



- (51) International Patent Classification:  
*H04W 4/06* (2009.01)
- (21) International Application Number:  
PCT/CN2019/098687
- (22) International Filing Date:  
31 July 2019 (31.07.2019)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
PCT/CN2018/108025  
27 September 2018 (27.09.2018) CN
- (71) Applicant: **TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)** [SE/SE]; S-164 83 Stockholm (SE).
- (72) Inventor; and  
(71) Applicant (for SC only): **ZHANG, Zhang** [CN/CN]; No.5 Lize East Street, Chaoyang District, Beijing 100102 (CN).
- (72) Inventor: **BELLESCHI, Marco**; Framnaesbacken 8, S-171 66 Solna (SE).
- (74) Agent: **ZHONGZI LAW OFFICE**; 7F, New Era Building, 26 Pinganli Xidajie, Xicheng District, Beijing 100034 (CN).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

(54) Title: METHOD FOR COMMUNICATION SYSTEM WITH GROUP SERVICE

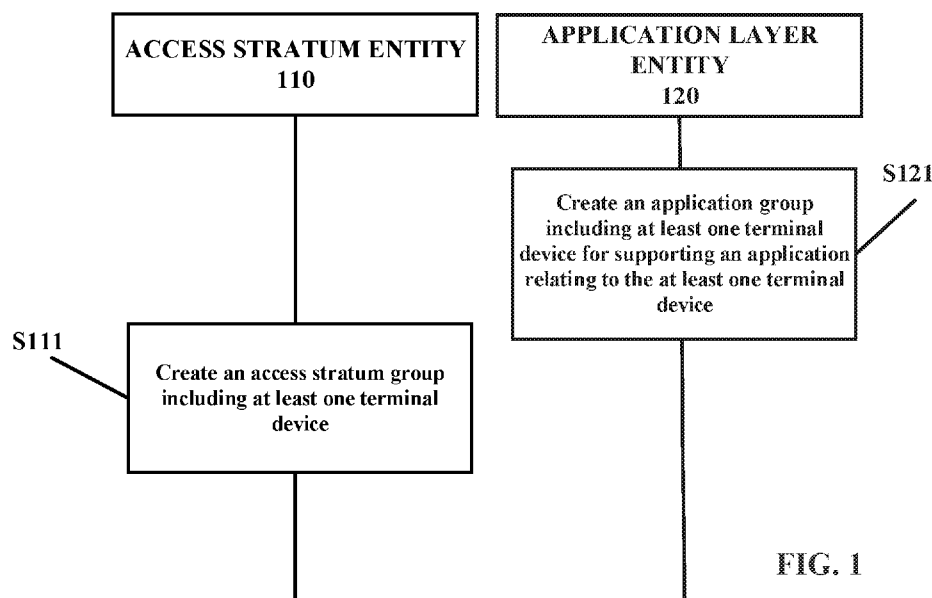


FIG. 1

(57) Abstract: The present disclosure provides a method for a communication system with group service. The method includes: creating (S111) an access stratum group including at least one terminal device. The at least one terminal device is included in a same application group for supporting an application relating to the at least one terminal device. It is an advantage that the terminal devices engaged in the same application group could be handled more consistently in an access stratum layer in the communication system. The group service quality may be further improved.



TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,  
KM, ML, MR, NE, SN, TD, TG).

**Published:**

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

## METHOD FOR COMMUNICATION SYSTEM WITH GROUP SERVICE

## Technical Field

**[0001]** The present disclosure relates generally to the technology of communications, and in particular, to a method for communication system with group service.

## Background

**[0002]** With the development of the communication technology, more and more types of terminal devices are able to be connected in the communication system. In release 14 of third generation partnership project technical specification (3GPP TS), the extensions for the device-to-device work consist of support of vehicle to everything (V2X) communication, which includes any combination of direct communication between vehicles, pedestrians and infrastructure. V2X communication may take advantage of a network (NW) infrastructure, when available, but at least basic V2X connectivity should be possible even in case of lack of coverage. As to the terminal devices in V2X communication, such as a driving vehicle in the public road, it is very important to exchange information with other terminal devices timely. For example, a vehicle may receive cooperation message to follow a track of another vehicle in the same vehicle platoon, or the vehicle may receive an alarm message to change the lane, so as to avoid an obstacle object. In such applications, some terminal devices have cooperation relationships as a group.

**[0003]** For achieving such group operations, the communication system is required to support a group service to a group of terminal devices.

## Summary

**[0004]** The present disclosure provides a method for communication system with group service.

**[0005]** A first aspect of the disclosure provides a method for a communication system, comprising: creating an access stratum group including at least one terminal device. The at least one terminal device is included in a same application group for supporting an application relating to the at least one terminal device.

**[0006]** In embodiments of the present disclosure, creating an access stratum group may comprise: creating at least one subgroup, based on a predetermined criterion.

**[0007]** In embodiments of the present disclosure, the predetermined criterion may comprise at least one of: a sidelink resource allocation (RA) mode of the at least one terminal device; a coverage by a network, associated to the at least one terminal device; a serving base station for the at least one terminal device; a serving cell for the at least one terminal device; a physical position

information of the at least one terminal device; a used frequency for communication of the at least one terminal device; a radio access technology (RAT) of the at least one terminal device; a number of terminal devices in each subgroup of the at least one subgroup; and a radio quality of the at least one terminal device.

[0008] In embodiments of the present disclosure, a subgroup identifier may be applied to a subgroup of the at least one subgroup.

[0009] In embodiments of the present disclosure, a subgroup of the at least one subgroup may comprise at least one terminal device with the same sidelink resource allocation mode.

[0010] In embodiments of the present disclosure, a subgroup of the at least one subgroup may comprise at least one terminal device with the same coverage by the network. The coverage by the network may include one of: coverage by a new radio (NR) network, coverage by a long term evolution (LTE) network, coverage by a new radio (NR) network and a long term evolution (LTE) network, and non-coverage.

[0011] In embodiments of the present disclosure, a subgroup of the at least one subgroup may comprise at least one terminal device associated to a same serving base station.

[0012] In embodiments of the present disclosure, a subgroup of the at least one subgroup may comprise at least one terminal device associated to a same serving cell.

[0013] In embodiments of the present disclosure, a subgroup of the at least one subgroup may comprise at least two terminal devices with a distance between each pair of terminal devices within the at least two terminal devices being less than a predetermined threshold value, wherein the distance is determined based on the physical position information.

[0014] In embodiments of the present disclosure, a subgroup of the at least one subgroup may comprise at least one terminal device using a same frequency for communication.

[0015] In embodiments of the present disclosure, a subgroup of the at least one subgroup may comprise at least one terminal device with a same radio access technology (RAT).

[0016] In embodiments of the present disclosure, the number of terminal devices in a subgroup of the at least one subgroup may be less than a predetermined threshold value.

[0017] In embodiments of the present disclosure, a subgroup of the at least one subgroup may comprise at least one terminal device with a radio quality within a predetermined quality range. The radio quality may comprise at least one of: sidelink radio quality, and Uu radio quality.

[0018] In embodiments of the present disclosure, the radio quality may be indicated by at least one of: a reference signal receiving power (RSRP), a reference signal receiving quality (RSRQ), and traffic load situation.

[0019] In embodiments of the present disclosure, a network node may create a subgroup, based on the predetermined criterion. During creating the subgroup, the network node may configure a terminal device belonging to the subgroup without notifying the terminal device.

[0020] In embodiments of the present disclosure, the at least one terminal device may create a subgroup distributedly, based on the predetermined criterion. During creating the subgroup, a terminal device may announce information relating to the predetermined criterion to other terminal devices; and the terminal device may receive information from another terminal device to determine whether the terminal device and the another terminal device belong to a same subgroup.

[0021] In embodiments of the present disclosure, the method may further comprise: applying a consistent access configuration for all terminal devices in a subgroup of the at least one subgroup.

[0022] In embodiments of the present disclosure, the access configuration may comprise at least one of: a quality of service (QoS) profile, and a bearer control profile.

[0023] In embodiments of the present disclosure, a same QoS level may be configured for all terminal devices in the subgroup of the at least one subgroup.

[0024] In embodiments of the present disclosure, the quality of service (QoS) profile may comprise a QoS level determined based on one of: an actual number of terminal devices in the subgroup, a predetermined maximum number of terminal devices allowed in the subgroup, and an estimated number of terminal devices to join the subgroup.

[0025] In embodiments of the present disclosure, the method may further comprise: removing a terminal device from the subgroup, in response to that the access configuration is no longer suitable for the terminal device.

[0026] In embodiments of the present disclosure, the method may further comprise: reconfiguring each terminal device in the subgroup consistently, in response to a change of the access configuration.

[0027] In embodiments of the present disclosure, wherein reconfiguring each terminal device may comprise: changing a same amount of the QoS level for all terminal devices in the subgroup.

[0028] In embodiments of the present disclosure, the method may further comprise: receiving a preemption request from a terminal device; preempting radio resource allocated to terminal devices in a selected subgroup; and allocating the radio resource preempted from terminal devices in the selected subgroup to the terminal device sending the preemption request.

[0029] In embodiments of the present disclosure, an amount of the preempted resource may be proportional to a QoS level or an amount of the radio resource associated to the selected subgroup.

[0030] In embodiments of the present disclosure, the selected subgroup may be a subgroup associated with a highest QoS or each terminal device in the subgroup is allocated the most radio resources.

[0031] In embodiments of the present disclosure, the method may further comprise: removing a terminal device from a subgroup of the at least one subgroup, in response that the terminal device no long satisfies the predetermined criterion to be included in the subgroup.

[0032] In embodiments of the present disclosure, the method may further comprise: informing an application layer entity in the network of the at least one subgroup, wherein the application layer entity is associated to the application group.

[0033] In embodiments of the present disclosure, the method may be implemented by an access stratum entity in a terminal device and/or in a network.

[0034] In embodiments of the present disclosure, the access stratum entity may be in a base station of the network.

[0035] A second aspect of the present disclosure provides a method performed by a terminal device for a communication system, comprising: joining an access stratum group including at least one terminal device. The at least one terminal device is included in a same application group for supporting an application relating to the at least one terminal device. The step of joining the access stratum group may comprise announcing information relating to a predetermined criterion to other terminal devices; and receiving information from another terminal device to determine whether the terminal device and the another terminal device belong to a same group, based on the predetermined criterion.

[0036] In embodiments of the present disclosure, joining an access stratum group may comprise: joining a subgroup of the access stratum group, based on the predetermined criterion.

[0037] In embodiments of the present disclosure, the method may further comprise: utilizing an access configuration associated to the subgroup, wherein the access configuration is consistent for all terminal devices in the subgroup.

[0038] In embodiments of the present disclosure, the method may further comprise: exiting from the subgroup, in response to no longer satisfying the predetermined criterion to be included in the subgroup.

[0039] In embodiments of the present disclosure, the method may be implemented by an access stratum entity in a terminal device.

[0040] A third aspect of the present disclosure provides a method for a communication system, comprising: obtaining preempted resource from an access stratum group including at least one terminal device. The at least one terminal device may be included in a same application group for supporting an application relating to the at least one terminal device.

[0041] In embodiments of the present disclosure, the preempted resource may be from a subgroup of the access stratum group.

[0042] In embodiments of the present disclosure, an amount of the preempted resource may be proportional to a QoS level or an amount of the radio resource associated to the subgroup.

[0043] In embodiments of the present disclosure, the subgroup may be a subgroup with a highest QoS or most radio resources.

[0044] In embodiments of the present disclosure, the method may be implemented by an access stratum entity in a terminal device.

[0045] A fourth aspect of the present disclosure provides a method for a communication system, comprising: creating an application group including at least one terminal device for supporting an application relating to the at least one terminal device. The application group may be associated to an access stratum group including the at least one terminal device.

[0046] In embodiments of the present disclosure, the method may further comprise: receiving information about at least one subgroup of the access stratum group, wherein the at least one subgroup is created based on a predetermined criterion.

[0047] In embodiments of the present disclosure, the method may further comprise: adjusting the application group based on the information about the at least one subgroup.

[0048] In embodiments of the present disclosure, the method may be implemented by an application layer entity in a terminal device and/or in a network.

[0049] A fifth aspect of the present disclosure provides an access stratum entity, comprising: a processor; and a memory, containing instructions executable by the processor. The access stratum entity may be operative to any of methods above mentioned.

[0050] A sixth aspect of the present disclosure provides a communication system comprising a host computer including: processing circuitry configured to provide user data; and a communication interface configured to forward the user data to a cellular network for transmission to a terminal device. The cellular network includes a base station. The base station includes the access stratum entity above mentioned, and/or the terminal device includes the access stratum entity above mentioned.

[0051] In embodiments of the present disclosure, the system may further comprise the terminal device, wherein the terminal device is configured to communicate with the base station.

[0052] In embodiments of the present disclosure, the processing circuitry of the host computer may be configured to execute a host application, thereby providing the user data; and the terminal device may comprise processing circuitry configured to execute a client application associated with the host application.

[0053] A seventh aspect of the present disclosure provides a communication system comprising a host computer including: a communication interface configured to receive user data originating from a transmission from a terminal device; a base station. The transmission is from the terminal device to the base station. The base station includes the access stratum entity above mentioned, and/or the terminal device includes the access stratum entity above mentioned.

[0054] In embodiments of the present disclosure, the processing circuitry of the host computer may be configured to execute a host application. The terminal device may be configured to execute

a client application associated with the host application, thereby providing the user data to be received by the host computer.

[0055] An eighth aspect of the present disclosure provides an application layer entity, comprising: a processor; and a memory, containing instructions executable by the processor. The application layer entity may be operative to any of the methods above mentioned.

[0056] A ninth aspect of the present disclosure provides a computer readable storage medium having a computer program stored thereon, the computer program executable by a device to cause the device to carry out any of the methods above mentioned.

[0057] It is an advantage that the terminal devices engaged in the same application group could be handled more consistently in an access stratum layer in the communication system. The group service quality may be further improved. Advanced application may be further supported. A more efficient use of radio resources may be achieved.

#### Brief Description of Drawings

[0058] Through the more detailed description of some embodiments of the present disclosure in the accompanying drawings, the above and other objects, features and advantages of the present disclosure will become more apparent, wherein the same reference generally refers to the same components in the embodiments of the present disclosure.

[0059] FIG. 1 is an exemplary procedure diagram according to embodiments of the present disclosure;

[0060] FIG. 2 is an exemplary block diagram of terminal devices and a network node in the communication system;

[0061] FIG. 3 is a procedure diagram showing other exemplary steps of method in FIG. 1;

[0062] FIG. 4 is a procedure diagram showing other exemplary steps of method in FIG. 3;

[0063] FIG. 5 is a procedure diagram showing other exemplary steps of method in FIG. 3;

[0064] FIG. 6 is another exemplary procedure diagram according to embodiments of the present disclosure;

[0065] FIG. 7 is a block diagram of a computer readable storage medium;

[0066] FIG. 8 is a block diagram of an access stratum entity;

[0067] FIG. 9 is a schematic showing a virtual apparatus for the access stratum entity;

[0068] FIG. 10 is a schematic showing a wireless network in accordance with some embodiments;

[0069] FIG. 11 is a schematic showing a user equipment in accordance with some embodiments;

[0070] FIG. 12 is a schematic showing a virtualization environment in accordance with some embodiments;

[0071] FIG. 13 is a schematic showing a telecommunication network connected via an intermediate network to a host computer in accordance with some embodiments;

[0072] FIG. 14 is a schematic showing a host computer communicating via a base station with a user equipment over a partially wireless connection in accordance with some embodiments;

[0073] FIG. 15 is a flowchart illustrating a method implemented in a communication system, in accordance with one embodiment;

[0074] FIG. 16 is a flowchart illustrating a method implemented in a communication system, in accordance with one embodiment;

[0075] FIG. 17 is a flowchart illustrating a method implemented in a communication system, in accordance with one embodiment; and

[0076] FIG. 18 is a flowchart illustrating a method implemented in a communication system, in accordance with one embodiment.

#### Detailed Description

[0077] Some preferable embodiments will be described in more detail with reference to the accompanying drawings, in which the preferable embodiments of the present disclosure have been illustrated. However, the present disclosure can be implemented in various manners, and thus should not be construed to be limited to the embodiments disclosed herein. On the contrary, those embodiments are provided for the thorough and complete understanding of the present disclosure, and completely conveying the scope of the present disclosure to those skilled in the art.

[0078] Reference throughout this specification to features, advantages, or similar language does not imply that all of the features and advantages that may be realized with the present disclosure should be or are in any single embodiment of the disclosure. Rather, language referring to the features and advantages is understood to mean that a specific feature, advantage, or characteristic described in connection with an embodiment is included in at least one embodiment of the present disclosure. Furthermore, the described features, advantages, and characteristics of the disclosure may be combined in any suitable manner in one or more embodiments. One skilled in the relevant art will recognize that the disclosure may be practiced without one or more of the specific features or advantages of a particular embodiment. In other instances, additional features and advantages may be recognized in certain embodiments that may not be present in all embodiments of the disclosure.

[0079] As used herein, the term “communication network/ system” refers to a network/ system following any suitable communication standards, such as new radio (NR), long term evolution (LTE), LTE-Advanced, wideband code division multiple access (WCDMA), high-speed packet access (HSPA), and so on. Furthermore, the communications between a terminal device and a

network node in the communication network may be performed according to any suitable generation communication protocols, including, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), 4G, 4.5G, 5G communication protocols, and/or any other protocols either currently known or to be developed in the future.

**[0080]** The term “network node” or “network side node” refers to a network device in a communication network via which a terminal device accesses to the network and receives services therefrom. The network node may refer to a base station (BS), an access point (AP), a multi-cell/multicast coordination entity (MCE), a controller or any other suitable device in a wireless communication network. The BS may be, for example, a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a next generation NodeB (gNodeB or gNB), a remote radio unit (RRU), a radio header (RH), a remote radio head (RRH), a relay, a low power node such as a femto, a pico, and so forth.

**[0081]** Yet further examples of the network node include multi-standard radio (MSR) radio equipment such as MSR BSs, network controllers such as radio network controllers (RNCs) or base station controllers (BSCs), base transceiver stations (BTSs), transmission points, transmission nodes, positioning nodes and/or the like. More generally, however, the network node may represent any suitable device (or group of devices) capable, configured, arranged, and/or operable to enable and/or provide a terminal device access to a wireless communication network or to provide some service to a terminal device that has accessed to the wireless communication network.

**[0082]** The term “terminal device” refers to any end device that can access a communication network and receive services therefrom. By way of example and not limitation, the terminal device may refer to a user equipment (UE), or other suitable devices. The UE may be, for example, a subscriber station, a portable subscriber station, a mobile station (MS) or an access terminal (AT). The terminal device may include, but not limited to, portable computers, image capture terminal devices such as digital cameras, gaming terminal devices, music storage and playback appliances, a mobile phone, a cellular phone, a smart phone, a tablet, a wearable device, a personal digital assistant (PDA), a vehicle, and the like.

**[0083]** As yet another specific example, in an Internet of things (IoT) scenario, a terminal device may also be called an IoT device and represent a machine or other device that performs monitoring, sensing and/or measurements etc., and transmits the results of such monitoring, sensing and/or measurements etc. to another terminal device and/or a network equipment. The terminal device may in this case be a machine-to-machine (M2M) device, which may in a 3rd generation partnership project (3GPP) context be referred to as a machine-type communication (MTC) device.

**[0084]** As one particular example, the terminal device may be a UE implementing the 3GPP narrow band Internet of things (NB-IoT) standard. Particular examples of such machines or devices are sensors, metering devices such as power meters, industrial machinery, or home or personal

appliances, e.g. refrigerators, televisions, personal wearables such as watches etc. In other scenarios, a terminal device may represent a vehicle or other equipment, for example, a medical instrument that is capable of monitoring, sensing and/or reporting etc. on its operational status or other functions associated with its operation.

**[0085]** As used herein, the terms “first”, “second” and so forth refer to different elements. The singular forms “a” and “an” are intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms “includes”, “including”, “has”, “having”, “includes” and/or “including” as used herein, specify the presence of stated features, elements, and/or components and the like, but do not preclude the presence or addition of one or more other features, elements, components and/or combinations thereof. The term “based on” is to be read as “based at least in part on”. The term “one embodiment” and “an embodiment” are to be read as “at least one embodiment”. The term “another embodiment” is to be read as “at least one other embodiment”. Other definitions, explicit and implicit, may be included below.

**[0086]** As one exemplary solution to support the group service in a communication system, an application layer entity in a communication network may create an application group (or called an application layer group) including at least one terminal device, for supporting an application relating to the at least one terminal device. For example, the terminal device may be a vehicle. The application layer entity may be any device handling an application layer protocol. The application layer entity may be located in the network, such as in an application server, or just located in the vehicle. The application group may correspond to a platoon of vehicles. The application relating to the at least one terminal device may be a platooning application accordingly. It should be understood that other types of applications, such as advanced driving, remote driving, extended sensor, etc., may also be applicable. Further, applicable terminal devices may include complicated types, such as aircraft, drone, or any other driving machines, or conventional type, such as mobile phone, or any other wireless communication device.

**[0087]** The application group facilitates the corresponding application. For example, the simultaneous access to all the terminal devices in the same group may be achieved much easier. The information directed to a group may be automatically transmitted to each terminal device in the group.

**[0088]** However, without corresponding arrangement in an access stratum (AS) layer in the network, each terminal device (also referred as a UE), e.g. a vehicle, is still handled independently at AS layer, particularly in sidelink. As a result, the UEs may have (quite) different access configuration. This is not suitable for an advanced application, such as an application with critical safety requirement.

**[0089]** For example, the adopted quality of service (QoS) for each UE may be quite different, and the adopted QoS of different UE may also vary inconsistently. For a group eV2X (Enhancement of

Vehicle-to-Everything) application, such inconsistent change of QoS will lead to unstable operation. For instance, if QoS of vehicle UEs vary inconsistently (e.g. some vehicle UEs have increased QoS while the other have decreased QoS), it becomes tricky to adjust the operation mode of the eV2X application, especially for group eV2X application. Besides, supposing that QoS of one vehicle UE becomes too low and has to leave the group, the whole group has to be reconstructed. This leads to that the (group) eV2X application operates unstably, which is a severe problem for eV2X as it is safety critical.

**[0090]** Moreover, independent handling of vehicle UEs in the same application group is resource inefficient as it makes no sense to have (very) different QoS for vehicle UEs in the same application group.

**[0091]** Therefore, the present disclosure also provides embodiments to further improve the group service in the communication system.

**[0092]** FIG. 1 is an exemplary procedure diagram according to embodiments of the present disclosure. As shown in figure 1, according to embodiments of the present disclosure, an access stratum entity implements a method for the communication system. The method includes: step S111, creating an access stratum group including at least one terminal device.

**[0093]** The at least one terminal device may be included in a same application group for supporting an application relating to the at least one terminal device. As an example, an application layer entity implements a method to create the application group. The method includes: step S121, creating an application group including at least one terminal device for supporting an application relating to the at least one terminal device.

**[0094]** With step S111, the access stratum group including the at least one terminal device is associated with the application group. It is an advantage that the terminal devices engaged in the same application group could be handled more consistently in an access stratum layer in the communication system. The group service quality may be further improved. Advanced application may be further supported. A more efficient use of radio resources may be achieved.

**[0095]** In such a manner, for example, some UEs may create an application layer group based on certain arrangement, e.g. supported applications, planned driving trajectory and schedule, supported level of automation, etc. The group identity, with which the UEs could join such group, is indicated to third generation partnership project (3GPP) AS layers in the network (RAN or core network), and/or 3GPP AS layers in UE.

**[0096]** UEs belonging to the same application group could be split into several (AS layer) subgroups based on certain criterion (the principle behind is to make UEs in different (AS layer) subgroups could be handled relatively independently).

**[0097]** Further, an access stratum group identifier (ID) may be used to indicate the access stratum group. The access stratum group ID may be any number and/or character created in accordance to a

predetermined rule. The access stratum group ID may be a newly created ID or just a reused existing ID, for example, the access stratum group identifier (ID) may include a destination layer 2 identifier (ID).

**[0098]** In embodiments of the present disclosure, the access stratum entity 110 may be arranged at terminal device side and/or at network side. Particularly, the access stratum entity 110 may be in a base station of the network.

**[0099]** FIG.2 is an exemplary block diagram of terminal devices in the communication system. As shown in FIG.2, for example, some terminal devices L1, N1, L2, N2, L3, and N3 are included in the communication system. Two exemplary radio access technologies, long term evolution (LTE) and new radio (NR) are shown in the communication system. The terminal devices L1, L2, L3 utilizes LTE technology, and the terminal devices N1, N2, N3 utilizes NR technology. The terminal devices L1 and N1 are under coverage of C1, namely coverage of LTE and NR. Thus, L1 and N1 are able to be connected to the network node 210 directly. The terminal devices L2 and N2 are under coverage of C2, namely coverage of only LTE. Thus, L2 is able to be connected to the network node 210 directly, N2 is not. The terminal devices L3 and N3 are under coverage of C3, namely without any coverage of LTE or NR. Thus, L3 and N3 are not able to be connected to the network node 210 directly.

**[00100]** Assuming terminal devices L1, L2, L3, N1, N2, and N3 are included in the same access stratum group, they still have a lot of differences associated to the communication manner.

Embodiments of the present disclosure provide further methods for such circumstance.

**[00101]** FIG. 3 is a procedure diagram showing other exemplary steps of method in FIG. 1. As shown in FIG. 3, the step S111 in FIG. 1 may include: step S1110, creating at least one subgroup, based on a predetermined criterion. The at least one subgroup based on the predetermined criterion facilitates the distinguishing of different terminal devices, such as shown in FIG. 2. Meanwhile, a subgroup identifier (ID) may be applied to a subgroup of the at least one subgroup. The subgroup ID may be any number or character, transmitted by any message via the communication system to any relevant terminal device or network node.

**[00102]** The predetermined criterion may include any technical features which is distinguishable between different terminal devices. In embodiments of the present disclosure, as an example, the predetermined criterion includes at least one of: a sidelink resource allocation (RA) mode of the at least one terminal device; a coverage by a network, associated to the at least one terminal device; a serving base station for the at least one terminal device; a serving cell for the at least one terminal device; a physical position information of the at least one terminal device; a used frequency for communication of the at least one terminal device; a radio access technology (RAT) of the at least one terminal device; a number of terminal devices in each subgroup of the at least one subgroup; and a radio quality of the at least one terminal device. It should be appreciated that any feature of

the above mentioned features may be utilized individually, or in combination with one or more any other features.

**[00103]** In embodiments of the present disclosure, a subgroup of the at least one subgroup includes at least one terminal device with the same sidelink resource allocation mode.

**[00104]** For example, in a V2X application, two different resource allocation (RA) procedures may be utilized on sidelink, i.e. centralized RA (so called mode 3) and distributed RA (so called mode 4), see 3GPP TS 36.321 V14.2.1, "Medium Access Control (MAC) protocol specification (Release 14). 3GPP TS refers to third generation partnership project technical specification. The Tx sidelink resource is selected within a Tx resource pool which is predefined or configured by the network.

**[00105]** With centralized RA, the Tx sidelink resource is scheduled by the network (e.g. eNB) and signaled to terminal device (e.g. UE) using downlink control information (DCI) format 5A. This is the case for both physical sidelink control channel (PSCCH) and physical sidelink shared channel (PSSCH). The PSSCH resource allocation is indicated by scheduling assignment (SA) which is transmitted on PSCCH over sidelink.

**[00106]** With distributed RA, each device independently decides which radio resources to use for each transmission, for both PSCCH and PSSCH. Such resources are selected by the UE from one or more pools of Tx resources which are preconfigured or provided by eNB using broadcast signaling (SIB). To reduce the collision probability, sensing is introduced with semi-persistent scheduling (SPS). Whenever a device is not transmitting, it measures the activity (e.g., in terms of received power) in all the radio resources. In addition, a device decodes the SAs transmitted by other devices to detect the resources occupied by nearby devices. Only the resources that are deemed not occupied could be selected for sidelink transmission by the UE performing sensing.

**[00107]** In such circumstance, the terminal devices with mode 3 may be assigned into one group, and the terminal devices with mode 4 may be assigned into another group.

**[00108]** In embodiments of the present disclosure, a subgroup of the at least one subgroup includes at least one terminal device with the same coverage by the network. The coverage by the network includes one of: coverage by a new radio (NR) network, coverage by a long term evolution (LTE) network, coverage by a new radio (NR) network and a long term evolution (LTE) network, and non-coverage.

**[00109]** As shown in FIG. 2, the terminal devices L1, N1 may be in the same subgroup, the terminal devices L2, N2 may be in the same subgroup, and the terminal devices L3, N3 may be in the same subgroup.

**[00110]** In embodiments of the present disclosure, a subgroup of the at least one subgroup includes at least one terminal device associated to a same serving base station (e.g. eNB, or gNB). In embodiments of the present disclosure, a subgroup of the at least one subgroup includes at least

one terminal device associated to a same serving cell. This can avoid inter-base station/cell coordination when operating subgroups at AS layer.

**[00111]** In embodiments of the present disclosure, a subgroup of the at least one subgroup includes at least two terminal devices with a distance between each pair of terminal devices within the at least two terminal devices being less than a predetermined threshold value, wherein the distance is determined based on the physical position information. The threshold can be predefined or configured by the network (NW). The NW could deduce the distance between the terminal devices (e.g. UE) based on e.g. the UE location contained in the radio resource control (RRC) measurement report.

**[00112]** Further, the distance threshold could be (pre)configured so that (radio) resources can be reused between UEs having distance larger than the threshold thus RA of these UEs could be performed relatively independently. Namely, if two UEs have a larger distance than the threshold, they may use the same radio resources (e.g. time, or frequency resources), without interference between each other.

**[00113]** In embodiments of the present disclosure, a subgroup of the at least one subgroup includes at least one terminal device using a same frequency for communication. In embodiments of the present disclosure, a subgroup of the at least one subgroup includes at least one terminal device with a same radio access technology (RAT).

**[00114]** For example, the terminal devices L1, L2, L3 as shown in FIG. 2 may be in the same subgroup, and the terminal devices N1, N2, N3 as shown in FIG. 2 may be in the same subgroup.

**[00115]** In embodiments of the present disclosure, the number of terminal devices in a subgroup of the at least one subgroup is less than a predetermined threshold value, for better balancing the resources.

**[00116]** In embodiments of the present disclosure, a subgroup of the at least one subgroup includes at least one terminal device with a radio quality within a predetermined quality range. The radio quality includes at least one of: sidelink radio quality, and Uu radio quality. The Uu refers to an interface between a UE and a network, and Uu radio quality indicates the radio quality of the Uu interface. The sidelink radio quality may be a radio quality of a PC5 interface.

**[00117]** In embodiments of the present disclosure, the radio quality is indicated by at least one of: a reference signal receiving power (RSRP), a reference signal receiving quality (RSRQ), and traffic load situation.

**[00118]** Namely, sidelink/Uu radio quality, such as RSRP/RSRQ or any other congestion metric may be utilized. A subgroup may be made up of all UEs that are experiencing similar sidelink/Uu channel quality, e.g. whose sidelink/Uu radio quality is within a (pre)configured range. In case the sidelink/Uu radio quality for any given UE goes outside the (pre)configured range, the UE is put in another subgroup where the sidelink/Uu radio quality of the UE is within the (pre)configured range

of that subgroup, otherwise a new subgroup may be created. The RSRP/RSRQ/congestion thresholds may be defined differently for different QoS level that the group application (e.g. platoon) should achieve.

**[00119]** Some features (e.g. sidelink resource allocation (RA) mode, coverage) are more relevant for the case when sidelink is used in AS layer. The other features could be used for both Uu and sidelink.

**[00120]** Any combination of the above features can be applied to determine/establish an AS layer subgroup. The details above the features can be configured by the operator or manufacturer of the terminal devices, such as vehicle OEM (original equipment manufacturer).

**[00121]** Further, the terminal device's situation may change because of movement or any other reason. In embodiments of the present disclosure, the method further includes: removing a terminal device from a subgroup of the at least one subgroup, in response that the terminal device no long satisfies the predetermined criterion to be included in the subgroup. Namely, a dynamic adjustment of the subgroups may be achieved.

**[00122]** In embodiments of the present disclosure, as shown in FIG.3, the method implemented by the access stratum entity 110 further includes: step S311, informing an application layer entity in the network of the at least one subgroup, wherein the application layer entity is associated to the application group.

**[00123]** Accordingly, in embodiments of the present disclosure, the method implemented by the application layer entity 120 further includes: step S321, receiving information about at least one subgroup of the access stratum group, wherein the at least one subgroup is created based on a predetermined criterion. Further, the method may include: step S322, adjusting the application group based on the information about the at least one subgroup.

**[00124]** For example, upon establishing a subgroup following any of the above criterion in step S1110, the 3GPP AS layers in the network (e.g. radio access network (RAN) or core network) or the UE may indicate the new subgroup and optionally the associated configurations (e.g. the QoS that can be guaranteed for each subgroup) to the application layer. Upon receiving such information, the application layer may adapt its configurations, e.g. adjust level of automation, split/merge the application layer group(s) based on the subgroup information indicated by the 3GPP AS layers.

**[00125]** In another examples, the application layer may not be informed about the 3GPP layer decision and from application layer perspective there will still be one group which at lower layers may be represented by multiple subgroups, potentially characterized by different QoS profiles.

**[00126]** FIG. 4 is a procedure diagram showing other exemplary steps of method in FIG. 3. As shown in FIG. 4, after creating subgroups, various access policies may be applied to these subgroups.

[00127] In embodiments of the present disclosure, the method further includes: step S411, applying a consistent access configuration for all terminal devices in a subgroup of the at least one subgroup.

[00128] In embodiments of the present disclosure, the access configuration includes at least one of: a quality of service (QoS) profile, and a bearer control profile.

[00129] In embodiments of the present disclosure, a same QoS level is configured for all terminal devices in the subgroup of the at least one subgroup.

[00130] In embodiments of the present disclosure, the quality of service (QoS) profile includes a QoS level determined based on one of: an actual number of terminal devices in the subgroup, a predetermined maximum number of terminal devices allowed in the subgroup, and an estimated number of terminal devices to join the subgroup.

[00131] In embodiments of the present disclosure, the method further includes: step S412, removing a terminal device from the subgroup, in response to that the access configuration is no longer suitable for the terminal device.

[00132] In embodiments of the present disclosure, the method further includes: step S413, reconfiguring each terminal device in the subgroup consistently, in response to a change of the access configuration.

[00133] In embodiments of the present disclosure, wherein reconfiguring each terminal device includes: changing a same amount of the QoS level for all terminal devices in the subgroup.

[00134] Namely, a so called subgroup wise QoS/bearer configuration may be achieved.

[00135] For example, the configuration of the subgroup could be handled differently depending on e.g. the UE RRC mode. For connected mode UEs, the subgroup configuration could be handled by the NW and unknown to the UE. Based on the destination layer 2 ID reported in *SidelinkUEInformation* the NW could know whether the UEs are engaged in the same group application. For sidelink capable UEs the NW can identify whether they are in the same application layer group regardless if they are actually transmitting on sidelink or Uu. Then the NW could configure the UEs belonging to the same application group into different (AS layer) subgroups based on the above criterion and tags each subgroup with a subgroup ID.

[00136] For instance, UEs in the same subgroup are configured with the same QoS profile/bearer for transmitting the group message. UEs in different subgroups could be configured with different QoS profile/bearer, while the configured QoS for all the subgroups should at least be able to provide the required key performance indicator (KPI) of the group application (otherwise the group application is not allowed to be run or some UEs should be removed from the (sub)group).

[00137] The number of UEs in a subgroup has impacts on the supported QoS of that subgroup. Configuring subgroup QoS based on the actual number of UEs in the subgroup may lead to instability issues as that number may vary fairly frequently especially with high speed vehicle UEs.

An alternative solution is to configure the subgroup QoS based on the maximum number of UEs allowed in a subgroup, or also the estimated maximum number of UEs that may be included in a subgroup (in a gNB/cell and/or a certain frequency/RAT). The gNB/cell could estimate this number based on the UE speed (both velocity and direction), the inter-UE distance, the gNB/cell coverage in a certain frequency/RAT, and optionally also the planned trajectory of the vehicle UEs (which could be got from eV2X server), etc.

**[00138]** When a UE is categorized into a subgroup, the NW could firstly check if the subgroup is already existed. If that is the case, the UE is configured with the QoS of the subgroup, otherwise the NW first determines what QoS could/should be configured for the new subgroup and then applies the configured QoS to the UE.

**[00139]** Further, a so called subgroup wise QoS/bearer reconfiguration may also be achieved.

**[00140]** For instance, supposing that due to some reasons (e.g. a change in radio condition), the current QoS can no longer be supported for a subgroup or a higher QoS can be supported, the QoS/bearer of all the UEs in that subgroup could be reconfigured so that the QoS is still supportable and optimized. Still, all the UEs in that subgroup should have the same QoS/bearer.

**[00141]** With Subgroup wise QoS/bearer (re)configuration, the QoS variation of one single UE could be decreased, with which the group application could be run more smoothly. Moreover, configuring the same QoS for a group of UEs mitigates the situation that different UEs have different QoS even they are close to each other, with which the group application could be run more stably and the (radio) resources could be used more efficiently. These are crucial for safety critical applications.

**[00142]** In embodiments of the present disclosure, the access stratum entity 110 may be in a terminal device and/or in a network.

**[00143]** Namely, in embodiments of the present disclosure, a network node creates a subgroup, based on the predetermined criterion. During creating the subgroup, the network node configures a terminal device belonging to the subgroup without notifying the terminal device. Alternatively, the at least one terminal device creates a subgroup distributedly, based on the predetermined criterion. During creating the subgroup, a terminal device announces information relating to the predetermined criterion to other terminal devices; and the terminal device receives information from another terminal device to determine whether the terminal device and the another terminal device belong to a same subgroup.

**[00144]** Therefore, the subgroup wise QoS/bearer (re)configuration could be applied to both sidelink and Uu.

**[00145]** For Uu, the network node may implement the (re)configuration of the UEs.

**[00146]** For sidelink, UEs may be in idle/inactive mode, in this case the subgrouping could be created distributedly by the UEs based on the camped gNB/cell and/or frequency/RAT. Besides

transmitting the group message over the sidelink, each UE could announce its used frequency/RAT and the gNB/cell on which it is camping, then the surrounding UEs will know which UEs are/should be in the same subgroup.

**[00147]** Further, the UE may measure locally any of the criteria mentioned in the second step above. For example, the UE may measure the distance with respect to the UE(s) in front of it, i.e. those are preceding in the platoon group, or the sidelink/Uu radio quality. In case the criterion for staying in the AS layer subgroup is not fulfilled any longer, the UE is put in another subgroup, which is either an existing one or a newly created one.

**[00148]** FIG. 5 is a procedure diagram showing other exemplary steps of method in FIG. 3. As shown in FIG. 5, the method may include further steps about preemption.

**[00149]** In embodiments of the present disclosure, the method further includes: step S511, receiving a preemption request from a terminal device; step S512, preempting radio resource allocated to terminal devices in a selected subgroup; and step S513, allocating the radio resource preempted from terminal devices in the selected subgroup to the terminal device sending the preemption request.

**[00150]** Accordingly, the terminal device requesting the preemption will obtain preempted resource from the access stratum group including at least one terminal device, particularly from the selected subgroup.

**[00151]** In embodiments of the present disclosure, an amount of the preempted resource is proportional to a QoS level or an amount of the radio resource associated to the selected subgroup.

**[00152]** In embodiments of the present disclosure, the selected subgroup is a subgroup associated with a highest QoS or each terminal device in the subgroup is allocated the most radio resources.

**[00153]** Namely, the sub-groups could be utilized by the UEs to perform sub-group wise preemption. For instance, suppose a UE starts an application with higher priority, and there is no sufficient resource to operate the application with the required QoS, instead of preempting resources from one single UE running a group application, which may lead to that the UE can no longer run the group application and the whole group has to be reconstructed, the preemption could be performed over multiple UEs. More specifically, the UE could obtain the adopted QoS from the logical channel ID in the received SL-SCH MAC (sidelink shared channel media access control) header, or from the priority/QoS indicated in the associated PSCCH (here, the “associated” means that the PSCCH at least carries information necessary to decode the PSSCH). The UE requesting preemption could first identify the UEs which have the same camped gNB/cell and/or frequency/RAT to it, and to which the distance is smaller than a distance threshold, and/or from which the SL RSRP is higher than a RSRP threshold, also the requesting UE determine how many resources it needs to preempt to meet its the QoS requirement. The preemption could then be performed over the identified UEs in different ways.

**[00154]** The amount of preempted resources is proportional to the adopted QoS or the used resources of the identified UE, i.e. more resources are preempted from UEs having higher adopted QoS or using more resources. The amount or the percentage of preempted resources should be the same for the UEs with the same adopted QoS or using the same amount of resources.

**[00155]** The preemption is started from the identified UEs with the highest adopted QoS or using the most resources. Also the amount or the percentage of preempted resources should be the same for the UEs with the same adopted QoS or using the same amount of resources. If the remained resources of the UEs that are preempted is smaller than that of UEs having not been preempted yet, or the highest supportable QoS (estimated based on the remained resources, the adopted MCS (modulation and coding scheme), the UE speed, the sidelink load, etc.) of the UEs that are preempted is lower than that of UEs having not been preempted yet, and the requesting UE still needs to preempt more resources to meet its QoS requirement, the preemption is continued for the identified UEs with the second highest adopted QoS or using the second most resources, and so on.

**[00156]** For Uu the sub-group wise preemption could be performed by the network following the same criterion as described above. The used resource/adopted QoS of each UE is naturally known by the network for Uu.

**[00157]** With such a preemption scheme the impact on each preempted UE is distinctly reduced, with which the group application could be run more smoothly. Besides, the preempted UEs are impacted more equally, with which the group application could be run more stably. These are crucial for safety critical applications.

**[00158]** In embodiments of the present disclosure, the number of the subgroups is not limited. There may be only one subgroup, which equals to the AS group. All UEs engaged in a group application are in the same AS group. In this case the above subgroup wise QoS (re)configuration and preemption could simply be extended to this single AS group. Configuring one single AS group could be useful for sidelink when UEs are out of coverage.

**[00159]** FIG. 6 is another exemplary procedure diagram according to embodiments of the present disclosure. As shown in FIG. 6, an exemplary method for a terminal device 610 to join an access group is illustrated.

**[00160]** The method performed by a terminal device includes: step S611, joining an access stratum group including at least one terminal device. The at least one terminal device is included in a same application group for supporting an application relating to the at least one terminal device. The step S611 of joining the access stratum group may include announcing information relating to a predetermined criterion to other terminal devices; and receiving information from another terminal device to determine whether the terminal device and the another terminal device belong to a same group, based on the predetermined criterion. Particularly, step S611 may include: joining a subgroup of the access stratum group, based on the predetermined criterion.

[00161] In embodiments of the present disclosure, the method further includes: step S612, utilizing an access configuration associated to the subgroup, wherein the access configuration is consistent for all terminal devices in the subgroup. The access configuration is already described above, thus will not repeated here.

[00162] In embodiments of the present disclosure, the method further includes: step S613, exiting from the subgroup, in response to no longer satisfying the predetermined criterion to be included in the subgroup.

[00163] In embodiments of the present disclosure, the method is implemented by an access stratum entity in the terminal device 610.

[00164] FIG. 7 is a block diagram of a computer readable storage medium. As shown in FIG. 7, a computer readable storage medium 700 has a computer program 701 stored thereon. The computer program 701 is executable by a device to cause the device to carry out the above described method for the access stratum, such as in FIG. 1, 3-6.

[00165] FIG. 8 is a block diagram of an access stratum entity. As shown in FIG. 8, the access stratum entity 110, includes: a processor 801; and a memory 802, containing instructions executable by the processor. The access stratum entity 110 is operative to any of methods above mentioned, as shown in FIGs. 1, 3-6.

[00166] Accordingly, embodiments of the present disclosure may also provide an application layer entity, including: a processor; and a memory, containing instructions executable by the processor. The application layer entity is operative to any of the corresponding methods above mentioned.

[00167] FIG. 9 is a schematic showing a virtual apparatus for the access stratum entity. As shown in FIG. 9, a virtual apparatus 910 for the access stratum entity may include a creation unit for creating the at least subgroup. It should be appreciated that the virtual apparatus 910 may include any other unit for implementing above mentioned functions.

[00168] With virtual apparatuses 910, the access stratum entity may not need a fixed processor or memory, any computing resource and storage resource may be arranged from at least one network node, or terminal device in the communication system. The introduction of virtualization technology and network computing technology may improve the usage efficiency of the network resources and the flexibility of the network.

[00169] Further, the exemplary overall commutation system including the access stratum entity will be introduced as below.

[00170] Embodiments of the present disclosure provide a communication system including a host computer including: processing circuitry configured to provide user data; and a communication interface configured to forward the user data to a cellular network for transmission to a terminal device. The cellular network includes a base station. The base station includes the access stratum

entity above mentioned, and/or the terminal device includes the access stratum entity above mentioned.

**[00171]** In embodiments of the present disclosure, the system further includes the terminal device, wherein the terminal device is configured to communicate with the base station.

**[00172]** In embodiments of the present disclosure, the processing circuitry of the host computer is configured to execute a host application, thereby providing the user data; and the terminal device includes processing circuitry configured to execute a client application associated with the host application.

**[00173]** Embodiments of the present disclosure also provide a communication system including a host computer including: a communication interface configured to receive user data originating from a transmission from a terminal device; a base station. The transmission is from the terminal device to the base station. The base station includes the access stratum entity above mentioned, and/or the terminal device includes the access stratum entity above mentioned.

**[00174]** In embodiments of the present disclosure, the processing circuitry of the host computer is configured to execute a host application. The terminal device is configured to execute a client application associated with the host application, thereby providing the user data to be received by the host computer.

**[00175]** FIG. 10 is a schematic showing a wireless network in accordance with some embodiments.

**[00176]** Although the subject matter described herein may be implemented in any appropriate type of system using any suitable components, the embodiments disclosed herein are described in relation to a wireless network, such as the example wireless network illustrated in FIG. 10. For simplicity, the wireless network of FIG. 10 only depicts network 1006, network nodes 1060 (corresponding to network side node) and 1060b, and WDs (corresponding to terminal device) 1010, 1010b, and 1010c. In practice, a wireless network may further include any additional elements suitable to support communication between wireless devices or between a wireless device and another communication device, such as a landline telephone, a service provider, or any other network node or end device. Of the illustrated components, network node 1060 and wireless device (WD) 1010 are depicted with additional detail. The wireless network may provide communication and other types of services to one or more wireless devices to facilitate the wireless devices' access to and/or use of the services provided by, or via, the wireless network.

**[00177]** The wireless network may comprise and/or interface with any type of communication, telecommunication, data, cellular, and/or radio network or other similar type of system. In some embodiments, the wireless network may be configured to operate according to specific standards or other types of predefined rules or procedures. Thus, particular embodiments of the wireless network may implement communication standards, such as Global System for Mobile

Communications (GSM), Universal Mobile Telecommunications System (UMTS), Long Term Evolution (LTE), and/or other suitable 2G, 3G, 4G, or 5G standards; wireless local area network (WLAN) standards, such as the IEEE 802.11 standards; and/or any other appropriate wireless communication standard, such as the Worldwide Interoperability for Microwave Access (WiMax), Bluetooth, Z-Wave and/or ZigBee standards.

**[00178]** Network 1006 may comprise one or more backhaul networks, core networks, IP networks, public switched telephone networks (PSTNs), packet data networks, optical networks, wide-area networks (WANs), local area networks (LANs), wireless local area networks (WLANs), wired networks, wireless networks, metropolitan area networks, and other networks to enable communication between devices.

**[00179]** Network node 1060 and WD 1010 comprise various components described in more detail below. These components work together in order to provide network node and/or wireless device functionality, such as providing wireless connections in a wireless network. In different embodiments, the wireless network may comprise any number of wired or wireless networks, network nodes, base stations, controllers, wireless devices, relay stations, and/or any other components or systems that may facilitate or participate in the communication of data and/or signals whether via wired or wireless connections.

**[00180]** As used herein, network node refers to equipment capable, configured, arranged and/or operable to communicate directly or indirectly with a wireless device and/or with other network nodes or equipment in the wireless network to enable and/or provide wireless access to the wireless device and/or to perform other functions (e.g., administration) in the wireless network. Examples of network nodes include, but are not limited to, access points (APs) (e.g., radio access points), base stations (BSs) (e.g., radio base stations, Node Bs, evolved Node Bs (eNBs) and NR NodeBs (gNBs)). Base stations may be categorized based on the amount of coverage they provide (or, stated differently, their transmit power level) and may then also be referred to as femto base stations, pico base stations, micro base stations, or macro base stations. A base station may be a relay node or a relay donor node controlling a relay. A network node may also include one or more (or all) parts of a distributed radio base station such as centralized digital units and/or remote radio units (RRUs), sometimes referred to as Remote Radio Heads (RRHs). Such remote radio units may or may not be integrated with an antenna as an antenna integrated radio. Parts of a distributed radio base station may also be referred to as nodes in a distributed antenna system (DAS). Yet further examples of network nodes include multi-standard radio (MSR) equipment such as MSR BSs, network controllers such as radio network controllers (RNCs) or base station controllers (BSCs), base transceiver stations (BTSs), transmission points, transmission nodes, multi-cell/multicast coordination entities (MCEs), core network nodes (e.g., MSCs, MMEs), O&M nodes, OSS nodes, SON nodes, positioning nodes (e.g., E-SMLCs), and/or MDTs. As another example, a network

node may be a virtual network node as described in more detail below. More generally, however, network nodes may represent any suitable device (or group of devices) capable, configured, arranged, and/or operable to enable and/or provide a wireless device with access to the wireless network or to provide some service to a wireless device that has accessed the wireless network.

**[00181]** In FIG. 10, network node 1060 includes processing circuitry 1070, device readable medium 1080, interface 1090, auxiliary equipment 1084, power source 1086, power circuitry 1087, and antenna 1062. Although network node 1060 illustrated in the example wireless network of FIG. 10 may represent a device that includes the illustrated combination of hardware components, other embodiments may comprise network nodes with different combinations of components. It is to be understood that a network node comprises any suitable combination of hardware and/or software needed to perform the tasks, features, functions and methods disclosed herein. Moreover, while the components of network node 1060 are depicted as single boxes located within a larger box, or nested within multiple boxes, in practice, a network node may comprise multiple different physical components that make up a single illustrated component (e.g., device readable medium 1080 may comprise multiple separate hard drives as well as multiple RAM modules).

**[00182]** Similarly, network node 1060 may be composed of multiple physically separate components (e.g., a NodeB component and a RNC component, or a BTS component and a BSC component, etc.), which may each have their own respective components. In certain scenarios in which network node 1060 comprises multiple separate components (e.g., BTS and BSC components), one or more of the separate components may be shared among several network nodes. For example, a single RNC may control multiple NodeB's. In such a scenario, each unique NodeB and RNC pair, may in some instances be considered a single separate network node. In some embodiments, network node 1060 may be configured to support multiple radio access technologies (RATs). In such embodiments, some components may be duplicated (e.g., separate device readable medium 1080 for the different RATs) and some components may be reused (e.g., the same antenna 1062 may be shared by the RATs). Network node 1060 may also include multiple sets of the various illustrated components for different wireless technologies integrated into network node 1060, such as, for example, GSM, WCDMA, LTE, NR, WiFi, or Bluetooth wireless technologies. These wireless technologies may be integrated into the same or different chip or set of chips and other components within network node 1060.

**[00183]** Processing circuitry 1070 is configured to perform any determining, calculating, or similar operations (e.g., certain obtaining operations) described herein as being provided by a network node. These operations performed by processing circuitry 1070 may include processing information obtained by processing circuitry 1070 by, for example, converting the obtained information into other information, comparing the obtained information or converted information to information stored in the network node, and/or performing one or more operations based on the

obtained information or converted information, and as a result of said processing making a determination.

**[00184]** Processing circuitry 1070 may comprise a combination of one or more of a microprocessor, controller, microcontroller, central processing unit, digital signal processor, application-specific integrated circuit, field programmable gate array, or any other suitable computing device, resource, or combination of hardware, software and/or encoded logic operable to provide, either alone or in conjunction with other network node 1060 components, such as device readable medium 1080, network node 1060 functionality. For example, processing circuitry 1070 may execute instructions stored in device readable medium 1080 or in memory within processing circuitry 1070. Such functionality may include providing any of the various wireless features, functions, or benefits discussed herein. In some embodiments, processing circuitry 1070 may include a system on a chip (SOC).

**[00185]** In some embodiments, processing circuitry 1070 may include one or more of radio frequency (RF) transceiver circuitry 1072 and baseband processing circuitry 1074. In some embodiments, radio frequency (RF) transceiver circuitry 1072 and baseband processing circuitry 1074 may be on separate chips (or sets of chips), boards, or units, such as radio units and digital units. In alternative embodiments, part or all of RF transceiver circuitry 1072 and baseband processing circuitry 1074 may be on the same chip or set of chips, boards, or units

**[00186]** In certain embodiments, some or all of the functionality described herein as being provided by a network node, base station, eNB or other such network device may be performed by processing circuitry 1070 executing instructions stored on device readable medium 1080 or memory within processing circuitry 1070. In alternative embodiments, some or all of the functionality may be provided by processing circuitry 1070 without executing instructions stored on a separate or discrete device readable medium, such as in a hard-wired manner. In any of those embodiments, whether executing instructions stored on a device readable storage medium or not, processing circuitry 1070 can be configured to perform the described functionality. The benefits provided by such functionality are not limited to processing circuitry 1070 alone or to other components of network node 1060, but are enjoyed by network node 1060 as a whole, and/or by end users and the wireless network generally.

**[00187]** Device readable medium 1080 may comprise any form of volatile or non-volatile computer readable memory including, without limitation, persistent storage, solid-state memory, remotely mounted memory, magnetic media, optical media, random access memory (RAM), read-only memory (ROM), mass storage media (for example, a hard disk), removable storage media (for example, a flash drive, a Compact Disk (CD) or a Digital Video Disk (DVD)), and/or any other volatile or non-volatile, non-transitory device readable and/or computer-executable memory devices that store information, data, and/or instructions that may be used by processing circuitry 1070.

Device readable medium 1080 may store any suitable instructions, data or information, including a computer program, software, an application including one or more of logic, rules, code, tables, etc. and/or other instructions capable of being executed by processing circuitry 1070 and, utilized by network node 1060. Device readable medium 1080 may be used to store any calculations made by processing circuitry 1070 and/or any data received via interface 1090. In some embodiments, processing circuitry 1070 and device readable medium 1080 may be considered to be integrated.

**[00188]** Interface 1090 is used in the wired or wireless communication of signalling and/or data between network node 1060, network 1006, and/or WDs 1010. As illustrated, interface 1090 comprises port(s)/terminal(s) 1094 to send and receive data, for example to and from network 1006 over a wired connection. Interface 1090 also includes radio front end circuitry 1092 that may be coupled to, or in certain embodiments a part of, antenna 1062. Radio front end circuitry 1092 comprises filters 1098 and amplifiers 1096. Radio front end circuitry 1092 may be connected to antenna 1062 and processing circuitry 1070. Radio front end circuitry may be configured to condition signals communicated between antenna 1062 and processing circuitry 1070. Radio front end circuitry 1092 may receive digital data that is to be sent out to other network nodes or WDs via a wireless connection. Radio front end circuitry 1092 may convert the digital data into a radio signal having the appropriate channel and bandwidth parameters using a combination of filters 1098 and/or amplifiers 1096. The radio signal may then be transmitted via antenna 1062. Similarly, when receiving data, antenna 1062 may collect radio signals which are then converted into digital data by radio front end circuitry 1092. The digital data may be passed to processing circuitry 1070. In other embodiments, the interface may comprise different components and/or different combinations of components.

**[00189]** In certain alternative embodiments, network node 1060 may not include separate radio front end circuitry 1092, instead, processing circuitry 1070 may comprise radio front end circuitry and may be connected to antenna 1062 without separate radio front end circuitry 1092. Similarly, in some embodiments, all or some of RF transceiver circuitry 1072 may be considered a part of interface 1090. In still other embodiments, interface 1090 may include one or more ports or terminals 1094, radio front end circuitry 1092, and RF transceiver circuitry 1072, as part of a radio unit (not shown), and interface 1090 may communicate with baseband processing circuitry 1074, which is part of a digital unit (not shown).

**[00190]** Antenna 1062 may include one or more antennas, or antenna arrays, configured to send and/or receive wireless signals. Antenna 1062 may be coupled to radio front end circuitry 1090 and may be any type of antenna capable of transmitting and receiving data and/or signals wirelessly. In some embodiments, antenna 1062 may comprise one or more omni-directional, sector or panel antennas operable to transmit/receive radio signals between, for example, 2 GHz and 66 GHz. An omni-directional antenna may be used to transmit/receive radio signals in any direction, a sector

antenna may be used to transmit/receive radio signals from devices within a particular area, and a panel antenna may be a line of sight antenna used to transmit/receive radio signals in a relatively straight line. In some instances, the use of more than one antenna may be referred to as MIMO. In certain embodiments, antenna 1062 may be separate from network node 1060 and may be connectable to network node 1060 through an interface or port.

**[00191]** Antenna 1062, interface 1090, and/or processing circuitry 1070 may be configured to perform any receiving operations and/or certain obtaining operations described herein as being performed by a network node. Any information, data and/or signals may be received from a wireless device, another network node and/or any other network equipment. Similarly, antenna 1062, interface 1090, and/or processing circuitry 1070 may be configured to perform any transmitting operations described herein as being performed by a network node. Any information, data and/or signals may be transmitted to a wireless device, another network node and/or any other network equipment.

**[00192]** Power circuitry 1087 may comprise, or be coupled to, power management circuitry and is configured to supply the components of network node 1060 with power for performing the functionality described herein. Power circuitry 1087 may receive power from power source 1086. Power source 1086 and/or power circuitry 1087 may be configured to provide power to the various components of network node 1060 in a form suitable for the respective components (e.g., at a voltage and current level needed for each respective component). Power source 1086 may either be included in, or external to, power circuitry 1087 and/or network node 1060. For example, network node 1060 may be connectable to an external power source (e.g., an electricity outlet) via an input circuitry or interface such as an electrical cable, whereby the external power source supplies power to power circuitry 1087. As a further example, power source 1086 may comprise a source of power in the form of a battery or battery pack which is connected to, or integrated in, power circuitry 1087. The battery may provide backup power should the external power source fail. Other types of power sources, such as photovoltaic devices, may also be used.

**[00193]** Alternative embodiments of network node 1060 may include additional components beyond those shown in FIG. 10 that may be responsible for providing certain aspects of the network node's functionality, including any of the functionality described herein and/or any functionality necessary to support the subject matter described herein. For example, network node 1060 may include user interface equipment to allow input of information into network node 1060 and to allow output of information from network node 1060. This may allow a user to perform diagnostic, maintenance, repair, and other administrative functions for network node 1060.

**[00194]** As used herein, wireless device (WD) refers to a device capable, configured, arranged and/or operable to communicate wirelessly with network nodes and/or other wireless devices. Unless otherwise noted, the term WD may be used interchangeably herein with user equipment

(UE). Communicating wirelessly may involve transmitting and/or receiving wireless signals using electromagnetic waves, radio waves, infrared waves, and/or other types of signals suitable for conveying information through air. In some embodiments, a WD may be configured to transmit and/or receive information without direct human interaction. For instance, a WD may be designed to transmit information to a network on a predetermined schedule, when triggered by an internal or external event, or in response to requests from the network. Examples of a WD include, but are not limited to, a smart phone, a mobile phone, a cell phone, a voice over IP (VoIP) phone, a wireless local loop phone, a desktop computer, a personal digital assistant (PDA), a wireless cameras, a gaming console or device, a music storage device, a playback appliance, a wearable terminal device, a wireless endpoint, a mobile station, a tablet, a laptop, a laptop-embedded equipment (LEE), a laptop-mounted equipment (LME), a smart device, a wireless customer-premise equipment (CPE), a vehicle-mounted wireless terminal device, etc.. A WD may support device-to-device (D2D) communication, for example by implementing a 3GPP standard for sidelink communication, vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-everything (V2X) and may in this case be referred to as a D2D communication device. As yet another specific example, in an Internet of Things (IoT) scenario, a WD may represent a machine or other device that performs monitoring and/or measurements, and transmits the results of such monitoring and/or measurements to another WD and/or a network node. The WD may in this case be a machine-to-machine (M2M) device, which may in a 3GPP context be referred to as an MTC device. As one particular example, the WD may be a UE implementing the 3GPP narrow band internet of things (NB-IoT) standard. Particular examples of such machines or devices are sensors, metering devices such as power meters, industrial machinery, or home or personal appliances (e.g. refrigerators, televisions, etc.) personal wearables (e.g., watches, fitness trackers, etc.). In other scenarios, a WD may represent a vehicle or other equipment that is capable of monitoring and/or reporting on its operational status or other functions associated with its operation. A WD as described above may represent the endpoint of a wireless connection, in which case the device may be referred to as a wireless terminal. Furthermore, a WD as described above may be mobile, in which case it may also be referred to as a mobile device or a mobile terminal.

**[00195]** As illustrated, wireless device 1010 includes antenna 1011, interface 1014, processing circuitry 1020, device readable medium 1030, user interface equipment 1032, auxiliary equipment 1034, power source 1036 and power circuitry 1037. WD 1010 may include multiple sets of one or more of the illustrated components for different wireless technologies supported by WD 1010, such as, for example, GSM, WCDMA, LTE, NR, WiFi, WiMAX, or Bluetooth wireless technologies, just to mention a few. These wireless technologies may be integrated into the same or different chips or set of chips as other components within WD 1010.

**[00196]** Antenna 1011 may include one or more antennas or antenna arrays, configured to send and/or receive wireless signals, and is connected to interface 1014. In certain alternative embodiments, antenna 1011 may be separate from WD 1010 and be connectable to WD 1010 through an interface or port. Antenna 1011, interface 1014, and/or processing circuitry 1020 may be configured to perform any receiving or transmitting operations described herein as being performed by a WD. Any information, data and/or signals may be received from a network node and/or another WD. In some embodiments, radio front end circuitry and/or antenna 1011 may be considered an interface.

**[00197]** As illustrated, interface 1014 comprises radio front end circuitry 1012 and antenna 1011. Radio front end circuitry 1012 comprise one or more filters 1018 and amplifiers 1016. Radio front end circuitry 1014 is connected to antenna 1011 and processing circuitry 1020, and is configured to condition signals communicated between antenna 1011 and processing circuitry 1020. Radio front end circuitry 1012 may be coupled to or a part of antenna 1011. In some embodiments, WD 1010 may not include separate radio front end circuitry 1012; rather, processing circuitry 1020 may comprise radio front end circuitry and may be connected to antenna 1011. Similarly, in some embodiments, some or all of RF transceiver circuitry 1022 may be considered a part of interface 1014. Radio front end circuitry 1012 may receive digital data that is to be sent out to other network nodes or WDs via a wireless connection. Radio front end circuitry 1012 may convert the digital data into a radio signal having the appropriate channel and bandwidth parameters using a combination of filters 1018 and/or amplifiers 1016. The radio signal may then be transmitted via antenna 1011. Similarly, when receiving data, antenna 1011 may collect radio signals which are then converted into digital data by radio front end circuitry 1012. The digital data may be passed to processing circuitry 1020. In other embodiments, the interface may comprise different components and/or different combinations of components.

**[00198]** Processing circuitry 1020 may comprise a combination of one or more of a microprocessor, controller, microcontroller, central processing unit, digital signal processor, application-specific integrated circuit, field programmable gate array, or any other suitable computing device, resource, or combination of hardware, software, and/or encoded logic operable to provide, either alone or in conjunction with other WD 1010 components, such as device readable medium 1030, WD 1010 functionality. Such functionality may include providing any of the various wireless features or benefits discussed herein. For example, processing circuitry 1020 may execute instructions stored in device readable medium 1030 or in memory within processing circuitry 1020 to provide the functionality disclosed herein.

**[00199]** As illustrated, processing circuitry 1020 includes one or more of RF transceiver circuitry 1022, baseband processing circuitry 1024, and application processing circuitry 1026. In other embodiments, the processing circuitry may comprise different components and/or different

combinations of components. In certain embodiments processing circuitry 1020 of WD 1010 may comprise a SOC. In some embodiments, RF transceiver circuitry 1022, baseband processing circuitry 1024, and application processing circuitry 1026 may be on separate chips or sets of chips. In alternative embodiments, part or all of baseband processing circuitry 1024 and application processing circuitry 1026 may be combined into one chip or set of chips, and RF transceiver circuitry 1022 may be on a separate chip or set of chips. In still alternative embodiments, part or all of RF transceiver circuitry 1022 and baseband processing circuitry 1024 may be on the same chip or set of chips, and application processing circuitry 1026 may be on a separate chip or set of chips. In yet other alternative embodiments, part or all of RF transceiver circuitry 1022, baseband processing circuitry 1024, and application processing circuitry 1026 may be combined in the same chip or set of chips. In some embodiments, RF transceiver circuitry 1022 may be a part of interface 1014. RF transceiver circuitry 1022 may condition RF signals for processing circuitry 1020.

**[00200]** In certain embodiments, some or all of the functionality described herein as being performed by a WD may be provided by processing circuitry 1020 executing instructions stored on device readable medium 1030, which in certain embodiments may be a computer-readable storage medium. In alternative embodiments, some or all of the functionality may be provided by processing circuitry 1020 without executing instructions stored on a separate or discrete device readable storage medium, such as in a hard-wired manner. In any of those particular embodiments, whether executing instructions stored on a device readable storage medium or not, processing circuitry 1020 can be configured to perform the described functionality. The benefits provided by such functionality are not limited to processing circuitry 1020 alone or to other components of WD 1010, but are enjoyed by WD 1010 as a whole, and/or by end users and the wireless network generally.

**[00201]** Processing circuitry 1020 may be configured to perform any determining, calculating, or similar operations (e.g., certain obtaining operations) described herein as being performed by a WD. These operations, as performed by processing circuitry 1020, may include processing information obtained by processing circuitry 1020 by, for example, converting the obtained information into other information, comparing the obtained information or converted information to information stored by WD 1010, and/or performing one or more operations based on the obtained information or converted information, and as a result of said processing making a determination.

**[00202]** Device readable medium 1030 may be operable to store a computer program, software, an application including one or more of logic, rules, code, tables, etc. and/or other instructions capable of being executed by processing circuitry 1020. Device readable medium 1030 may include computer memory (e.g., Random Access Memory (RAM) or Read Only Memory (ROM)), mass storage media (e.g., a hard disk), removable storage media (e.g., a Compact Disk (CD) or a Digital Video Disk (DVD)), and/or any other volatile or non-volatile, non-transitory device readable and/or

computer executable memory devices that store information, data, and/or instructions that may be used by processing circuitry 1020. In some embodiments, processing circuitry 1020 and device readable medium 1030 may be considered to be integrated.

**[00203]** User interface equipment 1032 may provide components that allow for a human user to interact with WD 1010. Such interaction may be of many forms, such as visual, aural, tactile, etc. User interface equipment 1032 may be operable to produce output to the user and to allow the user to provide input to WD 1010. The type of interaction may vary depending on the type of user interface equipment 1032 installed in WD 1010. For example, if WD 1010 is a smart phone, the interaction may be via a touch screen; if WD 1010 is a smart meter, the interaction may be through a screen that provides usage (e.g., the number of gallons used) or a speaker that provides an audible alert (e.g., if smoke is detected). User interface equipment 1032 may include input interfaces, devices and circuits, and output interfaces, devices and circuits. User interface equipment 1032 is configured to allow input of information into WD 1010, and is connected to processing circuitry 1020 to allow processing circuitry 1020 to process the input information. User interface equipment 1032 may include, for example, a microphone, a proximity or other sensor, keys/buttons, a touch display, one or more cameras, a USB port, or other input circuitry. User interface equipment 1032 is also configured to allow output of information from WD 1010, and to allow processing circuitry 1020 to output information from WD 1010. User interface equipment 1032 may include, for example, a speaker, a display, vibrating circuitry, a USB port, a headphone interface, or other output circuitry. Using one or more input and output interfaces, devices, and circuits, of user interface equipment 1032, WD 1010 may communicate with end users and/or the wireless network, and allow them to benefit from the functionality described herein.

**[00204]** Auxiliary equipment 1034 is operable to provide more specific functionality which may not be generally performed by WDs. This may comprise specialized sensors for doing measurements for various purposes, interfaces for additional types of communication such as wired communications etc. The inclusion and type of components of auxiliary equipment 1034 may vary depending on the embodiment and/or scenario.

Power source 1036 may, in some embodiments, be in the form of a battery or battery pack. Other types of power sources, such as an external power source (e.g., an electricity outlet), photovoltaic devices or power cells, may also be used. WD 1010 may further comprise power circuitry 1037 for delivering power from power source 1036 to the various parts of WD 1010 which need power from power source 1036 to carry out any functionality described or indicated herein. Power circuitry 1037 may in certain embodiments comprise power management circuitry. Power circuitry 1037 may additionally or alternatively be operable to receive power from an external power source; in which case WD 1010 may be connectable to the external power source (such as an electricity outlet) via input circuitry or an interface such as an electrical power cable. Power

circuitry 1037 may also in certain embodiments be operable to deliver power from an external power source to power source 1036. This may be, for example, for the charging of power source 1036. Power circuitry 1037 may perform any formatting, converting, or other modification to the power from power source 1036 to make the power suitable for the respective components of WD 1010 to which power is supplied.

**[00205]** FIG. 11 is a schematic showing a user equipment in accordance with some embodiments.

**[00206]** FIG. 11 illustrates one embodiment of a UE in accordance with various aspects described herein. As used herein, a user equipment or UE may not necessarily have a user in the sense of a human user who owns and/or operates the relevant device. Instead, a UE may represent a device that is intended for sale to, or operation by, a human user but which may not, or which may not initially, be associated with a specific human user (e.g., a smart sprinkler controller). Alternatively, a UE may represent a device that is not intended for sale to, or operation by, an end user but which may be associated with or operated for the benefit of a user (e.g., a smart power meter). UE 1100 may be any UE identified by the 3<sup>rd</sup> Generation Partnership Project (3GPP), including a NB-IoT UE, a machine type communication (MTC) UE, and/or an enhanced MTC (eMTC) UE. UE 1100, as illustrated in FIG. 11, is one example of a WD configured for communication in accordance with one or more communication standards promulgated by the 3<sup>rd</sup> Generation Partnership Project (3GPP), such as 3GPP's GSM, UMTS, LTE, and/or 5G standards. As mentioned previously, the term WD and UE may be used interchangeable. Accordingly, although FIG. 11 is a UE, the components discussed herein are equally applicable to a WD, and vice-versa.

**[00207]** In FIG. 11, UE 1100 includes processing circuitry 1101 that is operatively coupled to input/output interface 1105, radio frequency (RF) interface 1109, network connection interface 1111, memory 1115 including random access memory (RAM) 1117, read-only memory (ROM) 1119, and storage medium 1121 or the like, communication subsystem 1131, power source 1133, and/or any other component, or any combination thereof. Storage medium 1121 includes operating system 1123, application program 1125, and data 1127. In other embodiments, storage medium 1121 may include other similar types of information. Certain UEs may utilize all of the components shown in FIG. 11, or only a subset of the components. The level of integration between the components may vary from one UE to another UE. Further, certain UEs may contain multiple instances of a component, such as multiple processors, memories, transceivers, transmitters, receivers, etc.

**[00208]** In FIG. 11, processing circuitry 1101 may be configured to process computer instructions and data. Processing circuitry 1101 may be configured to implement any sequential state machine operative to execute machine instructions stored as machine-readable computer programs in the memory, such as one or more hardware-implemented state machines (e.g., in discrete logic, FPGA, ASIC, etc.); programmable logic together with appropriate firmware; one or more stored program,

general-purpose processors, such as a microprocessor or Digital Signal Processor (DSP), together with appropriate software; or any combination of the above. For example, the processing circuitry 1101 may include two central processing units (CPUs). Data may be information in a form suitable for use by a computer.

**[00209]** In the depicted embodiment, input/output interface 1105 may be configured to provide a communication interface to an input device, output device, or input and output device. UE 1100 may be configured to use an output device via input/output interface 1105. An output device may use the same type of interface port as an input device. For example, a USB port may be used to provide input to and output from UE 1100. The output device may be a speaker, a sound card, a video card, a display, a monitor, a printer, an actuator, an emitter, a smartcard, another output device, or any combination thereof. UE 1100 may be configured to use an input device via input/output interface 1105 to allow a user to capture information into UE 1100. The input device may include a touch-sensitive or presence-sensitive display, a camera (e.g., a digital camera, a digital video camera, a web camera, etc.), a microphone, a sensor, a mouse, a trackball, a directional pad, a trackpad, a scroll wheel, a smartcard, and the like. The presence-sensitive display may include a capacitive or resistive touch sensor to sense input from a user. A sensor may be, for instance, an accelerometer, a gyroscope, a tilt sensor, a force sensor, a magnetometer, an optical sensor, a proximity sensor, another like sensor, or any combination thereof. For example, the input device may be an accelerometer, a magnetometer, a digital camera, a microphone, and an optical sensor.

**[00210]** In FIG. 11, RF interface 1109 may be configured to provide a communication interface to RF components such as a transmitter, a receiver, and an antenna. Network connection interface 1111 may be configured to provide a communication interface to network 1143a. Network 1143a may encompass wired and/or wireless networks such as a local-area network (LAN), a wide-area network (WAN), a computer network, a wireless network, a telecommunications network, another like network or any combination thereof. For example, network 1143a may comprise a Wi-Fi network. Network connection interface 1111 may be configured to include a receiver and a transmitter interface used to communicate with one or more other devices over a communication network according to one or more communication protocols, such as Ethernet, TCP/IP, SONET, ATM, or the like. Network connection interface 1111 may implement receiver and transmitter functionality appropriate to the communication network links (e.g., optical, electrical, and the like). The transmitter and receiver functions may share circuit components, software or firmware, or alternatively may be implemented separately.

**[00211]** RAM 1117 may be configured to interface via bus 1102 to processing circuitry 1101 to provide storage or caching of data or computer instructions during the execution of software programs such as the operating system, application programs, and device drivers. ROM 1119 may

be configured to provide computer instructions or data to processing circuitry 1101. For example, ROM 1119 may be configured to store invariant low-level system code or data for basic system functions such as basic input and output (I/O), startup, or reception of keystrokes from a keyboard that are stored in a non-volatile memory. Storage medium 1121 may be configured to include memory such as RAM, ROM, programmable read-only memory (PROM), erasable programmable read-only memory (EPROM), electrically erasable programmable read-only memory (EEPROM), magnetic disks, optical disks, floppy disks, hard disks, removable cartridges, or flash drives. In one example, storage medium 1121 may be configured to include operating system 1123, application program 1125 such as a web browser application, a widget or gadget engine or another application, and data file 1127. Storage medium 1121 may store, for use by UE 1100, any of a variety of various operating systems or combinations of operating systems.

**[00212]** Storage medium 1121 may be configured to include a number of physical drive units, such as redundant array of independent disks (RAID), floppy disk drive, flash memory, USB flash drive, external hard disk drive, thumb drive, pen drive, key drive, high-density digital versatile disc (HD-DVD) optical disc drive, internal hard disk drive, Blu-Ray optical disc drive, holographic digital data storage (HDDS) optical disc drive, external mini-dual in-line memory module (DIMM), synchronous dynamic random access memory (SDRAM), external micro-DIMM SDRAM, smartcard memory such as a subscriber identity module or a removable user identity (SIM/RUIM) module, other memory, or any combination thereof. Storage medium 1121 may allow UE 1100 to access computer-executable instructions, application programs or the like, stored on transitory or non-transitory memory media, to off-load data, or to upload data. An article of manufacture, such as one utilizing a communication system may be tangibly embodied in storage medium 1121, which may comprise a device readable medium.

**[00213]** In FIG. 11, processing circuitry 1101 may be configured to communicate with network 1143b using communication subsystem 1131. Network 1143a and network 1143b may be the same network or networks or different network or networks. Communication subsystem 1131 may be configured to include one or more transceivers used to communicate with network 1143b. For example, communication subsystem 1131 may be configured to include one or more transceivers used to communicate with one or more remote transceivers of another device capable of wireless communication such as another WD, UE, or base station of a radio access network (RAN) according to one or more communication protocols, such as IEEE 802.11, CDMA, WCDMA, GSM, LTE, UTRAN, WiMax, or the like. Each transceiver may include transmitter 1133 and/or receiver 1135 to implement transmitter or receiver functionality, respectively, appropriate to the RAN links (e.g., frequency allocations and the like). Further, transmitter 1133 and receiver 1135 of each transceiver may share circuit components, software or firmware, or alternatively may be implemented separately.

**[00214]** In the illustrated embodiment, the communication functions of communication subsystem 1131 may include data communication, voice communication, multimedia communication, short-range communications such as Bluetooth, near-field communication, location-based communication such as the use of the global positioning system (GPS) to determine a location, another like communication function, or any combination thereof. For example, communication subsystem 1131 may include cellular communication, Wi-Fi communication, Bluetooth communication, and GPS communication. Network 1143b may encompass wired and/or wireless networks such as a local-area network (LAN), a wide-area network (WAN), a computer network, a wireless network, a telecommunications network, another like network or any combination thereof. For example, network 1143b may be a cellular network, a Wi-Fi network, and/or a near-field network. Power source 1113 may be configured to provide alternating current (AC) or direct current (DC) power to components of UE 1100.

**[00215]** The features, benefits and/or functions described herein may be implemented in one of the components of UE 1100 or partitioned across multiple components of UE 1100. Further, the features, benefits, and/or functions described herein may be implemented in any combination of hardware, software or firmware. In one example, communication subsystem 1131 may be configured to include any of the components described herein. Further, processing circuitry 1101 may be configured to communicate with any of such components over bus 1102. In another example, any of such components may be represented by program instructions stored in memory that when executed by processing circuitry 1101 perform the corresponding functions described herein. In another example, the functionality of any of such components may be partitioned between processing circuitry 1101 and communication subsystem 1131. In another example, the non-computationally intensive functions of any of such components may be implemented in software or firmware and the computationally intensive functions may be implemented in hardware.

**[00216]** FIG. 12 is a schematic showing a virtualization environment in accordance with some embodiments.

**[00217]** FIG. 12 is a schematic block diagram illustrating a virtualization environment 1200 in which functions implemented by some embodiments may be virtualized. In the present context, virtualizing means creating virtual versions of apparatuses or devices which may include virtualizing hardware platforms, storage devices and networking resources. As used herein, virtualization can be applied to a node (e.g., a virtualized base station or a virtualized radio access node) or to a device (e.g., a UE, a wireless device or any other type of communication device) or components thereof and relates to an implementation in which at least a portion of the functionality is implemented as one or more virtual components (e.g., via one or more applications, components, functions, virtual machines or containers executing on one or more physical processing nodes in one or more networks).

**[00218]** In some embodiments, some or all of the functions described herein may be implemented as virtual components executed by one or more virtual machines implemented in one or more virtual environments 1200 hosted by one or more of hardware nodes 1230. Further, in embodiments in which the virtual node is not a radio access node or does not require radio connectivity (e.g., a core network node), then the network node may be entirely virtualized.

**[00219]** The functions may be implemented by one or more applications 1220 (which may alternatively be called software instances, virtual appliances, network functions, virtual nodes, virtual network functions, etc.) operative to implement some of the features, functions, and/or benefits of some of the embodiments disclosed herein. Applications 1220 are run in virtualization environment 1200 which provides hardware 1230 comprising processing circuitry 1260 and memory 1290. Memory 1290 contains instructions 1295 executable by processing circuitry 1260 whereby application 1220 is operative to provide one or more of the features, benefits, and/or functions disclosed herein.

**[00220]** Virtualization environment 1200, comprises general-purpose or special-purpose network hardware devices 1230 comprising a set of one or more processors or processing circuitry 1260, which may be commercial off-the-shelf (COTS) processors, dedicated Application Specific Integrated Circuits (ASICs), or any other type of processing circuitry including digital or analog hardware components or special purpose processors. Each hardware device may comprise memory 1290-1 which may be non-persistent memory for temporarily storing instructions 1295 or software executed by processing circuitry 1260. Each hardware device may comprise one or more network interface controllers (NICs) 1270, also known as network interface cards, which include physical network interface 1280. Each hardware device may also include non-transitory, persistent, machine-readable storage media 1290-2 having stored therein software 1295 and/or instructions executable by processing circuitry 1260. Software 1295 may include any type of software including software for instantiating one or more virtualization layers 1250 (also referred to as hypervisors), software to execute virtual machines 1240 as well as software allowing it to execute functions, features and/or benefits described in relation with some embodiments described herein.

**[00221]** Virtual machines 1240, comprise virtual processing, virtual memory, virtual networking or interface and virtual storage, and may be run by a corresponding virtualization layer 1250 or hypervisor. Different embodiments of the instance of virtual appliance 1220 may be implemented on one or more of virtual machines 1240, and the implementations may be made in different ways.

**[00222]** During operation, processing circuitry 1260 executes software 1295 to instantiate the hypervisor or virtualization layer 1250, which may sometimes be referred to as a virtual machine monitor (VMM). Virtualization layer 1250 may present a virtual operating platform that appears like networking hardware to virtual machine 1240.

**[00223]** As shown in FIG. 12, hardware 1230 may be a standalone network node with generic or specific components. Hardware 1230 may comprise antenna 12225 and may implement some functions via virtualization. Alternatively, hardware 1230 may be part of a larger cluster of hardware (e.g. such as in a data center or customer premise equipment (CPE)) where many hardware nodes work together and are managed via management and orchestration (MANO) 12100, which, among others, oversees lifecycle management of applications 1220.

**[00224]** Virtualization of the hardware is in some contexts referred to as network function virtualization (NFV). NFV may be used to consolidate many network equipment types onto industry standard high volume server hardware, physical switches, and physical storage, which can be located in data centers, and customer premise equipment.

**[00225]** In the context of NFV, virtual machine 1240 may be a software implementation of a physical machine that runs programs as if they were executing on a physical, non-virtualized machine. Each of virtual machines 1240, and that part of hardware 1230 that executes that virtual machine, be it hardware dedicated to that virtual machine and/or hardware shared by that virtual machine with others of the virtual machines 1240, forms a separate virtual network elements (VNE).

**[00226]** Still in the context of NFV, Virtual Network Function (VNF) is responsible for handling specific network functions that run in one or more virtual machines 1240 on top of hardware networking infrastructure 1230 and corresponds to application 1220 in FIG. 12.

**[00227]** In some embodiments, one or more radio units 12200 that each include one or more transmitters 12220 and one or more receivers 12210 may be coupled to one or more antennas 12225. Radio units 12200 may communicate directly with hardware nodes 1230 via one or more appropriate network interfaces and may be used in combination with the virtual components to provide a virtual node with radio capabilities, such as a radio access node or a base station.

**[00228]** In some embodiments, some signalling can be effected with the use of control system 12230 which may alternatively be used for communication between the hardware nodes 1230 and radio units 12200.

**[00229]** FIG. 13 is a schematic showing a telecommunication network connected via an intermediate network to a host computer in accordance with some embodiments.

**[00230]** With reference to FIG. 13, in accordance with an embodiment, a communication system includes telecommunication network 1310, such as a 3GPP-type cellular network, which comprises access network 1311, such as a radio access network, and core network 1314. Access network 1311 comprises a plurality of base stations 1312a, 1312b, 1312c, such as NBs, eNBs, gNBs or other types of wireless access points, each defining a corresponding coverage area 1313a, 1313b, 1313c. Each base station 1312a, 1312b, 1312c is connectable to core network 1314 over a wired or wireless connection 1315. A first UE 1391 located in coverage area 1313c is configured to

wirelessly connect to, or be paged by, the corresponding base station 1312c. A second UE 1392 in coverage area 1313a is wirelessly connectable to the corresponding base station 1312a. While a plurality of UEs 1391, 1392 are illustrated in this example, the disclosed embodiments are equally applicable to a situation where a sole UE is in the coverage area or where a sole UE is connecting to the corresponding base station 1312.

**[00231]** Telecommunication network 1310 is itself connected to host computer 1330, which may be embodied in the hardware and/or software of a standalone server, a cloud-implemented server, a distributed server or as processing resources in a server farm. Host computer 1330 may be under the ownership or control of a service provider, or may be operated by the service provider or on behalf of the service provider. Connections 1321 and 1322 between telecommunication network 1310 and host computer 1330 may extend directly from core network 1314 to host computer 1330 or may go via an optional intermediate network 1320. Intermediate network 1320 may be one of, or a combination of more than one of, a public, private or hosted network; intermediate network 1320, if any, may be a backbone network or the Internet; in particular, intermediate network 1320 may comprise two or more sub-networks (not shown).

**[00232]** The communication system of FIG. 13 as a whole enables connectivity between the connected UEs 1391, 1392 and host computer 1330. The connectivity may be described as an over-the-top (OTT) connection 1350. Host computer 1330 and the connected UEs 1391, 1392 are configured to communicate data and/or signaling via OTT connection 1350, using access network 1311, core network 1314, any intermediate network 1320 and possible further infrastructure (not shown) as intermediaries. OTT connection 1350 may be transparent in the sense that the participating communication devices through which OTT connection 1350 passes are unaware of routing of uplink and downlink communications. For example, base station 1312 may not or need not be informed about the past routing of an incoming downlink communication with data originating from host computer 1330 to be forwarded (e.g., handed over) to a connected UE 1391. Similarly, base station 1312 need not be aware of the future routing of an outgoing uplink communication originating from the UE 1391 towards the host computer 1330.

**[00233]** FIG. 14 is a schematic showing a host computer communicating via a base station with a user equipment over a partially wireless connection in accordance with some embodiments.

**[00234]** Example implementations, in accordance with an embodiment, of the UE, base station and host computer discussed in the preceding paragraphs will now be described with reference to FIG. 14. In communication system 1400, host computer 1410 comprises hardware 1415 including communication interface 1416 configured to set up and maintain a wired or wireless connection with an interface of a different communication device of communication system 1400. Host computer 1410 further comprises processing circuitry 1418, which may have storage and/or processing capabilities. In particular, processing circuitry 1418 may comprise one or more

programmable processors, application-specific integrated circuits, field programmable gate arrays or combinations of these (not shown) adapted to execute instructions. Host computer 1410 further comprises software 1411, which is stored in or accessible by host computer 1410 and executable by processing circuitry 1418. Software 1411 includes host application 1412. Host application 1412 may be operable to provide a service to a remote user, such as UE 1430 connecting via OTT connection 1450 terminating at UE 1430 and host computer 1410. In providing the service to the remote user, host application 1412 may provide user data which is transmitted using OTT connection 1450.

**[00235]** Communication system 1400 further includes base station 1420 provided in a telecommunication system and comprising hardware 1425 enabling it to communicate with host computer 1410 and with UE 1430. Hardware 1425 may include communication interface 1426 for setting up and maintaining a wired or wireless connection with an interface of a different communication device of communication system 1400, as well as radio interface 1427 for setting up and maintaining at least wireless connection 1470 with UE 1430 located in a coverage area (not shown in FIG. 14) served by base station 1420. Communication interface 1426 may be configured to facilitate connection 1460 to host computer 1410. Connection 1460 may be direct or it may pass through a core network (not shown in FIG. 14) of the telecommunication system and/or through one or more intermediate networks outside the telecommunication system. In the embodiment shown, hardware 1425 of base station 1420 further includes processing circuitry 1428, which may comprise one or more programmable processors, application-specific integrated circuits, field programmable gate arrays or combinations of these (not shown) adapted to execute instructions. Base station 1420 further has software 1421 stored internally or accessible via an external connection.

**[00236]** Communication system 1400 further includes UE 1430 already referred to. Its hardware 1435 may include radio interface 1437 configured to set up and maintain wireless connection 1470 with a base station serving a coverage area in which UE 1430 is currently located. Hardware 1435 of UE 1430 further includes processing circuitry 1438, which may comprise one or more programmable processors, application-specific integrated circuits, field programmable gate arrays or combinations of these (not shown) adapted to execute instructions. UE 1430 further comprises software 1431, which is stored in or accessible by UE 1430 and executable by processing circuitry 1438. Software 1431 includes client application 1432. Client application 1432 may be operable to provide a service to a human or non-human user via UE 1430, with the support of host computer 1410. In host computer 1410, an executing host application 1412 may communicate with the executing client application 1432 via OTT connection 1450 terminating at UE 1430 and host computer 1410. In providing the service to the user, client application 1432 may receive request data from host application 1412 and provide user data in response to the request data. OTT

connection 1450 may transfer both the request data and the user data. Client application 1432 may interact with the user to generate the user data that it provides.

**[00237]** It is noted that host computer 1410, base station 1420 and UE 1430 illustrated in FIG. 14 may be similar or identical to host computer 1330, one of base stations 1312a, 1312b, 1312c and one of UEs 1391, 1392 of FIG. 13, respectively. This is to say, the inner workings of these entities may be as shown in FIG. 14 and independently, the surrounding network topology may be that of FIG. 13.

**[00238]** In FIG. 14, OTT connection 1450 has been drawn abstractly to illustrate the communication between host computer 1410 and UE 1430 via base station 1420, without explicit reference to any intermediary devices and the precise routing of messages via these devices. Network infrastructure may determine the routing, which it may be configured to hide from UE 1430 or from the service provider operating host computer 1410, or both. While OTT connection 1450 is active, the network infrastructure may further take decisions by which it dynamically changes the routing (e.g., on the basis of load balancing consideration or reconfiguration of the network).

**[00239]** Wireless connection 1470 between UE 1430 and base station 1420 is in accordance with the teachings of the embodiments described throughout this disclosure. One or more of the various embodiments improve the performance of OTT services provided to UE 1430 using OTT connection 1450, in which wireless connection 1470 forms the last segment. More precisely, the teachings of these embodiments may improve the latency, and power consumption for a reactivation of the network connection, and thereby provide benefits, such as reduced user waiting time, enhanced rate control.

**[00240]** A measurement procedure may be provided for the purpose of monitoring data rate, latency and other factors on which the one or more embodiments improve. There may further be an optional network functionality for reconfiguring OTT connection 1450 between host computer 1410 and UE 1430, in response to variations in the measurement results. The measurement procedure and/or the network functionality for reconfiguring OTT connection 1450 may be implemented in software 1411 and hardware 1415 of host computer 1410 or in software 1431 and hardware 1435 of UE 1430, or both. In embodiments, sensors (not shown) may be deployed in or in association with communication devices through which OTT connection 1450 passes; the sensors may participate in the measurement procedure by supplying values of the monitored quantities exemplified above, or supplying values of other physical quantities from which software 1411, 1431 may compute or estimate the monitored quantities. The reconfiguring of OTT connection 1450 may include message format, retransmission settings, preferred routing etc.; the reconfiguring need not affect base station 1420, and it may be unknown or imperceptible to base station 1420. Such procedures and functionalities may be known and practiced in the art. In certain

embodiments, measurements may involve proprietary UE signaling facilitating host computer 1410's measurements of throughput, propagation times, latency and the like. The measurements may be implemented in that software 1411 and 1431 causes messages to be transmitted, in particular empty or 'dummy' messages, using OTT connection 1450 while it monitors propagation times, errors etc.

**[00241]** FIG. 15 is a flowchart illustrating a method implemented in a communication system, in accordance with one embodiment. The communication system includes a host computer, a base station and a UE which may be those described with reference to Figures 13 and 14. For simplicity of the present disclosure, only drawing references to FIG. 15 will be included in this section. In step 1510, the host computer provides user data. In substep 1511 (which may be optional) of step 1510, the host computer provides the user data by executing a host application. In step 1520, the host computer initiates a transmission carrying the user data to the UE. In step 1530 (which may be optional), the base station transmits to the UE the user data which was carried in the transmission that the host computer initiated, in accordance with the teachings of the embodiments described throughout this disclosure. In step 1540 (which may also be optional), the UE executes a client application associated with the host application executed by the host computer.

**[00242]** FIG. 16 is a flowchart illustrating a method implemented in a communication system, in accordance with one embodiment. The communication system includes a host computer, a base station and a UE which may be those described with reference to Figures 13 and 14. For simplicity of the present disclosure, only drawing references to FIG. 16 will be included in this section. In step 1610 of the method, the host computer provides user data. In an optional substep (not shown) the host computer provides the user data by executing a host application. In step 1620, the host computer initiates a transmission carrying the user data to the UE. The transmission may pass via the base station, in accordance with the teachings of the embodiments described throughout this disclosure. In step 1630 (which may be optional), the UE receives the user data carried in the transmission.

**[00243]** FIG. 17 is a flowchart illustrating a method implemented in a communication system, in accordance with one embodiment. The communication system includes a host computer, a base station and a UE which may be those described with reference to Figures 13 and 14. For simplicity of the present disclosure, only drawing references to FIG. 17 will be included in this section. In step 1710 (which may be optional), the UE receives input data provided by the host computer. Additionally or alternatively, in step 1720, the UE provides user data. In substep 1721 (which may be optional) of step 1720, the UE provides the user data by executing a client application. In substep 1711 (which may be optional) of step 1710, the UE executes a client application which provides the user data in reaction to the received input data provided by the host computer. In providing the user data, the executed client application may further consider user

input received from the user. Regardless of the specific manner in which the user data was provided, the UE initiates, in substep 1730 (which may be optional), transmission of the user data to the host computer. In step 1740 of the method, the host computer receives the user data transmitted from the UE, in accordance with the teachings of the embodiments described throughout this disclosure.

**[00244]** FIG. 18 is a flowchart illustrating a method implemented in a communication system, in accordance with one embodiment. The communication system includes a host computer, a base station and a UE which may be those described with reference to Figures 13 and 14. For simplicity of the present disclosure, only drawing references to FIG. 18 will be included in this section. In step 1810 (which may be optional), in accordance with the teachings of the embodiments described throughout this disclosure, the base station receives user data from the UE. In step 1820 (which may be optional), the base station initiates transmission of the received user data to the host computer. In step 1830 (which may be optional), the host computer receives the user data carried in the transmission initiated by the base station.

**[00245]** Due to embodiments in the present disclosure, it is an advantage that the terminal devices engaged in the same application group could be handled more consistently in an access stratum layer in the communication system. The group service quality may be further improved. Advanced application may be further supported. A more efficient use of radio resources may be achieved. The teachings of these embodiments may improve the data rate, latency, power consumption and thereby provide benefits such as reduced user waiting time, better responsiveness, extended battery lifetime. Particularly, the stable operation may be improved in safety critical applications.

**[00246]** The term unit may have conventional meaning in the field of electronics, electrical devices and/or electronic devices and may include, for example, electrical and/or electronic circuitry, devices, modules, processors, memories, logic solid state and/or discrete devices, computer programs or instructions for carrying out respective tasks, procedures, computations, outputs, and/or displaying functions, and so on, as such as those that are described herein.

**[00247]** In general, the various exemplary embodiments of the present disclosure may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. For example, some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software that may be executed by a controller, microprocessor or other computing device, although the disclosure is not limited thereto. While various aspects of the exemplary embodiments of this disclosure may be illustrated and described as block diagrams, flow charts, or using some other pictorial representation, it is well understood that these blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

**[00248]** As such, it should be appreciated that at least some aspects of the exemplary embodiments of the disclosure may be practiced in various components such as integrated circuit chips and modules. It should thus be appreciated that the exemplary embodiments of this disclosure may be realized in an apparatus that is embodied as an integrated circuit, where the integrated circuit may include circuitry (as well as possibly firmware) for embodying at least one or more of a data processor, a digital signal processor, baseband circuitry and radio frequency circuitry that are configurable so as to operate in accordance with the exemplary embodiments of this disclosure.

**[00249]** It should be appreciated that at least some aspects of the exemplary embodiments of the disclosure may be embodied in computer-executable instructions, such as in one or more program modules, executed by one or more computers or other devices. Generally, program modules include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract data types when executed by a processor in a computer or other device. The computer executable instructions may be stored on a computer readable medium such as a hard disk, optical disk, removable storage media, solid state memory, RAM, etc. As will be appreciated by those skilled in the art, the functionality of the program modules may be combined or distributed as desired in various embodiments. In addition, the functionality may be embodied in whole or in part in firmware or hardware equivalents such as integrated circuits, field programmable gate arrays (FPGA), and the like.

**[00250]** The present disclosure includes any novel feature or combination of features disclosed herein either explicitly or any generalization thereof. Various modifications and adaptations to the foregoing exemplary embodiments of this disclosure may become apparent to those skilled in the relevant arts in view of the foregoing description, when read in conjunction with the accompanying drawings. However, any and all modifications will still fall within the scope of the non-limiting and exemplary embodiments of this disclosure.

## Claims

1. A method for a communication system, comprising:  
creating (S111) an access stratum group including at least one terminal device;  
wherein the at least one terminal device is included in a same application group for supporting an application relating to the at least one terminal device.
2. The method according to claim 1, wherein creating an access stratum group comprises:  
creating (S1110) at least one subgroup, based on a predetermined criterion.
3. The method according to claim 2, wherein the predetermined criterion comprises at least one of:  
a sidelink resource allocation (RA) mode of the at least one terminal device;  
a coverage by a network, associated to the at least one terminal device;  
a serving base station for the at least one terminal device;  
a serving cell for the at least one terminal device;  
a physical position information of the at least one terminal device;  
a used frequency for communication of the at least one terminal device;  
a radio access technology (RAT) of the at least one terminal device;  
a number of terminal devices in each subgroup of the at least one subgroup; and  
a radio quality of the at least one terminal device.
4. The method according to claim 3, wherein a subgroup identifier is applied to a subgroup of the at least one subgroup.
5. The method according to claim 3, wherein a subgroup of the at least one subgroup comprises at least one terminal device with the same sidelink resource allocation mode.

6. The method according to claim 3, wherein a subgroup of the at least one subgroup comprises at least one terminal device with the same coverage by the network, and wherein the coverage by the network comprises one of: coverage by a new radio (NR) network, coverage by a long term evolution (LTE) network, coverage by a new radio (NR) network and a long term evolution (LTE) network, and non-coverage.

7. The method according to claim 3, wherein a subgroup of the at least one subgroup comprises at least one terminal device associated to a same serving base station.

8. The method according to claim 3, wherein a subgroup of the at least one subgroup comprises at least one terminal device associated to a same serving cell.

9. The method according to claim 3, wherein a subgroup of the at least one subgroup comprises at least two terminal devices with a distance between each pair of terminal devices within the at least two terminal devices being less than a predetermined threshold value, wherein the distance is determined based on the physical position information.

10. The method according to claim 3, wherein a subgroup of the at least one subgroup comprises at least one terminal device using a same frequency for communication.

11. The method according to claim 3, wherein a subgroup of the at least one subgroup comprises at least one terminal device with a same radio access technology (RAT).

12. The method according to claim 3, wherein the number of terminal devices in a subgroup of the at least one subgroup is less than a predetermined threshold value.

13. The method according to claim 3, wherein a subgroup of the at least one subgroup comprises at least one terminal device with a radio quality within a predetermined quality range, wherein the radio quality comprises at least one of: sidelink radio quality, and Uu radio quality.

14. The method according to claim 13, wherein the radio quality is indicated by at least one of: a reference signal receiving power (RSRP), a reference signal receiving quality (RSRQ), and traffic load situation.

15. The method according to claim 3,  
wherein a network node creates a subgroup, based on the predetermined criterion; and  
wherein during creating the subgroup, the network node configures a terminal device belonging to the subgroup without notifying the terminal device.

16. The method according to claim 3,  
wherein the at least one terminal device creates a subgroup distributedly, based on the predetermined criterion;  
wherein during creating the subgroup, a terminal device announces information relating to the predetermined criterion to other terminal devices; and  
wherein during creating the subgroup, the terminal device receives information from another terminal device to determine whether the terminal device and the another terminal device belong to a same subgroup.

17. The method according to any of claims 2 to 16, further comprising:  
applying (S411) a consistent access configuration for all terminal devices in a subgroup of the at least one subgroup.

18. The method according to claim 17, wherein the access configuration comprises at least one of: a quality of service (QoS) profile, and a bearer control profile.

19. The method according to claim 18, wherein a same QoS level is configured for all terminal devices in the subgroup of the at least one subgroup.

20. The method according to claim 18, wherein the quality of service (QoS) profile comprises a QoS level determined based on one of: an actual number of terminal devices in the subgroup, a predetermined maximum number of terminal devices allowed in the subgroup, and an estimated number of terminal devices to join the subgroup.

21. The method according to claim 17, further comprising:

removing (S412) a terminal device from the subgroup, in response to that the access configuration is no longer suitable for the terminal device.

22. The method according to claim 17, further comprising:

reconfiguring (S413) each terminal device in the subgroup consistently, in response to a change of the access configuration.

23. The method according to claim 22, wherein reconfiguring each terminal device comprises:

changing a same amount of the QoS level for all terminal devices in the subgroup.

24. The method according to claim 17, further comprising:

receiving (S511) a preemption request from a terminal device;

preempting (S512) radio resource allocated to terminal devices in a selected subgroup;

allocating (S513) the radio resource preempted from terminal devices in the selected subgroup to the terminal device sending the preemption request.

25. The method according to claim 24, wherein an amount of the preempted resource is proportional to a QoS level or an amount of the radio resource associated to the selected subgroup.

26. The method according to claim 24, wherein the selected subgroup is a subgroup associated with a highest QoS or each terminal device in the subgroup is allocated the most radio resources.

27. The method according to any of claims 2 to 26, further comprising:

removing a terminal device from a subgroup of the at least one subgroup, in response that the terminal device no long satisfies the predetermined criterion to be included in the subgroup.

28. The method according to any of claims 2 to 26, further comprising:

informing (S311) an application layer entity in the network of the at least one subgroup, wherein the application layer entity is associated to the application group.

29. The method according to any of claims 1 to 28, wherein the method is implemented by an access stratum entity in a terminal device and/or in a network.

30. The method according to claim 29, wherein the access stratum entity is in a base station of the network.

31. A method performed by a terminal device for a communication system, comprising:

joining (S611) an access stratum group including at least one terminal device;

wherein the at least one terminal device is included in a same application group for supporting an application relating to the at least one terminal device.

wherein joining (S611) the access stratum group comprising:

announcing information relating to a predetermined criterion to other terminal devices; and

receiving information from another terminal device to determine whether the terminal device and the another terminal device belong to a same group, based on the predetermined criterion.

32. The method according to claim 31, joining (S611) the access stratum group comprises:

joining a subgroup of the access stratum group, based on the predetermined criterion.

33. The method according to claim 32, further comprising:

utilizing (S612) an access configuration associated to the subgroup, wherein the access

configuration is consistent for all terminal devices in the subgroup.

34. The method according to claim 32, further comprising:

exiting (S613) from the subgroup, in response to no longer satisfying the predetermined criterion to be included in the subgroup.

35. The method according to any of claims 32 to 34, wherein the method is implemented by an access stratum entity in a terminal device.

36. A method for a communication system, comprising:

obtaining preempted resource from an access stratum group including at least one terminal device;

wherein the at least one terminal device is included in a same application group for supporting an application relating to the at least one terminal device.

37. The method according to claims 36, wherein the preempted resource is from a subgroup of the access stratum group.

38. The method according to claim 37, wherein an amount of the preempted resource is proportional to a QoS level or an amount of the radio resource associated to the subgroup.

39. The method according to claim 38, wherein the subgroup is a subgroup with a highest QoS or most radio resources.

40. The method according to any of claims 36 to 39, wherein the method is implemented by an access stratum entity in a terminal device.

41. A method for a communication system, comprising:

creating (S121) an application group including at least one terminal device for supporting an application relating to the at least one terminal device;

wherein the application group is associated to an access stratum group including the at least one terminal device.

42. The method according to claim 41, further comprising:

receiving (S321) information about at least one subgroup of the access stratum group, wherein the at least one subgroup is created based on a predetermined criterion.

43. The method according to claim 42, further comprising:

adjusting (S322) the application group based on the information about the at least one subgroup.

44. The method according to any of claims 41 to 43, wherein the method is implemented by an application layer entity in a terminal device and/or in a network.

45. An access stratum entity (110), comprising:

a processor (801); and

a memory (802), containing instructions executable by the processor;

wherein the access stratum entity (110) is operative to the method according to any of claims 1 to 40.

46. A communication system (1400) including a host computer (1410) comprising:

processing circuitry (1418) configured to provide user data; and

a communication interface (1416) configured to forward the user data to a cellular network for transmission to a terminal device (1430),

wherein the cellular network comprises a base station (1420);

wherein the base station (1420) comprises the access stratum entity (110) according to claim 45, and/or the terminal device (1430) comprises the access stratum entity (110) according to claim 45.

47. The communication system (1400) of claim 46, further including the terminal device (1430), wherein the terminal device (1430) is configured to communicate with the base station (1420).

48. The communication system (1400) of claim 47, wherein:

the processing circuitry (1418) of the host computer (1410) is configured to execute a host application, thereby providing the user data; and

the terminal device (1430) comprises processing circuitry (1438) configured to execute a client application associated with the host application.

49. A communication system (1400) including a host computer (1410) comprising:

a communication interface (1416) configured to receive user data originating from a transmission from a terminal device (1430);

a base station (1420);

wherein the transmission is from the terminal device (1430) to the base station (1420);

wherein the base station (1420) comprises the access stratum entity (110) according to claim 45, and/or the terminal device (1430) comprises the access stratum entity (110) according to claim 45.

50. The communication system (1400) of claim 49, wherein:

the processing circuitry (1418) of the host computer is configured to execute a host application;

the terminal device (1430) is configured to execute a client application associated with the host application, thereby providing the user data to be received by the host computer (1410).

51. An application layer entity (120), comprising:

a processor; and

a memory, containing instructions executable by the processor;

wherein the application layer entity is operative to the method according to any of claims 41 to 44.

52. A computer readable storage medium (700) having a computer program (701) stored thereon, the computer program (701) executable by a device to cause the device to carry out the method according to any one of claims 1-44.

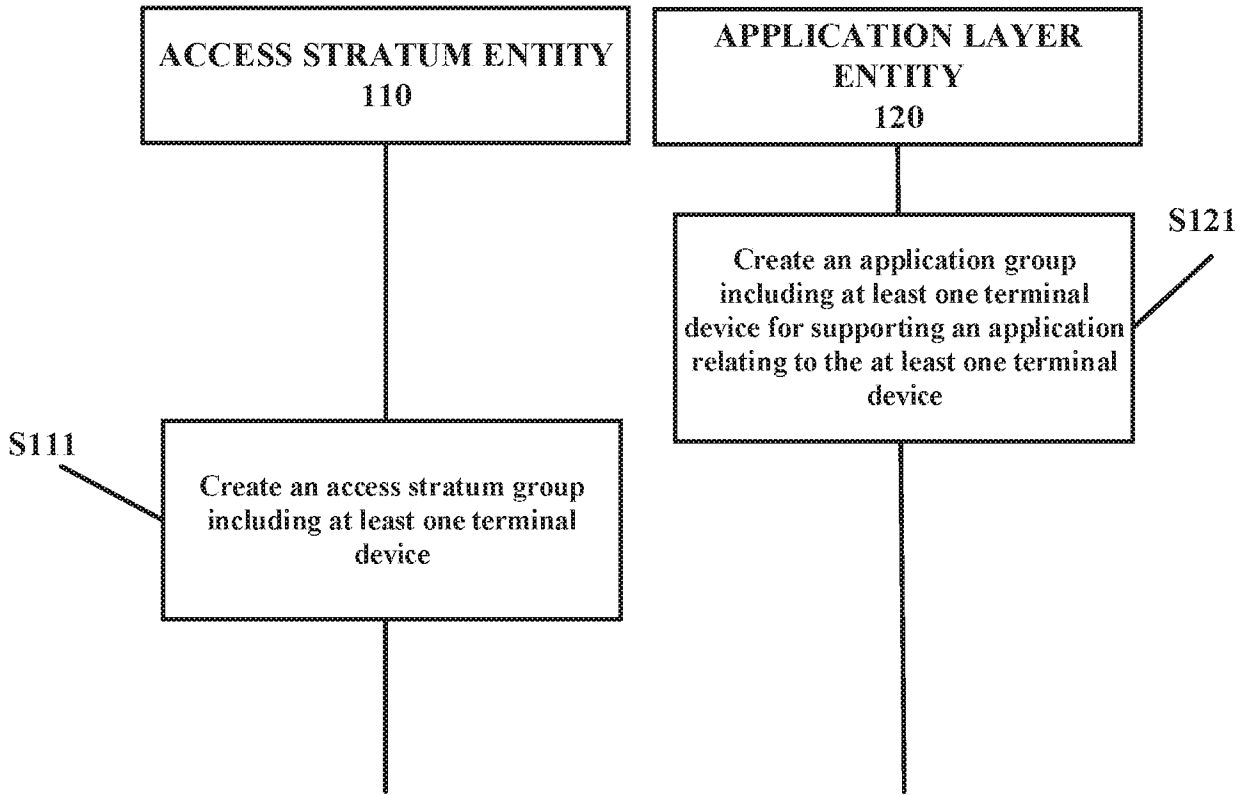


FIG. 1

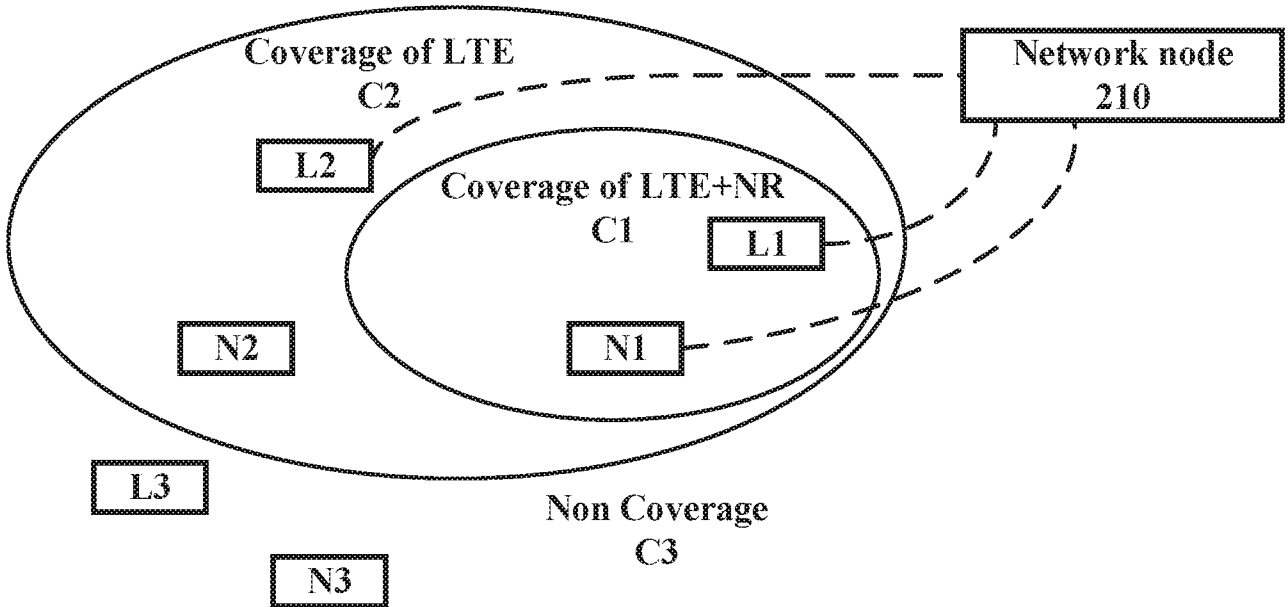


FIG. 2

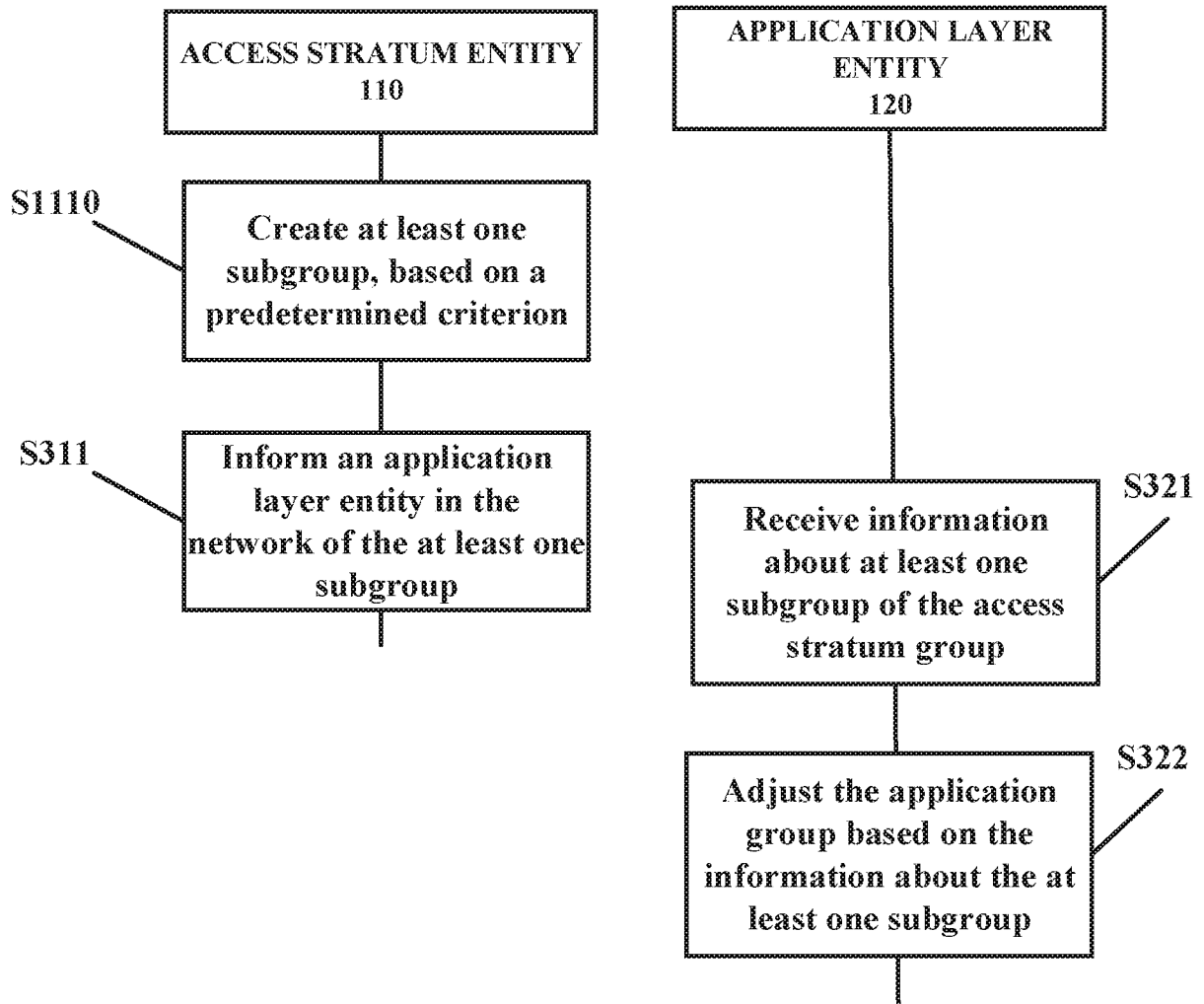


FIG. 3

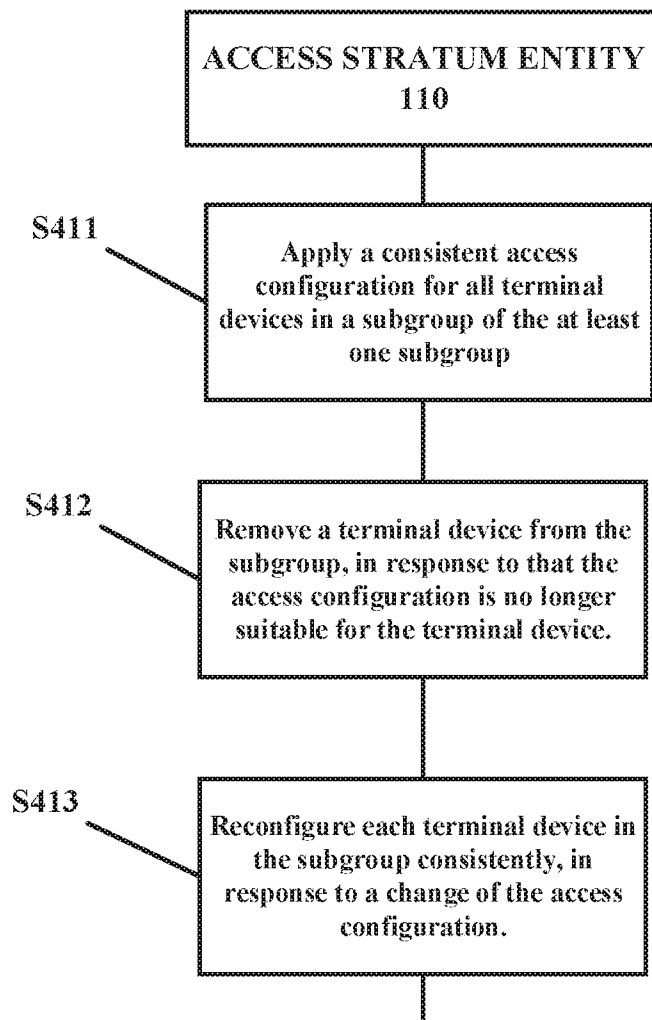


FIG. 4

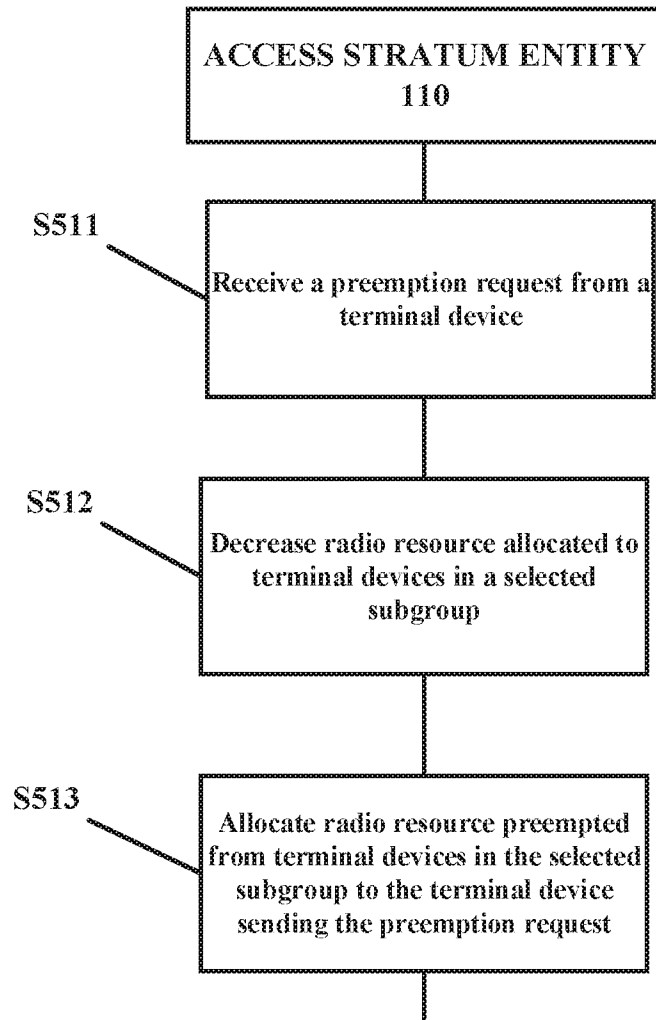


FIG. 5

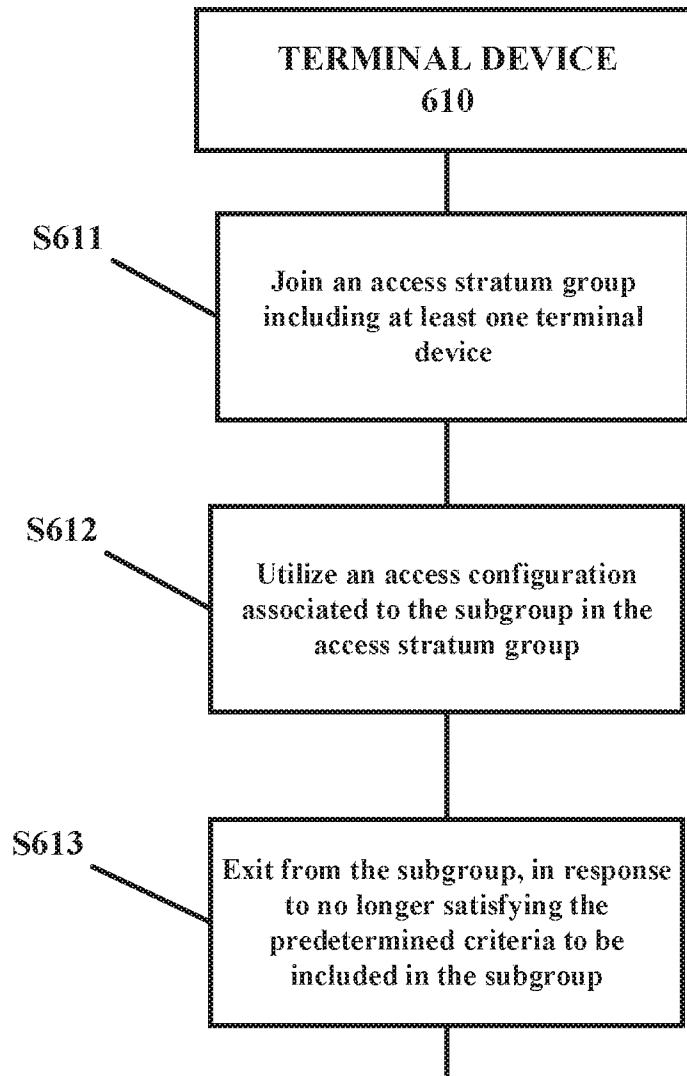


FIG. 6

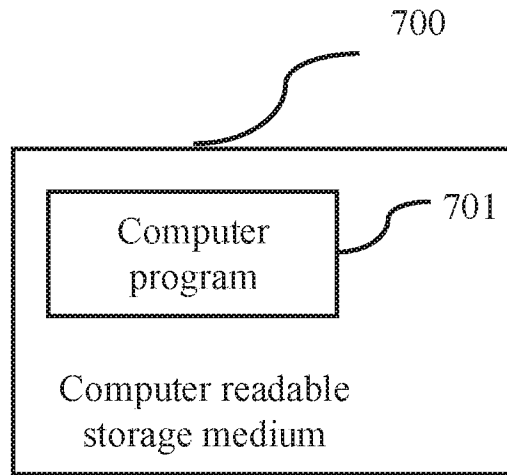


FIG. 7

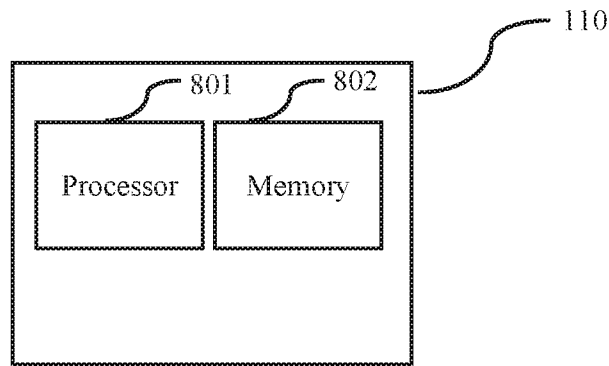
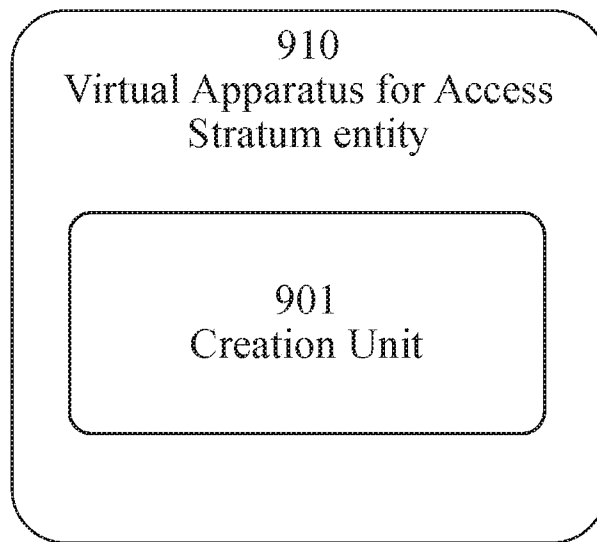


FIG. 8



**FIG. 9**

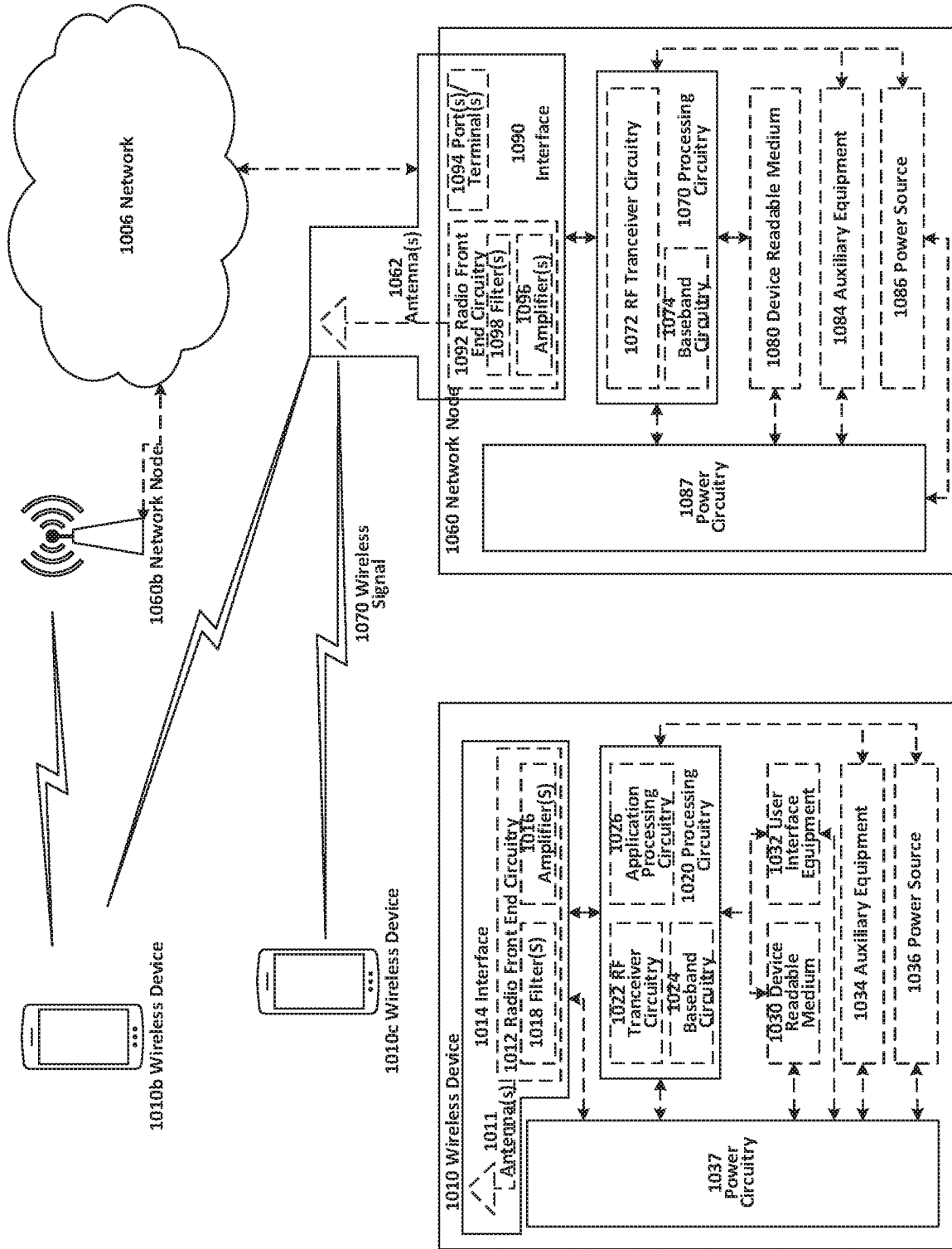


FIG. 10

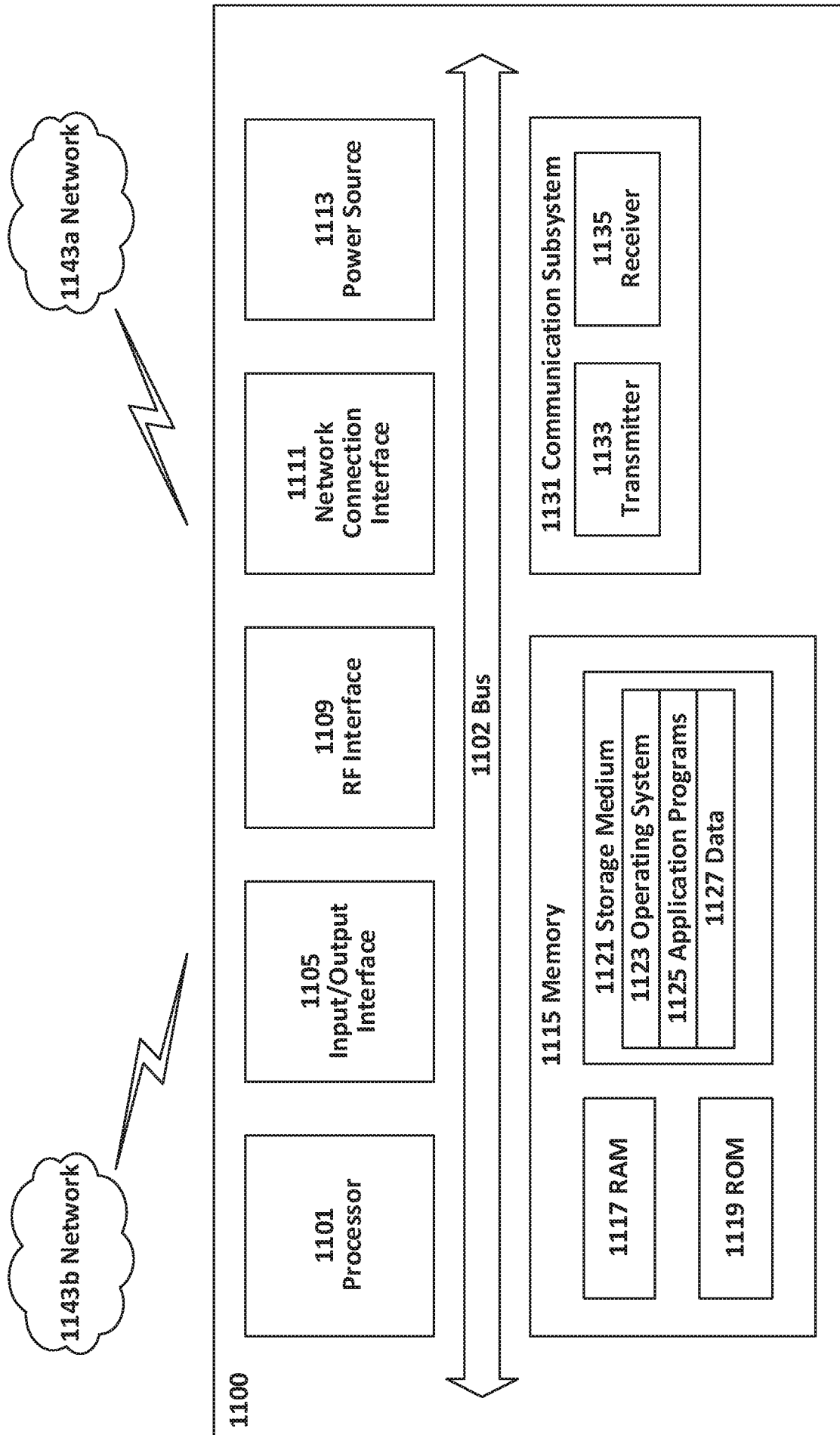


FIG. 11

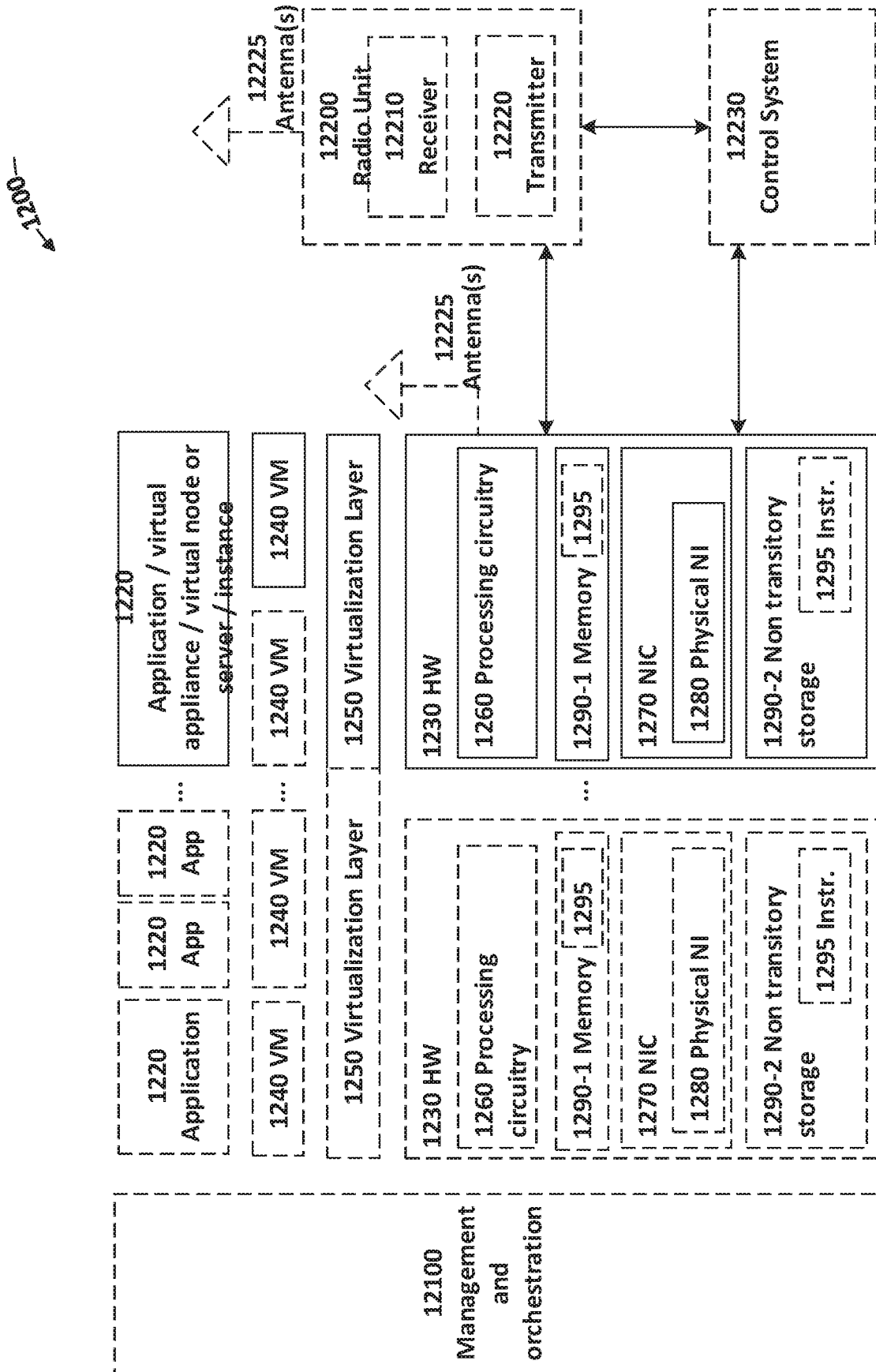


FIG. 12

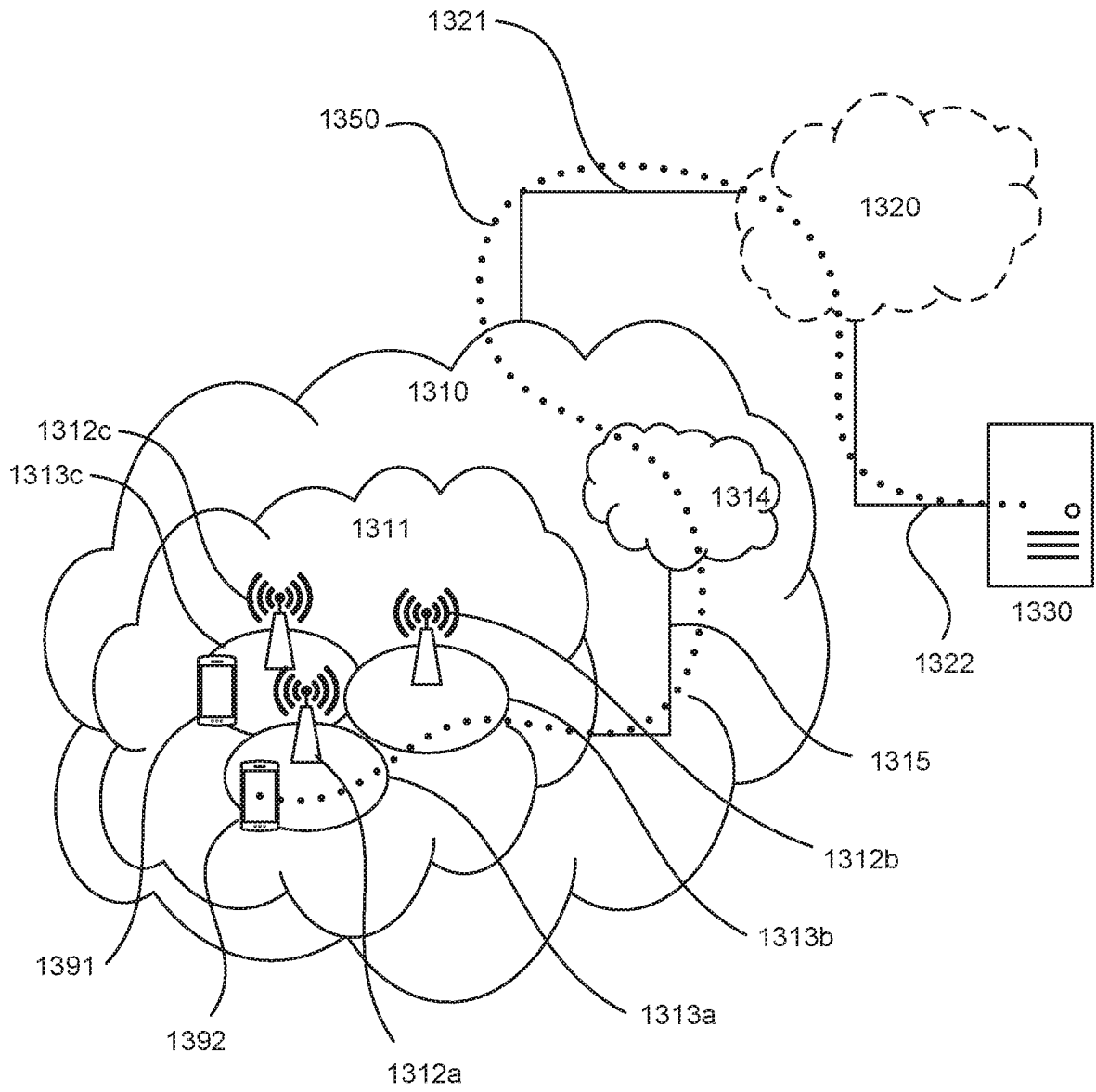


FIG. 13

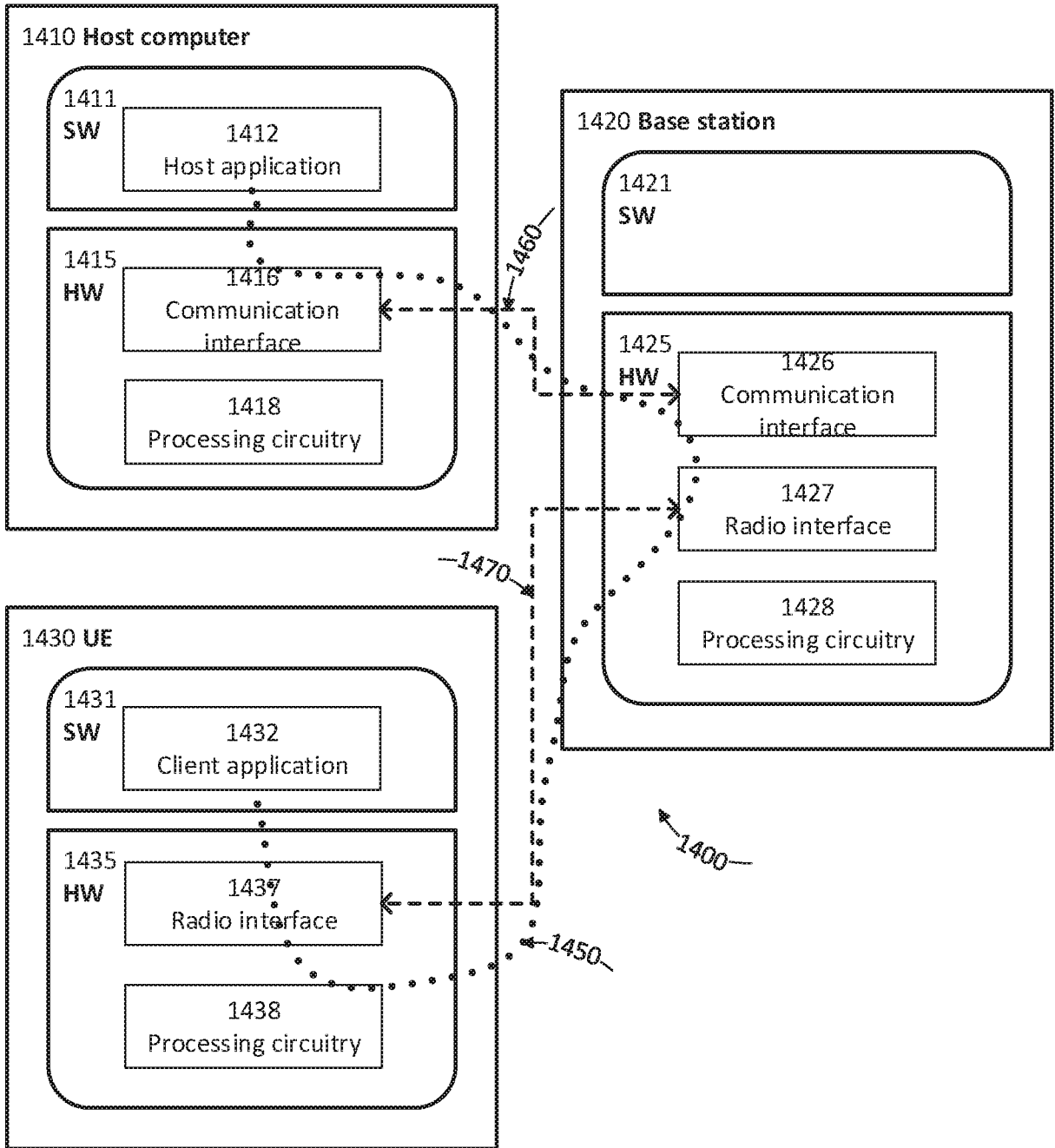


FIG. 14

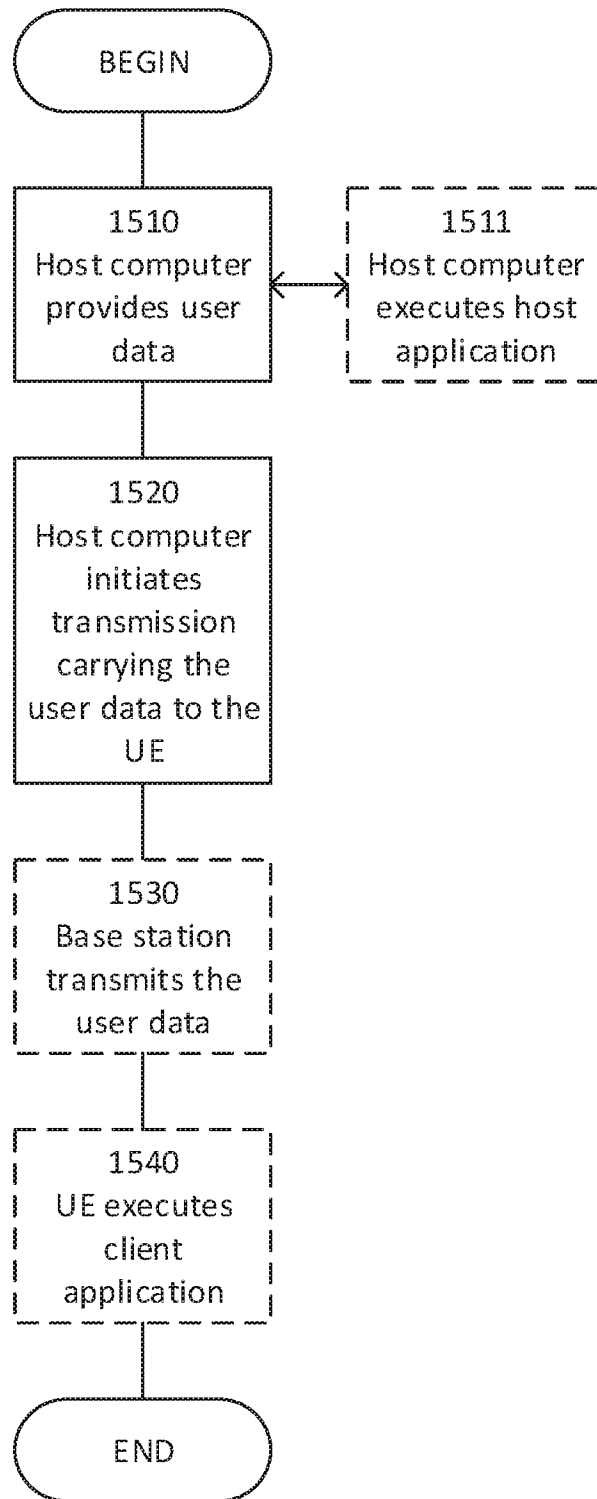


FIG. 15

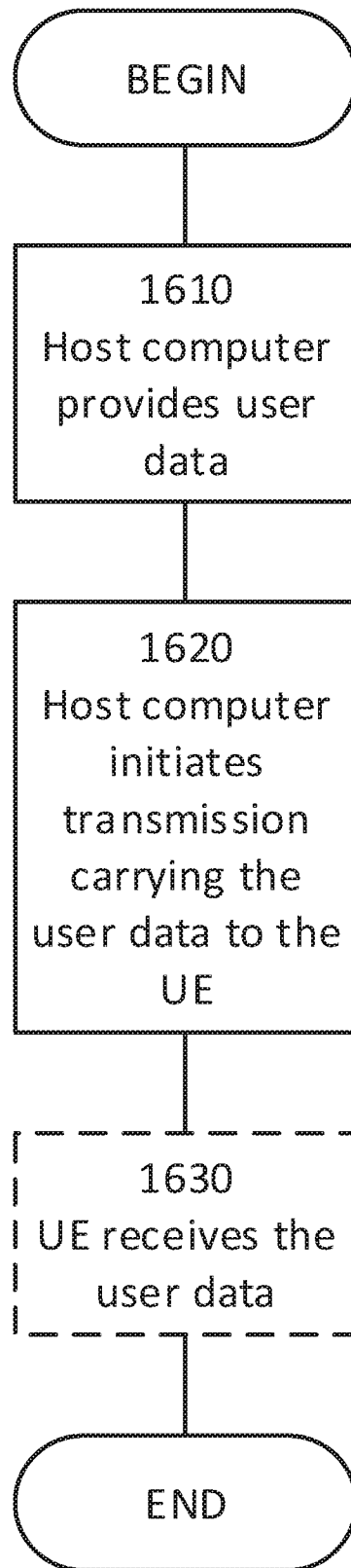


FIG. 16

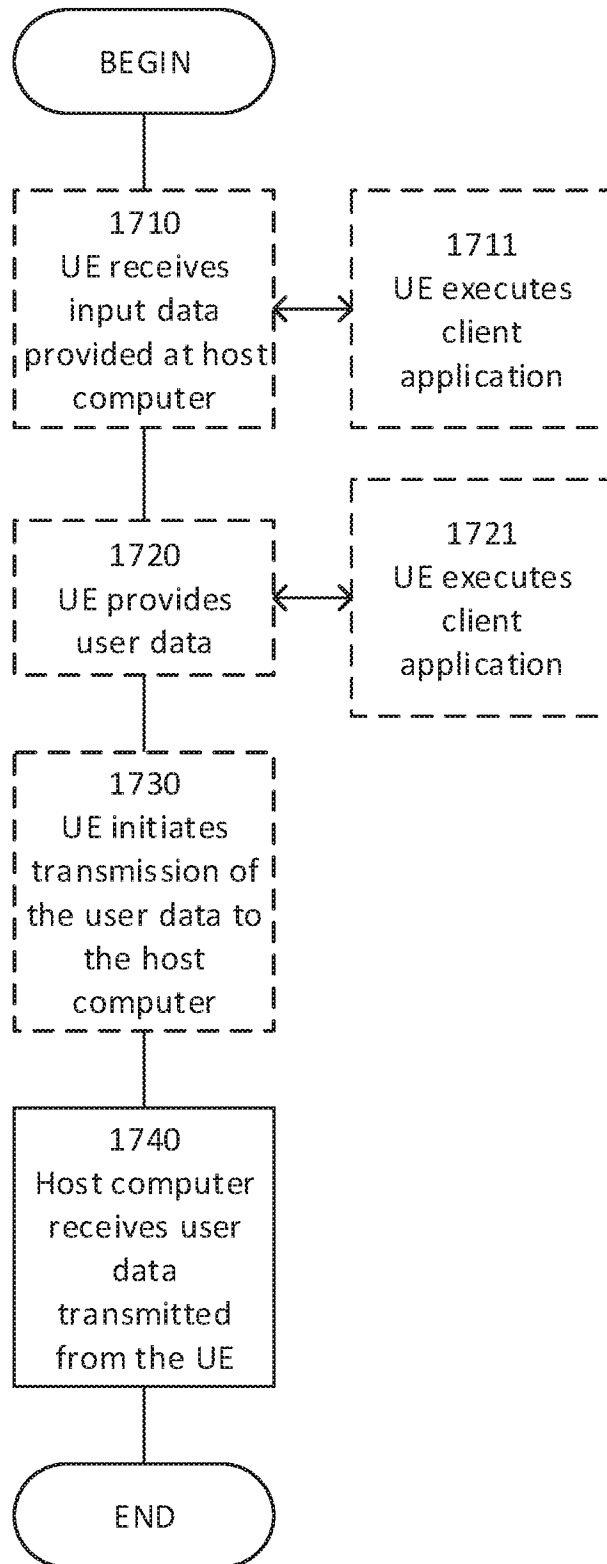


FIG. 17

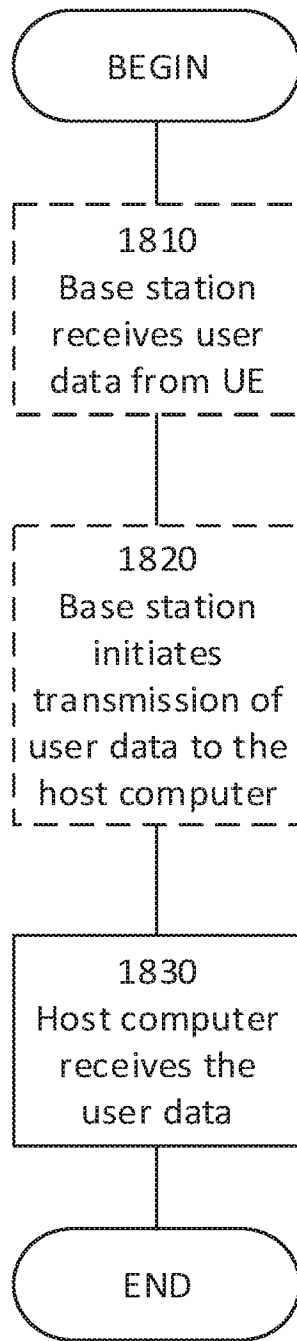


FIG. 18

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/098687

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
H04W 4/06(2009.01)i		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols)		
H04W; H04L		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
VEN;3GPP;CNABS;CNTXT;CNKI: creat, application, group, stratum, access, terminal		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 104540107 A (DONGGUAN YULONG COMMUNICATION TECHNOLOGY) 22 April 2015 (2015-04-22) description, paragraphs 49-97	1-52
A	CN 102948174 A (CASIO HITACHI MOBILE COMMUNICATIONS CO) 27 February 2013 (2013-02-27) the whole document	1-52
A	CN 102547989 A (MIN IND&INFORMATION TECHNOLOGY RES INS) 04 July 2012 (2012-07-04) the whole document	1-52
A	CN 108566299 A (JINAN INSPUR HIGH & NEW TECHNOLOGY INVES) 21 September 2018 (2018-09-21) the whole document	1-52
A	US 2017238221 A1 (QUALCOMM INC) 17 August 2017 (2017-08-17) the whole document	1-52
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
"A" document defining the general state of the art which is not considered to be of particular relevance		
"E" earlier application or patent but published on or after the international filing date		
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)		
"O" document referring to an oral disclosure, use, exhibition or other means		
"P" document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search	Date of mailing of the international search report	
<b>10 October 2019</b>	<b>18 October 2019</b>	
Name and mailing address of the ISA/CN	Authorized officer	
<b>National Intellectual Property Administration, PRC 6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088 China</b>	<b>SUN,Rongrong</b>	
Facsimile No. (86-10)62019451	Telephone No. 86-(010)-62089395	

**INTERNATIONAL SEARCH REPORT**  
**Information on patent family members**

International application No.

**PCT/CN2019/098687**

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	104540107	A	22 April 2015	None			
CN	102948174	A	27 February 2013	US	10412554	B2	10 September 2019
				US	9942730	B2	10 April 2018
				GB	2481788	A	11 January 2012
				JP	5758924	B2	05 August 2015
				US	2017280305	A1	28 September 2017
				EP	2583475	A4	28 June 2017
				JP	2017038391	A	16 February 2017
				US	2018184258	A1	28 June 2018
				EP	2583475	A1	24 April 2013
				GB	2481785	A	11 January 2012
				JP	6222326	B2	01 November 2017
				US	2013148565	A1	13 June 2013
				JP	2015149789	A	20 August 2015
				GB	201010896	D0	11 August 2010
				JP	2019013020	A	24 January 2019
				GB	201010846	D0	11 August 2010
				US	2017118605	A1	27 April 2017
				GB	2481396	A	28 December 2011
				JP	2018023157	A	08 February 2018
				JP	2013529861	A	22 July 2013
				US	9560491	B2	31 January 2017
				CN	102948174	B	24 June 2015
				WO	2011162401	A1	29 December 2011
				GB	201010393	D0	04 August 2010
				JP	6020664	B2	02 November 2016
				US	9813880	B2	07 November 2017
CN	102547989	A	04 July 2012	None			
CN	108566299	A	21 September 2018	None			
US	2017238221	A1	17 August 2017	WO	2017139531	A1	17 August 2017
				WO	2017139531	A8	14 December 2017