a total length of the at least one long TTI region is 3 slots. 10 means a total length of the at least one long TTI region is 4 slots. 11 means a total length of the at least one long TTI region is 5 slots. In some embodiments, the TTI length may be a length of each short TTI and is represented by two bits to provide four indications including 2, 3, 4, and 5 symbols. A number of the short TTIs is 5, 3, 2, and 2 when the length of each short TTI is 2, 3, 4, and 5 symbols, correspondingly. In details, 00 means a number of the short TTIs is 5 when the length of each short TTI is 2 symbols. 01 means a number of the short TTIs is 3 when the length of each short TTI is 3 symbols. 10 means a number of the short TTIs is 2 when the length of each short TTI is 4 symbols. 11 means a number of the short TTIs is 2 when the length of each short TTI is 5 symbols. In some embodiment, if the TTI length may be a length of the at least one TTI region such as a normal TTI region, 2 bits are not used or reserved.

[0106] In some embodiment, the existence of the GP/AGC region 322 and the PSCCH 323 is represented by 1 bit. If the bit is on, the at least one long TTI region 320 in another slot other than a beginning slot includes a part of the data region 321, instead of including the GP/AGC region 322 and the control region 323. Further, in some embodiments, the TTI type is represented by two bits to provide three indications including the at least one TTI region 310, the at least one long TTI region 320, and the at least one short TTI region 330. In details, 00 means the at least one TTI region 310 such as a normal TTI region, 01 means the at least one long TTI region 320, 10 means the at least one short TTI region 330.

[0107] As illustrated in FIG. 4, in some embodiments, the short TTIs 331, 332, and 333 have a same length. The processor 104 is configured to map and transmit the sidelink data TBs using the short TTIs 331, 332, and 333. The processor 204 is configured to receive and decode the sidelink data TBs using the short TTIs 331, 332, and 333. The at least one short TTI region 330 includes a last symbol 336 such as a blank/empty reserved when the sidelink resource pool 300 is allocated on a carrier.

[0108] Some examples are illustrated in FIG. 3, and FIG. 4. FIG. 3 illustrates that, in some embodiments, the at least one long TTI region 320 over 2 slots length is exemplarily illustrated, where a pre-allocated GP/AGC region 322 and a control region 323 in a second slot adjacent to a first slot are to be used for mapping and transporting of data TB (PSSCH), and a last symbol 324 of the at least one long TTI region 320 in a data region 321 for PSSCH is reserved/empty/blanked for cellular uplink (UL) transmission when the sidelink resource pool 300 is configured on a carrier that co-exists with cellular UL transmissions. If the carrier is network configured or pre-configured for only sidelink transmissions, the last symbol 324 such as a reserved/empty/blank symbol can be omitted and used for sidelink data TB mapping and transmission.

[0109] FIG. 4 illustrates that, in some embodiments, the at least one short TTI region 330 within a slot is exemplarily illustrated, where multiple short TTIs 331, 332, and 333 of equal length are mapped and

transmitted in a data region 334 for PSSCH and each short TTI (sTTI) is only used for mapping of a data TB. That is, associated scheduling control information of the short TTIs are all provided in a control region 335 for PSCCH. A last one symbol 336 or multiple symbols 336 of a slot in the data region 334 for PSSCH is reserved/empty/blanked for cellular uplink (UL) transmission when the sidelink resource pool 300 is configured on a carrier that co-exists with cellular UL transmissions. If the carrier is network configured or pre-configured for only sidelink transmissions, the last symbol 336 such as a reserved/empty/blank symbol can be omitted and used for sidelink data TB mapping and transmission.

[0110] FIG. 5 illustrates that, in some embodiments, the communication between the user equipment 100 and the user equipment 200 relates to vehicle-to-everything (V2X) communication including vehicle-to-vehicle (V2V), vehicle-to-pedestrian (V2P), and vehicle-to-infrastructure/network (V2I/N) according to LTE sidelink technology developed under 3rd generation partnership project (3GPP) in Release 14 and/or 5G-NR radio access technology. The user equipments 100 and 200 are communicated with each other directly via a sidelink interface such as a PC5 interface.

[0111] FIGs. 6A and 6B illustrate two methods 400, 400' of wireless communication according to the present disclosure, from an aspect of operation of the user equipment 100 for transmitting signals. The methods 400, 400' each include: at block 402, performing a communication over a sidelink interface to at least one user equipment 200, and at block 404, transmitting at least one data transport block using at least one sidelink resource of a sidelink resource pool to the at least one user equipment 200. The sidelink resource pool 300 includes a dimension of a plurality of slots in a time domain and a plurality of physical resource blocks (PRBs) in a frequency domain. The sidelink resource pool 300 includes at least one transmission time interval (TTI) region 310 or 312 each having one slot length, at least one long TTI region 320 or 322 each having an integer multiple of one slot length, and at least one short TTI region (sTTI) 330 each having one slot length. The at least one short TTI region 330 includes a plurality of short TTIs each having a length less than one slot length. The at least one TTI region 310 or 312 is, for example, a normal TTI region.

[0112] In the embodiment of the present disclosure, the user equipment 100 provides at least one of a transmission time interval (TTI) region, a long TTI region, and a short TTI region in a same sidelink resource pool 300 for new radio (NR) sidelink communication, so as to provide fast and reliable data transmission for NR-sidelink communication utilizing a short TTI structure such as the at least one short TTI region 330 and data repetition, perform an enhanced support for data transport blocks (TBs) with large size to use a long TTI structure and/or perform a flexible use of a sidelink resource pool with easy co-existence and harmonized operation for all normal TTI, long TTI and short TTI transmissions.

[0113] FIG. 6A further illustrates that the method 400 further includes: at block 406, mapping and transmitting the sidelink data TBs using a corresponding GP/AGC region and a corresponding control region for transmitting the PSSCH in the at least one neighboring slo.

[0114] FIG. 6B further illustrates that the method 400' further includes: at block 408, mapping and transmitting the sidelink data TBs using the short TTIs.

[0115] FIGs. 7A and 7B illustrate two methods 500, 500' of wireless communication according to the present disclosure, from an aspect of operation of the user equipment 200 for receiving signals. The methods

500, 500' include: at block 502, performing a communication over a sidelink interface to at least one user equipment 100, and at block 504, receiving at least one data transport block using at least one sidelink resource of a sidelink resource pool from the at least one user equipment 100. The sidelink resource pool 300 includes a dimension of a plurality of slots in a time domain and a plurality of physical resource blocks (PRBs) in a frequency domain. The sidelink resource pool 300 includes at least one transmission time interval (TTI) region 310 or 312 each having one slot length, at least one long TTI region 320 or 322 each having an integer multiple of one slot length, and at least one short TTI region (sTTI) 330 each having one slot length. The at least one short TTI region 330 includes a plurality of short TTIs each having a length less than one slot length. The at least one TTI region 310 or 312 is, for example, a normal TTI region.

[0116] In the embodiment of the present disclosure, the user equipment 200 receives at least one of a transmission time interval (TTI) region, a long TTI region, and a short TTI region in a same sidelink resource pool 300 for new radio (NR) sidelink communication, so as to provide fast and reliable data transmission for NR-sidelink communication utilizing a short TTI structure such as the at least one short TTI region 330 and data repetition, perform an enhanced support for data transport blocks (TBs) with large size to use a long TTI structure and/or perform a flexible use of a sidelink resource pool with easy co-existence and harmonized operation for all normal TTI, long TTI and short TTI transmissions.

[0117] FIG. 7A further illustrates that, in some embodiments, the method 500 further includes: at block 506, receiving and decoding the sidelink data TBs using a corresponding GP/AGC region and a corresponding control region for receiving the PSSCH in the at least one neighboring slot.

[0118] FIG. 7B further illustrates that, in some embodiments, the method 500' further includes: at block 508, receiving and decoding the sidelink data TBs using the short TTIs.

[0119] In the embodiment of the present disclosure, the user equipment and the method of wireless communication of same for providing or receiving at least one of a transmission time interval (TTI) region, a long TTI region, and a short TTI region in a same sidelink resource pool for new radio (NR) sidelink communication, so as to provide fast and reliable data transmission for NR-sidelink communication utilizing a short TTI structure and data repetition, perform an enhanced support for data TBs with large size to use a long TTI structure and/or perform a flexible use of a sidelink resource pool with easy co-existence and harmonized operation for all normal TTI, long TTI and short TTI transmissions.

[0120] A person having ordinary skill in the art understands that each of the units, algorithm, and steps described and disclosed in the embodiments of the present disclosure are realized using electronic hardware or combinations of software for computers and electronic hardware. Whether the functions run in hardware or software depends on the condition of application and design requirement for a technical plan. A person having ordinary skill in the art can use different ways to realize the function for each specific application while such realizations should not go beyond the scope of the present disclosure.

[0121] It is understood by a person having ordinary skill in the art that he/she can refer to the working processes of the system, device, and unit in the above-mentioned embodiment since the working processes of the above-mentioned system, device, and unit are basically the same. For easy description and simplicity, these working processes will not be detailed.

[0122] It is understood that the disclosed system, device, and method in the embodiments of the present disclosure can be realized with other ways. The above-mentioned embodiments are exemplary only. The division of the units is merely based on logical functions while other divisions exist in realization. It is possible that a plurality of units or components are combined or integrated in another system. It is also possible that some characteristics are omitted or skipped. On the other hand, the displayed or discussed mutual coupling, direct coupling, or communicative coupling operate through some ports, devices, or units whether indirectly or communicatively by ways of electrical, mechanical, or other kinds of forms.

[0123] The units as separating components for explanation are or are not physically separated. The units for display are or are not physical units, that is, located in one place or distributed on a plurality of network units. Some or all of the units are used according to the purposes of the embodiments.

[0124] Moreover, each of the functional units in each of the embodiments can be integrated in one processing unit, physically independent, or integrated in one processing unit with two or more than two units.

[0125] If the software function unit is realized and used and sold as a product, it can be stored in a readable storage medium in a computer. Based on this understanding, the technical plan proposed by the present disclosure can be essentially or partially realized as the form of a software product. Or, one part of the technical plan beneficial to the conventional technology can be realized as the form of a software product. The software product in the computer is stored in a storage medium, including a plurality of commands for a computational device (such as a personal computer, a server, or a network device) to run all or some of the steps disclosed by the embodiments of the present disclosure. The storage medium includes a USB disk, a mobile hard disk, a read-only memory (ROM), a random access memory (RAM), a floppy disk, or other kinds of media capable of storing program codes.

[0126] While the present disclosure has been described in connection with what is considered the most practical and preferred embodiments, it is understood that the present disclosure is not limited to the disclosed embodiments but is intended to cover various arrangements made without departing from the scope of the broadest interpretation of the appended claims.

What is claimed is:

1. A user equipment for wireless communication, comprising:

a memory; and

a processor coupled to the memory and configured to:

perform a communication over a sidelink interface to at least one second user equipment; and

transmit at least one data transport block using at least one sidelink resource of a sidelink resource pool to the at least one second user equipment, wherein the sidelink resource pool comprises a dimension of a plurality of slots in a time domain and a plurality of physical resource blocks (PRBs) in a frequency domain, wherein the sidelink resource pool comprises at least one transmission time interval (TTI) region each having one slot length, at least one long TTI region each having an integer multiple of one slot length, and at least one short TTI region each having one slot length, and the at least one short TTI region comprises a plurality of short TTIs each having a length less than one slot length.

2. The user equipment of claim 1, wherein the sidelink resource pool in each slot comprises a guard period (GP)/automatic gain control (AGC) region, a control region for transmitting a physical sidelink control channel (PSCCH) carrying sidelink control information (SCI), and a data region for transmitting a physical sidelink shared channel (PSSCH) for transmitting a plurality of sidelink data transport blocks (TBs).

3. The user equipment of claim 2, wherein the at least one long TTI region comprises a beginning slot and at least one neighboring slot neighboring the beginning slot, and the processor is configured to map and transmit the sidelink data TBs using a corresponding GP/AGC region and a corresponding control region for transmitting the PSSCH in the at least one neighboring slot.

4. The user equipment of claim 3, wherein the at least one long TTI region based on a network configuration or a pre-configuration comprises a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

5. The user equipment of claim 3, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one long TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

6. The user equipment of claim 2, wherein the short TTIs have a same length, and the processor is configured to map and transmit the sidelink data TBs using the short TTIs.

7. The user equipment of claim 6, wherein the at least one short TTI region based on a network configuration or a pre-configuration comprises a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

8. The user equipment of claim 6, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one short TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

9. The user equipment of claim 2, wherein the SCI comprises at least one of a TTI type, a TTI length, an existence of the GP/AGC region and the PSCCH of the at least one long TTI region, a modulation and coding scheme (MCS) level, a transport block size (TBS), a redundancy version of short TTI transmissions, and a sequence of the short TTI transmissions.

10. The user equipment of claim 9, wherein the TTI type is represented by two bits to provide three

indications comprising the at least one TTI region, the at least one long TTI region, and the at least one short TTI region.

11. The user equipment of claim 9, wherein the TTI length is a length of the at least one long TTI region and is represented by two bits to provide four indications comprising 2, 3, 4, and 5 slots.

12. The user equipment of claim 9, wherein the TTI length is a length of each short TTI and is represented by two bits to provide four indications comprising 2, 3, 4, and 5 symbols.

13. The user equipment of claim 9, wherein a number of the short TTIs is 5, 3, 2, and 2 when the length of each short TTI is 2, 3, 4, and 5 symbols, correspondingly.

14. The user equipment of claim 9, wherein the existence of the GP/AGC region and the PSCCH is represented by 1 bit.

15. The user equipment of claim 14, wherein if the bit is on, the at least one long TTI region in another slot other than a beginning slot comprises a part of the data region, instead of comprising the GP/AGC region and the control region.

16. The user equipment of claim 2, wherein each slot has a constant length of 14 symbols.

17. The user equipment of claim 2, wherein the GP/AGC region has a length of 1 to 2 symbols being allocated at a beginning of the slot.

18. The user equipment of claim 2, wherein the control region has a length of 2 symbols.

19. The user equipment of claim 2, wherein the data region has a length of 10 to 11 symbols.

20. The user equipment of claim 1, wherein the sidelink resource pool comprises the at least one TTI region of a slot based transmission and the at least one long TTI region and the at least one short TTI region of a non-slot based transmission.

21. A user equipment for wireless communication, comprising:

a memory; and

a processor coupled to the memory and configured to:

perform a communication over a sidelink interface to at least one second user equipment; and

receive at least one data transport block using at least one sidelink resource of a sidelink resource pool from the at least one second user equipment, wherein the sidelink resource pool comprises a dimension of a plurality of slots in a time domain and a plurality of physical resource blocks (PRBs) in a frequency domain, wherein the sidelink resource pool comprises at least one transmission time interval (TTI) region each having one slot length, at least one long TTI region each having an integer multiple of one slot length, and at least one short TTI region each having one slot length, and the at least one short TTI region comprises a plurality of short TTIs each having a length less than one slot length.

22. The user equipment of claim 21, wherein the sidelink resource pool in each slot comprises a guard period (GP)/automatic gain control (AGC) region, a control region for transmitting a physical sidelink control channel (PSCCH) carrying sidelink control information (SCI), and a data region for transmitting a physical sidelink shared channel (PSSCH) for transmitting a plurality of sidelink data transport blocks (TBs).

23. The user equipment of claim 22, wherein the at least one long TTI region comprises a beginning slot and at least one neighboring slot neighboring the beginning slot, and the processor is configured to receive and decode the sidelink data TBs using a corresponding GP/AGC region and a corresponding control region for

receiving the PSSCH in the at least one neighboring slot.

24. The user equipment of claim 23, wherein the at least one long TTI region based on a network configuration or a pre-configuration comprises a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

25. The user equipment of claim 23, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one long TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

26. The user equipment of claim 22, wherein the short TTIs have a same length, and the processor is configured to receive and decode the sidelink data TBs using the short TTIs.

27. The user equipment of claim 26, wherein the at least one short TTI region based on a network configuration or a pre-configuration comprises a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

28. The user equipment of claim 26, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one short TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

29. The user equipment of claim 22, wherein the SCI comprises at least one of a TTI type, a TTI length, an existence of the GP/AGC region and the PSCCH of the at least one long TTI region, a modulation and coding scheme (MCS) level, a transport block size (TBS), a redundancy version of short TTI transmissions, and a sequence of the short TTI transmissions.

30. The user equipment of claim 29, wherein the TTI type is represented by two bits to provide three indications comprising the at least one TTI region, the at least one long TTI region, and the at least one short TTI region.

31. The user equipment of claim 29, wherein the TTI length is a length of the at least one long TTI region and is represented by two bits to provide four indications comprising 2, 3, 4, and 5 slots.

32. The user equipment of claim 29, wherein the TTI length is a length of each short TTI and is represented by two bits to provide four indications comprising 2, 3, 4, and 5 symbols.

33. The user equipment of claim 29, wherein a number of the short TTIs is 5, 3, 2, and 2 when the length of each short TTI is 2, 3, 4, and 5 symbols, correspondingly.

34. The user equipment of claim 29, wherein the existence of the GP/AGC region and the PSCCH is represented by 1 bit.

35. The user equipment of claim 34, wherein if the bit is on, the at least one long TTI region in another slot other than a beginning slot comprises a part of the data region, instead of comprising the GP/AGC region and the control region.

36. The user equipment of claim 22, wherein each slot has a constant length of 14 symbols.

37. The user equipment of claim 22, wherein the GP/AGC region has a length of 1 to 2 symbols being allocated at a beginning of the slot.

38. The user equipment of claim 22, wherein the control region has a length of 2 symbols.

39. The user equipment of claim 22, wherein the data region has a length of 10 to 11 symbols.

40. The user equipment of claim 21, wherein the sidelink resource pool comprises the at least one TTI

region of a slot based transmission and the at least one long TTI region and the at least one short TTI region of a non-slot based transmission.

41. A method of wireless communication of a user equipment, comprising:

performing a communication over a sidelink interface to at least one second user equipment; and

transmitting at least one data transport block using at least one sidelink resource of a sidelink resource pool to the at least one second user equipment, wherein the sidelink resource pool comprises a dimension of a plurality of slots in a time domain and a plurality of physical resource blocks (PRBs) in a frequency domain, wherein the sidelink resource pool comprises at least one transmission time interval (TTI) region each having one slot length, at least one long TTI region each having an integer multiple of one slot length, and at least one short TTI region each having one slot length, and the at least one short TTI region comprises a plurality of short TTIs each having a length less than one slot length.

42. The method of claim 41, wherein the sidelink resource pool in each slot comprises a guard period (GP)/automatic gain control (AGC) region, a control region for transmitting a physical sidelink control channel (PSCCH) carrying sidelink control information (SCI), and a data region for transmitting a physical sidelink shared channel (PSSCH) for transmitting a plurality of sidelink data transport blocks (TBs).

43. The method of claim 42, wherein the at least one long TTI region comprises a beginning slot and at least one neighboring slot neighboring the beginning slot, and the method further comprising mapping and transmitting the sidelink data TBs using a corresponding GP/AGC region and a corresponding control region for transmitting the PSSCH in the at least one neighboring slot.

44. The method of claim 43, wherein the at least one long TTI region based on a network configuration or a pre-configuration comprises a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

45. The method of claim 43, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one long TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

46. The method of claim 42, wherein the short TTIs have a same length, and the method further comprising mapping and transmitting the sidelink data TBs using the short TTIs.

47. The method of claim 46, wherein the at least one short TTI region based on a network configuration or a pre-configuration comprises a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

48. The method of claim 46, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one short TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

49. The method of claim 42, wherein the SCI comprises at least one of a TTI type, a TTI length, an existence of the GP/AGC region and the PSCCH of the at least one long TTI region, a modulation and coding scheme (MCS) level, a transport block size (TBS), a redundancy version of short TTI transmissions, and a sequence of the short TTI transmissions.

50. The method of claim 49, wherein the TTI type is represented by two bits to provide three indications comprising the at least one TTI region, the at least one long TTI region, and the at least one short TTI region.

51. The method of claim 49, wherein the TTI length is a length of the at least one long TTI region and is represented by two bits to provide four indications comprising 2, 3, 4, and 5 slots.

52. The method of claim 49, wherein the TTI length is a length of each short TTI and is represented by two bits to provide four indications comprising 2, 3, 4, and 5 symbols.

53. The method of claim 49, wherein a number of the short TTIs is 5, 3, 2, and 2 when the length of each short TTI is 2, 3, 4, and 5 symbols, correspondingly.

54. The method of claim 49, wherein the existence of the GP/AGC region and the PSCCH is represented by 1 bit.

55. The method of claim 54, wherein if the bit is on, the at least one long TTI region in another slot other than a beginning slot comprises a part of the data region, instead of comprising the GP/AGC region and the control region.

56. The method of claim 42, wherein each slot has a constant length of 14 symbols.

57. The method of claim 42, wherein the GP/AGC region has a length of 1 to 2 symbols being allocated at a beginning of the slot.

58. The method of claim 42, wherein the control region has a length of 2 symbols.

59. The method of claim 42, wherein the data region has a length of 10 to 11 symbols.

60. The method of claim 41, wherein the sidelink resource pool comprises the at least one TTI region of a slot based transmission and the at least one long TTI region and the at least one short TTI region of a non-slot based transmission.

61. A method of wireless communication of a user equipment, comprising:

performing a communication over a sidelink interface to at least one second user equipment; and

receiving at least one data transport block using at least one sidelink resource of a sidelink resource pool from the at least one second user equipment, wherein the sidelink resource pool comprises a dimension of a plurality of slots in a time domain and a plurality of physical resource blocks (PRBs) in a frequency domain, wherein the sidelink resource pool comprises at least one transmission time interval (TTI) region each having one slot length, at least one long TTI region each having an integer multiple of one slot length, and at least one short TTI region each having one slot length, and the at least one short TTI region comprises a plurality of short TTIs each having a length less than one slot length.

62. The method of claim 61, wherein the sidelink resource pool in each slot comprises a guard period (GP)/automatic gain control (AGC) region, a control region for transmitting a physical sidelink control channel (PSCCH) carrying sidelink control information (SCI), and a data region for transmitting a physical sidelink shared channel (PSSCH) for transmitting a plurality of sidelink data transport blocks (TBs).

63. The method of claim 62, wherein the at least one long TTI region comprises a beginning slot and at least one neighboring slot neighboring the beginning slot, and the method further comprising receiving and decoding the sidelink data TBs using a corresponding GP/AGC region and a corresponding control region for receiving the PSSCH in the at least one neighboring slot.

64. The method of claim 63, wherein the at least one long TTI region based on a network configuration or a pre-configuration comprises a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

65. The method of claim 63, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one long TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

66. The method of claim 62, wherein the short TTIs have a same length, and the method further comprising receiving and decoding the sidelink data TBs using the short TTIs.

67. The method of claim 66, wherein the at least one short TTI region based on a network configuration or a pre-configuration comprises a last symbol reserved, empty, or blanked when the sidelink resource pool is allocated on a carrier that is also being used for cellular uplink operation.

68. The method of claim 66, if a carrier is network configured or pre-configured for only sidelink transmissions, a last symbol of the at least one short TTI region, as a reserved symbol, an empty symbol, or a blank symbol, is omitted and used for sidelink data TB mapping and transmission.

69. The method of claim 63, wherein the SCI comprises at least one of a TTI type, a TTI length, an existence of the GP/AGC region and the PSCCH of the at least one long TTI region, a modulation and coding scheme (MCS) level, a transport block size (TBS), a redundancy version of short TTI transmissions, and a sequence of the short TTI transmissions.

70. The method of claim 69, wherein the TTI type is represented by two bits to provide three indications comprising the at least one TTI region, the at least one long TTI region, and the at least one short TTI region.

71. The method of claim 69, wherein the TTI length is a length of the at least one long TTI region and is represented by two bits to provide four indications comprising 2, 3, 4, and 5 slots.

72. The method of claim 69, wherein the TTI length is a length of each short TTI and is represented by two bits to provide four indications comprising 2, 3, 4, and 5 symbols.

73. The method of claim 69, wherein a number of the short TTIs is 5, 3, 2, and 2 when the length of each short TTI is 2, 3, 4, and 5 symbols, correspondingly.

74. The method of claim 69, wherein the existence of the GP/AGC region and the PSCCH is represented by 1 bit.

75. The method of claim 74, wherein if the bit is on, the at least one long TTI region in another slot other than a beginning slot comprises a part of the data region, instead of comprising the GP/AGC region and the control region.

76. The method of claim 62, wherein each slot has a constant length of 14 symbols.

77. The method of claim 62, wherein the GP/AGC region has a length of 1 to 2 symbols being allocated at a beginning of the slot.

78. The method of claim 62, wherein the control region has a length of 2 symbols.

79. The method of claim 62, wherein the data region has a length of 10 to 11 symbols.

80. The method of claim 62, wherein the sidelink resource pool comprises the at least one TTI region of a slot based transmission and the at least one long TTI region and the at least one short TTI region of a non-slot based transmission.

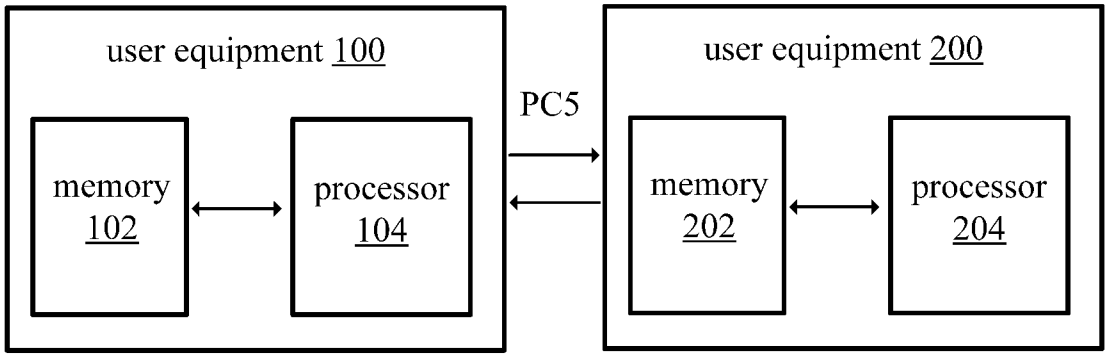

user equipment 100
memory
102
processor
104
PC5
user equipment 200
memory
202
processor
204

FIG. 1

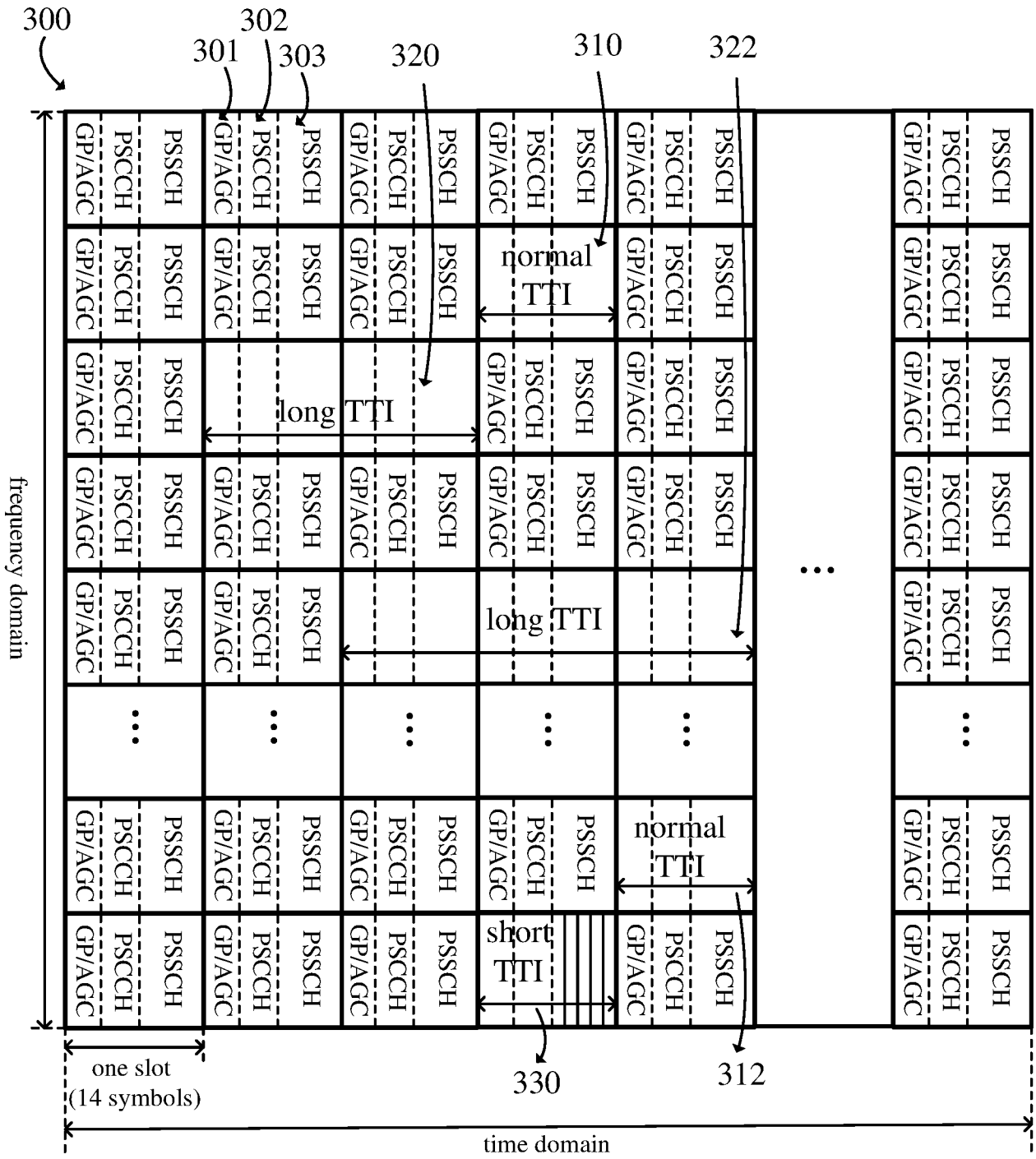

300
301
302
303
320
310
322
GP/AGC
PSCCH
PSSCH
normal TTI
long TTI
short TTI
frequency domain
one slot
(14 symbols)
330
312
time domain

FIG. 2

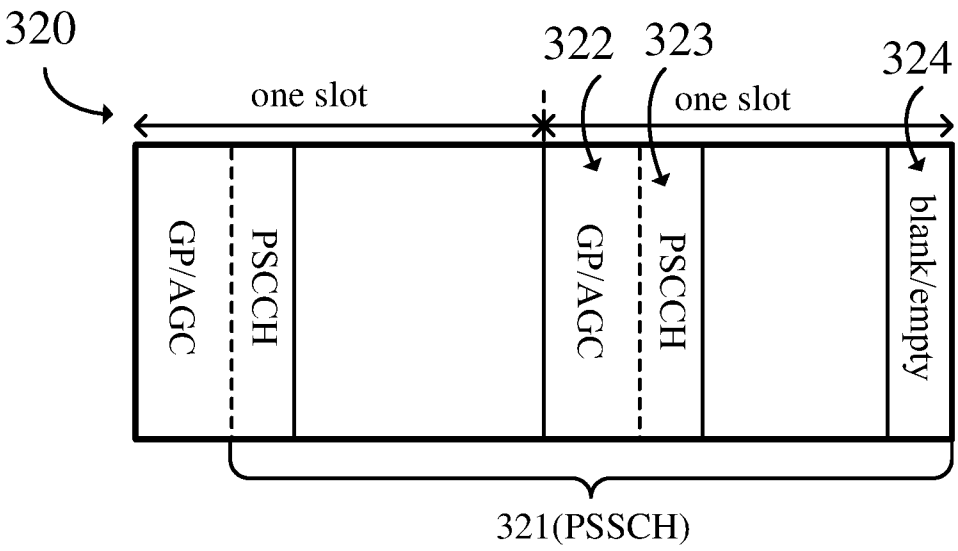


FIG. 3

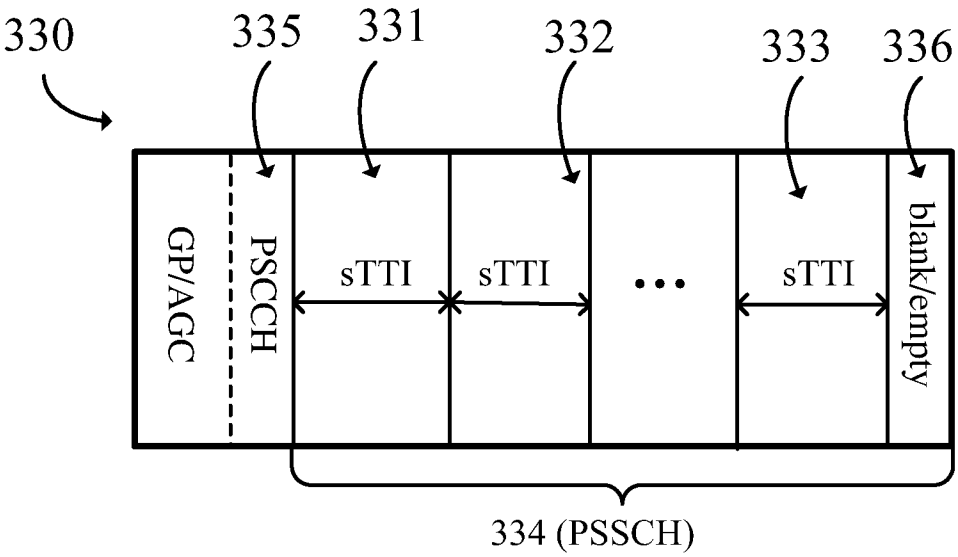


FIG. 4

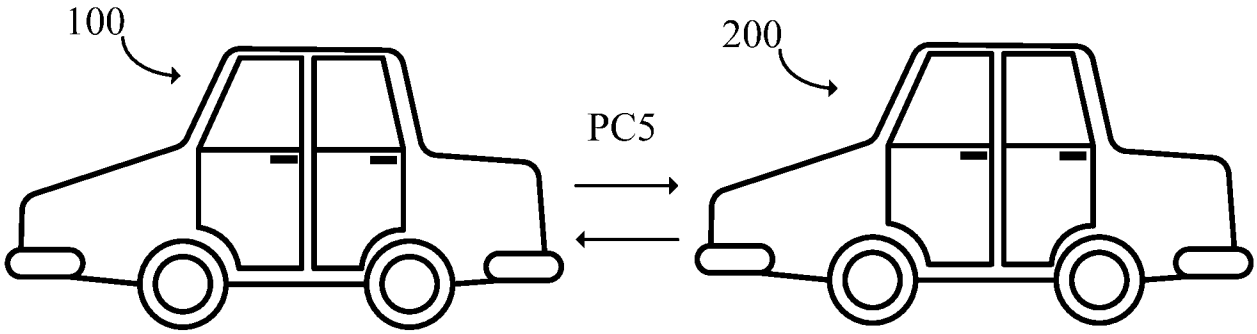


FIG. 5

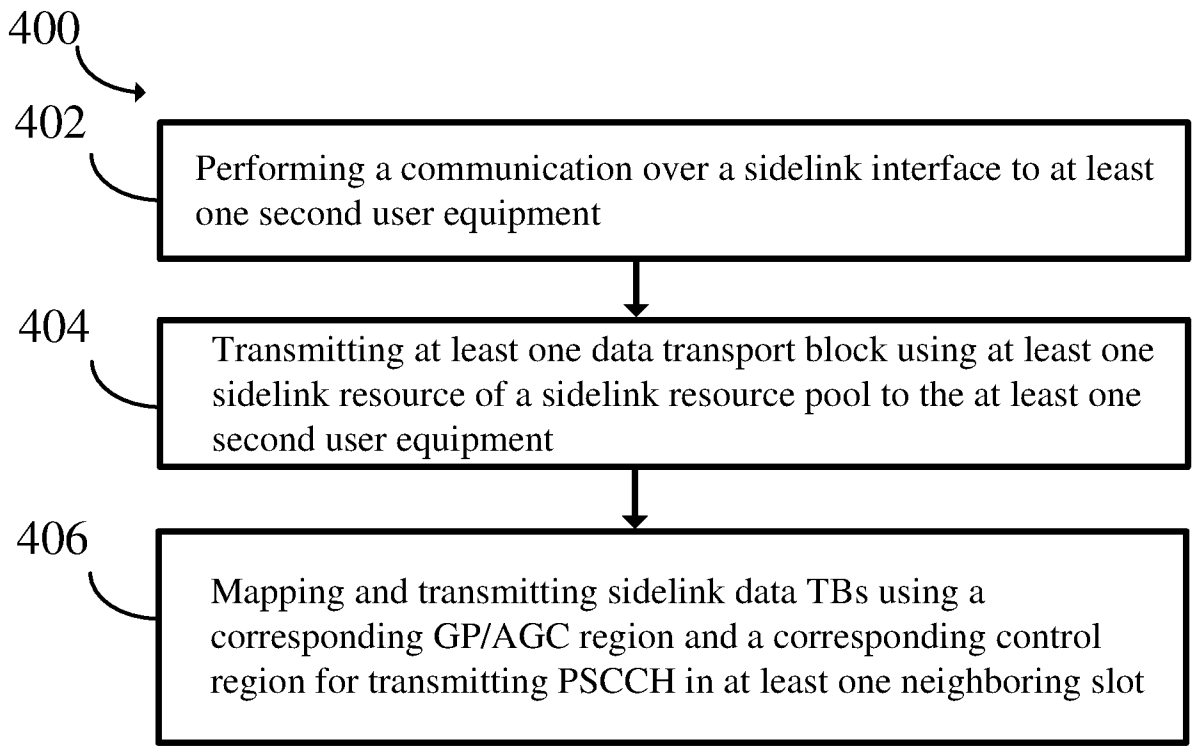

400
402
Performing a communication over a sidelink interface to at least one second user equipment
404
Transmitting at least one data transport block using at least one sidelink resource of a sidelink resource pool to the at least one second user equipment
406
Mapping and transmitting sidelink data TBs using a corresponding GP/AGC region and a corresponding control region for transmitting PSCCH in at least one neighboring slot

FIG. 6A

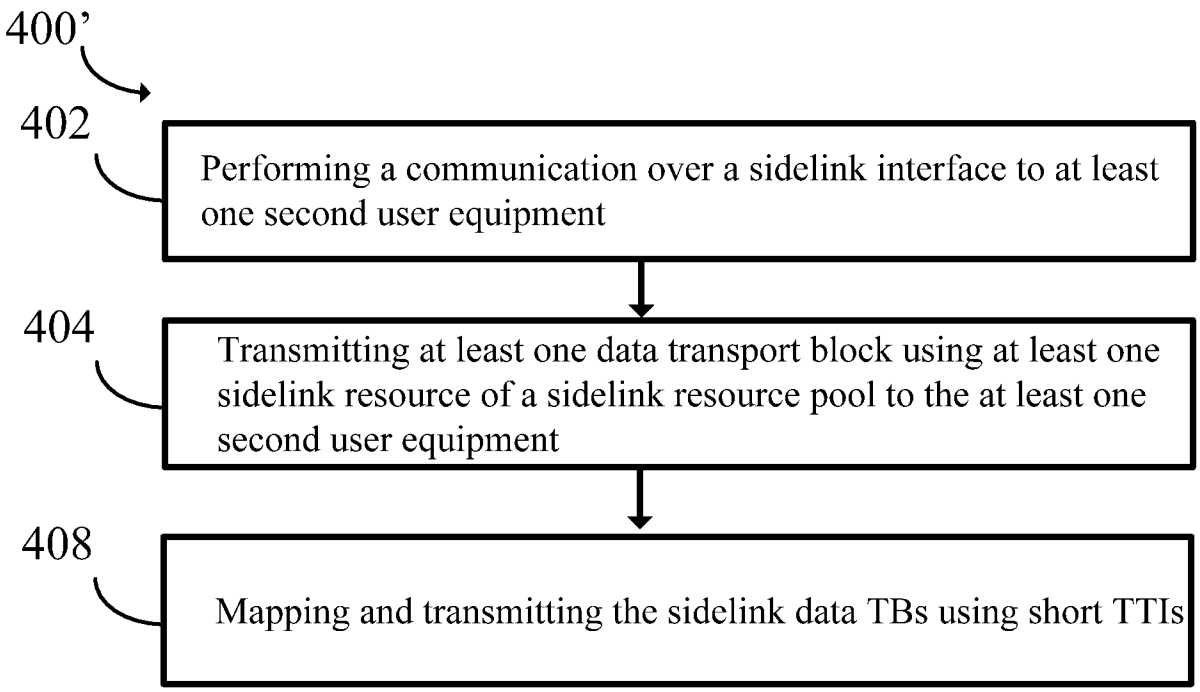

400'
402
Performing a communication over a sidelink interface to at least one second user equipment
404
Transmitting at least one data transport block using at least one sidelink resource of a sidelink resource pool to the at least one second user equipment
408
Mapping and transmitting the sidelink data TBs using short TTIs

FIG. 6B

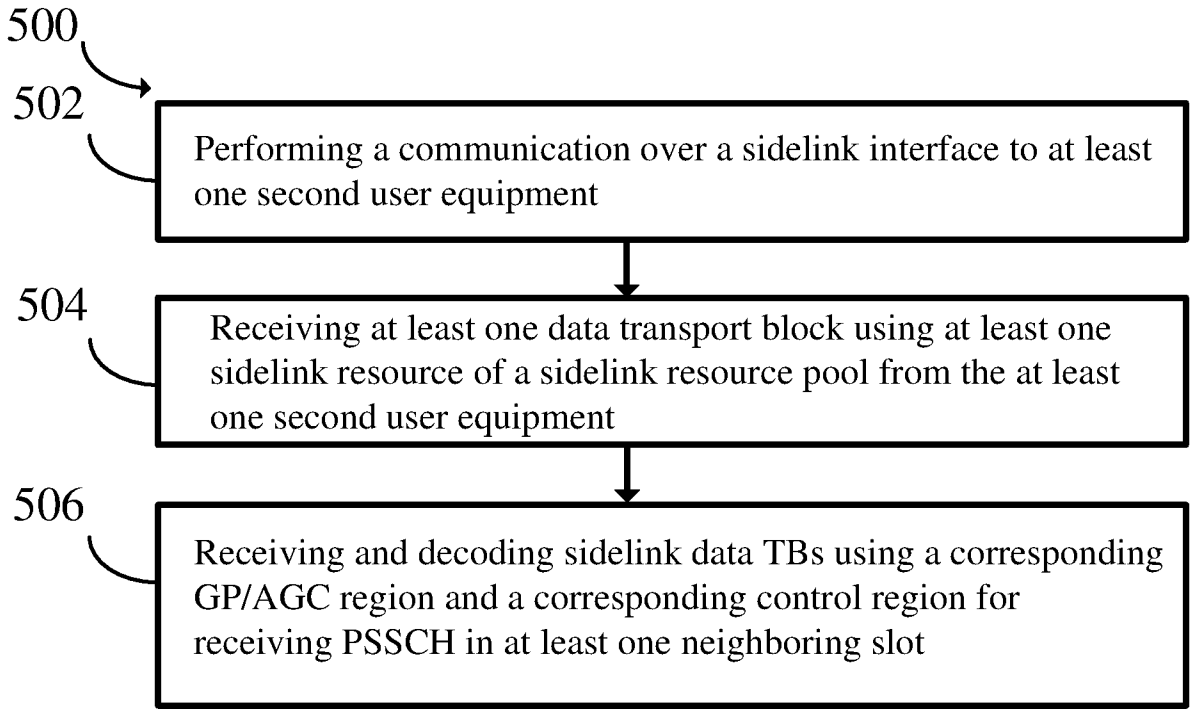

500
502
Performing a communication over a sidelink interface to at least one second user equipment
504
Receiving at least one data transport block using at least one sidelink resource of a sidelink resource pool from the at least one second user equipment
506
Receiving and decoding sidelink data TBs using a corresponding GP/AGC region and a corresponding control region for receiving PSSCH in at least one neighboring slot

FIG. 7A

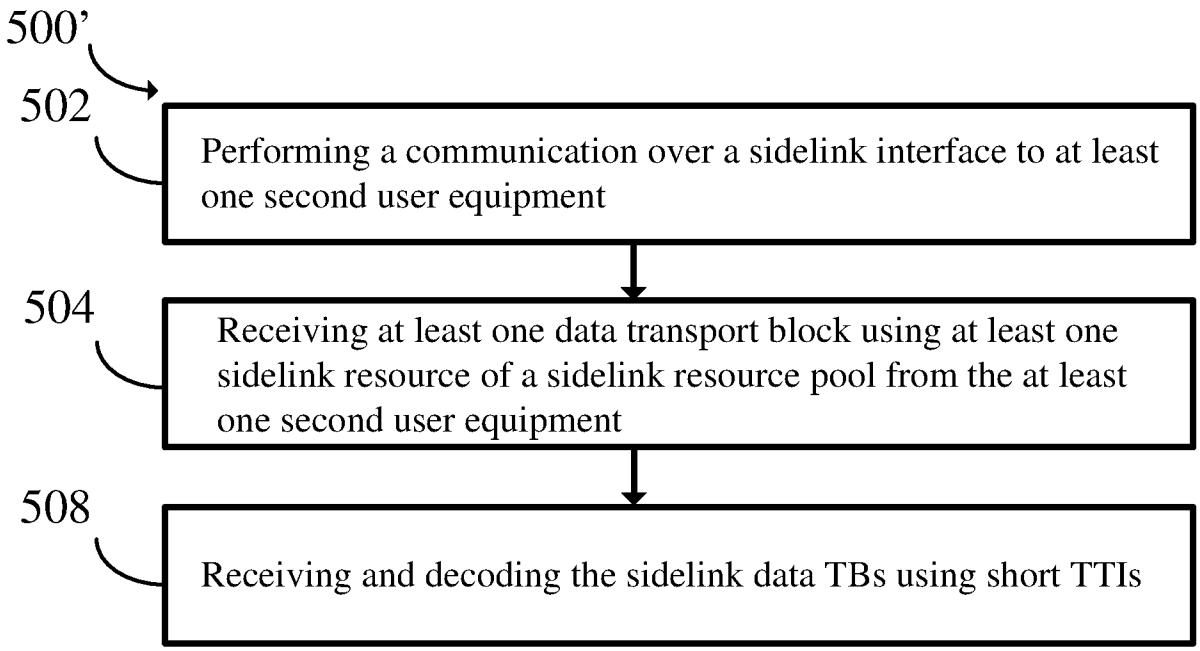

500'
502
Performing a communication over a sidelink interface to at least one second user equipment
504
Receiving at least one data transport block using at least one sidelink resource of a sidelink resource pool from the at least one second user equipment
508
Receiving and decoding the sidelink data TBs using short TTIs

FIG. 7B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2018/075643

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04(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)

CNABS, CNTXT, CNKI, VEN, USTXT, EPTXT, WOTXT: sidelink, device to device, D2D, vehicle to everything, V2X, vehicle to vehicle, V2V, PC5, transmission time interval, multiple, TTI, resource, pool, time domain, frequency domain, slot, symbol, physical resource block, PRB, transport block, TB, long, short, length

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2017011079 A1 (QUALCOMM INC.) 19 January 2017 (2017-01-19) description, paragraphs [0044]-[0157], and figures 2-17	1-80
Y	CN 104703224 A (YULONG COMPUTER TELECOM SCI SHENZHEN CO., LTD.) description, paragraphs [0010]-[0065]	1-80
Y	WO 2017038892 A1 (NTT DOCOMO INC.) 09 March 2017 (2017-03-09) description, paragraphs [0021]-[0158]	1-80
Y	CN 104620629 A (HUAWEI TECHNOLOGIES CO., LTD.) 13 May 2015 (2015-05-13) description, paragraphs [0024]-[0038], and figures 3-12	1-80
A	CN 106538022 A (INTEL CORP.) 22 March 2017 (2017-03-22) the whole document	1-80

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

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"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
19 October 2018	**29 October 2018**

Name and mailing address of the ISA/CN	Authorized officer
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2018/075643

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2017011079 A1	19 January 2017	IN 201747042213 A	01 December 2017
		JP 2018520607 W	26 July 2018
		CN 107852302 A	27 March 2018
		EP 3323252 A1	23 May 2018
		US 2017019886 A1	19 January 2017
		KR 20180030041 A	21 March 2018
CN 104703224 A		WO 2016161709 A1	13 October 2016
		CN 104703224 B	15 May 2018
WO 2017038892 A1	09 March 2017	JPWO 2017038892 S	21 June 2018
		EP 3346755 A1	11 July 2018
		US 2018220419 A1	02 August 2018
		CN 108029040 A	11 May 2018
CN 104620629 A	13 May 2015	WO 2014040531 A1	20 March 2014
		EP 2891357 A1	08 July 2015
		EP 2891357 A4	05 August 2015
		US 9131498 B2	08 September 2015
		US 2014071954 A1	13 March 2014
CN 106538022 A	22 March 2017	WO 2016022924 A1	11 February 2016
		HK 1234944 A0	23 February 2018
		EP 3178281 A4	28 March 2018
		RU 2017103925 A	08 August 2018
		CA 2954996 A1	11 February 2016
		KR 20170019440 A	21 February 2017
		IN 201747001200 A	21 April 2017
		JP 2017523728 A	17 August 2017
		CN 108337737 A	27 July 2018
		EP 3178281 A1	14 June 2017
		US 2017208616 A1	20 July 2017
		BR 112017002541 A2	05 December 2017