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(54) **Title:** METHODS OF BEAM MANAGEMENT FOR SIDELINK FR2

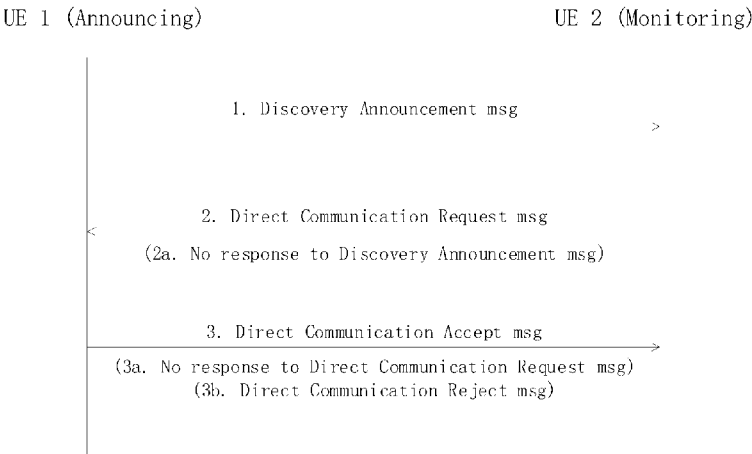


Figure 1

(57) **Abstract:** This disclosure describes methods of beam management for sidelink FR2. For the lack of concept of beam management in SL, relevant methods are put forward to solve the problem of coverage limitation, especially of FR2. This disclosure describes the methods for beam management of SL operated on FR2 spectrum with the following aspects: initial beam pairing procedure and beam management procedure.

METHODS OF BEAM MANAGEMENT FOR SIDELINK FR2

FIELD

The invention discussed below relates generally to wireless communication systems, and more particularly, to methods for beam management of sidelink FR2.

BACKGROUND

Beam management is a critical method in wireless communication system. It is a set of procedures to establish and retain an optimal beam pair for good connectivity which consists of a transmit beam and a corresponding receive beam. This process is important for FR2 communications, as the utilization of the high frequency spectrum requires the use of beamforming and beam management techniques to ensure good connection quality. Beam management can effectively increase the coverage area of the signal, especially important for wireless communication in FR2, since each beam sacrifices the coverage range of the signal to increase the coverage distance of and beam sweeping is applied during the procedure. For the lack of concept of beam management in SL, relevant methods need to be put forward to solve the problem of coverage limitation, especially of FR2.

SUMMARY

The following presents a simplified summary of one or more aspects in order to provide a basic understanding of such aspects. This summary is not an extensive overview of all contemplated aspects, and is intended to neither identify key or critical elements of all aspects nor delineate the scope of any or all aspects. Its sole purpose is to present some concepts of one or more aspects in a simplified form as a prelude to the more detailed description that is presented later.

Various aspects of the present disclosure relate to the methods of beam management in SL FR2 in the wireless communication. Compared with FR1, the signal of FR2 fades faster during transmission, causing the problem of coverage reduction. In this case, beam management methods can be applied in SL FR2 to achieve further coverage enhancement, including initial beam pairing, beam maintenance, beam failure recovery, etc.

In an aspect of the disclosure, a method of initial beam pairing based on Discovery procedure in SL FR2 is described. For Discovery Model A and Discovery Model B, 2 different type of initial beam pairing procedure are introduced based on their different characteristics. The initial beam pairing procedure is initiating by the announcing UE in Discovery Model A or discoverer UE in Discovery Model B, and the procedure will be fulfilled by link establishment procedure signaling exchange.

In another aspect of this disclosure, other designs for initial beam pairing aside from general procedure are described. The aspects including the concept of logical beam and spatial beam

correspondence, the timing relationships among initial beam pairing signaling or messages, the reference signals for initial beam pairing measuring and etc.

In another aspect of this disclosure, a method of beam maintenance is described. The reference signals used by beam maintenance procedure is standalone or non-standalone. For the case of standalone or non-standalone reference signals, a specific FDM resource for different UEs is introduced. For the case of non-standalone reference signals, the reference signals is via the same beam with data or via a different beam with data. A unique UE ID is used to generate the reference signals.

In another aspect of the disclosure, for SL operation on unlicensed spectrum (e.g., FR1 and/or FR2 unlicensed spectrums), contiguous RB based transmission is supported. In this case, the utilization of sub-channel including intra-cell GB PRBs (i.e., overlapped with intra-cell GB) for PSSCH transmission is introduced. Furthermore, IRB based transmission can be supported for PSFCH transmission.

To the accomplishment of the foregoing and related ends, the one or more aspects comprise the features hereinafter fully described and particularly pointed out in the claims. The following description and the annexed figures set forth in detail certain illustrative features of the one or more aspects. These features are indicative, however, of but a few of the various ways in which the principles of various aspects may be employed, and this description is intended to include all such aspects and their equivalents.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 illustrates an exemplary diagram of an initial beam pairing procedure based on Discovery Model A

FIG.2 illustrates an exemplary diagram of an initial beam pairing procedure based on Discovery Model B

DETAILED DESCRIPTION

The detailed description set forth below in connection with the appended drawings is intended as a description of various configurations and is not intended to represent the only configurations in which the concepts described herein may be practiced. The detailed description includes specific details for the purpose of providing a thorough understanding of various concepts. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. In some instances, well known structures and components are shown in block diagram form in order to avoid obscuring such concepts.

Several aspects of telecommunication systems will now be presented with reference to various apparatus and methods. These apparatus and methods will be described in the following detailed description and illustrated in the accompanying drawings by various blocks, components, circuits,

processes, algorithms, etc. (collectively referred to as “elements”). These elements may be implemented using electronic hardware, computer software, or any combination thereof. Whether such elements are implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system.

5 This invention is motivated by, but not limited to, a scenario where beam management is applied in the wireless communication system of SL FR2. In such scenario, high carrier frequency will lead to increasement in signal fading thus degradation of signal coverage. To solve this problem, methods of beam management for SL FR2 are proposed in this disclosure, including initial beam pairing , beam maintenance, beam failure recovery, and etc. However, the methods of beam management that
10 proposed in this closure may not be limited to SL FR2 only, e.g., SL FR1 and/or SL FR2.

In an aspect of this disclosure, the concept of logical beam and spatial beam correspondence and mapping rule is introduced. The definition of a logical beam is a transmitting beam or a receiving beam of a UE with a Beam ID assigned by the UE. The definition of a spatial beam is a transmitting beam or a receiving beam of a UE in spatial domain, and different spatial beams towards different
15 directions. A UE maintains a mapping between logical beams and spatial beams up to its implementation. The same spatial beams may be mapped to one or multiple logical beams and a logical beam may be mapped to one or multiple spatial beams. The mapping rules may change after a timer expires and/or other regulations due to UE’s rotation, movement and/or other UE behaviors. The direction of a logical beam that mapped to a spatial beam is the same as the direction of the
20 mapped spatial beam or within or contain the direction coverage of the mapped spatial beam.

In another aspect of this disclosure, a method of initial beam pairing based on Discovery procedure is described. For Discovery Model A and Discovery Model B, 2 different type of initial beam pairing procedure are introduced based on their different characteristics.

For Discovery Model A, the detailed description of initial beam pairing procedure, as is shown
25 in FIG.1, is as follows:

Step 1: The initiating UE (i.e., UE 1) of the initial beam pairing procedure is the Announcing UE of Discovery Model A. UE 1 repeat sending the Discovery Announcement message on the same logical or spatial beam. The other UE (e.g., UE 2) keep monitoring the Discovery Announcement message on the same or different logical or spatial beam.

30 Step 2: If UE 2 receives and decodes a Discovery Announcement message and decides to establish a link with UE 1, UE 2 sends a Direct Communication Request message via the same spatial beam as the Announcement message is received and decoded.

Step 3: If UE 1 receives and decodes a Direct Communication Request message from UE 2 and decides to accept it, an initial beam pair between UE 1 and UE 2 established. UE 1 sends a Direct
35 Communication Accept message back to UE 2 via the same spatial beam as the Direct Communication Request message is received and decoded. If UE 2 receives and decodes the Direct Communication Accept message from UE 1, the initial beam pairing procedure accomplished and

the 2 UEs will communicate via the logical or spatial beam pair.

Step 3b: If UE 1 receives and decodes a Direct Communication Request message from UE 2 and decides to reject it, UE 1 sends a Direct Communication Reject message back to UE 2 via the same spatial beam as the Direct Communication Request message is received and decoded. If UE 2 receives and decodes the Direct Communication Reject message from UE 1, both of the initial beam pairing procedure and the link establishment procedure failed. It is up to UE implementation to restart the initial beam pairing procedure.

For Discovery Model B, the detailed description of initial beam pairing procedure, as is shown in FIG.2, is as follows:

Step 1: The initiating UE (i.e., UE 1) of the initial beam pairing procedure is the Discoverer UE of Discovery Model B. UE 1 repeat sending the Discovery Solicitation message on the same logical or spatial beam. The other UE (e.g., UE 2) keep monitoring the Discovery Solicitation message on the same or different logical or spatial beam.

Step 2: If UE 2 receives and decodes a Discovery Solicitation message and decides to response to UE 1, UE 2 sends a Discovery Response message via the same spatial beam as the Solicitation message is received and decoded.

Step 3: If UE 1 receives and decodes a Discovery Response message from UE 2 and decides to accept it, an initial beam pair between UE 1 and UE 2 established. UE 1 sends a Direct Communication Request message back to UE 2 via the same spatial beam as the Discovery Response message is received and decoded.

Step 4: If UE 2 receives and decodes a Direct Communication Request message from UE 1 and decides to accept it, UE 2 sends a Direct Communication Accept message back to UE 1 via the same spatial beam as the Direct Communication Request message is received and decoded. If UE 1 receives and decodes the Direct Communication Accept message from UE 2, the initial beam pairing procedure fully accomplished and the 2 UEs will communicate via the logical or spatial beam pair.

Step 4b: If UE 2 receives and decodes a Direct Communication Request message from UE 1 and decides to reject it, UE 2 sends a Direct Communication Reject message back to UE 1 via the same spatial beam as the Direct Communication Request message is received and decoded. If UE 1 receives and decodes the Direct Communication Reject message from UE 2, both initial beam pairing procedure and the link establishment procedure failed. It is up to UE implementation to restart the initial beam pairing procedure.

In Discovery Model A initial beam pairing procedure Step 2a and Step 3a in FIG.1, for the case of no response is received from other UE (e.g., no Direct Communication Request from UE 2 is received and decoded by UE 1, no Direct Communication Accept or Reject from UE 1 is received and decoded by UE 2, etc.) and the max retransmission time of the Discovery Announcing messages or Direct Communication Request message on this logical or spatial beam is reached and/or the timer of sending Discovery Announcing messages or Direct Communication Request message on this

logical or spatial beam expires, it is up to UE's implementation to repeat sending Discovery Announcing messages or Direct Communication Request message on the other logical or spatial beams, till the max retransmission time of the Discovery Announcing messages or Direct Communication Request message on all the other logical or spatial beams reached and/or the timer of sending Discovery Announcing messages or Direct Communication Request message on all the other logical or spatial beams expires.

In Discovery Model B initial beam pairing procedure Step 2a and Step 4a in FIG2, for the case of no response is received from other UE (e.g., no Discovery Response message from UE 2 is received and decoded by UE 1, no Direct Communication Request from UE 1 is received and decoded by UE 2, no Direct Communication Accept or Reject from UE 2 is received and decoded by UE 1) and the max retransmission time of the Discovery Solicitation messages, Discovery Response messages or Direct Communication Request message on this logical or spatial beam is reached and/or the timer of sending Discovery Announcing messages, Discovery Response messages or Direct Communication Request message on this logical or spatial beam expires, it is up to UE's implementation to repeat sending Discovery Solicitation messages, Discovery Response messages or Direct Communication Request message on the other logical or spatial beams, till the max retransmission time of the Discovery Solicitation messages, Discovery Response messages or Direct Communication Request message on all the other logical or spatial beams reached and/or the timer of sending Discovery Solicitation messages, Discovery Response messages or Direct Communication Request message on all the other logical or spatial beams expires.

It should be noted that in the initial beam pairing procedure above, the Discovery messages (i.e. Discovery Announcement message, Discovery Solicitation message, etc.) is not confined within the concept of a whole and exact Discovery messages, but also represents for signals or channels share the similar concept of the Discovery messages, have the same function of the Discovery messages and/or segmented Discovery messages. For example, the Discovery messages can be a signal (e.g., a CSI-RS signal, etc.), the signal is generated based on the Source ID/Destination ID of the transmitting UE. The receiving UE will send a response to the transmitting UE by ACK/NACK and/or a message (e.g., a DCR message, a Discovery Response message, etc.).

In another aspect of this disclosure, timing and/or resource relationships among initial beam pairing signaling or messages is described. When a UE send a signaling or a message during the initial beam pairing procedure, the timing and/or resource of the response of this signaling or message from another UE should be indicated by the UE or preconfigured. The timing(s) of the response from other UE can be a time delay of granularity of slots and/or milliseconds. For example, in Discovery Model A initial beam pairing procedure, candidate time resource(s) for Direct Communication Request message should be indicated by UE 1's Announcement message or preconfigured. The candidate time resource(s) can be described as $n + T1, n + T2, \dots, n + Tr$, where the n represents for the slot timing of the first or last Announcement message among the

repetitions or sweepings, $T1, T2, \dots, Tr$ represents for the time delay of granularity of slots and/or milliseconds for the transmission of Direct Communication Request message. The signaling or message sending UE will monitor the response from other UE(s) at the candidate time resource(s) $n + T1, n + T2, \dots, n + Tr$ using the same spatial beam as the signaling or message sending spatial beam. For the response UE, the UE should prioritize to transmit response via the signaling or message receiving spatial beam. If the first transmission of the response failed, the response UE can decide to retransmit the response via the same spatial beam or different spatial beam at the other candidate time resource(s) that indicated by UE 1 or preconfigured. It should be noted that the case of only one candidate time resource $n + T1$ is also supported, where the response UE will send a response to the message sending UE via the best beam (e.g., highest RSRP, etc.).

In another aspect of this disclosure, the reference signal of the initial beam pairing procedure is introduced. The reference signal is sent via the same logical and spatial beam with the Discovery Announcement message or Discovery Solicitation message. For the case of the reference signal is DMRS, the other UE will measure the PSCCH and/or PSSCH DMRS RSRP within the Discovery Announcement message or Discovery Solicitation message. For the case of the reference signal is CSI-RS, the other UE will measure the CSI-RS transmitted with the Discovery Announcement message or Discovery Solicitation message. The CSI-RS is indicated in the 2nd SCI of the messages or preconfigured.

For the case of a standalone reference signal (e.g., CSI-RS, etc.) is used for the initial beam pairing procedure, the standalone reference signal is generated based on the Source Layer-2/PHY ID and/or Destination Layer-2/PHY ID. For example, an initial beam pairing procedure initiating UE send the standalone reference signals' repetition via the same spatial/logical beam or different spatial/logical beams. The reference signal receiving UE will send a feedback ACK/NACK and/or a response message back at a preconfigured timing. After the initiating UE received the feedback, it will send a Discovery message back to the receiving UE. It is noted that the standalone reference signal is using a dedicated resource pool and/or share the same resource pool of Discovery messages or common resource pool.

In another aspect of this disclosure, a method of beam maintenance is described. The reference signals (e.g., CSI-RS) used by beam maintenance procedure is standalone or non-standalone. A unique UE ID for beam management (e.g., for beam maintenance), which is different from any other physical IDs used during Discovery procedure, link establishment procedure or sidelink communication is used to identify the UEs. The reference signals may generate based on the unique UE ID for beam management or other means. For the case of standalone or non-standalone reference signals, a specific FDM resource for different UEs is preconfigured or choose by UE based on the unique UE ID for beam management. For the case of non-standalone reference signals, the reference signals is via the same logical/spatial beam with data and/or via a different logical/spatial beam with data.

In another aspect of the disclosure, for SL operation on unlicensed spectrum (e.g., FR1 and/or FR2 unlicensed spectrums), contiguous RB based transmission is supported. In this case, the utilization of sub-channel including intra-cell GB PRBs (i.e., overlapped with intra-cell GB) for PSSCH transmission should meet the following conditions:

1. Multi-channel access procedures on the respective LBT channels (wrapped around the intra-cell GB) are cleared.
2. The used sub-channel(s) for PSSCH transmission should occupy both of these two RB sets.

Based on the above conditions, the utilization of sub-channel for CRB based PSCCH/PSSCH transmission can be

1. PSSCH occupies only the sub-channel(s) overlapped with intra-cell GB. In this case, no resource/sub-channel can be used for corresponding PSCCH transmission, and the transmission is invalid.
2. PSCCH occupies both sub-channel(s) overlapped with intra-cell GB and sub-channel(s) non-overlapped with intra-cell GB where at least one sub-channel non-overlapped with intra-cell GB should have a lower index than that of the sub-channel(s) overlapped with intra-cell GB. In this case, the sub-channel(s) with the lowest index among the sub-channel(s) occupied by the PSSCH can be used for the corresponding PSCCH transmission.

It can be observed that regarding the usage of sub-channel overlapped with intra-cell GB for PSSCH transmission, considering PSCCH located in the lowest sub-channel of the lowest RB set of corresponding PSSCH and the sub-channel overlapped with intra-cell GB cannot be used for PSCCH transmission, at least one sub-channel having a lower index than that of the sub-channel(s) overlapped with intra-cell GB should be occupied simultaneously by the corresponding PSSCH. Therefore, for CRB based PSCCH/PSSCH transmission in SL-U, regarding the usage of sub-channel overlapped with intra-cell GB for PSSCH transmission, the PSSCH transmission should occupy at least one sub-channel with a lower index than that of the sub-channel(s) overlapped with intra-cell GB simultaneously for the corresponding PSCCH transmission.

In another aspect of the disclosure, for SL operation on unlicensed spectrum, IRB based transmission can be supported for PSFCH transmission. Additionally, for the case that each PSFCH transmission occupies 1 common interlace and K dedicated PRB(s), some guardband PRB(s) can be (pre-)configured between common PRB and dedicated PRB, where the number of guardband PRB(s) between common PRB and dedicated PRB should at least include the value of 0, and can include some other values from the set of {1, 2, 3, 4}.

In another aspect of the disclosure, a cyclic shift phase adjustment PAPR reduction method for frequency domain repetition signals is described. For signal repetition in frequency domain, phase adjustment among repetitions can be applied. The phase adjustment sequence has a frequency length of one S-SSB, or multiple S-SSBs after repetition. For the case of phase adjustment sequence having a length of one S-SSB, the different phase adjustment sequences used among repetitions can be

generated by different initial parameters, which can be related to some (pre-)configuration, e.g., UE ID, SLID, repetition index. Alternatively, the different phase adjustment sequences used among repetitions can be generated by a same initial parameter but with a cyclic shift among different phase adjustment sequences, where the cyclic shift can be based on some (pre-)configuration, e.g., UE ID, repetition index.

The PAPR represents for the PAPR value in time domain. For the case of frequency domain repetition signals, a phase adjustment vector with different cyclic shift value is multiplied with different repetitions. The cyclic shift phase adjustment vector is generated based on a initial phase vector (e.g., a ZC sequence vector, etc.).

For example, for the case of the initial phase vector is a ZC sequence, the initial phase vector can be expressed as

$$\alpha(n) = e^{j\frac{\pi un(n+1)}{L}}, n = 0, 1, \dots, L-1$$

where u is the root index of the ZC sequence, n is the index of the initial phase vector (i.e., the ZC sequence), L is the length of the initial phase vector. The cyclic shift phase adjustment vector can be expressed as

$$\alpha_v(n) = \alpha((n + C_v) \bmod L), n = 0, 1, \dots, L-1$$

where C_v is the cyclic shift value for cyclic shift phase adjustment vector. For different repetitions of the frequency domain signal, the cyclic shift value for phase adjustment vector is set to be different values.

For example, a frequency domain signal S of length L_s is repeated for 2 times, the repeated signal can be expressed as $\{S, S_1, S_2\}$. For signal S_1 , the cyclic shift value C_v for phase adjustment vector is set to K , where K is the length of resource elements in frequency domain of signal S per symbol. The length of the cyclic shift phase vector is $L = L_s$. The signal S_1 after multiplied with the cyclic shift phase adjustment vector can be expressed as $\{S_1(n) \cdot \alpha((n + K) \bmod L)\}, n = 0, 1, \dots, L-1$. For signal S_2 , the cyclic shift value C_v for phase adjustment vector is set to $2K$. The signal S_2 after multiplied with the cyclic shift phase adjustment vector can be expressed as $\{S_2(n) \cdot \alpha((n + 2K) \bmod L)\}, n = 0, 1, \dots, L-1$. The phase vector with different cyclic shift value C_v can be multiplied with all repetitions or some of the repetitions, where the repetitions include the original signal S or not include the original signal S .

The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but is to be accorded the full scope consistent with the language claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." The word "exemplary" is used herein to mean "serving as an example, instance, or illustration." Any

aspect described herein as “exemplary” is not necessarily to be construed as preferred or advantageous over other aspects. Unless specifically stated otherwise, the term “some” refers to one or more. Combinations such as “at least one of A, B, or C,” “one or more of A, B, or C,” “at least one of A, B, and C,” “one or more of A, B, and C,” and “A, B, C, or any combination thereof” include any combination of A, B, and/or C, and may include multiples of A, multiples of B, or multiples of C. Specifically, combinations such as “at least one of A, B, or C,” “one or more of A, B, or C,” “at least one of A, B, and C,” “one or more of A, B, and C,” and “A, B, C, or any combination thereof” may be A only, B only, C only, A and B, A and C, B and C, or A and B and C, where any such combinations may contain one or more member or members of A, B, or C. All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. The words “module,” “mechanism,” “element,” “UE,” and the like may not be a substitute for the word “means.” As such, no claim element is to be construed as a means plus function unless the element is expressly recited using the phrase “means for.”

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

CLAIMS

1.A method for beam management of SL FR2.

2.The method of claim 1, wherein the methods for beam management including methods for initial
5 beam pairing procedure.

3.The method of claim 1, wherein the logical beam and spatial beam correspondence and mapping
rules.

4.The method of claim 2, wherein the application scenarios including SL FR1 and SL FR2.

5.The method of claim 1, wherein for CRB based PSCCH/PSSCH transmission in SL-U, regarding
10 the usage of sub-channel overlapped with intra-cell GB for PSSCH transmission, the PSSCH
transmission should occupy at least one sub-channel with a lower index than that of the sub-channel(s)
overlapped with intra-cell GB simultaneously for the corresponding PSCCH transmission.

6.The method of claim 1, wherein for the case that each PSFCH transmission occupies 1 common
interlace and K dedicated PRB(s), some guardband PRB(s) can be (pre-)configured between common
15 PRB and dedicated PRB, where the number of the guardband PRB(s) between common PRB and
dedicated PRB should at least include the value of 0, and can include some other values from the set of
{1, 2, 3, 4}.

7.The method of claim 1, wherein the cyclic shift phase adjustment PAPR reduction method for
frequency domain repetition signals; The cyclic shift phase adjustment vector is generated based on a
20 initial phase vector and for different repetitions of the frequency domain signal, the cyclic shift value
for phase adjustment vector is set to be different values.

8.The method of claim 2, wherein the methods for initial beam pairing procedure is based on
Discovery Model A and Discovery Model B, including direct link establishment procedure.

9.The method of claim 8, wherein the beams used for initial initial beam pairing procedure is based
25 on Discovery Model A including Discovery Announcement message, Direct Communication Request
message and Direct Communication Accept or Reject message logical/spatial beam sweeping.

10.The method of claim 8, wherein the beams used for initial initial beam pairing procedure is
based on Discovery Model B including Discovery Solicitation message, Discovery Response message,
Direct Communication Request message and Direct Communication Accept or Reject message
30 logical/spatial beam sweeping.

11.The method of claim 8, wherein a max retransmission time of same messages on a logical or
spatial beam and a timer of sending same messages on a logical or spatial beam is indicated by the
message sending UE or preconfigured.

12.The method of claim 8, wherein the timing(s) of the response from other UE can be a time delay
35 of granularity of slots and/or milliseconds indicated by initiate message sending UE or preconfigured;
The candidate time resource(s) for response can be described as $n + T1, n + T2, \dots, n + Tr$, where the
n represents for the Announcement message slot timing, $T1, T2, \dots, Tr$ represents for the time delay of

granularity of slots and/or milliseconds.

13.The method of claim 8, wherein the reference signal is sent via the same logical and spatial beam with the Discovery Announcement message or Discovery Solicitation message.

5 14.The method of claim 1, wherein the methods for beam management including methods for beam maintenance procedure.

15.The method of claim 14, wherein the unique UE ID for beam management (e.g., for beam maintenance), which is different from any other physical IDs used during Discovery procedure, link establishment procedure or sidelink communication is used to identify the UEs.

10 16.The method of claim 14, wherein the reference signals may generated based on the unique UE ID for beam management or other means.

17.The method of claim 14, wherein for the case of standalone or non-standalone reference signals, a specific FDM resource for different UEs is preconfigured or choose by UE based on the unique UE ID for beam management.

15 18.The method of claim 8, wherein the a standalone reference signal (e.g., CSI-RS, etc.) is used for the initial beam pairing procedure, the standalone reference signal is generated based on the Source Layer-2/PHY ID and/or Destination Layer-2/PHY ID.

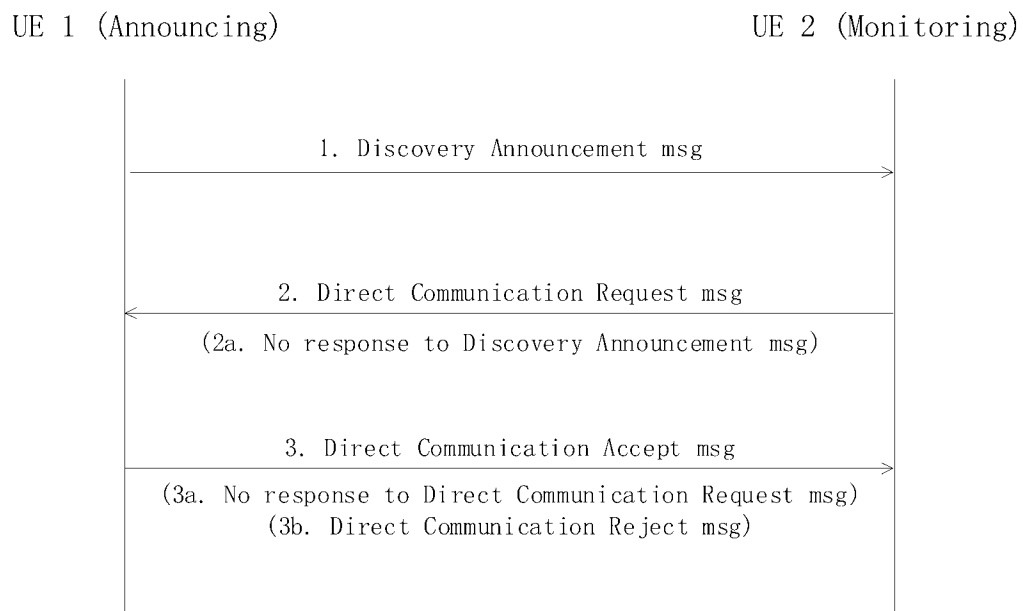


Figure 1

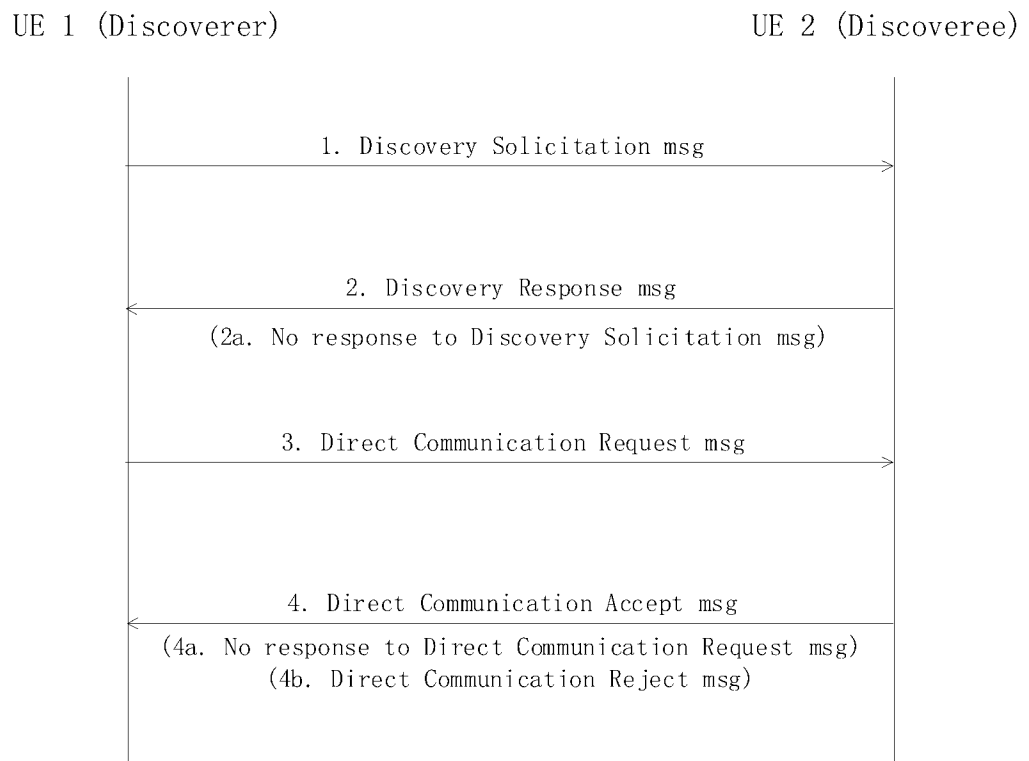


Figure 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/112656

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/25(2023.01)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)

IPC: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)

CNTXT,WPABSC,VEN,3GPP: beam, beam management, sidelink, frequency range, frequency range 2, PSCCH/PSSCH, beam pairing, mapping, guard band, discovery, direct communication

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2023146303 A1 (HYUNDAI MOTOR CO LTD et al.) 03 August 2023 (2023-08-03) the description paragraphs 6-7 and 107-112	1-18
A	CN 116508266 A (LENOVO (SINGAPORE) PTE. LTD.) 28 July 2023 (2023-07-28) the whole document	1-18
A	EP 3910806 A1 (HYUNDAI MOTOR CO LTD et al.) 17 November 2021 (2021-11-17) the whole document	1-18
A	US 2022286184 A1 (INTERDIGITAL PATENT HOLDINGS INC) 08 September 2022 (2022-09-08) the whole document	1-18
A	US 2023092649 A1 (QUALCOMM INC) 23 March 2023 (2023-03-23) the whole document	1-18
A	WO 2020033622 A1 (IDAC HOLDINGS INC) 13 February 2020 (2020-02-13) the whole document	1-18
A	WO 2021034572 A1 (CONVIDA WIRELESS LLC) 25 February 2021 (2021-02-25) the whole document	1-18

☐ 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

“D” document cited by the applicant in the international application

“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

22 April 2024

Date of mailing of the international search report

24 April 2024

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/112656

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2023146303	A1	03 August 2023	KR	20230116713	A	04 August 2023
CN	116508266	A	28 July 2023	EP	4186174	A1	31 May 2023
				WO	2022018688	A1	27 January 2022
				US	2023361955	A1	09 November 2023
EP	3910806	A1	17 November 2021	None			
US	2022286184	A1	08 September 2022	EP	4008064	A1	08 June 2022
				WO	2021034572	A1	25 February 2021
US	2023092649	A1	23 March 2023	US	11664860	B2	30 May 2023
				US	2023387973	A1	30 November 2023
WO	2020033622	A1	13 February 2020	TW	202025657	A	01 July 2020
WO	2021034572	A1	25 February 2021	None			