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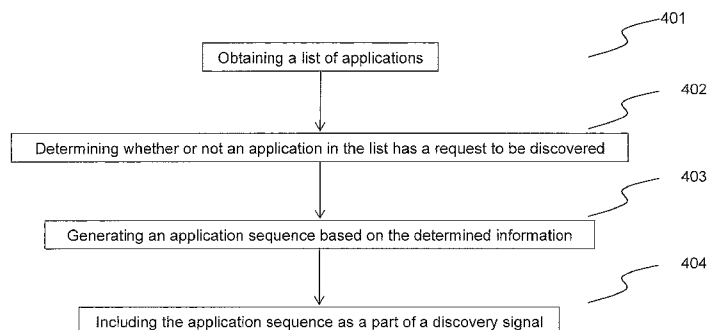

Figure 4

(57) Abstract: According to an example embodiment of this invention, a method may include obtaining a list of applications discov-
erable by a peer entity; determining whether or not an application in the list has demand to be discovered; generating an application
sequence based on the determined information; and including the application sequence as a part of a discovery signal.

APPARATUS AND METHOD FOR DEVICE DISCOVERY

[0001]   The presently described examples of embodiments of an invention relate generally to an apparatus and a method for device discovery and other related aspects.

[0002]   The presently described examples of embodiments of the invention may be better appreciated by first contemplating the following passages.

[0003]   In wireless communication, different collections of communication protocols are available to provide different types of services and capabilities. Long term evolution, LTE, is one of such collection of wireless communication protocols that extends and improves the performance of existing universal mobile telecommunications system, UMTS, protocols and is specified by different releases of the standard by the 3rd generation partnership project, 3GPP, in the area of mobile network technology. Other non-limiting example wireless communication protocols include global system for mobile, GSM, high speed packet access, HSPA, and worldwide interoperability for microwave access, WiMAX.

[0004]   The improvements of LTE are being made to cope with continuing new requirements and the growing base of users. Goals of this broadly based project include improving communication efficiency, lowering costs, improving services, making use of new spectrum opportunities, and achieving better integration with other open standards and backwards compatibility with some existing infrastructure that is compliant with earlier standards. The project envisions a packet switched communications environment with support for such services as voice over IP, VoIP. The 3GPP LTE project is not itself a standard-generating effort, but will result in new recommendations for standards for the UMTS. Now the project moved to planning the next generation standards, sometimes referred to as LTE-Advanced, LTE-A.

[0005]   A goal of LTE-A is to provide significantly enhanced services by means of higher data rates and lower latency with reduced cost. LTE-A is directed toward extending and optimizing the current 3GPP LTE radio access technologies to provide higher data rates at very low cost. LTE-A will be a more optimized radio system fulfilling the International Telecommunication Union Radio-communication sector, ITU-R, requirements for international

mobile telecommunications – advanced, IMT-A, while maintaining backward compatibility with the current LTE release.

[0006] Integration of new network topologies into a cellular network may provide a context for some examples of embodiments of the present invention. Heterogeneous networks in LTE and LTE-A exemplify such integration. Heterogeneous network can include, for example, a deployment of macros, micros, picos, femtos and relays in the same spectrum. One step further is to allow direct communication between devices operating in the cellular system when communicating devices are close to each other to use radio resources in the most efficient manner.

SUMMARY STATEMENTS

[0007] Various aspects of examples of embodiments of the invention are set out in the claims.

[0008] According to a first aspect of an example of an embodiment of the present invention, there is provided a method comprising obtaining a list of applications discoverable by a peer entity; determining whether or not an application in the list has demand to be discovered; generating an application sequence based on the determined information; and including the application sequence as a part of a discovery signal.

[0009] According to a second aspect of an example of an embodiment of the present invention, there is provided an apparatus comprising at least one processor, and at least one memory including computer program code, wherein the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus to obtain a list of applications discoverable by a peer entity; determine whether or not an application in the list has demand to be discovered; generate an application sequence based on the determined information; and include the application sequence as a part of a discovery signal.

[0010] According to a third aspect of an example of an embodiment of the present invention, there is provided a computer program product comprising a computer-readable medium bearing computer program code embodied therein for use with a computer, the computer program code may include code for obtaining a list of applications discoverable by a peer entity; determining whether or not an application in the list has demand to be discovered; generating an application sequence based on the determined information; and including the application sequence as a part of a discovery signal.

[0011]   According to a fourth aspect of an example of an embodiment of the present invention, there is provided an apparatus comprising means for obtaining a list of applications discoverable by a peer entity; means for determining whether or not an application in the list has demand to be discovered; means for generating an application sequence based on the determined information; and means for including the application sequence as a part of a discovery signal.

[0012]   According to a fifth aspect of an example of an embodiment of the present invention, there is provided a method comprising configuring a list of applications for a first user equipment; transmitting the list of applications to the first user equipment; receiving a request from a second user equipment to inquire information regarding an application mapping table of the first user equipment; and forwarding the information regarding the application mapping table of the first user equipment to the second user equipment.

[0013]   According to a sixth aspect of an example of an embodiment of the present invention, there is provided an apparatus comprising at least one processor, and at least one memory including computer program code, wherein the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus to configure a list of applications for a first user equipment; transmit the list of applications to the first user equipment; receive a request from a second user equipment to inquire information regarding an application mapping table of the first user equipment; and forward the information regarding the application mapping table of the first user equipment to the second user equipment.

[0014]   According to a seventh aspect of an example of an embodiment of the present invention, there is provided a computer program product comprising a computer-readable medium bearing computer program code embodied therein for use with a computer, the computer program code may include code for configuring a list of applications for a first user equipment; transmitting the list of applications to the first user equipment; receiving a request from a second user equipment to inquire information regarding an application mapping table of the first user equipment; and forwarding the information regarding the application mapping table of the first user equipment to the second user equipment.

[0015]   According to an eighth aspect of an example of an embodiment of the present invention, there is provided an apparatus comprising means for for configuring a list of applications for a first user equipment; means for transmitting the list of applications to the first user equipment; means for receiving a request from a second user equipment to inquire

information regarding an application mapping table of the first user equipment; and means for forwarding the information regarding the application mapping table of the first user equipment to the second user equipment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]   For a more complete understanding of example embodiments of the present invention, reference is now made to the accompanying drawings which are by way of example only when taken in connection with the following description and in which:

[0017]   Figure 1 illustrates an example wireless system 100 as described in some example embodiments which implement device-to-device, D2D, technology;

[0018]   Figure 2 illustrates an example of composite discovery signal structure as described in an example embodiment;

[0019]   Figure 3 illustrates an example of application sequence carrying information about an application mapping table as described in an example embodiment;

[0020]   Figure 4 illustrates a flow diagram of generating a discovery signal including an application sequence as described in an example embodiment;

[0021]   Figure 5 illustrates a flow diagram of a procedure performed by a discovering user equipment, UE, as described in an example embodiment;

[0022]   Figure 6 illustrates a flow diagram of a procedure performed by a network element as described in an example embodiment; and

[0023]   Figure 7 illustrates a simplified block diagram of various example apparatuses that are suitable for use in practicing various described example embodiments.

DETAILED DESCRIPTON

[0024]   Figure 1 illustrates an example of a wireless system 100 implemented using the device-to-device, D2D, technology of the following example embodiments. The example wireless system 100 comprises a network element, NE, such as for example, a 3rd generation partnership project, 3GPP, macro cell evolved NodeB, eNB, 101 connecting to a core network that is not shown for brevity. In an example scenario, the NE 101 serves three user equipments, UEs 102, 104 and 106 via a communication path 103, 105, and 107, respectively. When the UEs 102 and 104 are being moved to be in close proximity to each other, for the sake of power saving, cost saving, and/or offloading of the core network etc., it may be necessary to put them into a

D2D communication mode via a D2D communication path 109, for transporting traffic directly between the two UEs. Although just one NE and three UEs are shown in Figure 1, it is only for the purpose of illustration and the example wireless system 100 may comprise any number of NE(s) and UE(s).

[0025]   According to D2D service requirement 3GPP TS 22.278 v12.4.0 *Service requirements for the Evolved Packet System (EPS)*, section 9.3, which is incorporated herein by reference in its entirety, the permission of discovery can be "per-application basis", i.e., a user may just want to be discovered by a specific peer user on a specific application. The application layer based discovery signal design can provide higher granularity of proximity services, ProSe, discovery control at per-UE plus per-application level to support restricted discovery. If the physical layer discovery signal is designed independent of the application layer, a discovering UE needs to inquire the network about on which application the peer UE can be discovered and what is the corresponding permission of the discovery because different applications may have different requirements on the permission of discovery. For example, a user may be open for discovery on one application but is restricted for discovery on another application. This will further involve the procedures that the network will inquire the UE being discovered about which application(s) triggers the discovery signal. On the other hand, if the physical layer discovery signal includes the application layer information, a UE may send multiple discovery signals on the physical layer, which brings much radio resource waste from physical layer perspective.

[0026]   Figure 2 illustrates an example of composite discovery signal structure as described in an example embodiment. In the example embodiment of Figure 2, a composite discovery signal 200 in one discovery cycle transmitted between peer UEs, such as for example, between the UEs 102 and 104 of Figure 1, may comprise a discovery sequence 201, a discovery message 202, and an application sequence 203. The discovery sequence 201 is for proximity detection and the discovery message 202 may carry discovery related information such as UE identity.

[0027]   In an example embodiment, the application sequence 203 may carry information regarding an application mapping table, such as for example, a bit table. Figure 3 illustrates an example of application sequence carrying information about an application mapping table as described in an example embodiment. In Figure 3, the first bit of the bit table indicates whether the mapping relation of the table is updated or not. Each of the rest bits of the bit table has a one to one mapping to different applications. The bit for the corresponding application indicates

whether the application has a discovery demand or not. In an example embodiment, the mapping relation between the bits and the applications may be UE specific and semi-statically configured by the network. For example, the UE may receive a list of applications from the network, which can be the candidates to be discovered by a peer UE. In another word, the applications in the list can be discoverable by the peer UE. The UE can generate the application mapping table based at least in part on the received list of applications. In an example embodiment, the list of applications itself can be an application mapping table. When the network reconfigures or updates the list of the application so the mapping relation between bits and applications changes, the UE may obtain an updated list from the network. In an example embodiment, when a UE moves to a new area, such as for example, a new tracking area or a D2D registration area, the network needs to update all D2D related information including D2D application mapping table and UE identity used in discovery procedure. In an example embodiment, the application mapping table may be changed when the user opens/closes/activates applications which may trigger D2D discovery signal, or when there is a change for active applications. The first bit of the bit table carried in the discovery signal can be set to indicate the update of the mapping relation. Accordingly, the discovering UE may determine based on the received first bit whether it needs to inquire the network to update the mapping relation for the peer UE that transmitted the discovery signal.

[0028]   In some scenario, it is possible that the discovering UE may miss an earlier discovery message and therefore also miss the update indicator. Hence, it may further lead to mis-understanding of the table by the discovering UE. In an example embodiment, the UE being discovered can utilize a version number for the application mapping table. For example, the first two or three bits in the bit table of Figure 3 may indicate the version number. In another example, the version number may be carried by the discovery message 202 of Figure 2. When the discovering UE detects a different version number, it may inquire the network for the new table.

[0029]   In an example embodiment, the network may configure the list of applications, therefore, the mapping table, independently for different UEs. This may give the network the flexibility to configure the mapping according to applications status of different UEs. In another example embodiment, the network may apply same configuration for a group of UEs. This may be useful for the scenario where proximity D2D UEs form a D2D group with similar application layer requirement. With same configuration, UEs in the D2D group does not need to inquiry

network about the mapping table many times whenever it discovers other UE's application sequence in the group.

[0030]   In an example embodiment, for high priority ProSe services, it may be better to fix the mapping relation between the bit-table and different applications, i.e., the bits in the bit-table are used to represent a pre-defined set of applications. In this scenario, the UE can indicate this type of high priority services by utilizing a specific discovery sequence to represent the high priority applications on the discovered UE level. If discovering UE detects such a discovery sequence, it will use pre-defined mapping relation to interpret the bit-table carried by the application sequence. In that case, the first bit in the bit table conveyed by the application sequence may also be used to indicate an application.

[0031]   In an example embodiment, the application sequence 203 may be selected from a set of sequence, such as for example, a set of orthogonal sequences, based on the bit table. For example, if the bit table has a length of 6 bits, a set of 64 sequences can be used.

[0032]   Figure 4 illustrates a flow diagram of generating a discovery signal including an application sequence as described in an example embodiment. In Figure 4, a UE, such as for example, the UE 102 or 104 of Figure 1, wants to establish a D2D communication with a nearby peer UE and needs to send a discovery signal. At 401, the UE may obtain a list of applications discoverable by the peer UE. The list of application may be received from a network element or/and stored in the local storage of the UE. At 402, the UE determines which application in the list has demand to be discovered. Accordingly, the UE generates an application sequence based on the determined information at 403. In an example embodiment, the application sequence carries a bit table that is obtained at least in part based on the list of applications. The individual bit of the bit table indicates whether the corresponding application wants to be discovered. At 404, the UE includes the application sequence as a part of a discovery signal.

[0033]   Figure 5 illustrates a flow diagram of a procedure performed by a discovering UE as described in an example embodiment. In Figure 5, a UE, such as for example, the UE 102 or 104 of Figure 1, wants to establish a D2D communication with its nearby peer UE and needs to receive a discovery signal from the peer UE. At 501, the UE may obtain information regarding an application mapping table of the peer UE from the network. At 502, the UE may receive the discovery signal from the peer UE that includes an application sequence. In an example embodiment, the application sequence carries a bit table whose individual bit indicates whether

the corresponding application of the peer UE wants to be discovered. At 503, the UE may detect an indicator from the received discovery signal and check at 504 whether the indicator shows that the information regarding the application mapping table of the peer UE has been updated. If the indicator shows that the information has not been updated, the UE performs the procedure at 506. Otherwise, the UE may communicate the network to update the information at 505. At 506, based on the (updated) information regarding the application mapping table of the peer UE and the received application sequence, the UE may determine which application of the peer UE can be discovered.

[0034]   Figure 6 illustrates a flow diagram of a procedure performed by a network element as described in an example embodiment. In Figure 6, at 601, a network element, such as for example, the NE 101 of Figure 1, may configure a list of applications for a first UE, such as for example, the UE 102 of Figure 1. The applications in the list can be discoverable by a second UE, such as for example, the UE 104 of Figure 1. At 602, the NE may transmit the list of applications to the first UE. The NE may receive a request from the second UE at 603, which intends to establish a D2D connection with the first UE. The request conveys an inquiry about the information regarding an application mapping table of the first UE. The application mapping table is associated with the list of applications. In response to the request, the NE may forward information regarding the application mapping table of the first UE to the second UE at 604.

[0035]   Reference is made to Figure 7 for illustrating a simplified block diagram of various example apparatuses that are suitable for use in practicing various example embodiments of this invention. In Figure 7, a network element 701 is adapted for communication with a UE 711. The UE 711 may be in vicinity of another UE, which is not shown in Figure 7 for simplicity, and can enter a D2D mode with the other UE. The UE 711 includes at least one processor 715, at least one memory (MEM) 714 coupled to the at least one processor 715, and a suitable transceiver (TRANS) 713 (having a transmitter (TX) and a receiver (RX)) coupled to the at least one processor 715. The at least one MEM 714 stores a program (PROG) 712. The TRANS 713 is for bidirectional wireless communications with the NE 701.

[0036]   The NE 701 includes at least one processor 705, at least one memory (MEM) 704 coupled to the at least one processor 705, and a suitable transceiver (TRANS) 703 (having a transmitter (TX) and a receiver (RX)) coupled to the at least one processor 705. The at least one MEM 704 stores a program (PROG) 702.   The TRANS 703 is for bidirectional wireless

communications with the UE 711. The NE 701 is coupled to one or more external networks or systems, which is not shown in this figure.

[0037]   As shown in Figure 7, the NE 701 may further include a D2D control unit 706. The unit 706, together with the at least one processor 705 and the PROG 702, may be utilized by the NE 701 in conjunction with various example embodiments of this invention, as described herein, such as for example, the procedure illustrated in Figure 6.

[0038]   As shown in Figure 7, the UE 711 may further include a D2D communication unit 716. The unit 716, together with the at least one processor 715 and the PROG 712, may be utilized by the UE 711 in conjunction with various example embodiments of this invention, as described herein, such as for example, the procedure illustrated in Figure 4 or/and the procedure illustrated in Figure 5.

[0039]   At least one of the PROGs 702 and 712 is assumed to include program instructions that, when executed by the associated processor, enable the electronic apparatus to operate in accordance with the example embodiments of this disclosure, as discussed herein.

[0040]   In general, the various example embodiments of the apparatus 711 can include, but are not limited to, cellular phones, personal digital assistants (PDAs) having wireless communication capabilities, portable computers having wireless communication capabilities, image capture devices such as digital cameras having wireless communication capabilities, gaming devices having wireless communication capabilities, music storage and playback appliances having wireless communication capabilities, Internet appliances permitting wireless Internet access and browsing, as well as portable units or terminals that incorporate combinations of such functions.

[0041]   The example embodiments of this disclosure may be implemented by computer software or computer program code executable by one or more of the processors 705, 715 of the NE 701 and the UE 711, or by hardware, or by a combination of software and hardware.

[0042]   The MEMs 704 and 714 may be of any type suitable to the local technical environment and may be implemented using any suitable data storage technology, such as semiconductor-based memory devices, flash memory, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory, as non-limiting examples. The processors 705 and 715 may be of any type suitable to the local technical environment, and may include one or more of general purpose computers, special purpose

computers, microprocessors, digital signal processors (DSPs) and processors based on multi-core processor architecture, as non-limiting examples.

[0043] Without in any way limiting the scope, interpretation, or application of the claims appearing below, a technical effect of one or more of the example embodiments disclosed herein may be balancing different requirements between application layer and physical layer, in the sense that dynamic requirements may be expected from application layer, while semi-static design is more suitable for physical layer. The using of application sequence helps to minimize the waste of resource and simplify the signaling design. The configurable application mapping table provides network the flexibility to facilitate various requirements on the applications from different UEs.

[0044] Embodiments of the present invention may be implemented in software, hardware, application logic or a combination of software, hardware and application logic. The software, application logic and/or hardware may reside on an apparatus such as a user equipment, a NodeB or other mobile communication devices. If desired, part of the software, application logic and/or hardware may reside on an eNodeB/base station 701, part of the software, application logic and/or hardware may reside on a UE 711, and part of the software, application logic and/or hardware may reside on other chipset or integrated circuit. In an example embodiment, the application logic, software or an instruction set is maintained on any one of various conventional computer-readable media. In the context of this document, a "computer-readable medium" may be any media or means that can contain, store, communicate, propagate or transport the instructions for use by or in connection with an instruction execution system, apparatus, or device. A computer-readable medium may comprise a computer-readable storage medium that may be any media or means that can contain or store the instructions for use by or in connection with an instruction execution system, apparatus, or device.

[0045] Although various aspects of the example embodiment(s) described herein are set out in the accompanying independent claims, other aspects of the example embodiments of the invention comprise other combinations of features from the described embodiments and/or the dependent claims with the features of the independent claims, and not solely the combinations explicitly set out in the claims.

[0046] It is also noted herein that while the above describes example embodiments of the invention, these descriptions should not be viewed in a limiting sense. Rather, there are

several variations and modifications which may be made without departing from the general scope of inventive concept(s) of the example embodiments, at least one such inventive concept being as defined in the appended claims.

[0047] Further, the various names used for the described parameters are not intended to be limiting in any respect, as these parameters may be identified by any suitable names.

[0048] If desired, the different functions discussed herein may be performed in a different order and/or concurrently with each other. Furthermore, if desired, one or more of the above-described functions may be optional or may be combined. As such, the foregoing description should be considered as merely illustrative of the principles, teachings and example embodiments of this invention, and not in limitation thereof.

WHAT IS CLAIMED IS:

1. A method, comprising:

    obtaining a list of applications discoverable by a peer entity;

5   determining whether or not an application in the list has demand to be discovered;

    generating an application sequence based on the determination; and

    including the application sequence as a part of a discovery signal.

2. The method as claimed in claim 1, wherein the discovery signal is subsequently transmitted to

10 the peer entity.

3. The method as claimed in any preceding claim, wherein the application sequence carries a bit table associated with the list of applications.

15 4. The method as claimed in any preceding claim, wherein the application sequence comprises an indicator indicating whether the list of applications has been updated.

5. The method as claimed in any preceding claim, wherein at least part of the bits in the bit table have a one to one mapping with different applications, and each of the mapped bits indicates

20 whether a corresponding application has a discovery demand or not.

6. The method as claimed in any preceding claim, wherein the list of applications is pre-defined or dynamically configured.

25 7. The method as claimed in any preceding claim, wherein obtaining the list of applications comprises receiving the list of applications from a network element.

8. The method as claimed in any preceding claim, wherein generating the application sequence comprises selecting a sequence from a set of orthogonal sequences.

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9. The method as claimed in any preceding claim, wherein the list of applications has a version and an indicator of the version is included in the discovery signal.

10. The method as claimed in any preceding claim performed by a discovering entity, further
5   comprising the discovering entity: obtaining information regarding an application mapping table of a peer entity;
receiving a discovery signal carrying an application sequence from the peer entity; and
determining the application of the peer entity to be discovered based on the obtained information and the received application sequence.
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11. The method as claimed in claim 10, further comprising the discovering entity:
detecting an indicator in the received discovery signal; and
if the indicator indicating that the information regarding the application mapping table of the peer entity has been updated, communicating with the network element to update the information
15   regarding the application mapping table of the peer entity.

12. A method, comprising:
configuring a list of applications for a first user equipment;
transmitting the list of applications to the first user equipment;
20   receiving a request from a second user equipment to inquire information regarding an application mapping table of the first user equipment; and
forwarding the information regarding the application mapping table of the first user equipment to the second user equipment.

25   13. An apparatus comprising:
at least one processor, and at least one memory including computer program code, wherein the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to:
        obtain a list of applications discoverable by a peer entity;
30   determine whether or not an application in the list has demand to be discovered;
        generate an application sequence based on the determined information; and

include the application sequence as a part of a discovery signal.

14. The apparatus as claimed in claim 13, wherein the discovery signal is subsequently transmitted to the peer entity.

15. The apparatus as claimed in any preceding claim, wherein the application sequence carries a bit table associated with the list of applications.

16. The apparatus as claimed in any preceding claim, wherein the application sequence comprises an indicator indicating whether the list of applications has been updated.

17. The apparatus as claimed in any preceding claim, wherein at least part of the bits in the bit table have a one to one mapping with different applications, and each of the mapped bits indicates whether the corresponding application has a discovery demand or not.

18. The apparatus as claimed in any preceding claim, wherein the list of application is pre-defined or dynamically configured.

19. The apparatus as claimed in any preceding claim, wherein the list of applications is obtained by receiving the list of applications from a network element.

20. The apparatus as claimed in any preceding claim, wherein the application sequence is generated by selecting a sequence from a set of orthogonal sequences.

21. The apparatus as claimed in any preceding claim, wherein the list of applications has a version and an indicator of the version is included in the discovery signal.

22. The apparatus as claimed in any preceding claim, wherein the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus further to:
when acting as a discovering entity,

obtain information regarding an application mapping table of a peer entity;

receive a discovery signal carrying an application sequence from the peer entity; and

determine the application of the peer entity to be discovered based on the obtained information and the received application sequence.

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23. The apparatus as claimed in claim 22, wherein the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus further to: detect an indicator in the received discovery signal; and

if the indicator indicating that the information regarding the application mapping table of the

10   peer entity has been updated, communicate with the network element to update the information regarding the application mapping table of the peer entity.

24. An apparatus comprising:

at least one processor, and at least one memory including computer program code, wherein the at

15   least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to:

configure a list of applications for a first user equipment;

transmit the list of applications to the first user equipment;

receive a request from a second user equipment to inquire information regarding an application

20   mapping table of the first user equipment; and

forward the information regarding the application mapping table of the first user equipment to the second user equipment.

25. A computer program product comprising a computer-readable medium bearing computer

25   program code embodied therein for use with a computer, the computer program code includes code for:

obtaining a list of applications discoverable by a peer entity;

determining whether or not an application in the list has demand to be discovered;

generating an application sequence based on the determined information; and

30   including the application sequence as a part of a discovery signal.

26. The computer program product as claimed in claim 25, wherein the discovery signal is subsequently transmitted to the peer entity.

27. The computer program product as claimed in any preceding claim, wherein the application sequence carries a bit table associated with the list of applications.

28. The computer program product as claimed in any preceding claim, wherein the application sequence comprises an indicator indicating whether the list of applications has been updated.

29. The computer program product as claimed in any preceding claim, wherein at least part of the bits in the bit table have a one to one mapping with different applications, and each of the mapped bits indicates whether the corresponding application has a discovery demand or not.

30. The computer program product as claimed in any preceding claim, wherein the list of application is pre-defined or dynamically configured.

31. The computer program product as claimed in any preceding claim, wherein obtaining the list of applications comprises receiving the list of applications from a network element.

32. The computer program product as claimed in any preceding claim, wherein generating the application sequence comprises selecting a sequence from a set of orthogonal sequences.

33. The computer program product as claimed in any preceding claim, wherein the list of applications has a version and an indicator of the version is included in the discovery signal.

34. The computer program product as claimed in any preceding claim, wherein the computer program code further comprises code performed by a discovering entity for:
obtaining information regarding an application mapping table of a peer entity;
receiving a discovery signal carrying an application sequence from the peer entity; and
determining the application of the peer entity to be discovered based on the obtained information and the received application sequence.

35. The computer program product as claimed in claim 34, wherein the computer program code further comprises code for:

detecting an indicator in the received discovery signal; and

5   if the indicator indicating that the information regarding the application mapping table of the peer entity has been updated, communicating with the network element to update the information regarding the application mapping table of the peer entity.

36. A computer program product comprising a computer-readable medium bearing computer

10   program code embodied therein for use with a computer, the computer program code includes code for:

configuring a list of applications for a first user equipment;

transmitting the list of applications to the first user equipment;

receiving a request from a second user equipment to inquire information regarding an application

15   mapping table of the first user equipment; and

forwarding the information regarding the application mapping table of the first user equipment to the second user equipment.

37. An apparatus, comprising:

20   means for obtaining a list of applications discoverable by a peer entity;

means for determining whether or not an application in the list has demand to be discovered;

means for generating an application sequence based on the determined information; and

means for including the application sequence as a part of a discovery signal.

25

38. The apparatus as claimed in claim 37, further comprising:

when acting as a discovering entity,

means for obtaining information regarding an application mapping table of a peer entity;

means for receiving a discovery signal carrying an application sequence from the peer entity; and

30   means for determining the application of the peer entity to be discovered based on the obtained information and the received application sequence.

39. The apparatus as claimed in claim 38, further comprising:

means for detecting an indicator in the received discovery signal; and

means for, if the indicator indicating that the information regarding the application mapping table

5   of the peer entity has been updated, communicating with the network element to update the

information regarding the application mapping table of the peer entity.

40. An apparatus, comprising:

means for configuring a list of applications for a first user equipment;

10   means for transmitting the list of applications to the first user equipment;

means for receiving a request from a second user equipment to inquire information regarding an

application mapping table of the first user equipment; and

means for forwarding the information regarding the application mapping table of the first user

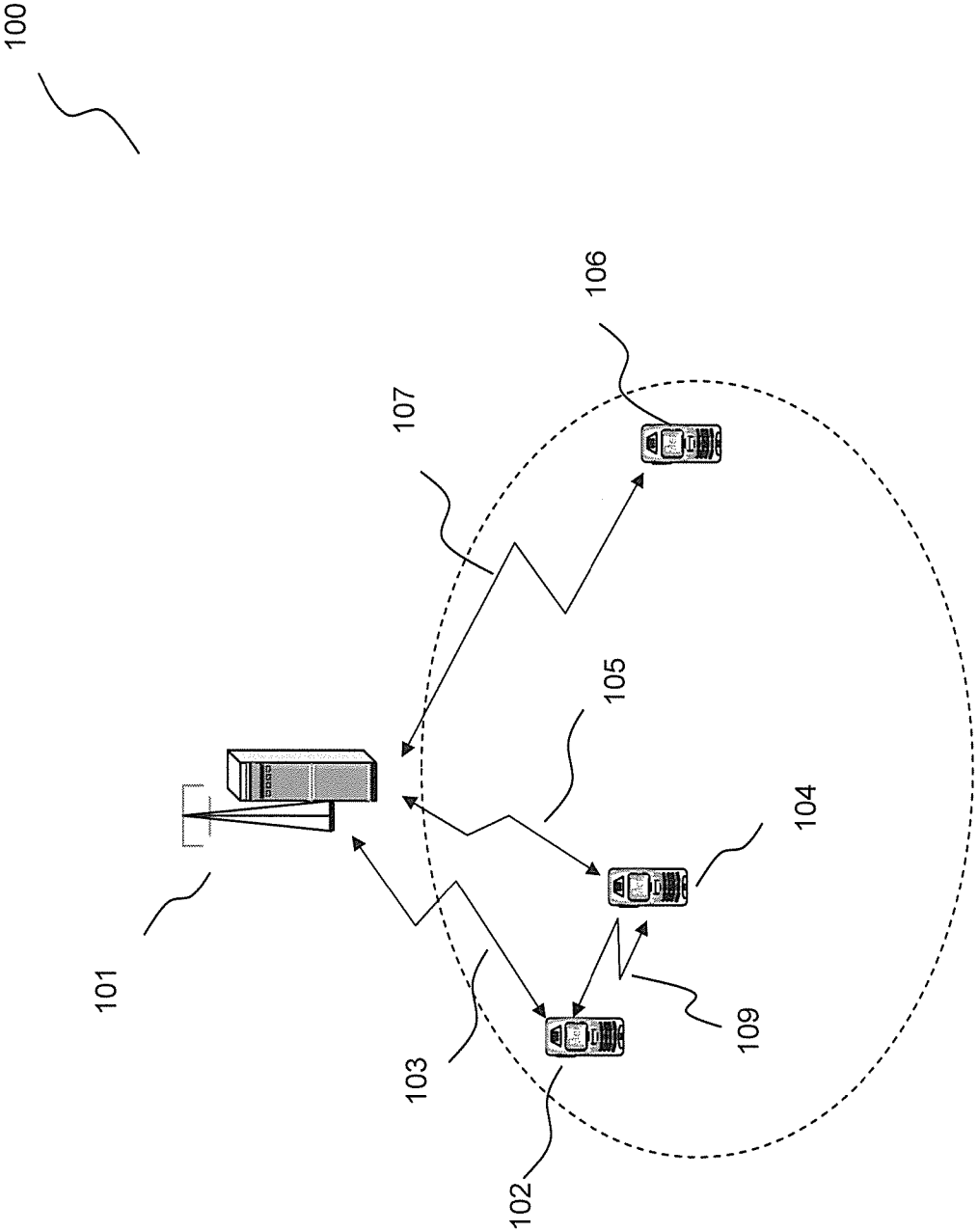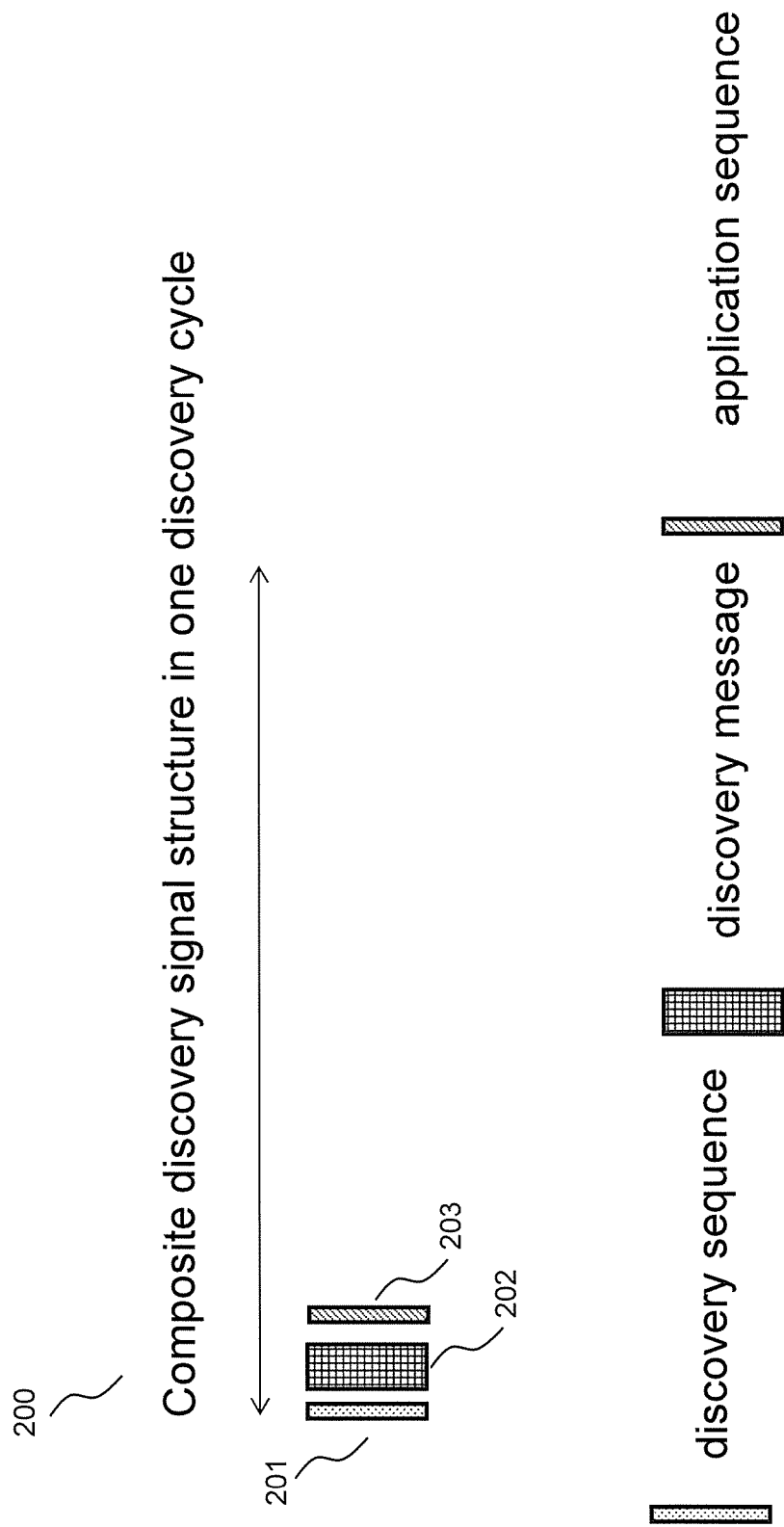equipment to the second user equipment.

Figure 1

Figure 2

Figure 3

401

402

403

404

Obtaining a list of applications

Determining whether or not an application in the list has a request to be discovered

Generating an application sequence based on the determined information

Including the application sequence as a part of a discovery signal

Figure 4

501 Obtaining information regarding an application mapping table of a peer UE

502 Receiving a discovery signal carrying an application sequence

503 Detecting an indicator in the discovery signal

504 Information Updated?

Yes

505 Updating the information regarding the application mapping table of the peer UE

No

506 Determining the application of the peer UE to be discovered

Figure 5

601

Configuring a list of applications for a first UE

602

Transmitting the list of applications to the first UE

603

Receiving a request from a second UE to inquire information regarding an application mapping table of the first UE

604

Forwarding the information regarding the application mapping table of the first UE to the second UE

Figure 6

Figure 7

INTERNATIONAL SEARCH REPORT
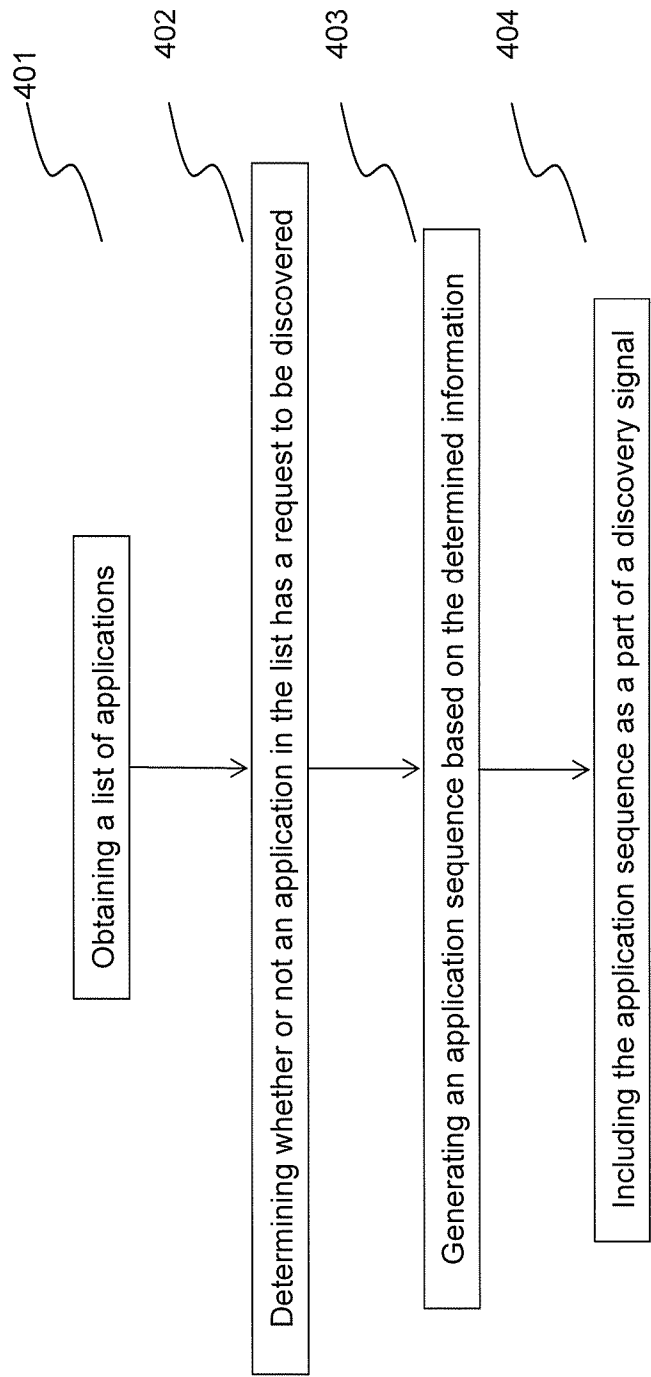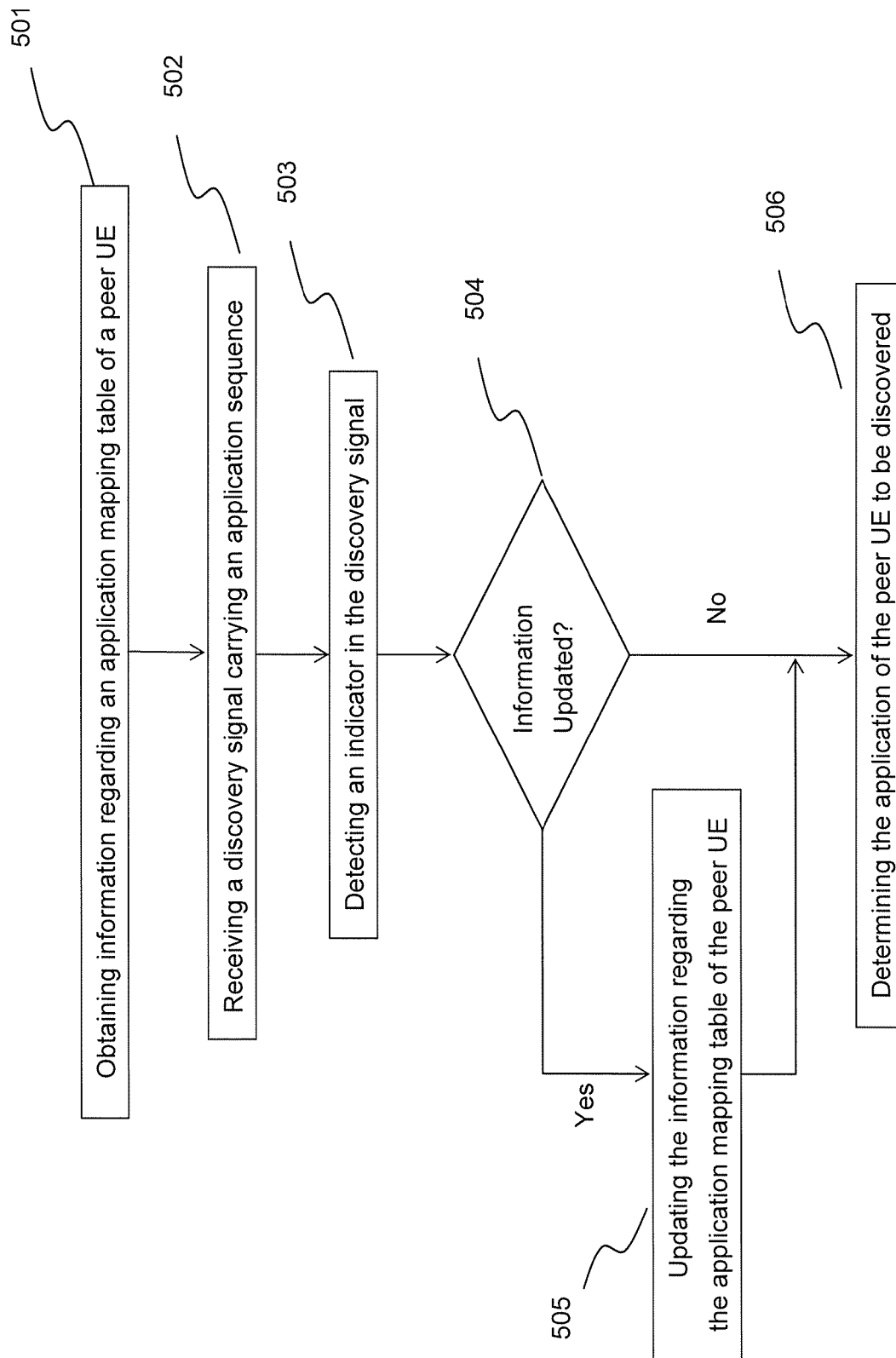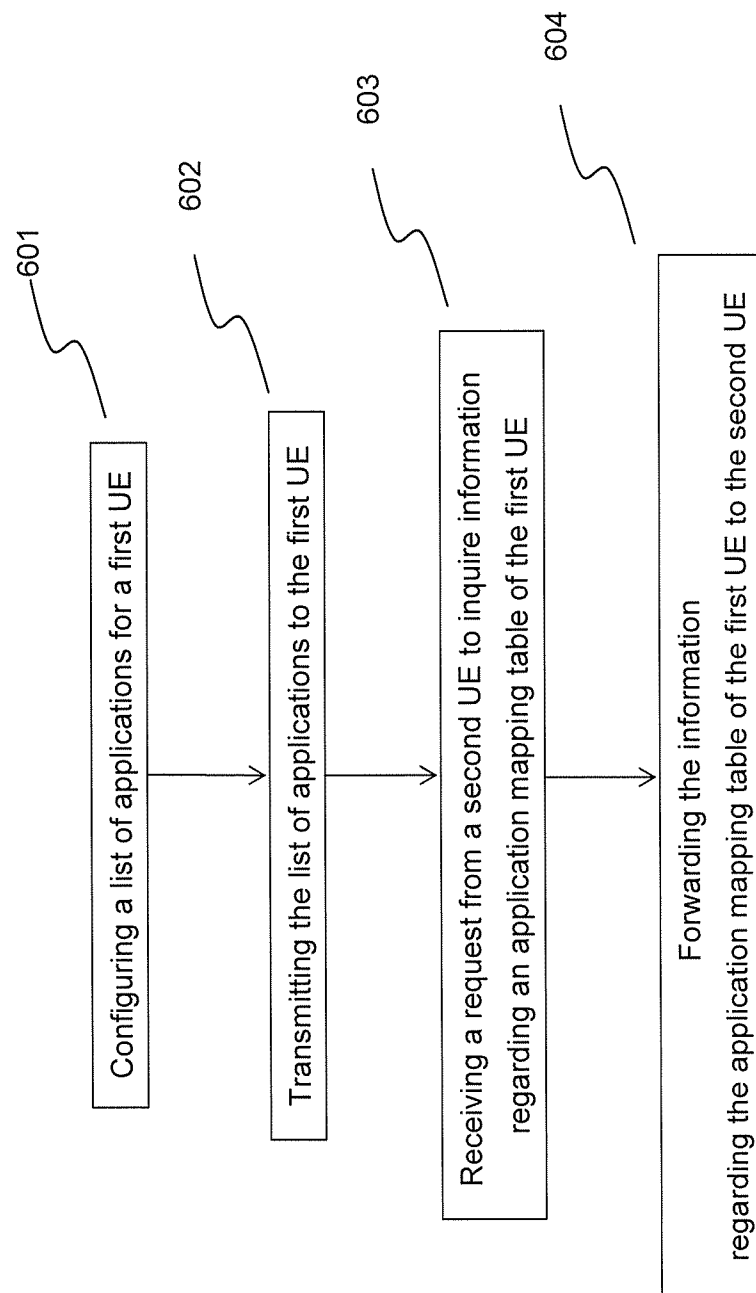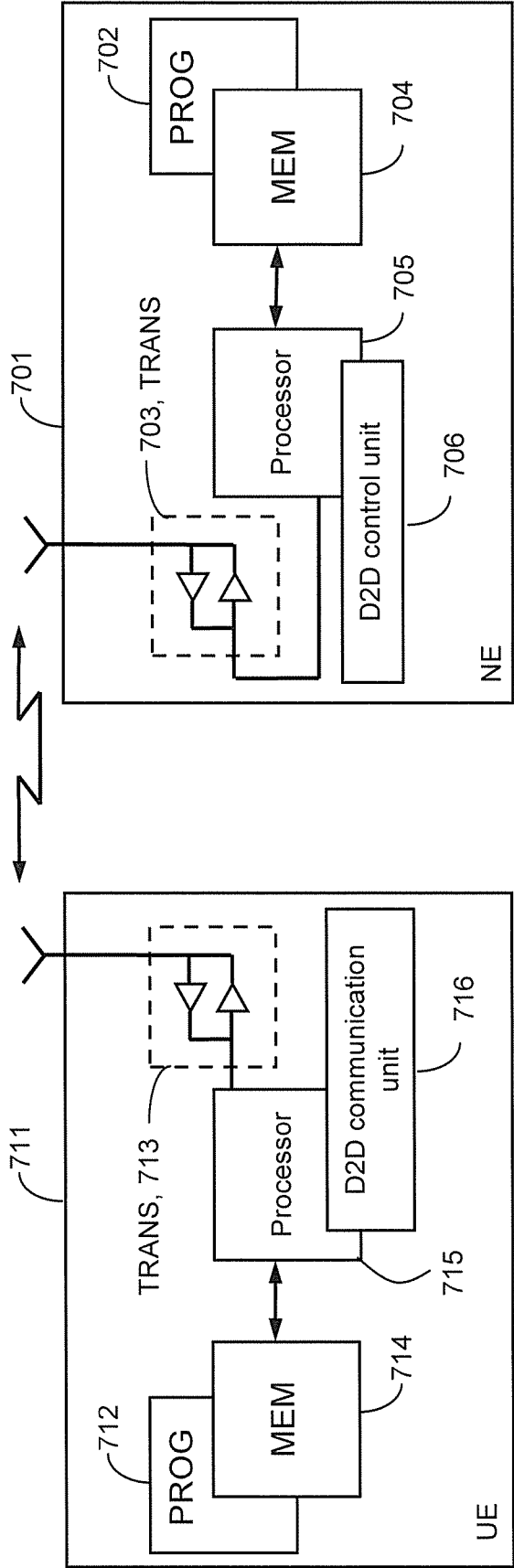
International application No.

PCT/CN2013/084842

A. CLASSIFICATION OF SUBJECT MATTER

H04W 76/02 (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; G06F

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, DWPI, USTXT, IEEE: device to device, D2D, peer to peer, P2P, discovery, application, list, map, table, bit

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2013048296A1 (TELEFONAKTIEBOLAGET L M ERICSSON) 04 April 2013 (2013-04-04) see description page 7 lines 1 – 20, page 11 lines 6 – 23	13, 14, 18, 19, 25, 26, 30, 31,
A	US 2004088369A1 (YEAGER WILLIAM J. ET AL) 06 May 2004 (2004-05-06) the whole document	1-40
A	US 2013204962A1 (ESTEVEZ, LEONARDO WILLIAM ET AL.) 08 August 2013 (2013-08-08) the whole document	1-40
A	US 2013083779A1 (ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE) 04 April 2013 (2013-04-04) the whole document	1-40

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

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"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

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"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
17 June 2014	**15 July 2014**

Name and mailing address of the ISA/	Authorized officer
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Form PCT/ISA/210 (second sheet) (July 2009)

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2013048296A1	04 April 2013	None	
US 2004088369A1	06 May 2004	None	
US 2013204962A1	08 August 2013	None	
US 2013083779A1	04 April 2013	KR 20130035964A	09 April 2013