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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
5 October 2017 (05.10.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/168253 A1

(51) International Patent Classification:
H04W 72/12 (2009.01)

(21) International Application Number:
PCT/IB2017/000459

(22) International Filing Date:
31 March 2017 (31.03.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201610200871.7 31 March 2016 (31.03.2016) CN

(71) Applicant: **ALCATEL LUCENT** [FR/FR]; 148/152 route de la Reine, 92100 Boulogne-Billancourt (FR).

(72) Inventors: **LIU, Yong**; Alcatel-Lucent Shanghai Bell Co., Ltd., 388 Ningqiao Road, PuDong Jinqiao, Shanghai 201206 (CN). **LI, Dong**; Alcatel-Lucent Shanghai Bell Co., Ltd., 388 Ningqiao Road, PuDong Jinqiao, Shanghai 201206 (CN). **WILDSCHEK, Torsten**; 8 Kimberland Way, Gloucester Gloucestershire GL4 5TW (GB).

(74) Agent: **SARUP, David Alexander**; ALCATEL-LUCENT TELECOM LTD, Christchurch Way, Greenwich, London Greater London SE10 0AG (GB).

(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, 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))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) Title: METHOD AND APPARATUS FOR CONTROLLING DATA TRANSMISSION IN V2V COMMUNICATION

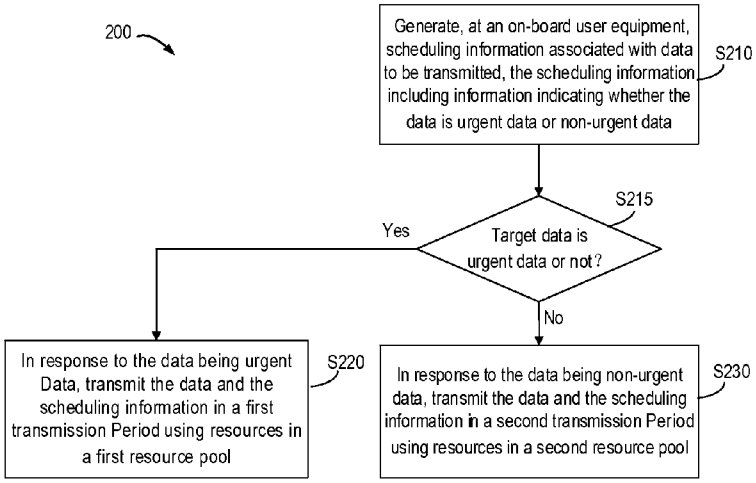

Fig. 2

(57) Abstract: Embodiments of the présent disclosure provide a method and apparatus for controlling data transmission in vehicle-to-vehicle communication. There is provided a method for controlling data transmission in vehicle-to-vehicle communication, comprising: generating, at an on-board user equipment, scheduling information associated with data to be transmitted, the scheduling information including information indicating whether the data is urgent data or non-urgent data; in response to the data being the urgent data, transmitting the data and the scheduling information in a first transmission period using a resource in a first resource pool for urgent data; and in response to the data being the non-urgent data, transmitting the data and the scheduling information in a second transmission period using a resource in a second resource pool for non-urgent data, the first and second transmission periods being pre-configured based on différent transmission latencies required by the urgent data and the non-urgent data. According to embodiments of the présent disclosure, the solution can satisfy différent latency requirements and strict reliability requirements in V2V communication.

WO 2017/168253 A1

METHOD AND APPARATUS FOR CONTROLLING DATA TRANSMISSION IN V2V COMMUNICATION

FIELD

[0001] Embodiments of the present disclosure relate to the field of wireless communication, and more specifically, to a method and apparatus for controlling data transmission in vehicle-to-vehicle (V2V) communication.

BACKGROUND

[0002] In the recent years, telematics have gained more and more attention along with the rapid growth of the Internet technologies. The study of Long Term Revolution LTE-based V2X (Vehicle-to-X) services is also carried out in the Third Generation Partnership Project (3GPP) to explore the opportunity to realize the "Internet of Vehicles" based on the widely deployed LTE networks. The LTE-based V2X comprises of three parts: Vehicle-to-Vehicle (V2V), Vehicle-to-Pedestrian (V2P) and Vehicle-to-Infrastructure/Network (V2I/N), wherein the V2V services cover the LTE-based communication between the vehicles through direct air interface or through indirect air interface (via relaying by the eNB).

[0003] The V2V communication usually involves transmission of data, such as GPS locating information, acceleration, braking state, steering wheel angle, speed and safety warnings for vehicles. Therefore, different latency requirements exist for different data transmissions in V2V communication and there is strict reliability requirement. Traditional solutions cannot satisfactorily meet different latency requirements for different types of data.

SUMMARY

[0004] According to embodiments of the present disclosure, there is provided a method for controlling data transmission in vehicle-to-vehicle communication, comprising: generating, at an on-board user equipment, scheduling information associated with data to be transmitted, the scheduling information indicating whether the data is urgent data or non-urgent data; in response to the data being the urgent data, transmitting the data and the scheduling information in a first transmission period using a resource in a first resource pool for urgent data; and in response to the data being the non-urgent data, transmitting the data and the scheduling information in a second transmission period using a resource in a second resource pool for non-urgent data, the first and second transmission periods being pre-configured based

on different transmission latencies required by urgent data and non-urgent data.

[0005] According to embodiments of the present disclosure, there is also provided an apparatus for controlling data transmission in vehicle-to-vehicle communication, comprising: a generation module configured for generating, at an on-board user equipment, scheduling information associated with data to be transmitted, the scheduling information including information indicating whether the data is urgent data or non-urgent data; a first transmission module configured for in response to the data being the urgent data, transmitting the data and the scheduling information in a first transmission period using a resource in a first resource pool for urgent data; a second transmission module configured for in response to the data being the non-urgent data, transmitting the data and the scheduling information in a second transmission period using a resource in a second resource pool for non-urgent data, the first and second transmission periods being pre-configured based on different transmission latencies required by urgent data and non-urgent data.

[0006] Embodiments of the present disclosure propose a corresponding solution for the V2V communication with direct air interface (hereinafter referred to as "V2V communication") to satisfy both the above latency and reliability requirements. According to embodiments of the present disclosure, there is provided a solution for controlling data transmission in V2V communication, which can satisfy both the latency and reliability requirements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The drawings explained here provide a further understanding of the present disclosure and form a part of the present disclosure. Example embodiments of the present disclosure and its descriptions are used to elaborate the present disclosure and do not put inappropriate limitations on the present disclosure. In the drawings:

[0008] Fig. 1 is a schematic diagram of V2V communication environment related to embodiments of the present disclosure;

[0009] Fig. 2 is a flow chart of a method for controlling data transmission in V2V communication according to embodiments of the present disclosure;

[0010] Fig. 3 is a schematic diagram of a scheme for a resource pool configuration and scheduling allocation and data transmission according to embodiments of the present disclosure;

[0011] Fig. 4 is a schematic diagram of another scheme for a resource pool configuration and

scheduling allocation and data transmission according to embodiments of the present disclosure;

[0012] Fig. 5 is a schematic diagram of a further scheme for a resource pool configuration and scheduling allocation and data transmission according to embodiments of the present disclosure;

[0013] Fig. 6 is a schematic diagram of a potential transmission collision according to embodiments of the present disclosure;

[0014] Fig. 7 is a schematic diagram of collision alleviation according to embodiments of the present disclosure;

[0015] Fig. 8 is a flow chart of collision detection and solution according to a further embodiment of the present disclosure; and

[0016] Fig. 9 is a schematic block diagram of an apparatus for controlling data transmission in V2V communication according to embodiments of the present disclosure.

DETAILED DESCRIPTION

[0017] Fig. 1 is a schematic diagram of V2V communication environment related to embodiments of the present disclosure. In the V2V communication system 100 shown in Fig. 1, a base station 110 pre-configures an available resource pool for data transmission between on-board user equipment 120 and 130, and then the on-board user equipment 120 and 130 transmit data by means of the pre-configured resource pool.

[0018] In V2V communication, most latency requirements are in the range of 100ms or more for non-urgent data, such as speed and orientation data of the vehicle and so on. However, most latency requirements are 20ms for urgent data for example in the case of pre-crash warning. In 3GPP LTE R12 version, the transmission period of the resource pool is set as 40ms, 80ms, 160ms and 320ms. The minimum transmission period of 40ms (which is less than 100ms/2=50ms) only allows meeting the latency requirement of 100ms for the above non-urgent data, and cannot meet the latency requirement of 20ms for the urgent data.

[0019] The inventive concept of the embodiments of the present disclosure lies in: preconfiguring respective resource pools for urgent data and non-urgent data at base station 110, and preconfiguring respective transmission periods for the respective resource pools based on the transmission latencies for the urgent data and the non-urgent data, e.g., configuring a relatively short transmission period for the resource pool of the urgent data

(such as 10ms as an example only) and a relatively long transmission period for the resource pool of the non-urgent data (such as 40m as an example only). Embodiments in this regard will be further described in the following text with reference to Figs. 3-5. Furthermore, data and its scheduling information are transmitted at the on-board user equipment 120 and 130 by using resources in the resource pool preconfigured by the base station 110, wherein the scheduling information comprises information indicating whether the data is urgent data or non-urgent data.

[0020] Accordingly, the latency requirements in V2V communication are satisfied. Besides, because the scheduling information comprises information indicating whether the data is urgent data or non-urgent data, the transmission of the scheduling information regarding the urgent data and the non-urgent data can share the system resource, so as to improve resource utilization and further enhance performance of the entire system. To make objectives, technical solutions and advantages of the present disclosure clearer, the present disclosure is further described in details with reference to example embodiments in some exemplary scenarios.

[0021] In common exemplary scenarios, a plurality of V2V on-board user equipment (on-board UE) each transmit data in a broadcasting mode specified in 3GPP LTE R12. For example, the spectrum resources preconfigured by the base station are divided within one transmission period into scheduling allocation (SA) resource pools and data resource pools, wherein scheduling information for data transmission, including resource allocation information and data transmission modes, are transmitted at the SA resource pools using corresponding physical side-link control channels (PSCCH) while data is transmitted at the data resource pools using corresponding physical side-link data channels (PSSCH). The SA scheduling information is transmitted prior to data transmission. UE first decodes the SA scheduling information and then determines whether the data is decoded based on the SA scheduling information and how to decode.

[0022] Fig. 2 is a flow chart of a method 200 for controlling data transmission in V2V communication according to embodiments of the present disclosure. The method can be implemented at various on-board UEs in the V2V communication. As shown in Fig. 2, generate scheduling information associated with data to be transmitted at the on-board user equipment in step S210.

[0023] In one embodiment, the scheduling information can comprise information indicating

whether the data is urgent data or non-urgent data. In an example embodiment, the scheduling information can comprise an indication bit, e.g., 0 or 1, for indicating whether the data is urgent data or non-urgent data. Alternatively or additionally, the scheduling information can also comprise transmission information of the data in the next transmission period. For example, the scheduling information can comprise resource information employed by data transmission in the next transmission period, such as sub-frame information and frequency information etc.

[0024] In step S215, the data is determined as urgent data or not based on the indication. If the data is determined as urgent data (branch "yes") in step S215, the method 200 proceeds to step S220, at which data and scheduling information are transmitted in a first transmission perio using resources in a first resource pool for urgent data. From another aspect, if the data is determined as non-urgent data (branch "no") in step S215, the method 200 proceeds to step S230, at which the data and scheduling information are transmitted in a second transmission period using resources in a second resource pool for non-urgent data.

[0025] In one embodiment, the first transmission period and the second transmission period can be preconfigured by the base station based on different transmission latencies required by the urgent data and the non-urgent data. Alternatively or additionally, in one embodiment, the first and second resource pools can also be preconfigured by the base station respectively for urgent data and non-urgent data.

[0026] For instance, in one embodiment, the scheduling information can be transmitted on PSCCH and data can be transmitted on PSSCH. For the sake of discussion, transmission of PSCCH will act as an example of scheduling information transmission and transmission of PSSCH will act as an example of data transmission in the following description. However, it should be understood that the above is only exemplary. In other environment or scenarios, it is completely feasible to transmit data and/or scheduling information on other channels.

[0027] In one embodiment, data scheduled at PSCCH from the on-board UE is transmitted at PSSCH within the next transmission period. For example, PSCCH comprises information about resource allocation of all corresponding PSSCH transmissions within the next transmission period. Therefore, it allows the transmission mode to evenly occupy resources of the data resource pool in time domain, which improves system level performance for V2V communication.

[0028] In one embodiment, the on-board user equipment can choose to transmit PSCCH and

PSSCH separately in different sub-frames. In one exemplary embodiment, scheduling information is transmitted in a first sub-frame and the data is transmitted in a second sub-frame, the second sub-frame being different from the first sub-frame. Alternatively, in another embodiment, the on-board user equipment can choose to transmit PSCCH and PSSCH simultaneously in the same sub-frame. In this case, PSSCH is not scheduled by the PSCCH transmitted simultaneously.

[0029] Transmission of PSCCH and PSSCH in the same sub-frame will increase the number of sub-frames received by the on-board UE, thereby reducing the impact of half-duplex constraint. Potentially, it can improve system level performance for V2V communication. However, the degradation of link level performance of PSCCH and PSSCH can be caused due to power sharing and increased Peak to Average Power Ratio (PAPR) in some cases. Therefore, in some embodiments, the number of simultaneous transmission of PSCCH and PSSCH in the same sub-frame can be adjusted based on the density of the on-board UE. For example, in one embodiment, a density of a plurality of on-board UE in one region is determined and whether PSSCH and PSSCH are transmitted in the same sub-frame is determined based on the determined density. If the determined density is high, more simultaneous transmissions are preferred. If the determined density is low, less simultaneous transmissions are preferred.

[0030] A plurality of examples is described about how PSCCH and PSSCH are transmitted using resources in the resource pool with reference to Figs. 3-5, which illustrate various examples of resource allocation schemes according to embodiments of the present disclosure. The resource allocation schemes can be executed at the side of the on-board UE for taking full advantage of the resources in the resource pool preconfigured by the base station to the on-board UE for scheduling allocation and data transmission.

[0031] As shown in Fig. 3, the bold block represents an SA resource pool and a data resource pool configured for non-urgent data in the corresponding transmission period, wherein the transmission period is set as 40ms for example. The thin frame denotes an SA resource pool and a data resource pool configured for urgent data in the corresponding transmission period, wherein the transmission period is set as 10ms for example.

[0032] In the case illustrated in Fig. 3, the scheduling information of PSCCH comprises information indicating whether the data is urgent data or non-urgent data, such as indication bit. Correspondingly, the SA resource pools for urgent data and non-urgent data can be

completely overlapped. At the on-board UE of a receiving side, the PSCCH for urgent data is identified based on the indication bit and the correct data resource pool is then located based on the scheduling information in PSCCH, so as to decode the corresponding PSSCH for the urgent data to obtain urgent messages. Furthermore, in the case illustrated in Fig. 3, data resource pools for urgent data and non-urgent data are also overlapped, which can accommodate dynamic traffic efficiently.

[0033] In the resource pool configuration shown in Fig. 3, although the SA resource pools and data resource pools for urgent data and non-urgent data are respectively overlapped, two SA resource pools and two data resource pools are still needed to be configured for urgent data and non-urgent data. To use the resources more efficiently, a common SA resource pool and a common data resource pool can be configured for urgent data and non-urgent data by designating additional transmission mechanism of PSCCH and PSSCH for urgent data.

[0034] Fig. 4 demonstrates the situation of sharing the common SA resource pool and the common data resource pool for urgent data and non-urgent data. In this case, to satisfy latency requirements, the scheduling information needs to comprise an indication bit indicating whether the data is urgent data or non-urgent data. Besides, an additional transmission mechanism of PSCCH and PSSCH is designated for the urgent data. In one embodiment, data transmission is completed after the transmission of scheduling information. The span from the transmission of the scheduling information to the transmission of the data transmission in time domain is smaller than a predefined transmission latency for the urgent data, wherein the predefined transmission latency is less than a predefined time length, e.g., 20ms. In such situation, if the on-board UE for transmitting urgent data completes transmission of PSCCH, it can transmit PSSCH by means of the following available sub-frames, which can be within the current transmission period, as shown in Fig. 4.

[0035] Fig. 5 shows a different resource allocation scheme. In the case of Fig. 5, the scheduling information of PSCCH can exclude indication bit, and make the SA resource pools for urgent data and non-urgent data orthogonal instead. Thus, at the on-board UE at the receiving side, a PSCCH for urgent data is differentiated from a PSCCH for non-urgent data based on a source of PSCCH, i.e., SA location. In the case of Fig. 5, the data resource pools for urgent data and non-urgent data are overlapped, such that they share the same resources to accommodate dynamic traffic efficiently.

[0036] However, the disadvantage of the above resource pool configuration is that a dedicate

SA resource pool is needed for urgent data. Since the urgent data appears occasionally, it results into low resource utilization rate.

[0037] The resource allocation schemes described with reference with Figs. 3-5 are only exemplary and shall not limit the present disclosure to this. For instance, although the figures show that a transmission period of 10ms is configured for urgent data, it is only exemplary and bears no intention to limit the present disclosure in any manner. As an example, a transmission period of less than 10 ms or any other suitable threshold time length can be configured for urgent data based on specific application scenarios and requirements.

[0038] The above describes controlling data transmission in V2V communication using appropriate resource allocation schemes, to satisfy latency requirements of V2V communication and improve system performance. The following content depicts a further control on data transmission in V2V communication by monitoring and solving potential collisions, to further meet strict reliability requirements in V2V communication.

[0039] To facilitate sensing-based scheduling, semi-persistent resource allocation for PSSCH/PSCCH needs to be employed. As mentioned above, persistent SA collisions may happen when multiple on-board UE employ the same set of sub-frames for PSCCH transmission. Fig. 6 shows scenarios of potential transmission collisions. In this situation, the on-board UE cannot decode each other's data/messages due to half-duplex constraint, and the issue becomes more serious when transmission of PSCCH/PSSCH is allowed simultaneously in the same sub-frame.

[0040] For SA transmission collisions, resources for transmission of scheduling information SA are reselected based on random probability in one embodiment to alleviate SA transmission collisions. For instance, the probability mechanism can comprise random number-based mechanism in one embodiment, e.g., a random number is generated first, which random number is then compared with reselection probability p_{sa} for SA. In one embodiment, the reselection probability p_{sa} can be set based on the balance between sensing accuracy and collision resolution capability. Therefore, whether or not to reselect the resources for scheduling information SA can be determined based on the comparison result.

[0041] For example, in one embodiment, the on-board UE can generate a random number p for each transmission period, wherein p ranges from 0 to 1 or any other suitable scope. If p is smaller than p_{sa}, the on-board UE reselects different resources for transmissions of PSCCH. In one embodiment, reselecting different resources may refer to selecting at least one different

sub-frame for transmissions of PSCCH. Fig. 7 illustrates a schematic diagram of resource reselection for SA transmission collisions, in which one sub-frame is reselected. In a special situation in which $p_{sa}=1$, it means that PSCCH resources are reselected for each transmission period.

[0042] Data transmission collision can be detected based on decoding of the scheduling information SA in one embodiment. When the current on-board UE decodes other on-board UEs' SA, it can identify whether its data channel PSSCH is collided with another on-board UE. If the risks of such potential collision exist, the current on-board UE can reselect a resource for its data channel.

[0043] Alternatively or additionally, resource reselection can also take situations of other on-board UE into account. For example, the current on-board UE can monitor transmissions of scheduling information transmitted from another on-board UE and determine whether there is a potential collision for data transmission based on the monitored scheduling information; and reselect a resource for data transmission in response to the existence of the potential collisions.

[0044] In another embodiment, regarding transmission collision of data, the aforementioned random probability can also be employed to reselect a resource for data transmission. In an exemplary embodiment, a reselection probability p_{data}, which is different reselection probability p_{sa} for SA, is set for data. For V2V communication, a PSSCH channel occupies much more resource blocks RB than a PSCCH channel. PSSCH transmissions determine interference environment, which is used for sensing-based scheduling. In addition, data collision can be detected and resource reselection can be triggered promptly based on SA decoding. Hence, p_{data} can be set much smaller than p_{sa}, which means resource reselection for SA transmissions is more frequent. Accordingly, the sensing accuracy and collision resolution capability are balanced.

[0045] Fig. 8 shows an example of an embodiment of the above collision detection and solution. As shown in Fig. 8, monitor transmissions of scheduling information transmitted from another on-board user equipment at step S810 and determine whether there is a potential collision for data transmission based on the monitored scheduling information at step S820. In response to determined potential collision at step S820, reselect a resource for data transmission at step S850. In response to determining that there is no potential collision for data transmission at step S820, it further determines, based on the random probability,

whether or not to reselect the resource for data transmission. Specifically, a random number is generated at step S830, and the random number is compared with the predefined reselection probability at step S840. If the random number is smaller than the reselection probability for data transmission, the procedure proceeds to step S850 to reselect the resource for data transmission. If the random number is not smaller than the reselection probability for data transmission, it determines that it is unnecessary to reselect the resource for data transmission.

[0046] After detecting the potential collision and reselecting the resource for data transmission, it determines, based on the random probability, whether or not to reselect a resource for transmission of scheduling information, which corresponds to steps S860 to S880. At step S860, a random number is generated. At step S870, whether the random number is smaller than the reselection probability for scheduling information is determined. If the random number is determined to be smaller than the reselection probability for scheduling information at S870, the procedure proceeds to step S880 to reselect the resource for transmissions of scheduling information. If the random number is determined to be not smaller than the reselection probability for scheduling information at S870, resource reselection is not needed and the next monitoring period is started. The above content has already described the probability mechanism, so it will not be repeated here.

[0047] So far, a method for controlling data transmission in V2V communication has been described, and embodiments of the present disclosure also provides a corresponding apparatus for controlling data transmission in V2V communication.

[0048] Fig. 9 is a schematic block diagram of an apparatus 900 for controlling data transmission in V2V communication according to embodiments of the present disclosure. The control apparatus 900 can be implemented at each of a plurality of on-board UE in V2V communication. As illustrated in Fig. 9, the apparatus 900 can comprise a generation module 910, a first transmission module 920 and a second transmission module 930.

[0049] In one embodiment, the generation module 910 can be configured for generating, at the on-board UE, scheduling information associated with data to be transmitted, the scheduling information including information indicating whether the data is urgent data or non-urgent data. The first transmission module 920 can be configured for in response to the data being the urgent data, transmitting the data and the scheduling information in a first transmission period using a resource in a first resource pool for urgent data. The second transmission module 930 can be configured for in response to the data being the non-urgent

data, transmitting the data and the scheduling information in a second transmission period using a resource in a second resource pool for non-urgent data, the first and second transmission periods being pre-configured based on different transmission latencies required by urgent data and non-urgent data.

[0050] In one embodiment, the resources for scheduling in the first resource pool and that in the second resource pool are completely overlapped.

[0051] In one embodiment, the resources for scheduling and the resources for data transmission in the first and second resource pools are shared. In the present embodiment, the first transmission module is also configured for: transmitting the scheduling information; and completing the data transmission after the transmission of the scheduling information, wherein the span from the transmission of the scheduling information to the transmission of the data transmission in time domain is smaller than a predefined transmission latency for the urgent data.

[0052] In one embodiment, the scheduling information can also comprise information about data transmission in the next transmission period.

[0053] In one embodiment, the first transmission module and the second transmission module can respectively be configured for: transmitting the scheduling information in a first sub-frame; and transmitting the data in a second sub-frame, the second sub-frame being different from the first sub-frame.

[0054] In one embodiment, the first transmission module and the second transmission module can respectively be configured for: transmitting the scheduling information and the data in the same sub-frame.

[0055] In one embodiment, the first transmission module and the second transmission module can respectively be configured for: determining density of a plurality of on-board user equipment in one region; and determining whether the scheduling information and the data are transmitted in the same sub-frame based on the determined density.

[0056] In one embodiment, the apparatus 900 further comprises: a monitoring module configured for monitoring scheduling information transmitted from another on-board user equipment; a determining module configured for determining, based on the monitored scheduling information, whether there is a potential collision for transmission of the data; and a resource reselecting module configured for reselecting a resource for the transmission of the data in response to existence of the potential collision.

[0057] In one embodiment, the apparatus 900 can further comprise: a first probability module configured for in response to determining that there is no potential collision for the transmission of the data, determining, based on a random probability, whether or not to reselect the resource for the transmission of the data.

[0058] In one embodiment, the apparatus 900 can further comprise: a second probability module configured for determining, based on a random probability, whether or not to reselect a resource for the transmission of the scheduling information.

[0059] The above described apparatus for controlling data transmission in V2V communication is corresponds to the process of the aforementioned method for controlling data transmission in V2V communication. Therefore, the exemplary details can be seen from the above mentioned control method and will not be repeated here.

[0060] Those skilled in the art should understand that the embodiments of the present disclosure can be provided as method, apparatus or computer program product. Therefore, embodiments of the present disclosure can take the form of full-hardware embodiments, full-software embodiment and embodiments combining software and hardware. Besides, embodiments of the present disclosure can adopt the form of computer program products implemented on one or more computer-available storage media (including but not limited to disk memory, CD-ROM, optical memory and so on) having computer-available program codes therein.

[0061] In a typical configuration, the computer device comprises one or more processors (CPU), input/output interfaces, network interface and internal storage, wherein the internal storage can comprise volatile memory, random-access memory (RAM) and/or non-volatile internal memory in the computer-readable medium, such as read-only memory (ROM) or flash RAM. The internal memory is just an example of the computer-readable medium.

[0062] The computer-readable medium comprises non-volatile and volatile, and removable and non-removable medium that can realize information storage via any methods and techniques. The information can be computer-readable instructions, data structure, program modules or other data. An example of the storage medium of the computer comprises but not limited to phase-change memory (PRAM), static random-access memory (SRAM), dynamic random-access memory (DRAM), other types of random-access memory (RAM), read-only memory (ROM), electrically erasable programmable read-only memory (EEPROM), flash memory, or other internal storage techniques, compact disk read-only

memory (CD-ROM), digital video disk (DVD), or other optical storage, magnetic tape, magnetic-tape disk storage or other magnetic storage devices or any other non-transmission medium for storing information accessible by the computer device. According to the definition in the text, the computer-readable medium excludes transient computer-readable medium, such as modulated data signals and carriers.

[0063] It should be explained that the technical terms "comprise" and "include" or other variants intend to encompass non-exclusive inclusion, such that the process, method, product or device consisting of a series of elements not only comprises the elements, but also other elements not explicitly listed, or further comprises the inherent elements of the process, method, product or device. In the case where no more constraints are set, the elements defined by the sentence "including one ..." do not exclude that other same elements may also exist in the process, method, produce or device having the above elements.

[0064] The above is just embodiments of the present disclosure and do not limit the present disclosure. For those skilled in the art, the present disclosure can have a variety of changes and modifications. Any modifications, equivalent substitutions and improvements made within the spirit and principle of the present disclosure shall be included within the claims of the present disclosure.

I/We Claim:

1. A method for controlling data transmission in a vehicle-to-vehicle communication, comprising:

generating, at an on-board user equipment, scheduling information associated with data to be transmitted, the scheduling information indicating whether the data is urgent data or non-urgent data;

in response to the data being the urgent data, transmitting the data and the scheduling information in a first transmission period using a resource in a first resource pool for urgent data; and

in response to the data being the non-urgent data, transmitting the data and the scheduling information in a second transmission period using a resource in a second resource pool for non-urgent data,

the first and second transmission periods being pre-configured based on different transmission latencies required by urgent data and non-urgent data.

2. The method of claim 1, wherein resources for scheduling allocation in the first and second resource pools are completely overlapped.

3. The method of claim 1, wherein resources for scheduling allocation and resources for data transmission in the first and second resource pools are shared.

4. The method of claim 3, wherein the transmitting the data and the scheduling information in the first transmission period comprises:

transmitting the scheduling information; and

completing the transmission of the data after the transmission of the scheduling information,

wherein a span from the transmission of the scheduling information to the transmission of the data in time domain is smaller than a predefined transmission latency for urgent data.

5. The method of claim 1, wherein the scheduling information also comprises information about transmission of the data in a next transmission period.

6. The method of claim 5, wherein the transmitting the data and the scheduling information comprises:

transmitting the scheduling information in a first sub-frame; and

transmitting the data in a second sub-frame, the second sub-frame being different from the first sub-frame.

7. The method of claim 5, wherein the transmitting the data and the scheduling information comprises:

transmitting the scheduling information and the data in a same sub-frame.

8. The method of claim 1, wherein the transmitting the data and the scheduling information comprises:

determining density of a plurality of on-board user equipment in a region; and

determining whether the scheduling information and the data are transmitted in a same sub-frame based on the determined density.

9. The method of claim 1, further comprising:

monitoring scheduling information transmitted from another on-board user equipment;

determining, based on the monitored scheduling information, whether there is a potential collision for transmission of the data; and

reselecting a resource for the transmission of the data in response to existence of the potential collision.

10. The method of claim 9, further comprising:

In response to determining that there is no potential collision for the transmission of the data, determining, based on a random probability, whether or not to reselect the resource for the transmission of the data.

11. The method of claim 1, further comprising:

determining, based on a random probability, whether or not to reselect a resource for the transmission of the scheduling information.

12. An apparatus for controlling data transmission in a vehicle-to-vehicle communication, comprising:

a generation module configured for generating, at an on-board user equipment, scheduling information associated with data to be transmitted, the scheduling information including information indicating whether the data is urgent data or non-urgent data;

a first transmission module configured for in response to the data being the urgent data, transmitting the data and the scheduling information in a first transmission period using a resource in a first resource pool for urgent data;

a second transmission module configured for in response to the data being the non-urgent data, transmitting the data and the scheduling information in a second transmission period using a resource in a second resource pool for non-urgent data,

the first and second transmission periods being pre-configured based on different transmission latencies required by urgent data and non-urgent data.

13. The apparatus of claim 12, wherein resources for scheduling allocation in the first and second resource pools are completely overlapped.

14. The apparatus of claim 12, wherein resources for scheduling allocation and resources for data transmission in the first and second resource pools are shared.

15. The apparatus of claim 14, wherein the first transmission module is further configured for:

transmitting the scheduling information; and

completing the transmission of the data after the transmission of scheduling information,

wherein a span from the transmission of the scheduling information to the transmission of the data in time domain is smaller than a predefined transmission latency for the urgent data.

16. The apparatus of claim 12, wherein the scheduling information also comprises information about transmission of the data in a next transmission period.

17. The apparatus of claim 16, wherein the first transmission module and the second transmission module are respectively configured for:

transmitting the scheduling information in a first sub-frame; and

transmitting the data in a second sub-frame, the second sub-frame being different from

the first sub-frame.

18. The apparatus of claim 16, wherein the first transmission module and the second transmission module are respectively configured for:

transmitting the scheduling information and the data in a same sub-frame.

19. The apparatus of claim 12, wherein the first transmission module and the second transmission module are respectively configured for:

determining density of a plurality of on-board user equipment in a region; and

determining whether the scheduling information and the data are transmitted in the same sub-frame based on the determined density.

20. The apparatus of claim 12, further comprising:

a monitoring module configured for monitoring scheduling information transmitted from another on-board user equipment;

a determining module configured for determining, based on the monitored scheduling information, whether there is a potential collision for transmission of the data; and

a resource reselecting module configured for reselecting a resource for the transmission of the data in response to existence of the potential collision.

21. The apparatus of claim 20, further comprising:

a first probability module configured for in response to determining that there is no potential collision for the transmission of the data, determining, based on a random probability, whether or not to reselect the resource for the transmission of the data.

22. The apparatus of claim 12, further comprising:

a second probability module configured for determining, based on a random probability, whether or not to reselect a resource for the transmission of the scheduling information.

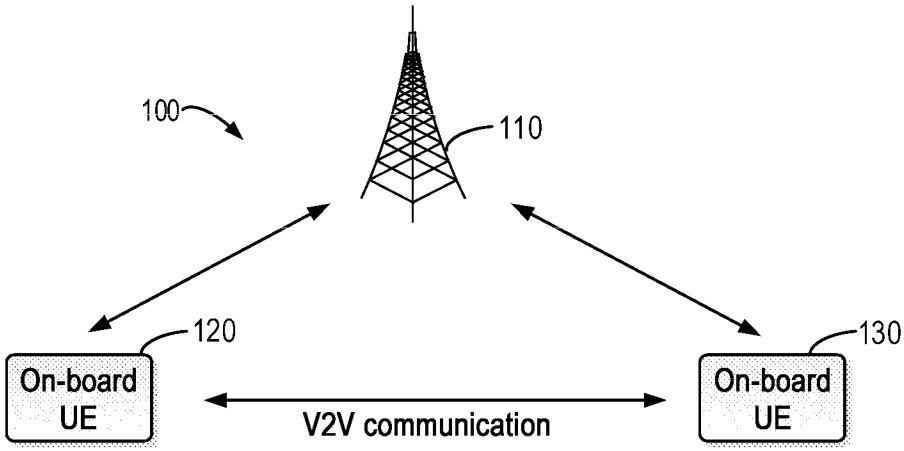
100
110
120
130
On-board UE
V2V communication
On-board UE

Fig.1

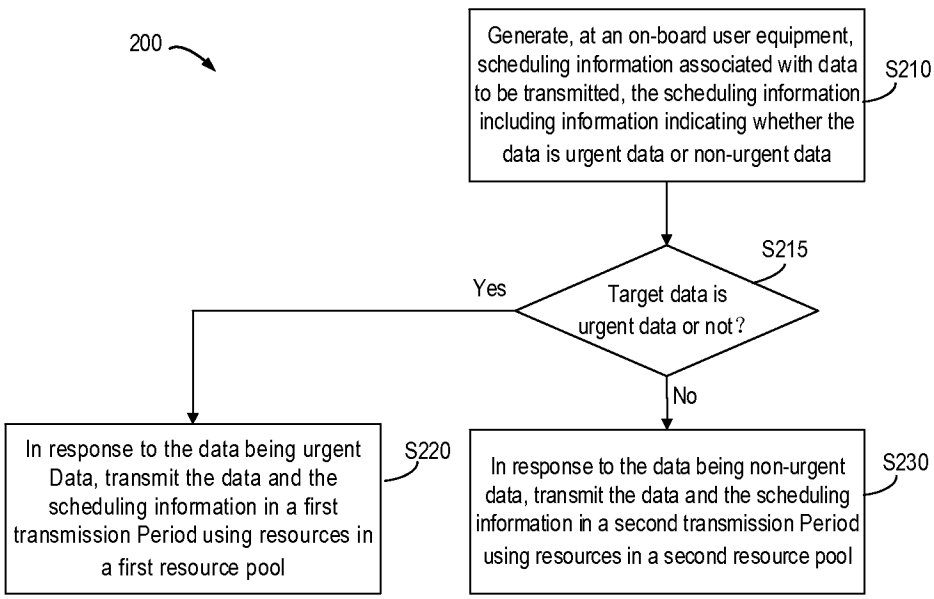
200
Generate, at an on-board user equipment, scheduling information associated with data to be transmitted, the scheduling information including information indicating whether the data is urgent data or non-urgent data
S210
S215
Target data is urgent data or not?
Yes
No
In response to the data being urgent Data, transmit the data and the scheduling information in a first transmission Period using resources in a first resource pool
S220
In response to the data being non-urgent data, transmit the data and the scheduling information in a second transmission Period using resources in a second resource pool
S230

Fig. 2

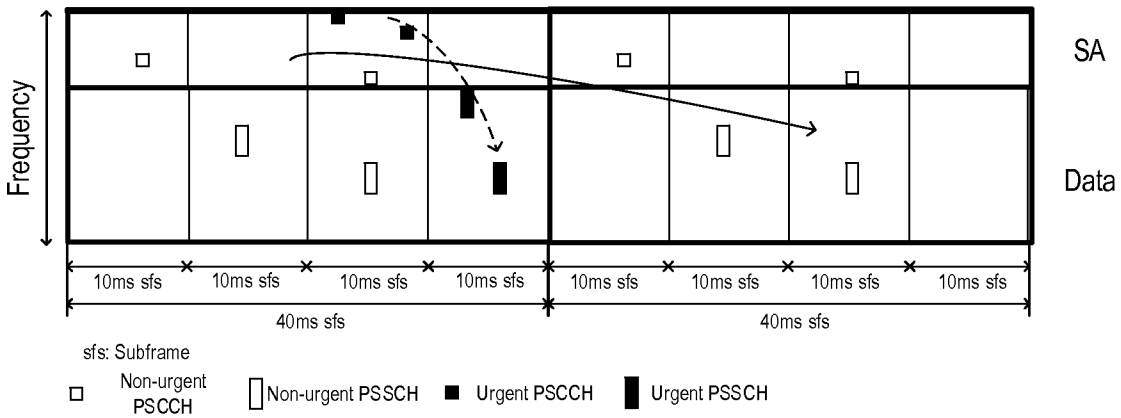

Fig. 3

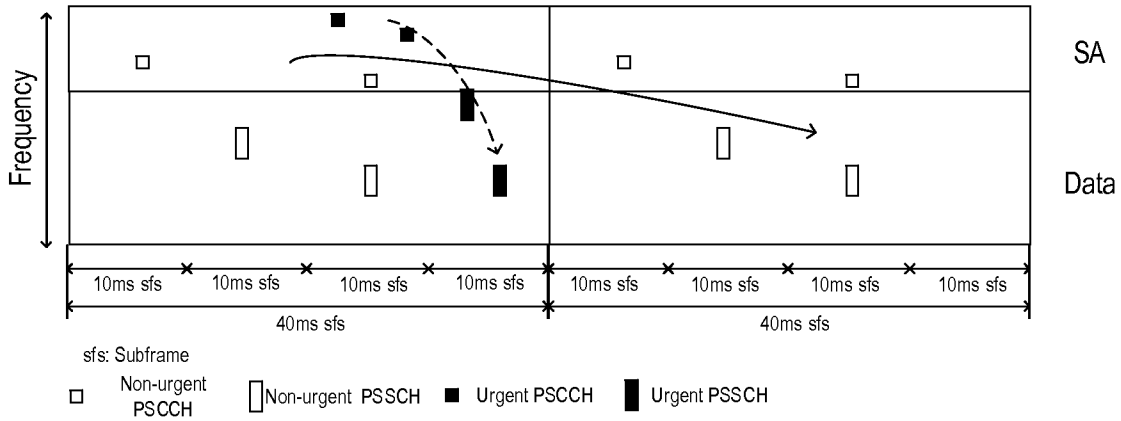

Fig. 4

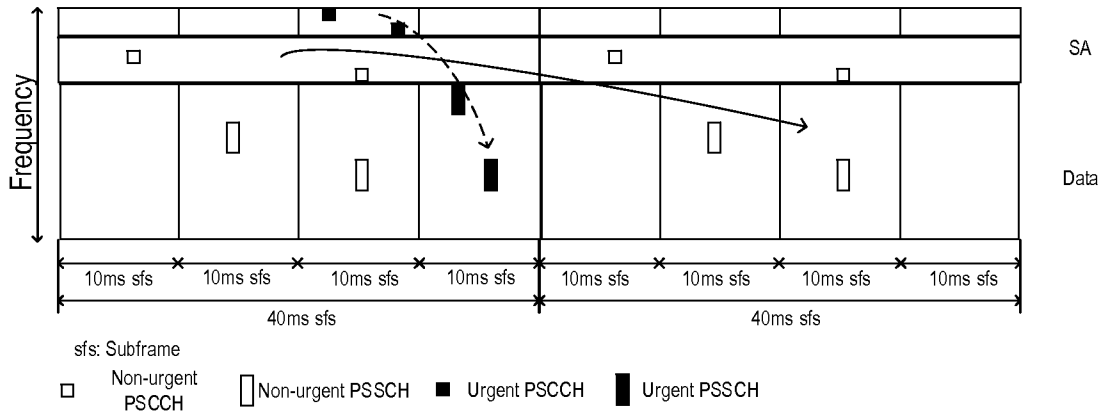

Fig. 5

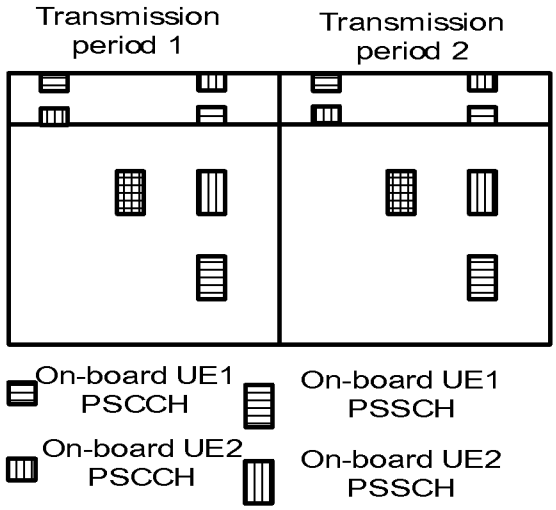
Transmission period 1
Transmission period 2
On-board UE1 PSCCH
On-board UE1 PSSCH
On-board UE2 PSCCH
On-board UE2 PSSCH

Fig. 6

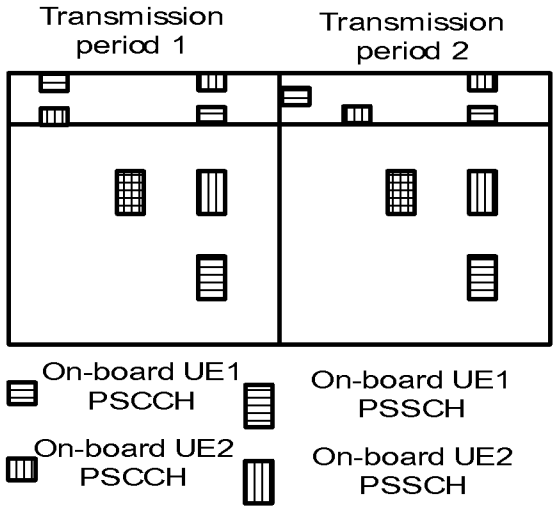
Transmission period 1
Transmission period 2
On-board UE1 PSCCH
On-board UE1 PSSCH
On-board UE2 PSCCH
On-board UE2 PSSCH

Fig.7

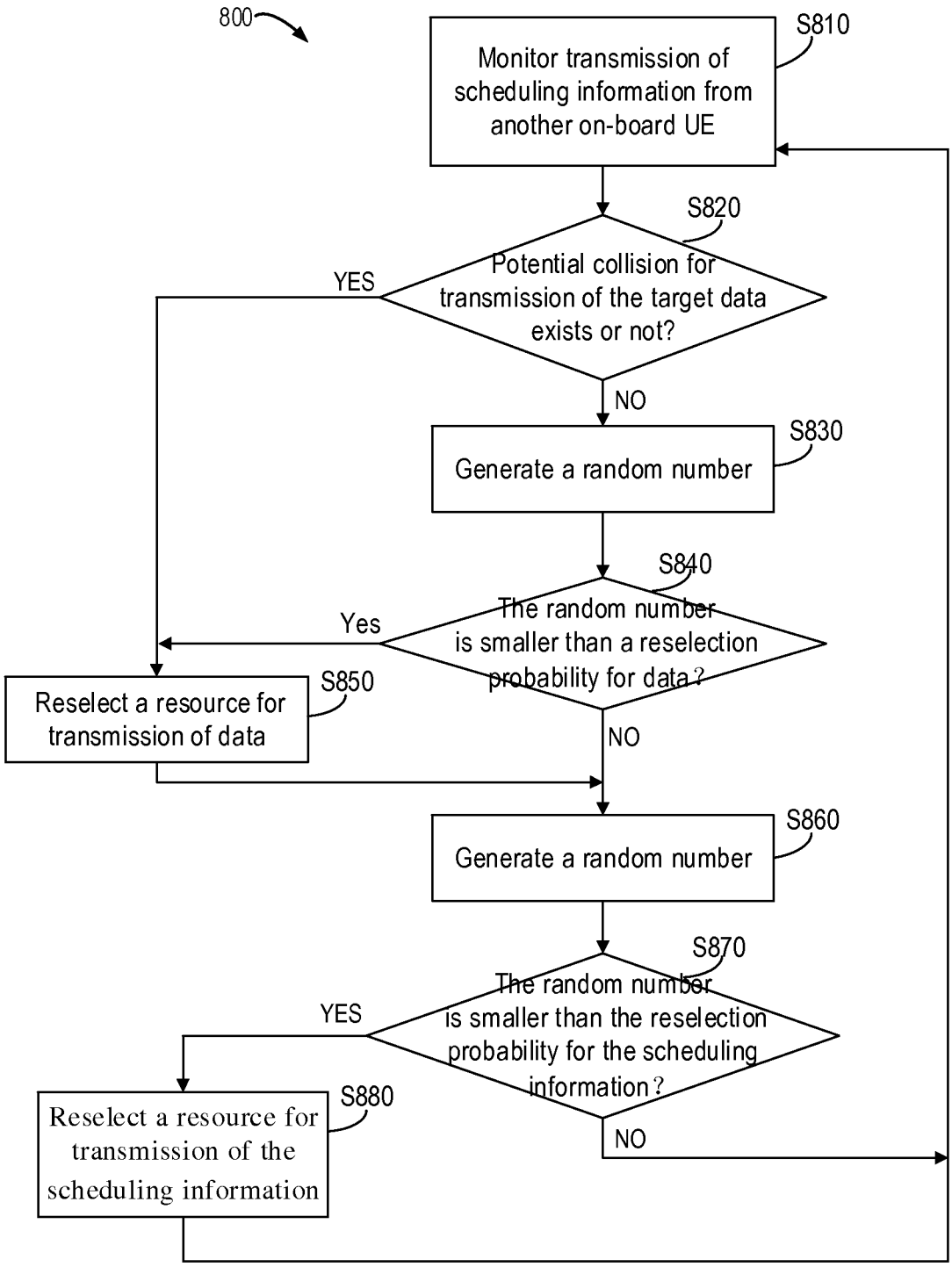
800
S810
Monitor transmission of scheduling information from another on-board UE
S820
Potential collision for transmission of the target data exists or not?
YES
NO
S830
Generate a random number
S840
The random number is smaller than a reselection probability for data?
Yes
NO
S850
Reselect a resource for transmission of data
S860
Generate a random number
S870
The random number is smaller than the reselection probability for the scheduling information?
YES
NO
S880
Reselect a resource for transmission of the scheduling information

Fig. 8

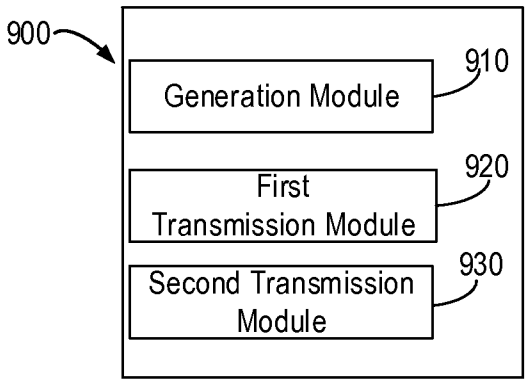
900
Generation Module
910
First Transmission Module
920
Second Transmission Module
930

Fig. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/000459

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W72/12
ADD.

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	ALCATEL-LUCENT SHANGHAI BELL ET AL: "System level consideration and evaluation for V2V communication", 3GPP DRAFT; R1-156978 - V2V SYSTEM LEVEL CONSIDERATION AND EVALUATION, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; , vol. RAN WG1, no. Anaheim, USA; 20151115 - 20151122 15 November 2015 (2015-11-15), XP051003294, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN1/Docs/ [retrieved on 2015-11-15] figures 5,6 -/--	1-22

[X] 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 July 2017	21/07/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Chimet, Dan

2

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	pages 4-6 -----	
Y	HUAWEI ET AL: "SA design for V2V", 3GPP DRAFT; R1-160308, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG1, no. St Julian's, Malta; 20160215 - 20160219 14 February 2016 (2016-02-14), XP051053648, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN1/Docs/ [retrieved on 2016-02-14] paragraphs [0001], [0003] -----	1-22