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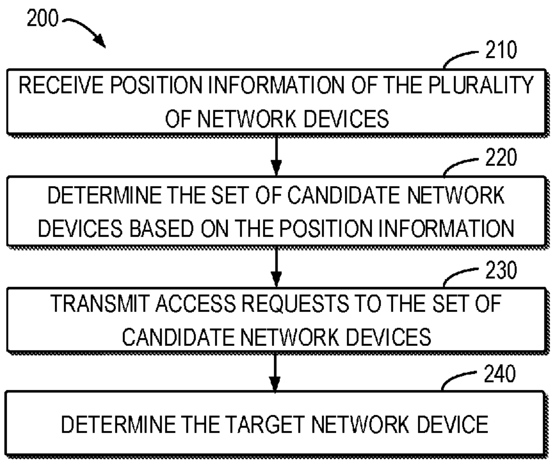

Fig. 2

(57) **Abstract:** Embodiments of the present disclosure relate to accessing approach in integrated networks. According to embodiments of the present disclosure, the network device transmits position information of network devices and the terminal device selects potential network devices based on its location and the position information. Further, the terminal device selects the serving network device based on downlink measurements and uplink measurements. In this way, the transmission delay is reduced and the power consumption at the terminal device is saved.

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ACCESSING APPROACH IN INTEGRATED NETWORK

FIELD

[0001] Embodiments of the present disclosure generally relate to the field of communications, especially in non-terrestrial network and in particular, to a method, device, apparatus and computer readable storage medium for accessing approach in integrated networks.

BACKGROUND

[0002] Since resources and infrastructure are limited in remote area, it is very difficult for terrestrial network to provide 5G coverage. The main benefits of introducing Non-Terrestrial Network (NTN) is to enable ubiquitous 5G services to terminal devices by extending connectivity in less densely populated areas with extremely low density of devices and the overall cost of deployment may be much less than providing permanent infra-structure on the ground. Using the space-borne or air-borne platforms may provide reliable coverage in remote areas, which have a distinct advantage. However, it has also brought some problems in other aspects.

SUMMARY

[0003] In general, example embodiments of the present disclosure provide a solution for accessing approach in integrated networks and corresponding communication devices.

[0004] In a first aspect, there is provided a first device. The first device comprises at least one processor; and at least one memory including computer program codes; the at least one memory and the computer program codes are configured to, with the at least one processor, cause the first device to receive, at the first device and from a second device, position information of a plurality of third devices. The first device is also caused to determine a set of candidate third devices from the plurality of third devices based on the position information and location of the first device. The first device is further caused to transmit access requests to the set of candidate third devices to measure qualities of communications between the first device and the set of candidate third devices. The first device is yet caused to determine a target third device from the set of candidate third devices based on the qualities.

[0005] In a second aspect, there is provided a second device. The second device comprises at least one processor; and at least one memory including computer program codes; the at least one memory and the computer program codes are configured to, with the at least one processor, cause the second device to obtain, at the second device, position information of a plurality of third devices. The second device is further caused to t transmit the position information to a first device for determining a target third device by the first device.

[0006] In a third aspect, there is provided a third device. The third device comprises at least one processor; and at least one memory including computer program codes; the at least one memory and the computer program codes are configured to, with the at least one processor, cause the third device to transmit, at a third device, position information to a second device. The third device is also caused to in response to a determination that a distance between the third device and a first device being below a threshold distance, receive an access request from a first device. The third device is further caused to r perform an uplink measurement based on the access request to obtain quality of communication between the first device and the third device. The third device is yet caused to transmit the quality of communication to the first device or the second device.

[0007] In a fourth aspect, there is provided a method. The method comprises receiving, at the first device and from a second device, position information of a plurality of third devices. The method further comprises determining a set of candidate third devices from the plurality of third devices based on the position information and location of the first device. The method also comprises transmitting access requests to the set of candidate third devices to measure qualities of communications between the first device and the set of candidate third devices. The method yet comprises determining a target third device from the set of candidate third devices based on the qualities.

[0008] In a fifth aspect, there is provided a method. The method comprises obtaining, at the second device, position information of a plurality of third devices. The method also comprises transmitting the position information to a first device for determining a target third device by the first device.

[0009] In a sixth aspect, there is provided a method. The method comprises transmitting, at a third device, position information to a second device. The method further comprises in response to a determination that a distance between the third device and a first device being below a threshold distance, receiving an access request from a first device. The method also comprises performing an uplink measurement based on the access request to obtain quality of communication between the first device and the third device. The method yet comprises transmitting the quality of communication to the first device or the second device.

[0010] In a seventh aspect, there is provided an apparatus. The apparatus comprises means for receiving, at the first device and from a second device, position information of a plurality of third devices; means for determining a set of candidate third devices from the plurality of third devices based on the position information and location of the first device; means for transmitting access requests to the set of candidate third devices to measure qualities of communications between the first device and the set of candidate third devices; and means for determining a target third device from the set of candidate third devices based on the qualities.

[0011] In an eighth aspect, there is provided an apparatus. The apparatus comprises means for obtaining, at the second device, position information of a plurality of third devices; and means for transmitting the position information to a first device for determining a target third device by the first device.

[0012] In a ninth aspect, there is provided an apparatus. The apparatus comprises means for transmitting, at a third device , position information to a second device; means for in response to a determination that a distance between the third device and a first device being below a threshold distance, receiving an access request from a first device; means for performing an uplink measurement based on the access request to obtain quality of communication between the first device and the third device; and means for transmitting the quality of communication to the first device or the second device.

[0013] In a tenth aspect, there is provided a non-transitory computer readable medium comprising program instructions for causing an apparatus to perform at least the method according to any one of the above fourth to sixth aspects.

[0014] It is to be understood that the summary section is not intended to identify key or essential features of embodiments of the present disclosure, nor is it intended to be used to limit the scope of the present disclosure. Other features of the present disclosure will become easily comprehensible through the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Some example embodiments will now be described with reference to the accompanying drawings, where:

[0016] Fig. 1 illustrates an example communication network in which embodiments of the present disclosure may be implemented;

[0017] Fig. 2 illustrates a flowchart of a method implemented at a terminal device according to some embodiments of the present disclosure;

[0018] Fig. 3 illustrates a flowchart of a method implemented at a terminal device according to some embodiments of the present disclosure;

[0019] Fig. 4 illustrates a flowchart of a method implemented at a network device according to some embodiments of the present disclosure;

[0020] Fig. 5 illustrates a schematic diagram of interactions among communication devices according to some embodiments of the present disclosure;

[0021] Fig. 6 illustrates a schematic diagram of interactions among communication devices according to some embodiments of the present disclosure;

[0022] Fig. 7 illustrates a simplified block diagram of a device that is suitable for implementing embodiments of the present disclosure; and

[0023] Fig 8 illustrates a block diagram of an example computer readable medium in accordance with some embodiments of the present disclosure.

[0024] Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

[0025] Principle of the present disclosure will now be described with reference to some example embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure.

The disclosure described herein can be implemented in various manners other than the ones described below.

[0026] In the following description and claims, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

[0027] References in the present disclosure to “one embodiment,” “an embodiment,” “an example embodiment,” and the like indicate that the embodiment described may include a particular feature, structure, or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

[0028] It shall be understood that although the terms “first” and “second” etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and similarly, a second element could be termed a first element, without departing from the scope of example embodiments. As used herein, the term “and/or” includes any and all combinations of one or more of the listed terms.

[0029] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example embodiments. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises”, “comprising”, “has”, “having”, “includes” and/or “including”, when used herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/ or combinations thereof.

[0030] As used in this application, the term “circuitry” may refer to one or more or all of the following:

(a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and

(b) combinations of hardware circuits and software, such as (as applicable):

(i) a combination of analog and/or digital hardware circuit(s) with software/firmware and

(ii) any portions of hardware processor(s) with software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions) and

(c) hardware circuit(s) and or processor(s), such as a microprocessor(s) or a portion of a microprocessor(s), that requires software (e.g., firmware) for operation, but the software may not be present when it is not needed for operation.

[0031] This definition of circuitry applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term circuitry also covers an implementation of merely a hardware circuit or processor (or multiple processors) or portion of a hardware circuit or processor and its (or their) accompanying software and/or firmware. The term circuitry also covers, for example and if applicable to the particular claim element, a baseband integrated circuit or processor integrated circuit for a mobile device or a similar integrated circuit in server, a cellular network device, or other computing or network device.

[0032] As used herein, the term “communication network” refers to a network following any suitable communication standards, such as Long Term Evolution (LTE), LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), High-Speed Packet Access (HSPA), Narrow Band Internet of Things (NB-IoT) ，New Radio（NR），Non-terrestrial network (NTN)and so on. Furthermore, the communications between a terminal device and a network device 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), the fourth generation (4G), 4.5G, the future fifth generation (5G) communication protocols, and/or any other protocols either currently known or to be developed in the future. Embodiments of the present disclosure may be applied in various communication systems. Given the rapid development in communications, there will of course also be future type communication technologies and systems with which the present disclosure may be embodied. It should not be seen as limiting the scope of the present disclosure to only the aforementioned system.

[0033] As used herein, the term “network device” refers to a node in a communication network via which a terminal device accesses the network and receives services therefrom. The network device may refer to a base station (BS) or an access point (AP), for example, a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a NR NB (also referred to as a 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, depending on the applied terminology and technology.

[0034] The term “terminal device” refers to any end device that may be capable of wireless communication. By way of example rather than limitation, a terminal device may also be referred to as a communication device, user equipment (UE), a Subscriber Station (SS), a Portable Subscriber Station, a Mobile Station (MS), or an Access Terminal (AT). The terminal device may include, but not limited to, a mobile phone, a cellular phone, a smart phone, voice over IP (VoIP) phones, wireless local loop phones, a tablet, a wearable terminal device, a personal digital assistant (PDA), portable computers, desktop computer, image capture terminal devices such as digital cameras, gaming terminal devices, music storage and playback appliances, vehicle-mounted wireless terminal devices, wireless endpoints, mobile stations, laptop-embedded equipment (LEE), laptop-mounted equipment (LME), USB dongles, smart devices, wireless customer-premises equipment (CPE), an Internet of Things (loT) device, a watch or other wearable, a head-mounted display (HMD), a vehicle, a drone, a medical device and applications (e.g., remote surgery), an industrial device and applications (e.g., a robot and/or other wireless devices operating in an industrial and/or an automated processing chain contexts), a consumer electronics device, a device operating on commercial and/or industrial wireless networks, and the like. In the following description, the terms “terminal device”, “communication device”, “terminal”, “user equipment” and “UE” may be used interchangeably.

[0035] As mentioned above, the NTN has also brought some problems in other aspects. For the NTN, the round-trip time (RTT) to the terminal device can be much larger than that in the terrestrial networks. Therefore, it is necessary to consider its impact for different aspects of new radio (NR) design, including cell search, Timing Advance (TA) adjustment and random access channel (RACH) procedure.

[0036] Large propagation delay may lead to long random access (RA) response procedure. The conventional gNB-UE hands-shaking based legacy preamble transmission/retransmission may lead to large access delay and long RA delay, which means long data transmission delay. As a result, it is highly necessary to shorten the RA transmission/ retransmission delay based on the air-borne gNB information to make the terminal device efficient and power saving.

[0037] For systems of Medium Earth orbit (MEO), Low-Earth Orbit (LEO) and High-Altitude Pseudo-Satellite (HAPS) in NTN network, there are strong varying delays because satellites and terminal devices are fast-moving and are not relatively static. In conventional technologies, there may be a stage where the satellites and the terminal devices must sweep through available antenna space until they find the proper beam pair (proper spot beam on proper satellite) to communicate. This is called the cell search (CS) procedure. After that, terminal devices in idle mode may initiate a random access (RA) procedure in order to acquire specific information from the serving satellite. If the CS and RA phases are not properly managed, it may result in significant impact on delay-sensitive applications and the overall performance may be degraded. Another problem is the individual TAs of the terminal devices have to be fast updated dynamically and appropriate TA index values are needed.

[0038] Furthermore, how to select the final serving satellites by the terminal device depending on both of uplink/downlink results in CS and RA phases are significantly important. For these reasons, it is necessary to propose a faster and more reliable beam pair discovery. It also needs to establish a fine refinement of access air-borne gNB in CS and contention-based RA phases as a reference method and to design a NTN-specific fast refinement of air-borne gNBs in contention-free RA phases. In addition, multiple critical factors including the latency, TA adjustment, link reliability, UE power consumption need to be taken into consideration at the same time rather than just a single aspect.

[0039] In conventional technologies, downlink based measurement is used for cell selection/reselection and access. The terminal device may first conduct downlink synchronization to space born/air borne neighboring cells and perform downlink measurement. However, huge power consumption and time delay may occur since the terminal device has to first beam aligned to the target network device before downlink synchronization and downlink measurement.

[0040] Further, uplink based measurement has been proposed. The terminal device does not need to do downlink synchronization. The terminal device only sends uplink reference signal or pilot signals (either periodically or event triggered) for surrounding air-borne gNBs perform downlink measurement. Based on the assumption that if terminal device is strictly uplink synchronized to NTN UE-Relay, then terminal device should be coarsely uplink synchronized to other network devices. Assuming that surrounding air-borne gNBs can detect the uplink reference signals of terminal device, then each of them do the uplink measurement, including the uplink beam aligned, uplink channel quality measurement, such as RSRP. Corresponding air-borne gNB sends report table (RT) to NTN UE-Relay through the NTN link, including the UL beam aligned information, search information. Then NTN UE-Relay finally update the serving air-borne gNB set, that is, NTN UE-Relay will make decision on which air-borne gNB should serve the related terminal device in the following. The NTN UE-Relay could select the maximum Signal to Interference plus Noise Ratio (SINR) to have the best channel propagation conditions.

[0041] However, the final target network device is totally determined by NTN UE-Relay based on the uplink measurement, which may not be optimal for downlink transmission, because most of the conventional satellite systems operate in the frequency bands designated for frequency division duplex (FDD) mode especially in GEO and MEO system. It may also impact on downlink performance since downlink transmission may be still the major case for data communication.

[0042] Other conventional technologies do not consider the optimization of air-to-ground transmitting efficiency. Moreover, they do not take into account the methods to avoid the UE power consumption and maintain the transmission reliability at the same time, which is critical in the real application. Thus, new mechanism for accessing integrated system is needed.

[0043] According to embodiments of the present disclosure, the network device transmits position information of network devices and the terminal device selects potential network devices based on its location and the position information. Further, the terminal device selects the serving network device based on downlink measurements and uplink measurements. In this way, the transmission delay is reduced and the power consumption at the terminal device is saved.

[0044] Principle and embodiments of the present disclosure will be described in detail below with reference to the accompanying drawings. Reference is first made to Fig. 1, which illustrates an example communication system 100 in which embodiments of the present disclosure may be implemented.

[0045] Fig. 1 illustrates a schematic diagram of a communication system 100 in which embodiments of the present disclosure can be implemented. The communication system 100 comprises the first devices 110, the second device 120 and the third device 130. For the purpose of illustrations, the first devices 110 may be referred to as the terminal device 110 and the second device 120 may be referred to as the network device 120 hereinafter. It should be noted that the first devices and the second devices are interchangeable. For example, the procedures which are described to be implemented at the terminal device may also be able to be implemented at the network device and the procedures which are described to be implemented at the network device may also be able to be implemented at the terminal device.

[0046] The link from the second device 120 to the first devices 110 may be referred to as the "downlink" and the link from the first devices 110 to the second device 120 may be referred to as the "uplink".

[0047] The communication system 100, which is a part of a communication network, comprises terminal devices 110-1, 110-2, . . . , 110-N (collectively referred to as "terminal device(s) 110" where N is an integer number). The communication system 100 comprises one or more network devices, for example, a network device 120. The network device 120 may be a NTN UE-Relay or (NTN IAB). The NTN UE-Relay is like the concept of terrestrial dual-connectivity. As an example, in the NTN discussion on Hybrid Automatic Repeat Request (HARQ), in case of deactivated HARQ, when it is required to guarantee a certain quality of service, the HARQ operation can still be resumed (with a reduced latency) utilizing a dual-connectivity with a ground station in a terrestrial network offloading scenario. Once the terminal device is in the coverage of a terrestrial node together with the NTN node, the initial transmission can be sent over the NTN link, while HARQ retransmissions (other RVs) and HARQ ACK/NACK feedbacks can simply flow over the terrestrial links (i.e., rather than the unstable NTN links). Here the NTN UE-Relay is not the full featured network device, it has the function of buffer, relay and control and in a sense, a relayer/IAB entity could be used instead of the NTN UE-Relay. In addition, besides GPS and GNSS, the positioning information could also be obtained from other positioning methods.

[0048] The system 100 also comprise the network device 130-1, 130-2, . . . , 130-N (collectively referred to as "network device(s) 130" where N is an integer number). The network device 130 may be air-bone network devices, for example, satellite. The network device 120 is fixed and has more reliable link with the network devices 130 than the terminal devices 110.

[0049] It should be understood that the communication system 100 may also comprise other elements which are omitted for the purpose of clarity. It is to be understood that the numbers of terminal devices and network devices shown in Fig. 1 are given for the purpose of illustration without suggesting any limitations. The terminal devices 110, the network device 120 and the network devices 130 may communicate with each other.

[0050] It is to be understood that the number of network devices and terminal devices is only for the purpose of illustration without suggesting any limitations. The system 100 may include any suitable number of network devices and terminal devices adapted for implementing embodiments of the present disclosure.

[0051] Communications in the communication system 100 may be implemented according to any proper communication protocol(s), comprising, but not limited to, cellular communication protocols of the first generation (1G), the second generation (2G), the third generation (3G), the fourth generation (4G) and the fifth generation (5G) and on the like, wireless local network communication protocols such as Institute for Electrical and Electronics Engineers (IEEE) 802.11 and the like, and/or any other protocols currently known or to be developed in the future. Moreover, the communication may utilize any proper wireless communication technology, comprising but not limited to: Code Division Multiple Access (CDMA), Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Frequency Division Duplex (FDD), Time Division Duplex (TDD), Multiple-Input Multiple-Output (MIMO), Orthogonal Frequency Division Multiple (OFDM), Discrete Fourier Transform spread OFDM (DFT-s-OFDM) and/or any other technologies currently known or to be developed in the future.

[0052] Fig. 2 shows a flowchart of an example method 200 implemented at a terminal device in accordance with some embodiments of the present disclosure. The method 300 may be implemented at any suitable devices. For the purpose of discussion, the method 300 will be described from the perspective of the terminal device 110-1 with reference to Fig. 1.

[0053] At block 210, the terminal device 110-1 receives position information of the plurality of network devices 130 from the network device 120. For example, the terminal device may receive the coordinate and ephemeris of the network devices 130. In scenario of contention-free communications, the terminal device 110-1 may also receive system information from the network device 120, which originally acquired from the CS phase through synchronization signal block (SSB) detection. For fast access, the system information (for example, common delay, and position information) may be forwarded by the network device 120 rather than acquisition from the traditional SSB detection. The terminal device 110-1 may also receive information of propagation delay from the network device 120 to achieve the fast TA adjustment. In this way, the transmission delay is reduced.

[0054] At block 220, the terminal device 110-1 determines a set of candidate network devices (for example, the network devices 130-1, 130-2 and 130-3) from the plurality of network devices 130 based on the position information and location of the terminal device 110-1. It should be noted that the number of candidate network devices can be any suitable number.

[0055] In some embodiments the terminal device 110-1 may determine the distance between the terminal device 110-1 and the network devices 130. If the distance is smaller than a threshold distance, the terminal device 110-1 may determine the network device belongs to the set of candidate network devices. Alternatively, the terminal device 110-1 may select a number of closest network devices to be the set of candidate network devices.

[0056] In some embodiments, the terminal device 110-1 may calculate one closest terminal device 130-1. Both the terminal device 110-1 and the terminal device 130-1 know, from the CS phase, the best directions through which they should steer their beams, and therefore they may exchange the following RA messages. In other embodiments, the terminal device 110-1 may calculate several closest candidate network devices 130 (for example, the network devices 130-1, 130-2 and 130-3) and steers a beam toward each network devices 130 from the best direction. The steered beams may go through three situations: deviation, no deviation, and blockage or deafness. In some embodiments, especially in the last case of blockage or deafness, once the direct path does not correspond to the good channel conditions, candidate beams can be explored. For example, the terminal device 110-1 may form additional beams in adjacent directions symmetrically to look for a stronger path.

[0057] In scenario of contention-based system, the terminal device 110-1 may receive one or more of primary synchronization signal (PSS), secondary synchronization signal (SSS) or a physical broadcast channel (PBCH) at the steered beam detection for acquisition of system information. The propagation delay can be obtained from the system information. For one given beam covering a cell, there is one common propagation delay for all served terminal devices.

[0058] The common propagation delay is at the point when the terminal device 110-1 locates at the Nadir distance corresponding to the vertical footprint. The terminal device 110-1 may use this information to compensate the physical random access channel (PRACH) transmit time so that PRACH from terminal devices 110 within the beam are received by the network device 130 more or less in same time window. The common response delay can be roughly estimated at the base station side when the NTN is deployed. For example, when a satellite is deployed, its altitude information should be determined and accessible by itself. Then, the propagation delay can be estimated based on its altitude carried in the system information block (SIB). Since the different airborne access points have different Nadir distances, different propagation delays can be obtained respectively from each air-borne network devices.

[0059] At block 230, the terminal device 110-1 transmits access requests to the set of candidate network devices 130-1, 130-2 and 130-3. The access requests may be used to measure communication qualities. In some embodiments, as mentioned above, the terminal device 110-1 may obtain the propagation delay by synchronization signals or from the network device 120, the terminal device 110-1 may transmit the access request with the delay compensation based on the propagation delay.

[0060] In some embodiments, due to the mobility of the terminal device and deviation or sudden change of position, the terminal device 110-1 may transmit PRACH (MSG.1) to the set of candidate network devices 130-1, 130-2 and 130-3 through the best directions obtained from the CS phase when the location of the terminal device 110-1 is comparatively stable. In some embodiments, the terminal device 110-1 may transmit PRACH (MSG.10 to the set of candidate network devices 130-1, 130-2 and 130-3 though beam sweeping pattern due to high speed mobility of the terminal device 110-1 and GPS-based deviation.

[0061] At block 240, the terminal device 110-1 determines a target network device from the set of candidate network devices based on the communication qualities. In this way, hybrid DL and UL measurement considering both the link reliability is achieved.

[0062] In some embodiments, the terminal device 110-1 may receive access responses from the set of candidate network devices 130-1, 130-2 and 130-3. The access response may comprise the qualities of communications between the terminal device 110-1 and the set of candidate network devices 130-1, 130-2 and 130-3. For example, the candidate network device 130-1 may provide a signal quality metric in the random access response (MSG 2) to allow the terminal device 110-1 to select the beast uplink transmitting beam. The terminal device 110-1 may perform downlink measurements on the access responses. The terminal device 110-1 may determine the target network device based on the qualities of communications and the downlink measurements.

[0063] Alternatively or in addition, the terminal device 110-1 may receive a subset of the set of candidate network devices 130-1, 130-2 and 130-3 from the network device 120. For example, the terminal device 110-1 may receive the identity information of the network devices 130-1 and 130-2. The subset of candidate network devices may be determined by the network device 120, which will described in details later. In this way, power consumption at the terminal device is saved. The terminal device 110-1 may perform downlink measurements on the access responses of the subset of candidate network devices 130-1 and 130-2. In some embodiments, the terminal device 110-1 may measure Reference Signal Received Power (RSRP) on the downlink. Alternatively or in addition, the terminal device 110-1 may measure Signal to Interference plus Noise Ratio (SINR) on the downlink. The terminal device 110-1 may determine the network device 130-1 to be the target network device based on the downlink measurements. For example, if the downlink measurement indicates quality of the downlink of the network device 130-1 is the best, the terminal device 110-1 may determine the network device 130-1 to be the target network device. In some embodiments, the terminal device 110-1 may transmit information of the target network device 130-1 to the network device 120.

[0064] Fig. 3 shows a flowchart of an example method 300 implemented at a terminal device in accordance with some embodiments of the present disclosure. The method 300 may be implemented at any suitable devices. For the purpose of discussion, the method 300 will be described from the perspective of the network device 120 with reference to Fig. 1.

[0065] At block 310, the network device 120 obtains position information of the plurality of network devices 130. The position information may comprise the coordinate and ephemeris of the network devices 130.

[0066] At block 320, the network device 120 transmits the position information to the terminal device 110-1. The position information is used for determining a target network device 130-1 by the terminal device 110-1. In scenario of contention-free communications, the network device 120 may also transmit system information to the terminal device 110-1, which originally acquired from the CS phase through synchronization signal block (SSB) detection. For fast access, the system information (for example, common delay, and position information) may be forwarded by the network device 120 rather than acquisition from the traditional SSB detection. The network device 120 may also transmit information of propagation delay to the terminal device 110-1 to achieve the fast TA adjustment. In this way, the transmission delay is reduced.

[0067] In some embodiments, the network device 120 may receive information concerning qualities of communications between the terminal device 110-1 and a set of candidate network devices (for example, the network devices 130-1, 130-2 and 130-3). The network device 120 may determine a subset of candidate network devices (the network devices 130-1 and 130-2). For example, if the network device 120 determines the communication quality of the network device 130-1 exceeds a threshold quality and the network device 120 determines that the network device 130-1 belongs to the subset. Alternatively, the network device 120 may determine a number of network devices with better communication quality. The number may be any suitable number. The network device 120 may transmit information concerning the subset of candidate network devices to the terminal device 110-1. The terminal device 110-1 may determine the target network device from the subset of candidate network devices. In this way, the computation burden on the terminal device has released to reduce power consumption.

[0068] In some embodiments, the network device 120 may receive information of the target network device 130-1 from the terminal device 110-1. The network device 120 may inform other network devices 130 other than the network device 130-1 that they fail in the selection and the terminal device 110-1 does not select them.

[0069] Fig. 4 shows a flowchart of an example method 400 implemented at a terminal device in accordance with some embodiments of the present disclosure. The method 400 may be implemented at any suitable devices. For the purpose of discussion, the method 400 will be described from the perspective of the network device 130-1 with reference to Fig. 1

[0070] At block 410, the network device 130-1 transmits its position information to the network device 120. The position information may comprise the coordinate and ephemeris of the network device 130-1.

[0071] At block 420, the network device 130-1 receives an access request from the terminal device 110-1 of the distance between the network device 130-1 and the terminal device 110-1 is below a threshold distance. As discussed above, the terminal device 110-1 may select a set of network device which are closest to the terminal device 110-1 and transmit

[0072] At block 430, the network device 130-1 performs measurement on the access request to obtain quality of communication between the network device 130-1 and the terminal device 110-1. In some embodiments, the network device 130-1 may measure RSRP on the access request. Alternatively or in addition, the network device 130-1 may SINR on the access request.

[0073] At block 440, the network device 130-1 transmits the quality of communication to the terminal device 110-1 or the network device 120. In some embodiments, the network device 130-1 may generate the access response comprising the quality of communication and transmit the access response to the terminal device 110-1. In other embodiments, the network device 130-1 may transmit information concerning the quality of communication between the terminal device 110-1 and the network device 130-1 to the network device 120.

[0074] In some embodiments, if the terminal device 110-1 does not select the network device 130-1, the network device 130-1 may receive an indication of failure in selection.

[0075] Fig. 5 illustrates a schematic diagram of interactions 500 in contention-based system in accordance with embodiments of the present disclosure. The interactions 500 may be implemented at any suitable devices. Only for the purpose of illustrations, the interactions 500 are described to be implemented at the terminal device 110-1, the network device 120 and the network devices 130-1, 130-2 and 130-3.

[0076] The network device 120 obtains position information of the plurality of network devices 130. The position information may comprise the coordinate and ephemeris of the network devices 130. The network device 120 transmits 5008 the position information to the terminal device 110-1.

[0077] The terminal device 110-1 may calculate 5010 one closest network device 130-1. Both the terminal device 110-1 and the network devices 130 know, from the CS phase, the best directions through which they should steer their beams, and therefore they will exchange the following RA messages. In some embodiments, the terminal device 110-1 may calculate several closest candidate network devices 130 (for example the network devices 130-1, 130-2 and 130-3) and steers a beam toward each network devices 130 from the best direction. The steered beams may go through three situations: deviation, no deviation, and blockage or deafness. In real environments, especially in the last case of blockage or deafness, once the direct path does not correspond to the good channel conditions, candidate beams could be explored. The terminal device 110-1 may form additional beams in adjacent directions symmetrically to look for a stronger path. In fact, the knowledge of the estimated terminal device position is extremely important to reduce the discovery time. In addition, information on the past beamforming attempts can provide a significant references by testing the most successful connections at each access.

[0078] The network device 130-1 transmits 5018 the PSS/SSS/PBCH to the terminal device 130-1. Similarly, the network device 130-2 also transmits 5020 the PSS/SSS/PBCH to the terminal device 130-1 and the network device 130-3 transmits 5022 the PSS/SSS/PBCH to the terminal device 130-1. The terminal device 110-1 may acquire system information based on the PSS/SSS/PBCH and obtain the propagation delay from the system information. For one given beam covering a cell, there is one common propagation delay d1 for all served terminal devices. The common propagation delay is at the point when the terminal device 110-1 locates at the Nadir distance corresponding to the vertical footprint.

[0079] The terminal devices may use this information to compensate the PRACH transmit time so that PRACH from the terminal devices within the beam are received by the network devices 130 almost in same time window. Actually, the common response delay can be roughly estimated at the base station side when the NTN is deployed. For example, when a satellite is deployed, its altitude information should be determined and accessible by itself. Then, the propagation delay can be estimated based on its altitude carried in the SIB. Since the different airborne access points have different Nadir distances, the propagation delays d1, d2 and d3 respectively from each network devices 130 can be known. However even if only the differential value left (after the common propagation compensation), the differential propagation delay could be hundreds of kilometers which cannot be ignored.

[0080] Due to the mobility of the terminal device 110-1 and deviation or sudden change of position, the terminal device 110-1 transmits 5024 PRACH (MSG.1) to the candidate network device 130-1 through the best directions obtained from the CS phase if the location of the terminal device 110-1 is stable. The terminal device 110-1 may transmit an access request (MSG.1) to the candidate network device 130-1 though beam sweeping pattern due to high speed mobility and GPS-based deviation. Similarly, the terminal device 110-1 also transmits 5026 an access request (MSG.1) to the candidate network device 130-2 and the terminal device 110-1 transmits 5028 an access request (MSG.1) to the candidate network device 130-3.

[0081] In some embodiments, the network device 130-1 transmits 5030 the random access response (MSG.2) comprising a signal quality metric to allow the terminal device 110-1 to select the best uplink Tx beam. Similarly, the network device 130-2 transmits 5032 the random access response (MSG.2) comprising a signal quality metric and the network device 130-3 transmits 5034 the random access response (MSG.2) comprising a signal quality metric.

[0082] Alternatively, the network device 130 may perform measurement the access request to obtain the communication quality between the terminal deice 110-1 and the corresponding network devices 130. The network device 130-1 transmits 5036 its measurement report to the network device 120. Similarly, the network device 130-2 transmits 5038 its measurement report to the network device 120 and the network device 130-3 transmits 5040 its measurement report to the network device 120. The network device 120 determines 5042 potential network devices (for example, the network devices 130-1 and 130-1). The network device 120 transmits 5044 information about the potential network devices. The network device 130-2 transmits 5046 the random access response (MSG.2) and the network device 130-2 transmits 5048 the random access response (MSG.2).

[0083] The terminal device 110-1 does scheduled transmission (RRC connection request) in MSG.3 and the network devices 130-1 and 130-2 perform contention resolution in MSG.4. The terminal device 110-1 may perform the downlink synchronization to the potential candidate network devices 130-1 and 130-2 through downlink measurement performed on MSG.4. The terminal device 110-1 determines 5052 the target network device 130-1. The terminal device 110-1 transmits 5054 the information of the target network device 130-1 to the network device 120. In some embodiments, the network device 120 may those network device 130s, which ones are not selected as the serving network device 130.

[0084] Fig. 6 illustrates a schematic diagram of interactions 600 in contention-free system in accordance with embodiments of the present disclosure. The interactions 600 may be implemented at any suitable devices. Only for the purpose of illustrations, the interactions 600 are described to be implemented at the terminal device 110-1, the network device 120 and the network devices 130-1, 130-2 and 130-3.

[0085] The network device 120 obtains position information of the plurality of network devices 130. The position information may comprise the coordinate and ephemeris of the network devices 130. The network device 120 transmits 6008 the position information to the terminal device 110-1. In some embodiments, the network device 120 may inform all the necessary system information (SI) to the terminal device 110-1, which originally acquired from the CS phase through SS block detection. For fast access, the necessary system information (like common delay, position information) could be forwarded by NTN UE-Relay rather than acquisition from the traditional SSB detection. In some embodiments, the network device 120 may also inform a common propagation delay to the terminal device 110-1 to achieve the fast TA adjustment.

[0086] The terminal device 110-1 calculates 6010 one closest network device 130-1 or several closest candidate network devices 130 (for example, the network devices 130-1, 130-2 and 130-3) and directly steers a beam containing MSG.1 toward each network devices 130 from the best direction. The steered beams may also go through three situations: deviation, no deviation, and blockage or deafness. Regarding the beam adjustment to align with the network device 130, due to drastic changes related to the terminal device position and orientation, the receiver and transmitter beams have become irrevocably misaligned. There are several methods to solve the problem. For example, when the required beam alignment changes are small, the beam tuning procedures (i.e. the selection of nearby beams to test if these provide better signal quality) is enough to keep the communication link. However, when the beam is misaligned irrevocably, then schemes taking advantage of the multiple inertial sensors inside a device and other sources of positional information may be used to re-establish beam alignment and allow the terminal devices to re-transition to RRC Connected state.

[0087] Due to the mobility of the terminal device 110-1 and deviation or sudden change of position, the terminal device 110-1 transmits 6024 PRACH (MSG.1) to the candidate network device 130-1 through the best directions obtained from the CS phase if the location of the terminal device 110-1 is stable. The terminal device 110-1 may transmit an access request (MSG.1) to the candidate network device 130-1 though beam sweeping pattern due to high speed mobility and GPS-based deviation. Similarly, the terminal device 110-1 also transmits 6026 an access request (MSG.1) to the candidate network device 130-2 and the terminal device 110-1 transmits 6028 an access request (MSG.1) to the candidate network device 130-3.

[0088] In some embodiments, the network device 130-1 transmits 6030 the random access response (MSG.2) comprising a signal quality metric to allow the terminal device 110-1 to select the best uplink Tx beam. Similarly, the network device 130-2 transmits 6032 the random access response (MSG.2) comprising a signal quality metric and the network device 130-3 transmits 6034 the random access response (MSG.2) comprising a signal quality metric.

[0089] Alternatively, the network device 130 may perform measurement the access request to obtain the communication quality between the terminal deice 110-1 and the corresponding network devices 130. The network device 130-1 transmits 5036 its measurement report to the network device 120. Similarly, the network device 130-2 transmits 5038 its measurement report to the network device 120 and the network device 130-3 transmits 5040 its measurement report to the network device 120. The network device 120 determines 5042 potential network devices (for example, the network devices 130-1 and 130-1). The network device 120 transmits 5044 information about the potential network devices. The network device 130-2 transmits 6046 the random access response (MSG.2) and the network device 130-2 transmits 6048 the random access response (MSG.2).

[0090] Afterwards, the terminal device 110-1 performs downlink RS measurement in the receiving MSG.2. On the basis of downlink measurement, the terminal deice finally selects 6052 the serving network device 130-1 and feedback 6054 to the network device

120. The network device 120 may inform those network device 130s, which ones are not selected as the serving network device.

[0091] Embodiments of the present disclosure can maintain the link reliability and lower the UE power consumption. Embodiments of the present disclosure can provide a fine refinement of network devices in CS and contention-based contention RA phases. Further, embodiments of the present disclosure provide a fast refinement of network devices in CS and contention-free RA phases, which is more preferred in NTN system because large transmission delay. Embodiments of the present disclosure establish an effective interactive mechanism by introducing the NTN UE-Relay entity. Embodiments of the present disclosure have greatly simplified the conventional CS phase. Embodiments of the present disclosure can achieve fast and reliable beam-pair discovery and fast TA adjustment. Embodiments of the present disclosure combine DL and UL measurement considering both the link reliability and the UE power consumption in the same time.

[0092] In some embodiments, an apparatus for performing the method 200 (for example, the terminal device 110-1) may comprise respective means for performing the corresponding steps in the method 200. These means may be implemented in any suitable manners. For example, it can be implemented by circuitry or software modules.

[0093] In some embodiments, the apparatus comprises: means for receiving, at the first device and from a second device, position information of a plurality of third devices; means for determining a set of candidate third devices from the plurality of third devices based on the position information and location of the first device; means for transmitting access requests to the set of candidate third devices to measure qualities of communications between the first device and the set of candidate third devices; and means for determining a target third device from the set of candidate third devices based on the communication qualities.

[0094] In some embodiments, the means for determining the set of candidate third devices comprises: means for determining a distance between the first device and one of the plurality of third devices based on the position information and the location of the first device; and means for in responses to the distance being lower than a threshold distance, determining the one of the plurality of third devices belonging to the set of candidate third devices.

[0095] In some embodiments, the means for determining the target third device comprises: means for receiving access responses from the set of candidate third devices, the access responses comprising the qualities of communications between the first device and the set of candidate third devices; and means for determining the target third device based on the qualities of communications.

[0096] In some embodiments, the means for determining the target third device comprises: means for receiving information concerning a subset of the set of candidate third devices from the second device, qualities of communications between the subset and the first device exceeding a threshold quality; means for determining the target third device from the subset.

[0097] In some embodiments, the means for transmitting the access requests to the set of candidate third devices comprises: means for receiving system information from the second device; means for determining a propagation delay from the system information; and means for transmitting the access requests with a compensation of the propagation delay.

[0098] In some embodiments, the apparatus further comprises means for transmitting information concerning the target third device to the second device.

[0099] In some embodiments, the first device comprise a terminal device, the second device comprises a network device and the third device comprise a further network device.

[00100] In some embodiments, an apparatus for performing the method 300 (for example, the network device 120) may comprise respective means for performing the corresponding steps in the method 300. These means may be implemented in any suitable manners. For example, it can be implemented by circuitry or software modules.

[00101] In some embodiments, the apparatus comprises means for obtaining, at the second device, position information of a plurality of third devices; and means for transmitting the position information to a first device for determining a target third device by the first device.

[00102] In some embodiments, the apparatus further comprises means for receiving information concerning qualities of communications between the first device and a set of candidate third devices in the plurality of third devices from the set of candidate third devices; means for determine a subset of the set of candidate third devices based on the qualities, qualities of communications between the subset and the first device exceeding a threshold quality; and means for transmitting information concerning the subset of candidate third devices to the first device.

[00103] In some embodiments, the apparatus further comprises means for transmitting system information to the first device, the system information comprising a propagation delay from the system information.

[00104] In some embodiments, the apparatus further comprises means for receiving information concerning the target third device from the first device; and means for informing a failure in selection to the plurality of third devices except for the target third device.

[00105] In some embodiments, the first device comprises a terminal device, the second device comprises a network device and the third device comprises a further network device.

[00106] In some embodiments, an apparatus for performing the method 400 (for example, the network device 130-1) may comprise respective means for performing the corresponding steps in the method 400. These means may be implemented in any suitable manners. For example, it can be implemented by circuitry or software modules.

[00107] In some embodiments, the apparatus comprises means for transmitting, at a third device , position information to a second device; means for in response to a determination that a distance between the third device and a first device being below a threshold distance, receiving an access request from a first device; means for performing an uplink measurement based on the access request to obtain quality of communication between the first device and the third device ; and means for transmitting the quality of communication to the first device or the second device.

[00108] In some embodiments, the means for transmitting the quality of communication to the first device comprises: means for generating the access response indicating the quality of communication; and means for transmitting the access response to the first device.

[00109] In some embodiments, the apparatus comprises means for receiving, from the second device, an indication of failure in selection, in response to a determination that the quality of communication being below a threshold quality.

[00110] In some embodiments, the first device comprises a terminal device, the second device comprises a network device and the third device comprises a further network device.

[00111] FIG. 7 is a simplified block diagram of a device 700 that is suitable for implementing embodiments of the present disclosure. The device 700 may be provided to implement the communication device, for example the network device 120 or the terminal device 110-1 as shown in Fig. 1. As shown, the device 700 includes one or more processors 710, one or more memories 720 coupled to the processor 710, and one or more communication module (for example, transmitters and/or receivers (TX/RX)) 740 coupled to the processor 710.

[00112] The communication module 740 is for bidirectional communications. The communication module 740 has at least one antenna to facilitate communication. The communication interface may represent any interface that is necessary for communication with other network elements.

[00113] The processor 710 may be of any type suitable to the local technical network and may include one or more of the following: general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 700 may have multiple processors, such as an application specific integrated circuit chip that is slaved in time to a clock which synchronizes the main processor.

[00114] The memory 720 may include one or more non-volatile memories and one or more volatile memories. Examples of the non-volatile memories include, but are not limited to, a Read Only Memory (ROM) 724, an electrically programmable read only memory (EPROM), a flash memory, a hard disk, a compact disc (CD), a digital video disk (DVD), and other magnetic storage and/or optical storage. Examples of the volatile memories include, but are not limited to, a random access memory (RAM) 722 and other volatile memories that will not last in the power-down duration.

[00115] A computer program 730 includes computer executable instructions that are executed by the associated processor 710. The program 730 may be stored in the ROM 724. The processor 710 may perform any suitable actions and processing by loading the program 730 into the RAM 722.

[00116] The embodiments of the present disclosure may be implemented by means of the program 730 so that the device 700 may perform any process of the disclosure as discussed with reference to Figs. 2 to 6. The embodiments of the present disclosure may also be implemented by hardware or by a combination of software and hardware.

[00117] In some embodiments, the program 730 may be tangibly contained in a computer readable medium which may be included in the device 700 (such as in the memory 720) or other storage devices that are accessible by the device 700. The device 700 may load the program 730 from the computer readable medium to the RAM 722 for execution. The computer readable medium may include any types of tangible non-volatile storage, such as ROM, EPROM, a flash memory, a hard disk, CD, DVD, and the like. Fig. 8 shows an example of the computer readable medium 800 in form of CD or DVD. The computer readable medium has the program 730 stored thereon.

[00118] Generally, various embodiments of the present disclosure may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device. While various aspects of embodiments of the present disclosure are illustrated and described as block diagrams, flowcharts, or using some other pictorial representations, it is to be understood that the block, apparatus, system, technique or method 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.

[00119] The present disclosure also provides at least one computer program product tangibly stored on a non-transitory computer readable storage medium. The computer program product includes computer-executable instructions, such as those included in program modules, being executed in a device on a target real or virtual processor, to carry out the methods 200-400 as described above with reference to Figs. 2-6. Generally, program modules include routines, programs, libraries, objects, classes, components, data structures, or the like that perform particular tasks or implement particular abstract data types. The functionality of the program modules may be combined or split between program modules as desired in various embodiments. Machine-executable instructions for program modules may be executed within a local or distributed device. In a distributed device, program modules may be located in both local and remote storage media.

[00120] Program code for carrying out methods of the present disclosure may be written in any combination of one or more programming languages. These program codes may be provided to a processor or controller of a general purpose computer, special purpose computer, or other programmable data processing apparatus, such that the program codes, when executed by the processor or controller, cause the functions/operations specified in the flowcharts and/or block diagrams to be implemented. The program code may execute entirely on a machine, partly on the machine, as a stand-alone software package, partly on the machine and partly on a remote machine or entirely on the remote machine or server.

[00121] In the context of the present disclosure, the computer program codes or related data may be carried by any suitable carrier to enable the device, apparatus or processor to perform various processes and operations as described above. Examples of the carrier include a signal, computer readable medium, and the like.

[00122] The computer readable medium may be a computer readable signal medium or a computer readable storage medium. A computer readable medium may include but not limited to an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. More specific examples of the computer readable storage medium would include an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing.

[00123] Further, while operations are depicted in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Likewise, while several specific implementation details are contained in the above discussions, these should not be construed as limitations on the scope of the present disclosure, but rather as descriptions of features that may be specific to particular embodiments. Certain features that are described in the context of separate embodiments may also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment may also be implemented in multiple embodiments separately or in any suitable sub-combination.

[00124] Although the present disclosure has been described in languages specific to structural features and/or methodological acts, it is to be understood that the present disclosure defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

WHAT IS CLAIMED IS:

1. A first device comprising:

at least one processor; and

at least one memory including computer program codes;

the at least one memory and the computer program codes are configured to, with the at least one processor, cause the first device to:

receive, at the first device and from a second device, position information of a plurality of third devices;

determine a set of candidate third devices from the plurality of third devices based on the position information and a location of the first device;

transmit access requests to the set of candidate third devices to measure qualities of communications between the first device and the set of candidate third devices; and

determine a target third device from the set of candidate third devices based on the qualities.

2. The first device of claim 1, wherein the first device is caused to determine the set of candidate third devices by:

determining a distance between the first device and one of the plurality of third devices based on the position information and the location of the first device; and

in responses to the distance being lower than a threshold distance, determining the one of the plurality of third devices belonging to the set of candidate third devices.

3. The first device of claim 1, wherein the first device is caused to determine the target third device by:

receiving access responses from the set of candidate third devices, the access responses comprising the qualities of communications between the first device and the set of candidate third devices; and

determining the target third device based on the qualities of communications.

4. The first device of claim 1, wherein the first device is caused to determine the target third device by:

receiving information concerning a subset of the set of candidate third devices from the second device, qualities of communications between the subset and the first device exceeding a threshold quality; and

determining the target third device from the subset.

5. The first device of claim 1, wherein the first device is caused to transmit the access requests to the set of candidate third devices by:

receiving system information from the second device;

determining a propagation delay from the system information; and

transmitting the access requests with a compensation of the propagation delay.

6. The first device of claim 1, wherein the first device is further caused to:

transmit information concerning the target third device to the second device.

7. The first device of claim 1, wherein the first device comprises a terminal device, the second device comprises a network device and the third device comprises a further network device.

8. A second device comprising:

at least one processor; and

at least one memory including computer program codes;

the at least one memory and the computer program codes are configured to, with the at least one processor, cause the second device to:

obtain, at the second device, position information of a plurality of third devices; and

transmit the position information to a first device for determining from the plurality of third devices a target third device by the first device.

9. The second device of claim 8, wherein the second device is further caused to:

receive, from a set of candidate third devices in the plurality of third devices, information concerning qualities of communications between the first device and the set of candidate third devices ;

determine a subset of the set of candidate third devices based on the qualities, qualities of communications between the subset and the first device exceeding a threshold quality; and

transmit information concerning the subset of candidate third devices to the first device.

10. The second device of claim 8, wherein the second device is further caused to:

transmit system information to the first device, the system information comprising a propagation delay from the system information.

11. The second device of claim 8, wherein the second device is further caused to:

receive information concerning the target third device from the first device; and

transmit an indication of failure in selection to the plurality of third devices except for the target third device.

12. The second device of claim 8, wherein the first device comprises a terminal device, the second device comprises a network device and the third device comprises a further network device.

13. A third device comprising:

at least one processor; and

at least one memory including computer program codes;

the at least one memory and the computer program codes are configured to, with the at least one processor, cause the third device to:

transmit, at a third device, position information to a second device;

in response to a determination that a distance between the third device and a first device being below a threshold distance, receive an access request from a first device;

perform an uplink measurement based on the access request to obtain quality of communication between the first device and the third device; and

transmit the quality of communication to the first device or the second device.

14. The third device of claim 13, wherein the third device is caused to transmit the quality of communication to the first device by:

generating the access response indicating the quality of communication; and transmitting the access response to the first device.

15. The third device of claim 13, wherein the quality of communication is below a threshold quality, and the third device is further caused to:

receive, from the second device, an indication of failure in selection.

16. The third device of claim 13, wherein the first device comprises a terminal device, the second device comprises a network device and the third device comprises a further network device.

17. A method comprising:

receiving, at the first device and from a second device, position information of a plurality of third devices;

determining a set of candidate third devices from the plurality of third devices based on the position information and location of the first device;

transmitting access requests to the set of candidate third devices to measure qualities of communications between the first device and the set of candidate third devices; and

determining a target third device from the set of candidate third devices based on the qualities.

18. The method of claim 17, wherein determining the set of candidate third devices comprises:

determining a distance between the first device and one of the plurality of third devices based on the position information and the location of the first device; and

in responses to the distance being lower than a threshold distance, determining the one of the plurality of third devices belonging to the set of candidate third devices.

19. The method of claim 17, wherein determining the target third device comprises:

receiving access responses from the set of candidate third devices, the access responses comprising the qualities of communications between the first device and the set of candidate third devices; and

determining the target third device based on the qualities of communications.

20. The method of claim 17, wherein determining the target third device comprises:

receiving information concerning a subset of the set of candidate third devices from the second device, qualities of communications between the subset and the first device exceeding a threshold quality; and

determining the target third device from the subset.

21. The method of claim 17, wherein transmitting the access requests to the set of candidate third devices comprises:

receiving system information from the second device;

determining a propagation delay from the system information; and

transmitting the access requests with a compensation of the propagation delay.

22. The method of claim 17, further comprising:

transmitting information concerning the target third device to the second device.

23. The method of claim 17, wherein the first device comprises a terminal device, the second device comprises a network device and the third device comprise a further network device.

24. A method comprising:

obtaining, at the second device, position information of a plurality of third devices; and

transmitting the position information to a first device for determining from the plurality of third devices a target third device by the first device.

25. The method of claim 24, further comprising:

receiving, a set of candidate third devices in the plurality of third devices, information concerning qualities of communications between the first device and the set of candidate third devices;

determining a subset of the set of candidate third devices based on the qualities, qualities of communications between the subset and the first device exceeding a threshold quality; and

transmitting information concerning the subset of candidate third devices to the first device.

26. The method of claim 24, further comprising:

transmitting system information to the first device, the system information comprising a propagation delay from the system information.

27. The method of claim 24, further comprising:

receiving information concerning the target third device from the first device; and

informing an indication of failure in selection to the plurality of third devices except for the target third device.

28. The method of claim 24, wherein the first device comprise a terminal device, the second device comprises a network device and the third device comprise a further network device.

29. A method comprising:

transmitting, at a third device , position information to a second device;

in response to a determination that a distance between the third device and a first device being below a threshold distance, receiving an access request from a first device;

performing an uplink measurement based on the access request to obtain quality of communication between the first device and the third device ; and

transmitting the quality of communication to the first device or the second device.

30. The method of claim 29, wherein transmitting the quality of communication to the first device comprises:

generating the access response indicating the quality of communication; and

transmitting the access response to the first device.

31. The method of claim 29, wherein the quality of communication is below a threshold quality, and the method further comprises:

receiving, from the second device, an indication of failure in selection.

32. The method of claim 29, wherein the first device comprises a terminal device, the second device comprises a network device and the third device comprises a further network device.

33. An apparatus, comprising:

means for receiving, at the first device and from a second device, position information of a plurality of third devices;

means for determining a set of candidate third devices from the plurality of third devices based on the position information and location of the first device;

means for transmitting access requests to the set of candidate third devices to measure qualities of communications between the first device and the set of candidate third devices; and

means for determining a target third device from the set of candidate third devices based on the qualities.

34. An apparatus, comprising:

means for obtaining, at the second device, position information of a plurality of third devices; and

means for transmitting the position information to a first device for determining a target third device by the first device.

35. An apparatus comprising:

means for transmitting, at a third device , position information to a second device;

means for in response to a determination that a distance between the third device and a first device being below a threshold distance, receiving an access request from a first device;

means for performing an uplink measurement based on the access request to obtain quality of communication between the first device and the third device; and

means for transmitting the quality of communication to the first device or the second device.

36. A computer readable medium storing instructions thereon, the instructions, when executed by at least one processing unit of a machine, causing the machine to perform the method according to any one of claims 17-23.

37. A computer readable medium storing instructions thereon, the instructions, when executed by at least one processing unit of a machine, causing the machine to perform the method according to any one of claims 24-28.

38. A computer readable medium storing instructions thereon, the instructions, when executed by at least one processing unit of a machine, causing the machine to perform the method according to any one of claims 29-32.

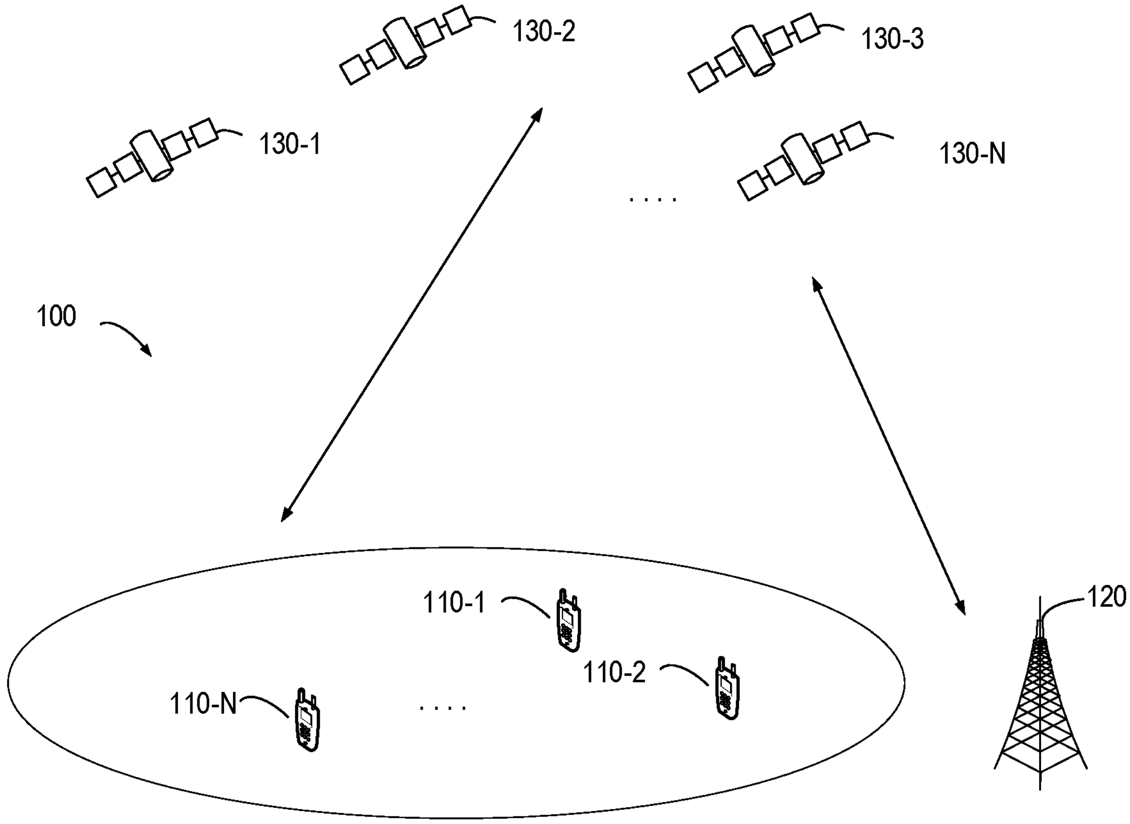


Fig. 1

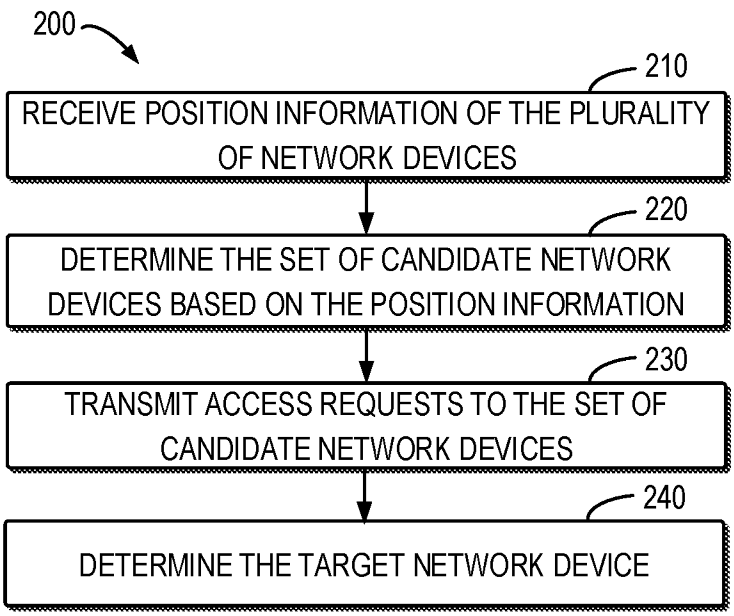

200
210
RECEIVE POSITION INFORMATION OF THE PLURALITY OF NETWORK DEVICES
220
DETERMINE THE SET OF CANDIDATE NETWORK DEVICES BASED ON THE POSITION INFORMATION
230
TRANSMIT ACCESS REQUESTS TO THE SET OF CANDIDATE NETWORK DEVICES
240
DETERMINE THE TARGET NETWORK DEVICE

Fig. 2

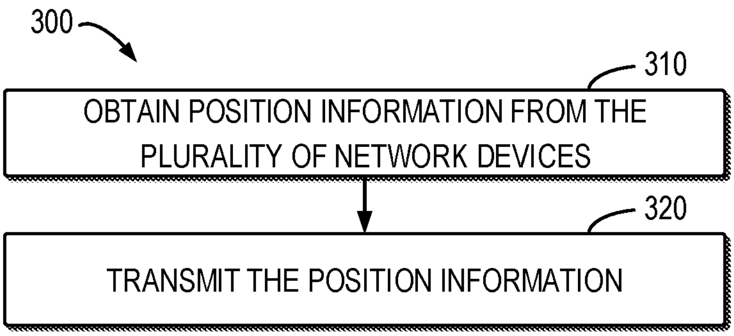

300
310
OBTAIN POSITION INFORMATION FROM THE PLURALITY OF NETWORK DEVICES
320
TRANSMIT THE POSITION INFORMATION

Fig. 3

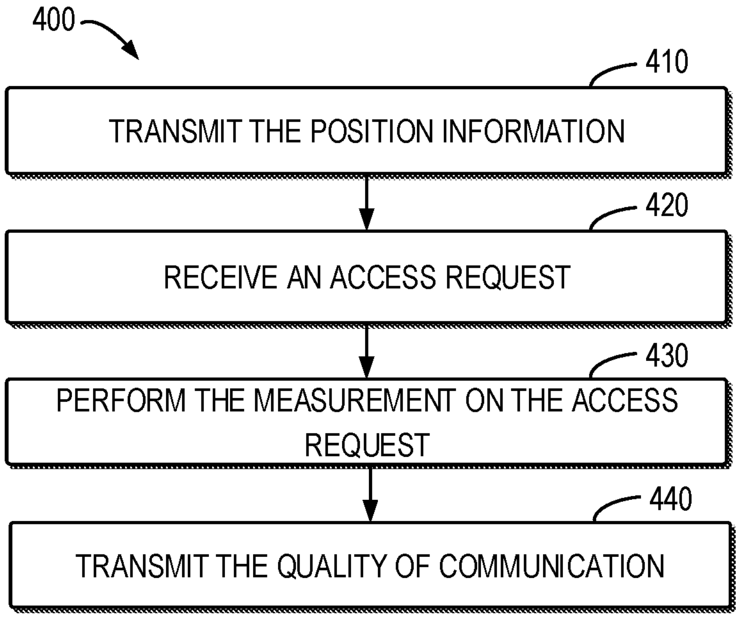

400
410
TRANSMIT THE POSITION INFORMATION
420
RECEIVE AN ACCESS REQUEST
430
PERFORM THE MEASUREMENT ON THE ACCESS REQUEST
440
TRANSMIT THE QUALITY OF COMMUNICATION

Fig. 4

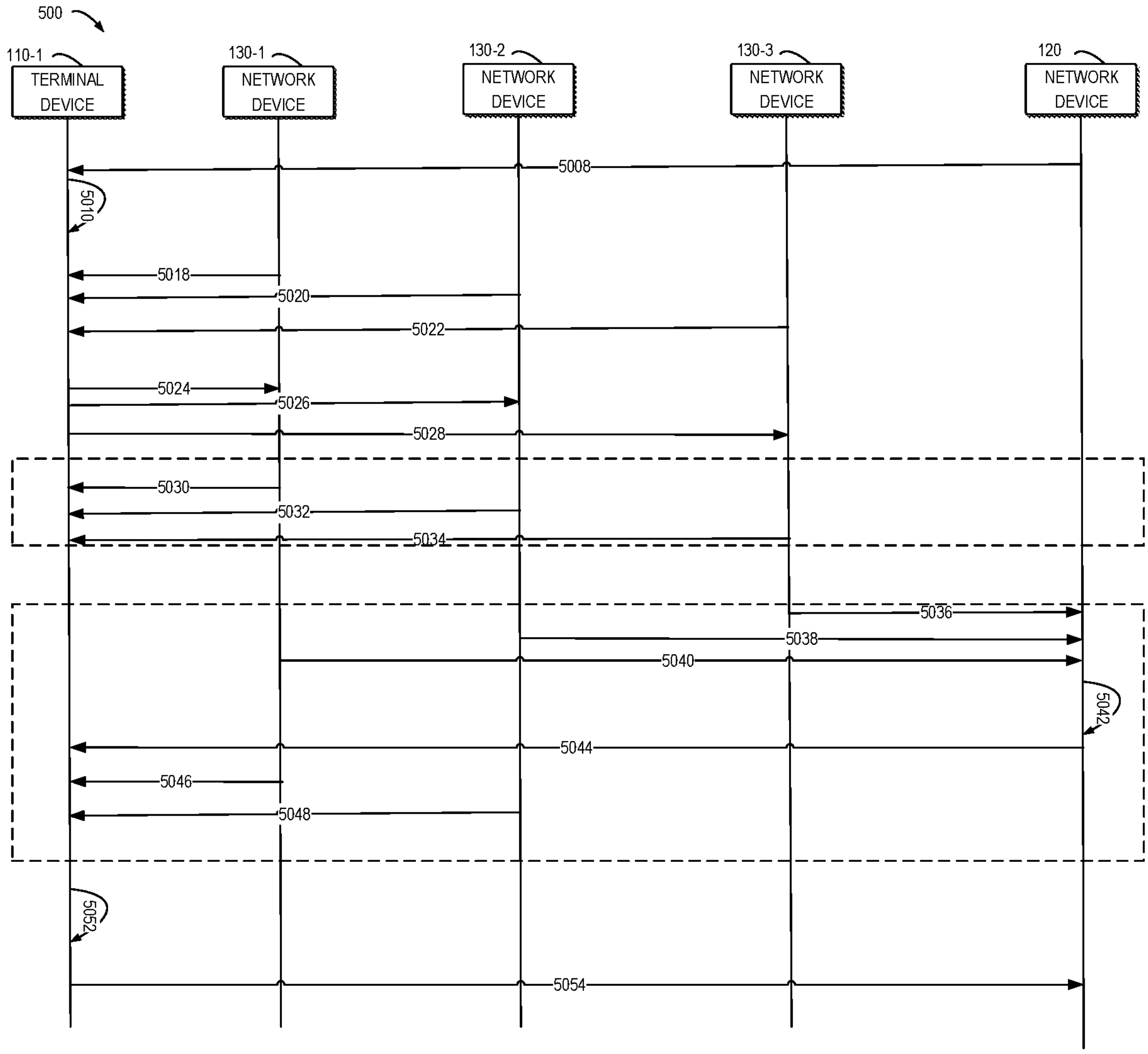
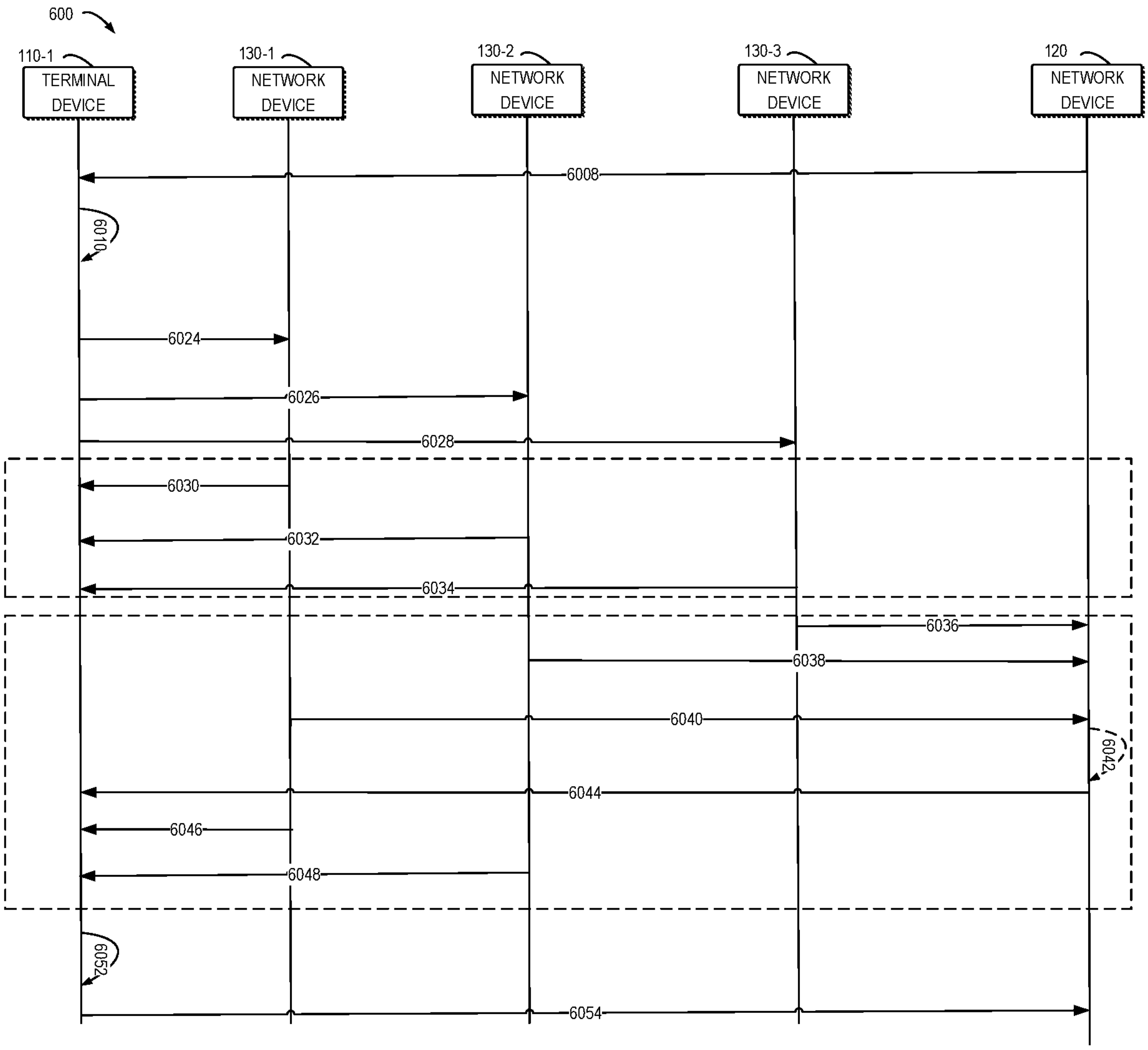

500
110-1
TERMINAL DEVICE
130-1
NETWORK DEVICE
130-2
NETWORK DEVICE
130-3
NETWORK DEVICE
120
NETWORK DEVICE
5008
5010
5018
5020
5022
5024
5026
5028
5030
5032
5034
5036
5038
5040
5042
5044
5046
5048
5052
5054

Fig. 5


600
110-1
TERMINAL DEVICE
130-1
NETWORK DEVICE
130-2
NETWORK DEVICE
130-3
NETWORK DEVICE
120
NETWORK DEVICE
6008
6010
6024
6026
6028
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6034
6036
6038
6040
6042
6044
6046
6048
6052
6054

Fig. 6

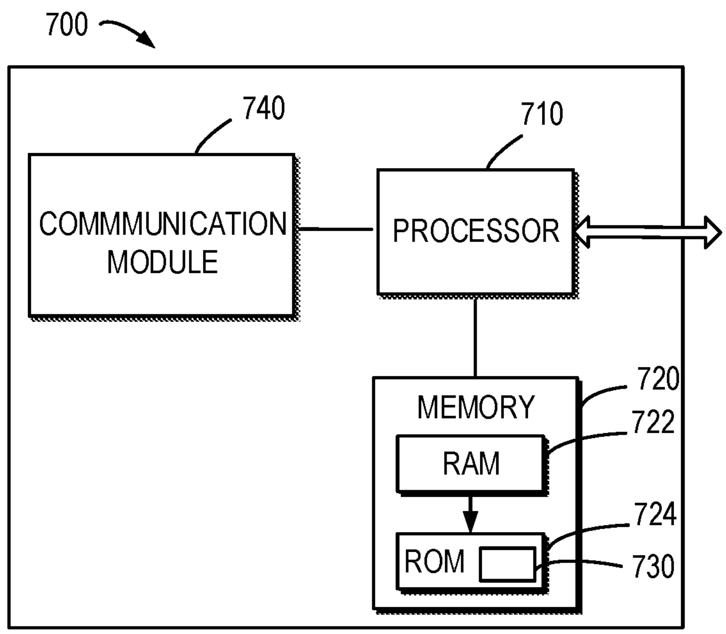
700
740
710
COMMMUNICATION MODULE
PROCESSOR
720
MEMORY
722
RAM
724
ROM
730

Fig. 7

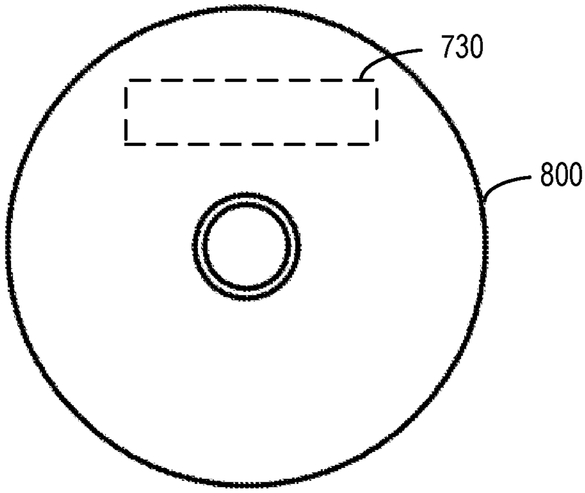

Fig. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/100656

A. CLASSIFICATION OF SUBJECT MATTER

G01S 19/42(2010.01)i; H04W 4/02(2018.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G01S; H04W

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT;CNKI;WPI;EPODOC;3GPP: satellite, candidate, measure, quality, uplink, relay, request, access, location, position, communication, distance, threshold, information, target, transmit

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 108243391 A (SPREADTRUM COMMUNICATIONS SHANGHAI CO., LTD.) 03 July 2018 (2018-07-03) description, paragraphs [0096]-[0109]	1-38
Y	CN 104181570 A (HAOXIN MICROELECTRONICS TECHNOLOGY SHANGHAI CO., LTD.) 03 December 2014 (2014-12-03) claims 1-11	1-38
A	US 2019230568 A1 (HUGHES NETWORK SYSTEMS, LLC) 25 July 2019 (2019-07-25) the whole document	1-38
A	US 2018097559 A1 (UBIQOMM, LLC) 05 April 2018 (2018-04-05) the whole document	1-38
A	THALES et al. "R1-1807864: NR-NTN: solution principles for NR to support non-terrestrial networks" *3GPP TSG RAN1 Meeting #93,* 25 May 2018 (2018-05-25), the whole document	1-38

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 April 2020	**14 May 2020**

Name and mailing address of the ISA/CN	Authorized officer
National Intellectual Property Administration, PRC 6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088 China	**YU, Xiaoxi**
Facsimile No. **(86-10)62019451**	Telephone No. **86-(10)-53961578**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/100656

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 108243391 A	03 July 2018	None	
CN 104181570 A	03 December 2014	None	
US 2018097559 A1	25 July 2019	WO 2019144078 A1	25 July 2019
US 2018097559 A1	05 April 2018	WO 2018067862 A1	12 April 2018