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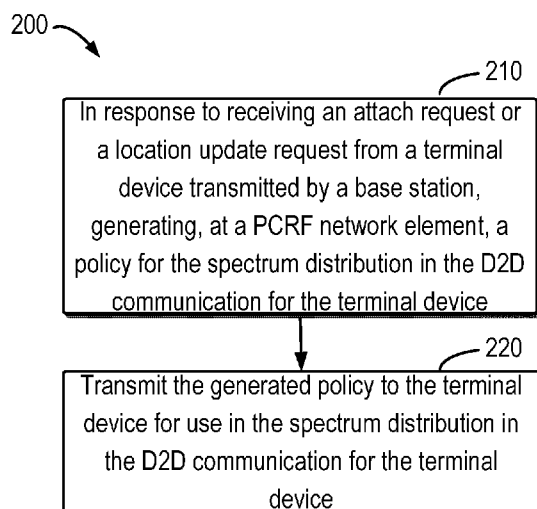


Fig. 2

(57) Abstract: Embodiments of the present disclosure provide methods and apparatuses for spectrum distribution in D2D communication. A method implemented at a policy management network element in a communication system comprises: in response to receiving (210) an attach request or a location update request from a terminal device transmitted by a policy execution network element in the communication system, generating, at the policy management network element, a policy for the spectrum distribution in the D2D communication for the terminal device; and transmitting (220) the generated policy to the policy execution network element for use in the spectrum distribution in the D2D communication for the terminal device. Thus, a dynamic and flexible spectrum distribution mechanism based on policy control can be provided for D2D communication, thereby taking full advantage of limited spectrum resource in D2D communications for the maximum benefit.

METHODS AND APPARATUSES FOR SPETRUM DISTRIBUTION IN D2D COMMUNICATION

FIELD

5 [0001] Embodiments of the present disclosure generally relate to the field of wireless communications, and more specifically, to methods and apparatuses for spectrum distribution in device-to-device (D2D) communication.

BACKGROUND

10 [0002] In the evolution of wireless communication technology for the fifth generation (5G), as a key candidate technology for 5G, D2D communication has attracted wide attention owing to its prospect of improving system performance, enhancing user experience and expanding the application of cellular communication.

15 [0003] In the mode of D2D communication, user data is transmitted directly between terminals, avoiding the transmission of user data in cellular communication through the network and resulting in link gain; secondly, resources between D2D users and between the D2D and the cell can be multiplexed, thereby generating resource reuse gain; with link gain and resource reuse gain, wireless spectrum resource efficiency can be improved, thereby improving network throughput.

20 [0004] However, the introduction and adoption of D2D communication has some very obvious challenges. From the radio perspective, the key challenges are how to share the spectrum resources between cellular and D2D communications and how to eliminate unpredictable interference among different communications. The above challenges raise another unavoidable question for wireless operators in the adoption of D2D communication, that is, how to take full advantage of limited spectrum resource in D2D communication for
25 the maximum benefit.

SUMMARY

[0005] On the whole, embodiments of the present disclosure provide a method for spectrum distribution in D2D communication, a policy management network element, a policy execution network element and an electronic device.

[0006] In one aspect of the present disclosure, there is provided a method for spectrum distribution in D2D communication. The method includes: in response to receiving an attach request or a location update request from a terminal device transmitted by a policy execution network element in a communication system, generating, at a policy management network element in the communication system, a policy for the spectrum distribution in the D2D communication for the terminal device; and transmitting the generated policy to the policy execution network element for use in the spectrum distribution in the D2D communication for the terminal device.

[0007] In another aspect of the present disclosure, there is provided a method for spectrum distribution in D2D communication. The method may include: transmitting, at a policy execution network element in a communication system, an attach request or location update request from a terminal device to a policy management network element in the communication system; receiving a policy for the spectrum distribution in the D2D communication for the terminal device, the policy being generated by the policy management network element based on the attach request or location update request; and storing the received policy for use in the spectrum distribution in the D2D communication for the terminal device.

[0008] In still another aspect of the present disclosure, there is provided a policy management network element in the communication system. The policy management network element includes: a receiver configured to receive an attach request or a location update request from the terminal device transmitted by a policy execution network element in the communication system; a controller configured to, in response to receiving the attach request or the location update request, generate a policy for spectrum distribution in D2D communication for the terminal device; and a transmitter configured to transmit the generated policy to the policy execution network element for use in the spectrum distribution in the D2D communication for the terminal device.

[0009] In still another aspect of the present disclosure, there is provided a policy execution network element in the communication system. The policy execution network element includes: a transmitter configured to transmit an attach request or location update request from the terminal device to a policy management network element in the communication system; a receiver configured to receive a policy for spectrum distribution in D2D communication for the terminal device generated by the policy management network element based on the attach request or location update request; and a storage device configured to

store the received policy for use in the spectrum distribution in the D2D communication for the terminal device.

[0010] In still another aspect of the present disclosure, there is provided an electronic device. The electronic device can be implemented at a policy execution network element in a communication system. The electronic device includes: a processor; and a memory coupled to the processor, the memory having instructions stored therein, the instructions, when run by the processor, causing the electronic device to perform actions including: in response to receiving an attach request or a location update request from a terminal device transmitted by a policy execution network element in the communication system, generating a policy for spectrum distribution in device-to-device (D2D) communication for the terminal device; and transmitting the generated policy to the policy execution network element for use in the spectrum distribution in the D2D communication for the terminal device.

[0011] In still another aspect of the present disclosure, there is provided an electronic device. The electronic device can be implemented at a policy management network element in a communication system. The electronic device includes: a processor; and a memory coupled to the processor, the memory having instructions stored therein, the instructions, when run by the processor, causing the electronic device to perform actions including: transmitting, at a policy execution network element in a communication system, an attach request or location update request from a terminal device to a policy management network element in the communication system; receiving a policy for spectrum distribution in D2D communication for the terminal device generated by the policy management network element based on the attach request or location update request; and storing the received policy for use in the spectrum distribution in the D2D communication for the terminal device.

[0012] According to the solution of embodiments of the present disclosure, a dynamic and flexible mechanism for spectrum distribution based on policy control can be provided for D2D communication in a mobile network, thereby taking full advantage of the limited spectrum resource in D2D communication for the maximum benefit.

[0013] It will be appreciated that the Summary part does not intend to indicate essential or important features of embodiments of the present disclosure or to limit the scope of the present disclosure. Other features of the present disclosure will be made apparent by the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Through the following detailed description with reference to the accompanying drawings, the above and other features, advantages and aspects of example embodiments of the present disclosure will become more apparent. In the drawings, identical or similar reference numbers represent the same or similar elements, in which:

5 [0015] Fig. 1 is a diagram illustrating an example communication system in which embodiments of the present disclosure can be implemented;

[0016] Fig. 2 is a flowchart illustrating a method for spectrum distribution in D2D communication implemented at a policy management network element according to embodiments of the present disclosure;

10 [0017] Fig. 3 is a flowchart illustrating a method for spectrum distribution in D2D communication implemented at a policy execution network element according to embodiments of the present disclosure;

[0018] Fig. 4 illustrates an example process of generation and transmission of a policy for spectrum distribution in D2D communication according to embodiments of the present
15 disclosure;

[0019] Fig. 5 illustrates a structural diagram of an apparatus implemented at a policy management network element according to embodiments of the present disclosure;

[0020] Fig. 6 illustrates a structural diagram of an apparatus implemented at a policy execution network element according to embodiments of the present disclosure; and

20 [0021] Fig. 7 illustrates a simplified block diagram of an electronic device 700 that is suitable for implementing embodiments of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

[0022] Embodiments of the present disclosure will be described with reference to the drawings in detail. Though some embodiments of the present disclosure are shown in the
25 drawings, it should be appreciated that the present disclosure can be implemented in various manners and should not be interpreted as limited to the implementations described herein. Conversely, these implementations are provided for thorough and complete understanding of the present disclosure. It is to be understood that the drawings and implementations are only for the purpose of example, rather than to limit the scope of protection of the present
30 disclosure.

[0023] The term “policy management network element” used herein can represent a network element that can implement generation, modification or updating of a policy in the communication system, such as a policy and charging rule function (PCRF) network element. In the context of the present disclosure, for the sake of convenience of discussion, PCRF network element is used as an example of the policy management network element.

[0024] The term “policy execution network element” used herein can represent a network element that can perform the policy generated by the policy management network element in the communication system, such as a base station. In the context of the present disclosure, for the sake of convenience of discussion, the base station is mainly used as an example of the policy execution network element.

[0025] The term “base station” used herein can represent a node B (NodeB or NB), an evolved node B (eNodeB or eNB), a remote radio unit (RRU), a radio frequency head (RH), a remote radio head (RRH), a relay, or a low power node such as a femto station and a pico station and the like. In the context of the present disclosure, for the sake of convenience of discussion, eNB is employed as an example for the base station.

[0026] The term “terminal device” used in the text refers to any terminal device or user equipment (UE) that can perform wireless communication with base stations or with each other. As an example, the terminal device may include a sensor, a detector, a mobile terminal (MT), a subscriber station (SS), a portable subscriber station (PSS), a mobile station (MS), or an access terminal (AT) and the above vehicle-mounted devices. In the context of the present disclosure, for the sake of convenience of discussion, terms “terminal device” and “user equipment (UE)” can be used interchangeably and UE is mainly taken as an example of the terminal device.

[0027] As used herein, the term “includes” and its variants are to be read as open-ended terms that mean “includes, but is not limited to.” The term “based on” is to be read as “based at least in part on.” The term “one example embodiment” is to be read as “at least one example embodiment,” and the term “another embodiment” is to be read as “at least one another embodiment.” Relevant definition for other terms will be given in the following depiction.

[0028] Fig. 1 is a diagram illustrating an example communication system 100 in which embodiments of the present disclosure can be implemented. For the sake of convenience of discussion, a PCRF network element will be utilized as an example of a policy management

network element and an eNB is employed as an example of a policy execution network element in the following description. However, it is to be understood that this is simply to explain the idea of the implementations the present disclosure, rather than to limit the application scenario and the scope of the present disclosure in any manner.

5 [0029] As shown in Fig. 1, the communication system 100 may include terminal devices 110 and 120, a base station 130, an evolved packet core network (EPC) 140 and a PCRF network element 150. The terminal devices 110 and 120 each makes access to the EPC 140 via the base station 130. The PCRF network element 150 may perform policy and charging control via an interface Gx to the EPC 140. The EPC 140 may include a mobility
10 management node (MME) 141 and a gateway node (GW) 142. Both the base station 130 and the PCRF network element 150 can communicate with the EPC 140 via the MME 141 and the GW 142. The terminal devices 110 and 120 can communicate with the base station 130 via LTE-Uu interfaces respectively, and can make D2D direct communication via a PC5 interface. For example, when the terminal device 110 initiates a request for D2D
15 communication with the terminal device 120 to the base station 130, the base station 130 can perform spectrum distribution for them so as to distribute dedicated frequency band for direct communication between the terminal device 110 and the terminal device 120.

[0030] The fundamental concept of embodiments of the present disclosure is to achieve spectrum distribution in D2D communication based on a policy control. For example, a
20 corresponding policy for spectrum distribution for D2D communication can be generated for each terminal device such as the terminal devices 110 and 120 at the PCRF network element 150 and the generated policy is transmitted to the base station 130 for use in the spectrum distribution in the D2D communication for the corresponding terminal device. On the other hand, the generation and updating of the policy is dependent on the context, thereby achieving
25 a dynamic and flexible mechanism for spectrum distribution. According to this concept, embodiments of the present disclosure provide a method, apparatus and device for spectrum distribution in D2D communication. Detailed depiction will be given below with reference to Figs. 2 to 8.

[0031] Fig. 2 is a flowchart illustrating a method 200 for spectrum distribution in D2D
30 communication implemented at a policy management network element in the communication system according to embodiments of the present disclosure. The method can be implemented at the PCRF network element 150 in Fig. 1. It is to be understood that the method can be implemented at any policy management network element in the art known or

to be developed in the future.

[0032] As shown in Fig. 2, at 210, in response to an attach request or a location update request from a terminal device transmitted by an base station, a policy for spectrum distribution in D2D communication is generated. For example, the PCRF network element
5 150 can generate a policy for spectrum distribution in D2D communication for the terminal device 110 in response to an attach request or a location update request from the terminal device 110 transmitted by the base station 130. More detailed depiction will be made with reference to Fig. 4 in the following text. Fig. 4 illustrates an example process of generation and transmission of a policy for spectrum distribution in D2D communication according to
10 embodiments of the present disclosure. For example, at 410, the terminal device 110 can transmit the attach request or the location update request for the EPC 140 to the base station 130. At 420, the base station 130 transmits the request to the MME 141 in the EPC 140. After identification or location update confirmation, at 430 and 440, the MME 141 initiates a “Create Session Request” to the PCRF network element 150 via the GW 142 in the EPC 140.
15 At 450, the PCRF network element 150 generates the policy for spectrum distribution in D2D communication for the terminal device 110 during an establishment of a session for the Internet protocol-connection access network (IP-CAN).

[0033] According to an embodiment of the present disclosure, the PCRF network element 150 can generate the policy based at least one of the following: attribute information about a
20 user of UE, network information from other network elements in the communication system and local settings of the PCRF network element. In an embodiment, the attribute information about the user, such as contract information about the user, can be obtained from at least one of a subscriber profile register (SPR) or a home subscriber server (HSS). In an embodiment, the network information may include billing information about the user,
25 communication network status information, location information about the user, and so on. For example, in an embodiment, the billing information, such as utilization of service, data use pattern on the communication network, current account balance and so on, can be obtained from an online charging system (OCS). In an embodiment, the D2D communication status information, for instance, if a large number of D2D communication
30 requests appear in a certain region of the network, can be obtained from a proximity service (ProSe) application server. In an embodiment, the location information, such as global positional system (GPS) information, can be obtained from a base station. For instance, the local settings can be service settings for management of spectrum distribution policy for D2D

communication in a PCRF network element. It is to be understood that the generation of the policy according to embodiments of the present disclosure can be based on other appropriate aspects, not being limited to these specifically listed above.

[0034] According to an embodiment of the present disclosure, the PCRF network element
5 150 can determine one or more control parameters for spectrum distribution based on at least one of the following: attribute information about the user of the terminal device, network information from a further network element in the communication system and a local setting of the PCRF network element, and then generate a policy based on the one or more control parameters. According to embodiments of the present disclosure, the control parameters
10 may include at least one of the following: a priority of the terminal device, a validity condition of the D2D communication, a type of spectrum sharing of the D2D communication and an indication of quality of service (QoS) of the D2D communication.

[0035] In embodiments of the present disclosure, the priority indicates a priority of a terminal device in D2D spectrum utilization. For example, a terminal device with a higher
15 priority will obtain D2D spectrum preferentially and a minimum priority value (such as priority as 0) means that D2D communication is forbidden for the terminal device and thus, it is impossible to obtain D2D spectrum distribution. In an embodiment, the priority can be set as a certain value directly. In another embodiment, the priority may be determined in dependence on the context. According to embodiments of the present disclosure, the priority
20 parameter can be determined based on at least one of the following: the attribute information about the user of the terminal device, the network information from a further network element in the communication system and the local setting of the PCRF network element. For example, the priority can be determined based on user location and/or time and then the policy is determined based on the priority. For instance, a user Alice has more D2D
25 communication requirements, such as social application, office application, during her daily work from 9:00 to 17:00 than other time. Therefore, PCRF network element 150 can be set in Alice's D2D policy: if "location=Alice's company" and "time is in [9:00-17:00]", then D2D priority is 7; otherwise, D2D priority is 3.

[0036] In embodiments of the present disclosure, the validity condition indicates the criteria
30 allowing D2D communication. For example, the time interval allowing D2D communication, power status allowing D2D communication, location allowing D2D communication and so on. According to embodiments of the present disclosure, the validity condition parameter can be determined based on at least one of the following: the attribute

information about the user of the terminal device, the network information from a further network element in the communication system and the local setting of the PCRF network element.

[0037] In embodiments of the present disclosure, the type of spectrum sharing may indicate the type of the sharing for D2D spectrum, for instance, INBAND D2D or OUTBAND D2D. Each type will have its corresponding priority indication. According to embodiments of the present disclosure, the spectrum sharing type indication can be determined based on at least one of the following: the attribute information about the user of the terminal device, the network information from a further network element in the communication system and the local setting of the PCRF network element.

[0038] In embodiments of the present disclosure, the QoS indication is for indicating QoS parameters relating to D2D spectrum distribution. According to embodiments of the present disclosure, the QoS indication can be determined based on at least one of the following: the attribute information about the user of the terminal device, the network information from a further network element in the communication system and the local setting of the PCRF network element.

[0039] A policy of spectrum distribution for D2D communication can be generated based on one or more of these control parameters. According to an embodiment of the present disclosure, priority use of spectrum for D2D communication can be determined based on the priority level. For example, as Alice's boss, D2D utilization for Tom is similar to Alice. However, as Tom is VIP client, the priority of Tom in D2D policy is set higher than Alice as follows: if "location=Tom's company" and "time is in [9:00-17:00]", then D2D priority is 8; otherwise, D2D priority is 4. Thus, under shortage of spectrum, Tom has higher priority than Alice in obtaining D2D spectrum. According to another embodiment of the present disclosure, the spectrum for D2D communication with lower priority can be released for D2D communication with a higher priority. For example, a public security application of a terminal device may request D2D communication in the scenario of spectrum shortage. In this case, an eNB can release spectrum distributed for a terminal device with a low priority and distribute the released spectrum to the terminal device utilizing the public security application. Apart from the above manner, the policy can be generated in any appropriate manner in the art known or to be developed in the future. For example, the policy can be generated based on auction mechanism. For instance, in the advertisement-based D2D scenario, different stores expect to broadcast their advertisement through D2D communication.

Then, the PCRF 150 can set respective priority of D2D communication for each store based on the payment of each store. For example, the higher the payment is, the higher priority is obtained, thereby obtaining spectrum for D2D communication more preferentially.

[0040] After the policy is generated, at 220, the generated policy is transmitted to the base station for use in spectrum distribution in D2D communication for the terminal device. According to embodiments of the present disclosure, the PCRF network element 150 can transmit, to the base station 130, the policy generated by the EPC 140 for the terminal device 110. In an embodiment, the generated policy can be transmitted to the base station via existing messages. More detailed depiction will be made in the following text with reference to Fig. 4. For example, at 460 and 470, the PCRF network element 150 can transmit the generated policy via the GW 142 in the message "Create Session Response" to the MME 141 and transmit the generated policy by the MME 141 to the base station 130 in the message of "Initial Context Setup Request/Attach Accept" for use in the spectrum distribution in the D2D communication for the UE 110. Fig. 4 is only an illustrative example of the solution of the present application. It shall be appreciated that the implementation of the present application is not limited to this. For example, the present application does not make any limit to the transmission between a base station and a PCRF network element and the transmission therebetween can be used to achieve communication in any proper manner in the art known or to be developed in the future. For example, in another embodiment, the policy can be transmitted via a newly defined message. In other embodiments, a PCRF network element can transmit the policy directly to a base station without the intermediate medium such as an EPC. In addition, Fig. 4 only illustrates an example process related to the present application and other processes which are well known in the art are omitted here.

[0041] According to embodiments of the present disclosure, the PCRF network element (such as the PCRF network element 150 shown in Fig. 1) can update the policy in response to a change in at least one of the following: the attribute information about the user of the terminal device, the network information from a further network element in the communication system and the local setting of the PCRF network element, and transmit the updated policy to the base station (such as the base station 130 shown in Fig. 1). The attribute information about the user of the terminal device, the network information from a further network element in the communication system and the local setting of the PCRF network element can be known with reference to depiction in 210 of Fig. 2. In response to

the change in one or more parameters of these items, modification or updating of the policy for spectrum distribution in D2D communication can be triggered. For example, the updated policy can be transmitted to the base station via existing messages, such as “Update Bearer Request” to the base station in place of the previous policy for use in subsequent spectrum distribution. Similar to what is mentioned in the previous context, it is to be understood that the embodiments of the present application are not limited to this respect. For example, the updated policy can be transmitted via a newly defined message. In other embodiments, a PCRF network element can transmit the updated policy to a base station directly without through the intermediate medium, such as an EPC.

[0042] Fig. 3 is a flowchart illustrating method 300 for spectrum distribution in D2D communication implemented at a base station according to embodiments of the present disclosure. The method can be implemented at the base station 130 shown in FIG. 1. It is to be understood that the method can be implemented at any policy execution network element in the art known or to be developed in the future.

[0043] As shown in FIG. 3, at 310, the base station can transmit an attach request or a location update request from a terminal device to a PCRF network element. The process corresponds to the process depicted with reference to 210 in Fig. 2 and 410-440 in Fig. 4, and thus the related description is not repeated here.

[0044] At 320, the base station can receive a policy for spectrum distribution in D2D communication for the terminal device, the policy being generated by the PCRF network element based on the attach request or the location update request. For example, with reference to the process depicted in 450-480 in Fig. 4, the base station 130 can receive the policy from the PCRF network element 150.

[0045] At 330, the eNB can store the received policy for use in spectrum distribution in D2D communication for the terminal device. As shown in 490 of Fig. 4, the base station 130 can store the received policy. According to embodiments of the present disclosure, in response to receiving a request for D2D communication from the terminal device (such as the terminal device 110 in Fig. 1), the base station (for example, the base station 130 shown in Fig. 1) can perform spectrum distribution for the base station 110 based on the D2D spectrum distribution policy generated by the PCRF network element 150 for the terminal device 110. For example, as shown in Fig. 4, at 491, the base station 130 can receive the request for D2D communication from the terminal device 110. At 492, in response to receiving the request,

the base station 130 performs the stored policy for the terminal device 100 to distribute spectrum for D2D communication for the terminal device 110. At 493, the base station 130 notifies the distributed spectrum to the terminal device 110.

[0046] According to embodiments of the present disclosure, the base station can receive a updated policy generated by the PCRF network element in response to a change in at least one of the following: the attribute information about the user of the terminal device, the network information from a further network element in the communication system and the local setting of the PCRF network element, and store the updated policy for use in the spectrum distribution.

[0047] Heretofore, a method for spectrum distribution in D2D communication implemented at a base station is described, which corresponds to the method for spectrum distribution in D2D communication implemented at a PCRF network element with reference to Fig. 2 and Fig. 4. Reference can be made to Fig. 2 and Fig. 4 in the preceding context for other processing details which are not repeated here.

[0048] The method according to embodiments of the present disclosure can provide a dynamic and flexible spectrum distribution mechanism for D2D communication, which is based on a context-dependent policy control, thereby taking full advantage of limited spectrum resource in D2D communication, improving utilization rate of spectrum resource and enhancing system performance.

[0049] Corresponding to the above method, an apparatus is provided in embodiments of the present disclosure. FIG. 5 illustrates a structural diagram of an apparatus 500 implemented at a PCRF network element according to embodiments of the present disclosure. It is to be understood that the apparatus 500 can be implemented at a policy management network element such as the PCRF network element 150 shown in Fig. 1. Alternatively, the apparatus 500 can be the policy management network element *per se*, such as a PCRF network element.

[0050] As shown in FIG. 5, the apparatus 500 may include a generating unit 510 and a transmitting unit 520. The generating unit 510 can be configured to generate a policy for spectrum distribution in D2D communication for a terminal device in response to receiving an attach request or a location update request from the terminal device transmitted by a base station and the transmitting unit 520 can be configured to transmit the generated policy to the base station for use in spectrum distribution in D2D communication for the terminal device.

[0051] According to embodiments of the present disclosure, the generating unit 510 may further include (not shown in the drawings): a determining sub-unit configured to determine one or more control parameters for spectrum distribution based on at least one of the following: attribute information about a user of the terminal device, network information from a further network element in the communication system and a local setting of the PCRF network element; a generating sub-unit configured to generate the policy based on the one or more control parameters. In an embodiment, the determining sub-unit can obtain the attribute information about the user from at least one of subscriber profile register (SPR) or home subscriber server (HSS). In an embodiment, the determining sub-unit can obtain the network information based on at least one of the following: billing information about the user obtained from the online charging system (OCS); communication network status information obtained from the proximity service application server; and obtain position information about the user from the policy execution network element. In an embodiment, the one or more control parameters includes at least one of the following: a priority of the terminal device, a validity condition of the D2D communication, a type of spectrum sharing of the D2D communication and an indication of QoS of the D2D communication.

[0052] According to embodiments of the present disclosure, the apparatus 500 further includes (not shown in the drawings): an updating unit configured to update the policy in response to a change in at least one of the following: the attribute information about the user of the terminal device, the network information from other network elements in the communication system and the local settings of the PCRF network element. The transmitting unit 520 can be further configured to transmit the updated policy to the base station for use in the spectrum distribution.

[0053] Fig. 6 illustrates a structural diagram of an apparatus 600 implemented at a base station according to embodiments of the present disclosure. It is to be understood that the apparatus 600 can be implemented at a policy execution network element such as the base station 130 shown in Fig. 1. Alternatively, the apparatus 600 can be the policy execution network element *per se*, such as a base station.

[0054] As shown in FIG. 6, the apparatus 600 may include a transmitting unit 610, a receiving unit 620 and a storing unit 630. The transmitting unit 610 can be configured to transmit an attach request or a location update request from a terminal device to a PCRF network element. The receiving unit 620 can be configured to receive a policy for spectrum distribution in D2D communication for the terminal device, the policy being generated by the

PCRF network element based on the attach request or the location update request. The storing unit 630 can be configured to store the received policy for use in the spectrum distribution in the D2D communication for the terminal device.

[0055] According to embodiments of the present disclosure, the apparatus 600 may further include (not shown in the drawings): a controlling unit configured to perform the spectrum distribution for the terminal device based on the stored policy in response to a request for the D2D communication from the terminal device.

[0056] According to embodiments of the present disclosure, the receiving unit 620 can be further configured to receive a updated policy generated by the PCRF network element in response to a change in at least one of the following: attribute information about a user of the terminal device, network information from a further network element in the communication system and a local setting of the PCRF network element, and the storing unit 630 can be further configured to store the updated policy for use in the spectrum distribution.

[0057] It is to be understood that each unit or sub-unit recited in the apparatus 500 and 600 corresponds to each action of the method 200 and 300 described with reference to Figs. 2 to 4. Moreover, the operations and features of the apparatus 500 and 600 and the units or sub-units contained therein correspond to that described with reference to Figs. 2 to 4 and achieve the same effect, and hence the specific details are not repeated here.

[0058] Fig. 7 illustrates a simplified block diagram of an electronic device 700 that is suitable for implementing embodiments of the present disclosure. The device 700 can be used to implement a policy execution network element such as a base station (for example, the base station 130 shown in Fig. 1) and/or a policy management network element such as a PCRF network element (for example, the PCRF network element 150 as shown in Fig. 1).

[0059] As shown, the device 700 may include one or more processors 710, one or more memories 720 coupled to the processor(s) 710, and one or more transmitters and/or receivers (TX/RX) 740 coupled to the processor(s) 710.

[0060] The processor 710 may be of any type suitable to the local technical network, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 700 may have multiple processors, such as an application specific integrated circuit chip that is slaved in time to a clock which synchronizes the main processor.

[0061] The memory 720 may be of any type suitable to the local technical network and may be implemented using any suitable data storage technology, such as a non-transitory computer readable storage medium, semiconductor based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory, as non-limiting examples.

[0062] The memory 720 stores at least a part of a program 730. The TX/RX 740 is for bidirectional communications. The TX/RX 740 has at least one antenna to facilitate communication, though in practice an Access Node mentioned in this application may have several ones. The communication interface may represent any interface that is necessary for communication with other network elements.

[0063] The program 730 may include program instructions that, when executed by the associated processor(s) 710, enable the device 700 to operate in accordance with embodiments of the present disclosure, as discussed herein with reference to Figs. 2 to 4. That is, embodiments of the present disclosure can be implemented by computer software executable by the processor(s) 710 of the device 700, or by hardware, or by a combination of software and hardware.

[0064] Generally, various exemplary embodiments of the present disclosure may be implemented in hardware or application-specific circuit, software, logic, or in any combination thereof. Some aspects may be implemented in hardware, while the other aspects may be implemented in firmware or software executed by a controller, a microprocessor or other computing device. When various aspects of the present invention are illustrated or described into block diagrams, flowcharts, or other graphical representations, it would be appreciated that the block diagrams, apparatus, system, technique or method described here may be implemented, as non-restrictive examples, in hardware, software, firmware, dedicated circuit or logic, common software or controller or other computing device, or some combinations thereof. An example of the hardware logic components that can implement the present disclosure includes but is not limited to: a field programmable gate array (FPGA), an application specific integrated circuit (ASIC), application specific standard parts (ASSP), a system on chip (SOC), and a complex programmable logic device (CPLD), etc.

[0065] As an example, the implementations of the subject matter disclosed herein can be described in a context of machine-executable instructions which are included, for instance, in

the program module executed in the device on a target real or virtual processor. Generally, a program module includes routine, program, bank, object, class, component and data structure, etc. and performs a particular task or implements a particular abstract data structure. In the implementations, the functions of the program modules can be combined or divided among the described program modules. The machine executable instructions for the program module can be executed in a local or distributed device. In the distributed device, the program module can be located between the local and remote storage mediums.

[0066] The computer program code for implementing the method of the present disclosure may be compiled with one or more programming languages. These computer program codes may be provided to a general-purpose computer, a dedicated computer or a processor of other programmable data processing apparatus, such that when the program codes are executed by the computer or other programmable data processing apparatus, the functions/operations prescribed in the flowchart and/or block diagram are caused to be implemented. The program code may be executed completely on a computer, partially on a computer, partially on a computer as an independent software packet and partially on a remote computer, or completely on a remote computer or server.

[0067] In the context of the present disclosure, the machine-readable medium may be any tangible medium including or storing a program for or about an instruction executing system, apparatus or device. The machine-readable medium may be a machine-readable signal medium or machine-readable storage medium. The machine-readable medium may include, but not limited to, electronic, magnetic, optical, electro-magnetic, infrared, or semiconductor system, apparatus or device, or any appropriate combination thereof. More detailed examples of the machine-readable storage medium includes, an electrical connection having one or more wires, a portable computer magnetic disk, hard drive, random-access memory (RAM), read-only memory (ROM), erasable programmable read-only memory (EPROM or flash memory), optical storage device, magnetic storage device, or any appropriate combination thereof.

[0068] Besides, although the operations are depicted in a particular sequence, it should not be understood that such operations are completed in a particular sequence as shown or in a successive sequence, or all shown operations are executed so as to achieve a desired result. In some cases, multi-task or parallel-processing would be advantageous. Likewise, although the above discussion includes some specific implementation details, they should not be explained as limiting the scope of any invention or claims, but should be explained as a

description for a particular implementation of a particular invention. In the present invention, some features described in the context of separate implementations may also be integrated into a single implementation. On the contrary, various features described in the context of a single implementation may also be separately implemented in a plurality of implementations or in any suitable sub-group.

[0069] Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter specified in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

I/We Claim:

1. A method of spectrum distribution in device-to-device (D2D) communication, comprising:

in response to receiving an attach request or a location update request from a terminal device transmitted by a policy execution network element in a communication system, generating, at a policy management network element in the communication system, a policy for the spectrum distribution in the D2D communication for the terminal device; and

transmitting the generated policy to the policy execution network element for use in the spectrum distribution in the D2D communication for the terminal device.

2. The method according to Claim 1, wherein generating the policy comprises:

determining one or more control parameters for the spectrum distribution based on at least one of the following: attribute information about a user of the terminal device, network information from a further network element in the communication system, or a local setting of the policy management network element; and

generating the policy based on the one or more control parameters.

3. The method according to Claim 2, wherein generating the policy further comprises:

obtaining the attribute information about the user from at least one of a subscriber profile register (SPR) or a home subscriber server (HSS).

4. The method according to Claim 2, wherein generating the policy further comprises:

obtaining the network information based on at least one of the following:

obtaining billing information about the user from an online charging system (OCS);

obtaining D2D communication status information from a proximity service application server; and

obtaining location information about the user from the policy execution network element.

5. The method according to Claim 2, wherein the one or more control parameters includes at least one of the following: a priority of the terminal device, a validity condition of the D2D communication, a type of spectrum sharing of the D2D communication, or an

indication of quality of service (QoS) of the D2D communication.

6. The method according to Claim 1, further comprising:

updating the policy, in response to a change in at least one of the following: attribute
5 information about a user of the terminal device, network information from a further network
element in the communication system, or a local setting of the policy management network
element; and

transmitting the updated policy to the policy execution network element for use in the
spectrum distribution.

10

7. A method of spectrum distribution in device-to-device (D2D) communication,
comprising:

transmitting, by a policy execution network element in a communication system, an
attach request or a location update request from a terminal device to a policy management
15 network element in the communication system;

receiving a policy for the spectrum distribution in the D2D communication from the
policy management network element, the policy being generated by the policy management
network element based on the attach request or the location update request; and

storing the received policy for use in the spectrum distribution in the D2D
20 communication for the terminal device.

8. The method according to Claim 7, further comprising:

receiving an updated policy from the policy management network element, the
updated policy being generated by the policy management network element in response to a
25 change in at least one of the following: attribute information about a user of the terminal
device, network information from a further network element in the communication system, or
a local setting of the policy management network element; and

replacing the policy with the updated policy for use in the spectrum distribution.

30

9. The method according to Claim 7, further comprising:

in response to receiving a request for the D2D communication from the terminal
device, performing the spectrum distribution for the terminal device based on the policy.

10. A policy management network element in a communication system, comprising:

a receiver configured to receive an attach request or a location update request from the terminal device transmitted by a policy execution network element in the communication system;

5 a controller configured to, in response to receiving the attach request or the location update request, generate a policy for spectrum distribution in device-to-device (D2D) communication for the terminal device; and

a transmitter configured to transmit the generated policy to the policy execution network element for use in the spectrum distribution in the D2D communication for the terminal device.

10

11. The policy management network element according to Claim 10, wherein the controller is configured to:

determine one or more control parameters for the spectrum distribution based on at least one of the following: attribute information about a user of the terminal device, network
15 information from a further network element in the communication system, or a local setting of the policy management network element; and

generate the policy based on the one or more control parameters.

12. The policy management network element according to Claim 11, wherein the
20 controller is further configured to:

obtain the attribute information about the user from at least one of a subscriber profile register (SPR) or a home subscriber server (HSS).

13. The policy management network element according to Claim 11, wherein the
25 controller is further configured to:

obtain the network information based on at least one of the following:

obtaining billing information about the user from an online charging system (OCS);

30 obtaining D2D communication status information from a proximity service application server; and

obtaining location information about the user from the policy execution network element.

14. The policy management network element according to Claim 11, wherein the one

or more control parameters includes at least one of the following: a priority of the terminal device, a validity condition of the D2D communication, a type of spectrum sharing of the D2D communication, or an indication of quality of service (QoS) of the D2D communication.

5 15. The policy management network element according to Claim 10, wherein the controller is further configured to:

 update the policy, in response to a change in at least one of the following: attribute information about a user of the terminal device, network information from a further network element in the communication system, or a local setting of the policy management network
10 element; and

 transmit the updated policy to the policy execution network element for use in the spectrum distribution.

 16. A policy execution network element in a communication system, comprising:

15 a transmitter configured to transmit an attach request or a location update request from a terminal device to a policy management network element in the communication system;

 a receiver configured to receive, from the policy management network element, a policy for spectrum distribution in device-to-device (D2D) communication for the terminal device, the policy being generated by the policy management network element based on the
20 attach request or location update request; and

 a storage device configured to store the received policy for use in the spectrum distribution in the D2D communication for the terminal device.

 17. The policy execution network element according to Claim 16, wherein the receiver
25 is further configured to receive an updated policy from the policy management network element, the updated policy being generated by the policy management network element in response to a change in at least one of the following: attribute information about a user of the terminal device, network information from a further network element in the communication system, or a local setting of the policy management network element; and

30 wherein the storage device is further configured to replace the policy with the updated policy for use in the spectrum distribution.

 18. The policy execution network element according to Claim 16, further comprising:

 a controller configured to, in response to receiving a request for the D2D

communication from the terminal device, perform the spectrum distribution for the terminal device based on the policy.

19. An electronic device implemented at a policy management network element in a communication system, comprising:

a processor; and

a memory coupled to the processor, the memory having instructions stored therein, the instructions, when run by the processor, causing the electronic device to perform actions including:

in response to receiving an attach request or a location update request from a terminal device transmitted by a policy execution network element in the communication system, generating a policy for spectrum distribution in device-to-device (D2D) communication for the terminal device; and

transmitting the generated policy to the policy execution network element for use in the spectrum distribution in the D2D communication for the terminal device.

20. The device according to Claim 19, wherein generating the policy comprises:

determining one or more control parameters for the spectrum distribution based on at least one of the following: attribute information about a user of the terminal device, network information from a further network element in the communication system, or a local setting of the policy management network element; and

generating the policy based on the one or more control parameters.

21. The device according to Claim 20, wherein generating the policy further comprises:

obtaining the attribute information about the user from at least one of a subscriber profile register (SPR) or a home subscriber server (HSS).

22. The device according to Claim 20, wherein generating the policy further comprises:

obtaining the network information based on at least one of the following:

obtaining billing information about the user from an online charging system (OCS);

obtaining D2D communication status information from a proximity service application server; and

obtaining location information about the user from the policy execution network element.

5

23. The device according to Claim 20, wherein the one or more control parameters includes at least one of the following: a priority of the terminal device, a validity condition of the D2D communication, a type of spectrum sharing of the D2D communication, or an indication of quality of service (QoS) of the D2D communication.

10

24. The device according to Claim 19, wherein the actions further include:

updating the policy in response to a change in at least one of the following: attribute information about a user of the terminal device, network information from a further network element in the communication system, or a local setting of the policy management network element; and

15

transmitting the updated policy to the policy execution network element for use in the spectrum distribution.

25. An electronic device implemented at a policy execution network element in a communication system, comprising:

20

a processor; and

a memory coupled to the processor, the memory having instructions stored therein, the instructions, when run by the processor, causing the electronic device to perform actions including:

25

transmitting an attach request or a location update request from a terminal device to a policy management network element in the communication system;

receiving a policy for the spectrum distribution in device-to-device (D2D) communication from the policy management network element, the policy being generated by the policy management network element based on the attach request or the location update request; and

30

storing the received policy for use in the spectrum distribution in the D2D communication for the terminal device.

26. The device according to Claim 25, wherein the actions further include:

receiving an updated policy from the policy management network element, the updated policy being generated by the policy management network element in response to a change in at least one of the following: attribute information about a user of the terminal device, network information from a further network element in the communication system, or
5 a local setting of the policy management network element; and

replacing the policy with the updated policy for use in the spectrum distribution.

27. The device according to Claim 25, wherein the actions further include:

in response to receiving a request for the D2D communication from the terminal
10 device, performing the spectrum distribution for the terminal device based on the policy.

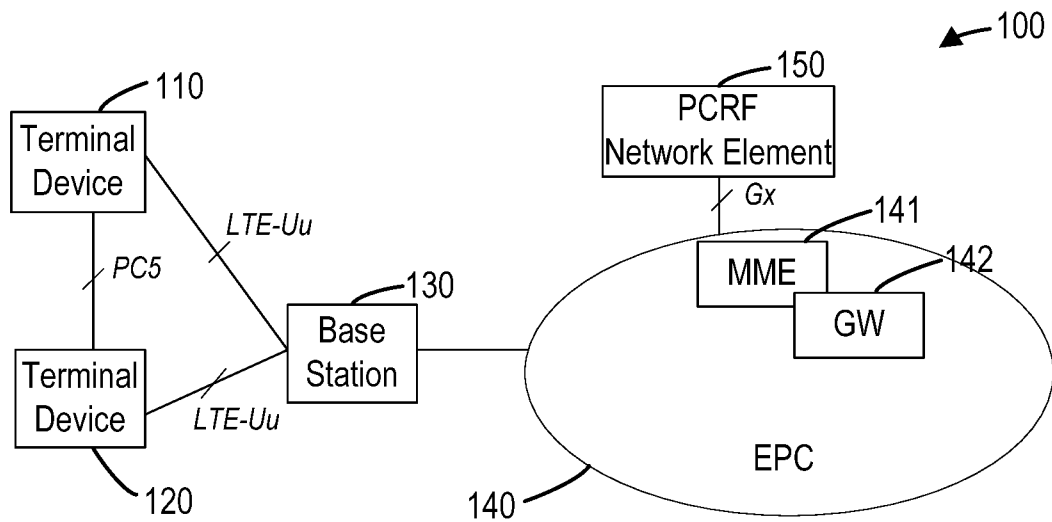


Fig. 1

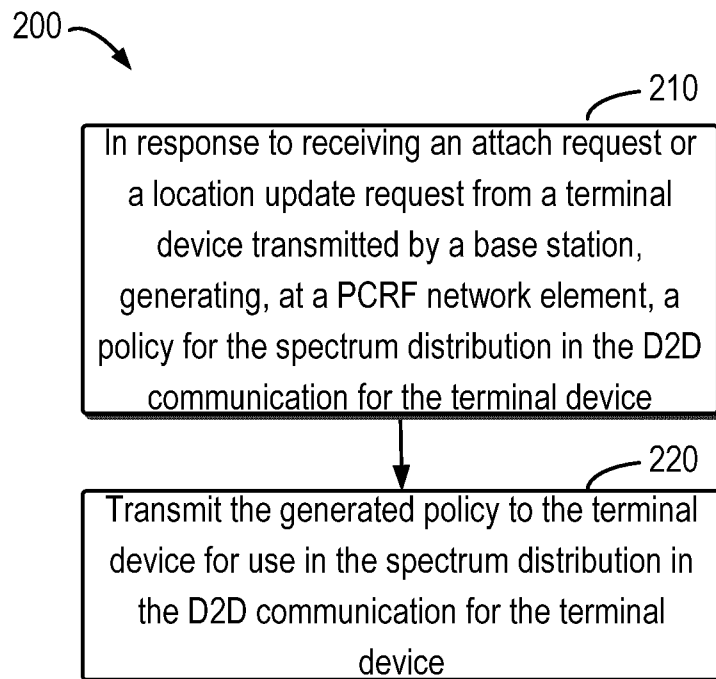
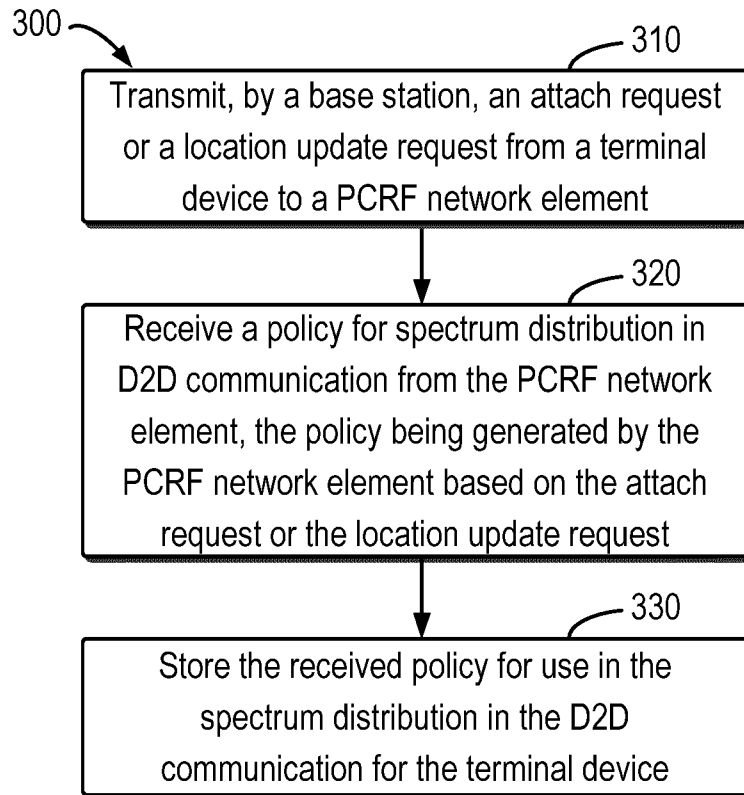
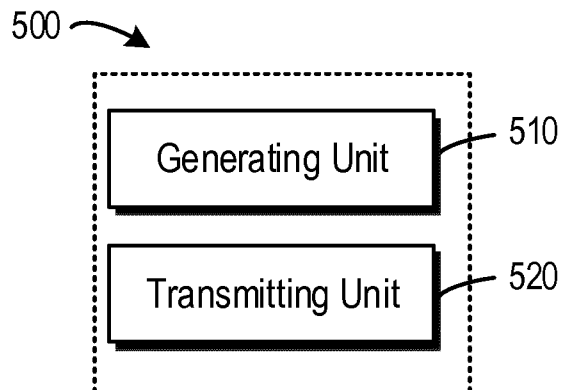
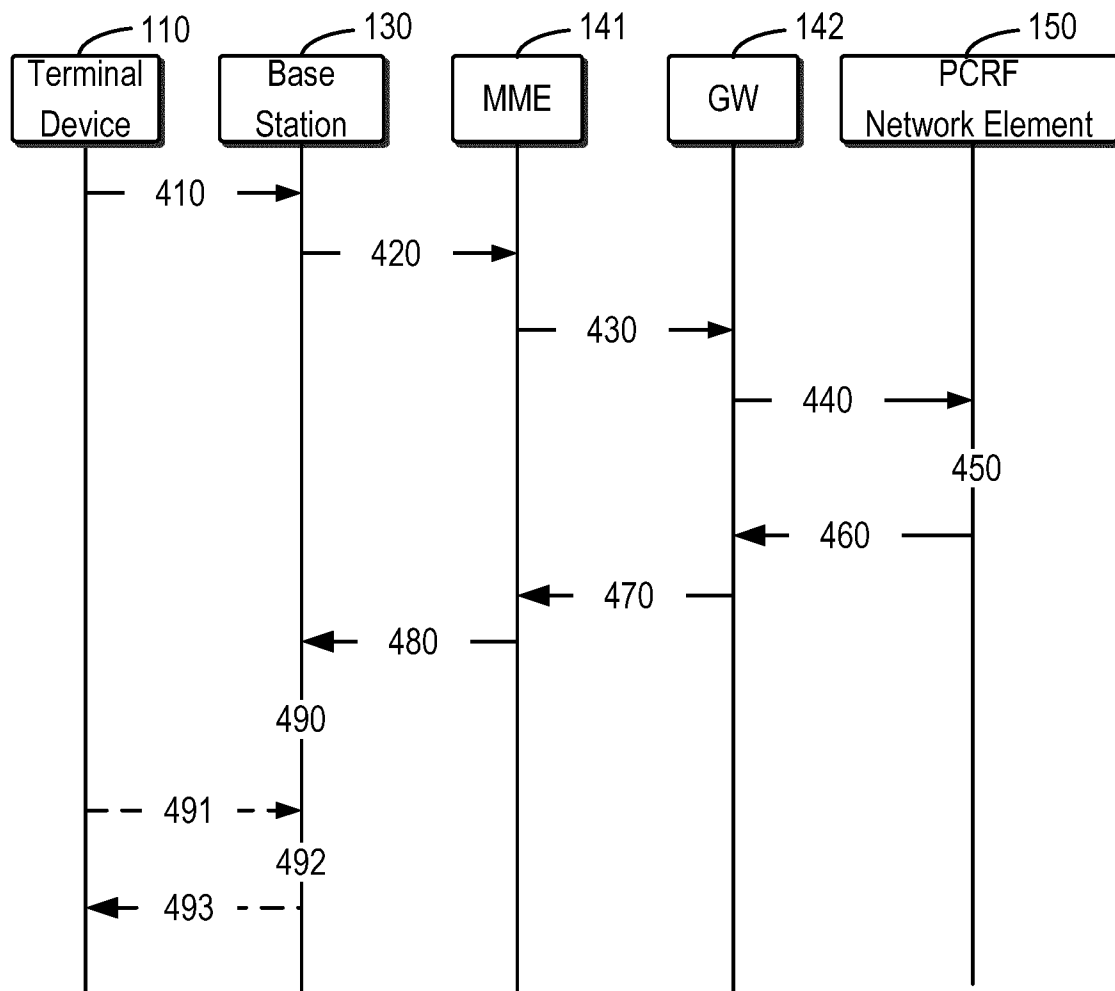
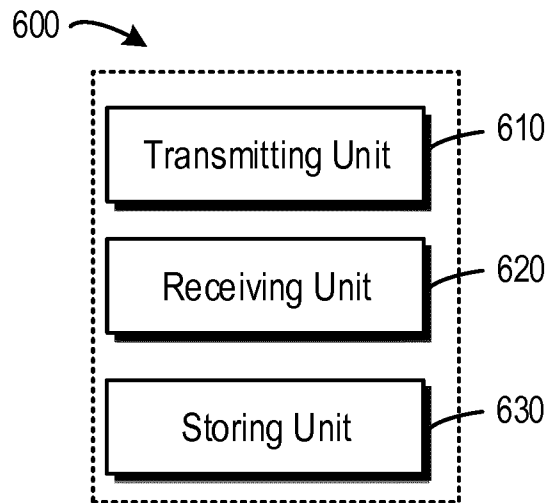
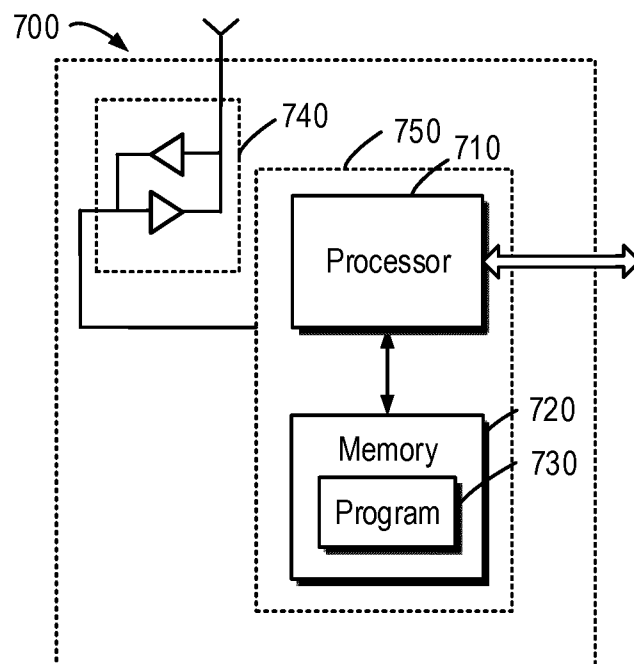


Fig. 2

**Fig. 3****Fig. 5**

**Fig. 4**

**Fig. 6****Fig. 7**

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/060014

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W76/14
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

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X	US 2014/227997 A1 (KIM KYUNG-KYU [KR] ET AL) 14 August 2014 (2014-08-14) abstract; figures 2,4 paragraphs [0005], [0006], [0031] - [0045], [0053] - [0054], [0060] - [0063] -----	1-27
X A	CN 103 379 654 A (ZTE CORP) 30 October 2013 (2013-10-30) see the section "Summary of the invention"; claims 1, 4-7; figures 14, 15 -----	1,7,10, 16,19,25 2-6,8,9, 11-15, 17,18, 20-24, 26,27
X	US 2016/249255 A1 (KHAWER MOHAMMAD R [US] ET AL) 25 August 2016 (2016-08-25) paragraphs [0030], [0041], [0042], [0045] ----- -/-	1-27

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/060014

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 2014/102335 A1 (KONINKL KPN NV [NL]; TNO [NL]) 3 July 2014 (2014-07-03) page 15, line 14 - page 17, line 24 -----	1-27
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