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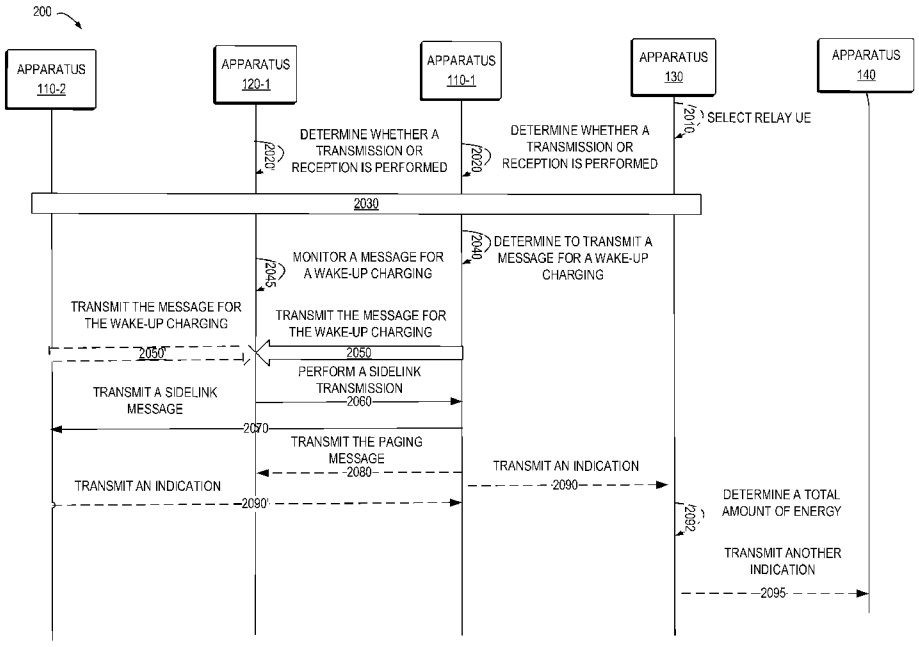

FIG. 2

(57) Abstract: The present discourse relates to wake-up charging. In particular, a sidelink wake-up signal (SL-WUS) that is used for waking up at least one Ambient/Passive IoT device over SL is associated with a broadcast SL wake-up charging message for initial wireless power transfer (WPT). That is, the SL-WUS is used not only for waking-up but also for triggering or requesting transmissions of the associated sidelink wake-up charging (SL-WUC) for the initial WPT. In this way, it can provide energy to the passive IoT devices during a wake-up procedure.

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MECHANISM FOR WAKE-UP CHARGING

FIELDS

[0001] Various example embodiments of the present disclosure generally relate to the field of telecommunication and in particular, to methods, devices, apparatuses and computer readable storage medium for wake-up charging.

BACKGROUND

[0002] Internet of Things (IoT) may be considered as a network of physical devices. These devices can transfer data to one another without human intervention. Ambient/passive IoT devices, referred to as IoT tags, need to harvest energy from their operating environment for their functioning operations including radio transmission and/or reception for required communication applications. It is considered that a serving network or capable user equipments (UEs) located near-by may provide wireless power transfer (WPT) over Uu or sidelink (SL) PC5 interfaces to the IoT tags in need of charging for example. Therefore, it is worth studying on how to efficiently provide power to the IoT devices.

SUMMARY

[0003] In a first aspect of the present disclosure, there is provided a first apparatus. The first apparatus comprises at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the first apparatus to: determine whether a transmission or reception of a wake-up signal is performed at the first apparatus; based on a determination that the transmission or reception of the wake-up signal is performed, determine to transmit a message for a wake-up charging to at least one second apparatus; and transmit, to the at least one second apparatus, the message for the wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal.

[0004] In a second aspect of the present disclosure, there is provided a second apparatus. The second apparatus comprises at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the second apparatus to: determine whether a transmission or reception of a wake-up signal is performed at the second apparatus; based on a determination that the transmission or reception of the wake-

up signal is performed, monitor a message for a wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal; and receive, from at least one first apparatus, the message for the wake-up charging.

[0005] In a third aspect of the present disclosure, there is provided a third apparatus. The third apparatus comprises at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the third apparatus to: transmit, to at least one first apparatus, a paging message for at least one second apparatus; and receive, from the at least one first apparatus, an indication indicating the wake-up charging is completed.

[0006] In a fourth aspect of the present disclosure, there is provided a method. The method comprises: determining whether a transmission or reception of a wake-up signal is performed at the first apparatus; based on a determination that the transmission or reception of the wake-up signal is performed, determining to transmit a message for a wake-up charging to at least one second apparatus; and transmitting, to the at least one second apparatus, the message for the wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal.

[0007] In a fifth aspect of the present disclosure, there is provided a method. The method comprises: determining whether a transmission or reception of a wake-up signal is performed at the second apparatus; based on a determination that the transmission or reception of the wake-up signal is performed, monitoring a message for a wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal; and receiving, from at least one first apparatus, the message for the wake-up charging.

[0008] In a sixth aspect of the present disclosure, there is provided a method. The method comprises: transmitting, to at least one first apparatus, a paging message for at least one second apparatus; and receiving, from the at least one first apparatus, an indication indicating the wake-up charging is completed.

[0009] In a seventh aspect of the present disclosure, there is provided a first apparatus. The first apparatus comprises means for determining whether a transmission or reception of a wake-up signal is performed at the first apparatus; means for based on a determination that the transmission or reception of the wake-up signal is performed, determining to transmit a message for a wake-up charging to at least one second apparatus; and means

for transmitting, to the at least one second apparatus, the message for the wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal.

[0010] In an eighth aspect of the present disclosure, there is provided a second apparatus. The second apparatus comprises means for determining whether a transmission or reception of a wake-up signal is performed at the second apparatus; means for based on a determination that the transmission or reception of the wake-up signal is performed, monitoring a message for a wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal; and means for receiving, from at least one first apparatus, the message for the wake-up charging.

[0011] In a ninth aspect of the present disclosure, there is provided a third apparatus. The third apparatus comprises means for transmitting, to at least one first apparatus, a paging message for at least one second apparatus; and means for receiving, from the at least one first apparatus, an indication indicating the wake-up charging is completed.

[0012] In a tenth aspect of the present disclosure, there is provided a computer readable medium. The computer readable medium comprises instructions stored thereon for causing an apparatus to perform at least the method according to the fourth aspect.

[0013] In an eleventh aspect of the present disclosure, there is provided a computer readable medium. The computer readable medium comprises instructions stored thereon for causing an apparatus to perform at least the method according to the fifth aspect.

[0014] In a twelfth aspect of the present disclosure, there is provided a computer readable medium. The computer readable medium comprises instructions stored thereon for causing an apparatus to perform at least the method according to the sixth aspect.

[0015] 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

[0016] Some example embodiments will now be described with reference to the accompanying drawings, where:

[0017] FIG. 1 illustrates an example communication environment in which example embodiments of the present disclosure can be implemented;

[0018] FIG. 2 illustrates a signaling chart for wake-up charging according to some example embodiments;

[0019] FIG. 3A to FIG. 3C illustrate signaling charts for transmitting a wake-up signal according to some example embodiments, receptively;

[0020] FIG. 4A and FIG. 4B illustrate schematic diagrams of transmission occasions according to some example embodiments, receptively;

[0021] FIG. 4C illustrates a schematic diagram of a transmission pattern according to some example embodiments;

[0022] FIG. 5 illustrates a flowchart of a method implemented at a first device according to some example embodiments of the present disclosure;

[0023] FIG. 6 illustrates a flowchart of a method implemented at a second device according to some example embodiments of the present disclosure;

[0024] FIG. 7 illustrates a flowchart of a method implemented at a third device according to some example embodiments of the present disclosure;

[0025] FIG. 8 illustrates a simplified block diagram of a device that is suitable for implementing example embodiments of the present disclosure; and

[0026] FIG. 9 illustrates a block diagram of an example computer readable medium in accordance with some example embodiments of the present disclosure.

[0027] Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

[0028] 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. Embodiments described herein can be implemented in various manners other than the ones described below.

[0029] 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.

[0030] 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.

[0031] It shall be understood that although the terms "first," "second,"..., etc. in front of noun(s) and the like 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 and they do not limit the order of the noun(s). 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.

[0032] As used herein, "at least one of the following: <a list of two or more elements>" and "at least one of <a list of two or more elements>" and similar wording, where the list of two or more elements are joined by "and" or "or", mean at least any one of the elements, or at least any two or more of the elements, or at least all the elements.

[0033] As used herein, unless stated explicitly, performing a step "in response to A" does not indicate that the step is performed immediately after "A" occurs and one or more intervening steps may be included.

[0034] 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.

[0035] 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.

[0036] 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.

[0037] As used herein, the term "communication network" refers to a network following any suitable communication standards, such as New Radio (NR), 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) 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 fifth generation (5G), the sixth generation (6G) 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.

[0038] 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), an NR NB (also referred to as a gNB), a Remote Radio Unit (RRU), a radio header (RH), a remote radio head (RRH), a relay, an Integrated Access and Backhaul (IAB) node, a low power node such as a femto, a pico, a non-terrestrial network (NTN) or non-ground network device such as a satellite network device, a low earth orbit (LEO) satellite and a geosynchronous earth orbit (GEO) satellite, an aircraft network device, and so forth, depending on the applied terminology and technology. In some example embodiments, radio access network (RAN) split architecture comprises a Centralized Unit (CU) and a Distributed Unit (DU) at an IAB donor node. An IAB node comprises a Mobile Terminal (IAB-MT) part that behaves like a UE toward the parent node, and a DU part of an IAB node behaves like a base station toward the next-hop IAB node.

[0039] 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 (IoT) 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. The terminal device may also correspond to a Mobile Termination (MT) part of an IAB node (e.g., a relay node). In the following description, the terms "terminal device", "communication device", "terminal", "user equipment" and "UE" may be used interchangeably.

[0040] As used herein, the term "resource," "transmission resource," "resource block," "physical resource block" (PRB), "uplink resource," or "downlink resource" may refer to any resource for performing a communication, for example, a communication between a terminal device and a network device, such as a resource in time domain, a resource in frequency domain, a resource in space domain, a resource in code domain, or any other combination of the time, frequency, space and/or code domain resource enabling a communication, and the like. In the following, unless explicitly stated, a resource in both frequency domain and time domain will be used as an example of a transmission resource for describing some example embodiments of the present disclosure. It is noted that example embodiments of the present disclosure are equally applicable to other resources in other domains.

[0041] As mentioned above, IoT is considered, focusing on Cellular IoT (CIoT). CIoT technologies, referred to as licensed spectrum-based low-power wide-area (LPWA) access technologies, are deployed in cellular networks for providing enhanced IoT services with respects to quality of service, reliability, latency, and coverage range for examples. They also have the characteristics of low complexity, low cost, and low power consumption. One of CIoT power saving mechanisms is based on using a wake-up signal (WUS) which is similar to a paging indicator channel to wake up an IoT device or, that is, a UE from a deep sleep state of a long discontinuous reception (DRX) cycle for an incoming data from a serving network. The benefit of introducing WUS is to reduce unnecessary power consumption related to a need for monitoring downlink control information (DCI) sent on a physical downlink control channel (PDCCH) from the serving network, referred to as the PDCCH monitoring. By using WUS, the UE only needs to decode the PDCCH when

WUS is detected; otherwise, the UE will stay in the sleep mode. This represents an efficiency improvement in term of UE power saving, especially when considering low activity periods, e.g., at night-time.

[0042] A Single Frequency Network (SFN) is a network of transmitting stations or devices that use the same frequency to transmit the same information. A Single Frequency Network is a means to extend the coverage area without the use of additional frequencies. It is to be noted that the term 'frequency' here is meant for resources in general that may comprise other domains such as time, code, information format. SFN transmissions from transmitting stations or devices may appear as a single transmission to a receiver. A SFN is particularly interesting for broadcasting. Both T-DAB (digital radio via terrestrial transmitters) and DVB-T (digital television via terrestrial transmitters) have the possibility for a single frequency network. A SFN can be used with other radio communication systems, such as wireless local area networks and Cellular networks as well.

[0043] Passive IoT refers to an IoT technology that is to be "greener" compared to existing IoT technologies such as 3GPP Narrow Band IoT (NB-IoT) or Long Term Evolution Machine Type Communication (LTE-M), as Passive IoT devices such as sensors or IoT tags are typically to be powered through energy harvesting. Passive IoT device or tag comprises an energy harvester. Early forms of passive IoT can already be found in commercial applications (e.g., RFID). In order to trigger Ambient/Passive IoT device for energy harvesting and fulfil requirements in NG RAN, below observed problems need to be solved.

[0044] For example, it is not clear how to provide an initial wake-up charging (WUC) to a remote Ambient/Passive IoT device over sidelink, denoted as SL-WUC, upon waking up the remote Ambient/Passive IoT device for radio transmission or reception, considering the remote Ambient/Passive IoT device may be out-of-coverage or in-partial-coverage of the serving network. The remote IoT device may not have enough energy after waking-up for regular SL transmissions/receptions and therefore SL-WUC is expected. This is due to, for example, that there may be, e.g., a small amount of electricity stored in capacitors for a passive IoT device such as a battery-less sensor. However, the remote IoT device needs to have enough energy for some designated transmission/reception over SL for SL-WUC. The remote IoT device may be in idle or inactive state of the serving network via a relay UE over SL. The relay UE is responsible

for monitoring WUS and paging from the network for the remote IoT device and then forward it to the remote IoT device over SL. The network may page an individual IoT device or a group of co-located IoT devices simultaneously. The remote IoT device may also wake up by itself for UE-initiated transmission. For example, a battery-less sensor actively wakeup for environment monitoring and reporting. It is to be noted that the remote IoT device may also be in a deep sidelink DRX (SL-DRX) state and, similar to the use of WUS from the network, sidelink WUS (SL-WUS) may be used for waking up the remote IoT device from the deep SL-DRX state by the relay UE over SL. Furthermore, it is also not clear how to involve more than one available transmitting UEs to provide WPT for SL-WUC to a target IoT Tag in Single Frequency Network (SFN) fashion. In other words, how to explore SFN gain for SL-WUC, as transmit (Tx) power of a single Tx UE is rather limited and restricted by predefined Tx power UE categories.

[0045] According to some example embodiments of the present disclosure, there is provided a solution for wake-up charging. In particular, a SL-WUS that is used for waking up at least one IoT device over SL is associated with a broadcast SL wake-up charging (SL-WUC) message for initial wireless power transfer (WPT). That is, the SL-WUS is used not only for waking up the at least one IoT device over SL but also for triggering or requesting transmissions of the associated SL-WUC message for the initial WPT for the at least one IoT device over SL. In this way, it can provide energy to passive IoT devices during a wake-up procedure.

[0046] The term wake-up signal (WUS) used herein may refer to a physical signal in conjunction with discontinuous reception (DRX) operation that may be decoded or detected before the UE monitors a paging on a channel. The term wake-up charging used herein may refer to a charging process that a device can be charged during waking up. The term transmission pattern used herein may refer to a pattern that indicates timings and durations for a transmission. The term discontinuous reception (DRX) used herein may refer to a power-saving feature used to reduce power consumption in UEs by periodically turning off the radio when there may be no data to be transmitted or received. The term sidelink discontinuous reception (DRX) configuration used herein may refer to information that indicates when a device may be awakened to receive/transmit data over sidelink and when the device goes to sleep for a period of time. The term occasion used herein may refer to a resource in time domain where a signal can be transmitted. The term connected state or connected mode used herein may refer to a state in which the terminal

device has an established radio resource control (RRC) connection with the serving network. The term idle state or idle mode used herein may refer to a state where the terminal device is registered and attached to the serving network but does not have any established RRC connection with the serving network. The term inactive state or inactive mode used herein may refer to a state where the RRC connection of the terminal device has been suspended.

[0047] FIG. 1 illustrates an example communication environment 100 in which example embodiments of the present disclosure can be implemented. In the communication environment 100, there are an apparatus 110-1 and an apparatus 110-2 which are collectively referred to as "first apparatus 110." It is noted that the communication environment 100 may include any proper number of first apparatus 110.

[0048] The communication environment 100 may also include an apparatus 120-1 and an apparatus 120-2 which are collectively referred to as "second apparatus 120." It is noted that the communication environment 100 may include any proper number of second apparatus 120. The communication environment 100 may further include an apparatus 130, also referred to as "third apparatus 130". It is noted that the communication environment 100 may include any proper number of third apparatus 130. It is further noted that there may be other apparatus(es) inter-connected with third apparatus(es) for serving the communication environment 100.

[0049] In the following, for the purpose of illustration, some example embodiments are described with the first apparatus 110 operating as a terminal device, the second apparatus 120 operating as a passive IoT device and the third apparatus 130 operating as a network device.130. However, in some example embodiments, operations described in connection with a terminal device may be implemented at a network device or other device, and operations described in connection with a network device may be implemented at a terminal device or other device.

[0050] In some example embodiments, a link from the third apparatus 130 to the first apparatus 110 is referred to as a downlink (DL), and a link from the first apparatus 110 to the third apparatus 130 is referred to as an uplink (UL). In DL, the third apparatus 130 is a transmitting (TX) device (or a transmitter) and the first apparatus 110 is a receiving (RX) device (or a receiver). In UL, the first apparatus 110 is a TX device (or a transmitter) and the third apparatus 130 is a RX device (or a receiver).

[0051] Communications in the communication environment 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), the fifth generation (5G), the sixth generation (6G), and 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] Example embodiments of the present disclosure will be described in detail below with reference to the accompanying drawings.

[0053] Reference may be now made to FIG. 2, which shows a signaling chart 300 for communication according to some example embodiments of the present disclosure. Only for the purpose of illustration, the signaling chart 200 involves the first apparatus 110-1, the first apparatus 110-2, the second apparatus 120-1, the third apparatus 130, and the apparatus 140 as a fourth apparatus. For example, the apparatus 110-2 may be a collaborative WUC UE, apparatus 120-1 may be a passive IoT device or tag, apparatus 110-2 may be a serving relay UE, apparatus 130 may be a network node, e.g. gNB, and apparatus 140 may be a network entity providing functions such as session management function and charging transfer function.

[0054] In some example embodiments, the apparatus 120-1 may select and maintain a PC5 connection with the apparatus 110-1 which is a serving relay device. The apparatus 120-1 may be in a DRX state over SL. In this case, the apparatus 110-1 may be responsible for monitoring paging for the apparatus 120-1. The apparatus 110-1 may be in an idle or inactive state over Uu interface. Alternatively, the apparatus 110-1 may be in a connected state. In some other embodiments, the apparatus 130 may select (2010) the apparatus 110-1 as the relay device for the apparatus 120-1.

[0055] In an example embodiment, the apparatus 110-1 and/or the apparatus 110-2 may be configured with a set of allocated resources for transmitting a wake-up signal. The wake-up signal is a SL-WUS. For example, as shown in FIG. 4A, the apparatus 110-1 and/or the apparatus 110-2 may transmit the wake-up signal on at least one of occasion 420-1 or occasion 420-2 which are a set of time domain resources.

[0056] In another example embodiment, the apparatus 110-1 may be configured with another set of allocated resources for transmitting a wake-up signal. The wake-up signal is a SL-WUS. For example, as shown in FIG. 4B, the apparatus 110-1 may transmit the wake-up signal on at least one of occasion 420-1' or occasion 420-2' which are another set of time domain resources.

[0057] The apparatus 110-1 determines (2020) whether a transmission or reception (2030) of a wake-up signal is performed by the apparatus 110-1. The wake-up signal may be a SL-WUS. For example, the apparatus 110-1 may determine whether it transmits the wake-up signal to one or more of: the apparatus 120-1 and the apparatus 110-2. Alternatively, the apparatus 110-1 may determine whether it receives the wake-up signal from one or more of: the apparatus 120-1 and the apparatus 110-2. The apparatus 120-1 determines (2020') whether the transmission or reception (2030) of a wake-up signal is performed by the apparatus 120-1. The wake-up signal is a SL-WUS. For example, the apparatus 120-1 may determine whether it transmits the wake-up signal to one or more of: the apparatus 110-1 and the apparatus 110-2. Alternatively, the apparatus 120-1 may determine whether it receives the wake-up signal from one or more of: the apparatus 110-1 and the apparatus 110-2. Example embodiments of the transmission or reception (2030) of the wake-up signal are described with reference to FIG. 3A to FIG. 3C. In some example embodiments, the wake-up signal transmitted by the apparatus 110-1 and/or the apparatus 110-2 and the wake-up signal transmitted by the apparatus 120-1 may be different sequences and/or in different occasions. In an example embodiment, a maximum transmission power limit may be applied to the wake-up signal. In other words, the wake-up signal may be transmitted at a power which is smaller than or equal to the maximum transmission power, or not larger than the maximum transmission power.

[0058] The apparatus 110-2 which is capable of providing WPT may monitor the wake-up signal from the apparatus 120-1 or the wake-up signal from the apparatus 110-1 in proximity. If the wake-up signal is received, the apparatus 110-2 may get involved in providing the initial wake-up charging for the apparatus 120-1 by broadcasting the

message for the wake-up charging in SFN based on the received wake-up signal from the apparatus 110-1 or the apparatus 120-1. The apparatus 110-2 may also provide the initial wake-up charging by broadcasting the message based on a paging message received from the apparatus 130, which will be described later.

[0059] In some example embodiments, as shown in FIG. 3A, the apparatus 130 may transmit (3001) a paging message for the apparatus 120-1 (i.e., IoT device) via the apparatus 110-1 (i.e., relay UE). That is, the apparatus 110-1 may receive (3001) the paging message from the apparatus 130 for the apparatus 120-1. In an example embodiment, the paging message may be used for triggering the apparatus 110-1 to provide the wake-up charging to the apparatus 120-1. In other words, the paging message may be a designated message used for triggering one or more serving relay devices to provide the wake-up charging for one or more targeted first apparatus(es) or, that is, remote IoT devices, from time to time. Alternatively, the apparatus 110-1 may monitor the paging message that is targeted for the apparatus 120-1. The apparatus 110-1 may forward the paging message to the apparatus 120-1 after providing the wake-up charging for the apparatus 120-1. That is, the paging message may be a regular paging targeted for the apparatus 120-1 and the apparatus 110-1 may be responsible for monitoring and forwarding the paging message for the apparatus 120-1. In some example embodiments, the paging message may be for or targeted for more than one second apparatus, for example, for the apparatus 120-1 and the apparatus 120-2 (referred to FIG. 1).

[0060] The apparatus 110-1 may perform the transmission of the wake-up signal to the apparatus 120-1 and the apparatus 110-2. In some example embodiments, repetitions of the wake-up signal may be applied. In this case, it can wake up the apparatus 120-1 as well as to request the apparatus 110-2 or collaborative wake-up charging (WUC) UE(s) in proximity of the apparatus 110-1 to provide the wake-up charging to the apparatus 120-1. In some embodiments, the apparatus 110-1 may also wake up other second apparatus in proximity to benefit from the wake-up charging provided to the apparatus 120-1, and since the paging message is not for them, they may return to the DRX after the wake-up charging.

[0061] As shown in FIG. 3A, the apparatus 110-1 may transmit/broadcast (3002) the wake-up signal to the apparatus 110-2 and to the apparatus 120-1 on the occasion 420-1. That is, the apparatus 110-2 and the apparatus 120-1 may receive (3002) the wake-up signal from the apparatus 110-1. The apparatus 110-1 may also transmit (3003) the wake-

up signal to the apparatus 110-2 and to the apparatus 120-1 on the occasion 420-2 associated with the occasion 420-1.

[0062] In some example embodiments, after receiving the wake-up signal on the occasion 420-1, the apparatus 110-2 may transmit/broadcast (3004) the wake-up signal to the apparatus 120-1 and other first and second apparatuses on the occasion 420-2 associated with the occasion 420-1. For example, the apparatus 110-2 may determine whether a reference signal received power (RSRP) level related to the wake-up signal received on the occasion 420-1 is above a threshold. In this case, if the reference signal received power level is above the threshold, the apparatus 110-2 may transmit/broadcast (3004) the wake-up signal to the apparatus 120-1 and other first and second apparatuses on the occasion 420-2. In other words, the collaborative apparatus 110-2 upon receiving the wake-up signal on a first occasion may send the wake-up signal together with the apparatus 110-1 in SFN on a second occasion associated with the first occasion. In this way, it can improve reliability of the wake-up signal. Moreover, it can request further collaborative devices to provide the wake-up charging for the apparatus 120-1.

[0063] Alternatively, as shown in FIG. 3B, the apparatus 130 may transmit (3101) the paging message to the apparatus 110-1. The apparatus 110-1 may transmit/broadcast (3102) the wake-up signal to the apparatus 120-1, for example, on the occasion 420-1. The apparatus 130 may also transmit (3103) the paging message to the apparatus 110-2. The apparatus 110-2 may transmit/broadcast (3104) the wake-up signal to the apparatus 120-1, for example, on the occasion 420-2. The occasion 420-2 may be associated with the occasion 420-1. The apparatus 130 may also transmit the same or single paging message to trigger more than one first apparatuses, the apparatus 110-1 and the apparatus 110-2, to transmit the wake-up signal on at least one of the same occasion 420-1 or 420-2.

[0064] In some other embodiments, as shown in FIG. 3C, the apparatus 120-1 may transmit/broadcast (3201) the wake-up signal to the apparatus 110-1 and the apparatus 110-2. That is, the apparatus 110-1 and the apparatus 110-2 may receive the wake-up signal from the apparatus 120-1. For example, the apparatus 120-1 may transmit/broadcast (3201) the wake-up signal on the occasion 420-1'. In some other embodiments, after receiving the wake-up signal from the apparatus 120-1, the apparatus 110-1 may transmit/broadcast (3202) the wake-up signal to other first apparatus, the apparatus 110-2, on another occasion, for example the occasion 420-2 shown in FIG. 4A. The occasion

420-2 is associated with the occasion 420-1'.

[0065] In an example embodiment, the apparatus 120-1 may transmit/broadcast the wake-up signal, if a condition is fulfilled. For example, the condition may include one or more of: an amount of stored energy at the apparatus 120-1 is below an energy threshold, an additional charging is needed by the apparatus 120-1, or the apparatus 120-1 has no other capability for receiving wireless power transfer than using the wake-up charging. For example, the apparatus 120-1 may be configured or preconfigured with one or more conditions to trigger a transmission of the wake-up signal to request the wake-up charging that may not be limited to waking-up from deep DRX state. For example, the apparatus 120-1 may be allowed to initiate the transmission of the wake-up signal when its stored energy drops below a threshold or when it has an urgent need for additional charging or if it has no other capability for receiving WPT than using the wake-up charging.

[0066] Referring back to FIG. 2, if the transmission or reception of the wake-up signal is performed at the apparatus 110-1, the apparatus 110-1 determines (2040) to transmit a message for a wake-up charging to at least one second apparatus, for example the apparatus 120-1. In an example embodiment, the apparatus 110-1 may obtain a configuration (also referred to as "first configuration") including one or more of: a transmission pattern, a first set of resources for the transmission of the wake-up signal or a second set of resources for the transmission message. For example, the apparatus 110-1 may receive the first configuration from the apparatus 130. By way of example, the first configuration may be transmitted from the apparatus 130 to the apparatus 110-1 via a system information block or a dedicated RRC message. Alternatively, the first configuration may be static and pre-configured at the apparatus 110-1. In some example embodiments, the first configuration may be cell specific or, that is, specific to the serving cell of the apparatus 110-1. Alternatively, the first configuration may be public land mobile network (PLMN) specific or, that is, specific to the serving PLMN of the apparatus 110-1. In some other embodiments, the first configuration may be common to all first apparatuses including the apparatus 110-1, regardless of their serving cells or PLMNs.

[0067] Alternatively or additionally, the apparatus 120-1 may obtain a configuration (also referred to as "second configuration") including at least one of: the transmission pattern, a first set of resources for the transmission or reception of the wake-up signal, or a second set of resources for the reception of the message. For example, the apparatus 120-1 may receive the second configuration from the apparatus 130. By way of example,

the second configuration may be transmitted from the apparatus 130 to the apparatus 120-1 via a system information block or a dedicated RRC message. Alternatively, the second configuration may be static and pre-configured at the apparatus 120-1. In some example embodiments, the second configuration may be cell specific. Alternatively, the second configuration may be PLMN specific. In some other embodiments the second configuration may be common to all second apparatuses including the apparatus 120-1, regardless of cell or PLMN. In some example embodiments, the first configuration and the second configuration may be the same. Alternatively, the first configuration and the second configuration may be different. In some other embodiments, the patterns and/or resources for the transmission of the wake-up signal and/or the transmission of the message may be configured separately from that for the corresponding reception of the wake-up signal and/or the corresponding reception of the message.

[0068] The transmission pattern may indicate a duration for transmitting/monitoring the message for the wake-up charging and a time interval between two adjacent transmissions of the message for the wake-up charging message. For example, as shown in FIG. 4C, the transmission pattern may indicate the duration 430 for transmitting/monitoring the message for the wake-up charging. By way of example, a timer with the running time being the duration 430 may be configured. For example, this timer may indicate maximum time length for the wake-up charging. In an example, the timer may start from a time instance where the last transmission of the wake-up signal is transmitted or received.

[0069] The transmission pattern may also indicate the time interval 440 between two adjacent transmissions. For example, another timer with the running time being the time interval 440 may be configured. In an example embodiment, a start of the transmission pattern may be associated with timing of the transmission or reception of the wake-up signal. For example, as shown in FIG. 4C, the start 4301 of the transmission pattern may be from the second transmission or reception of the wake-up signal on the occasion 420-2 or 420-2'.

[0070] If the transmission or reception of the wake-up signal is performed at the apparatus 120-1, the apparatus 120-1 monitors (2045) the message for the wake-up charging based on the transmission or reception pattern of the message associated with the transmission or reception of the wake-up signal. For example, the apparatus 120-1 may start monitoring the message for the wake-up charging at the timing 4301 and stop monitoring the message for the wake-up charging at the timing 4302. The apparatus 120-

1 may not configured to monitor or not to react to wake-up signals from other second apparatus, for example, the apparatus 120-2 (referred to FIG. 1). As mentioned above, the sequences for the wake-up signal transmitted by the second apparatus 120-1 or 120-2 and transmitted by the first apparatus 110-1 or 110-2 may be different; or the transmission resources of the wake-up signals for the first apparatus 110-1 or 110-2 and the second apparatus 120-1 or 120-2 may be different. Thus, the apparatus 120-1 may not monitor the wake-up signals from other second apparatus.

[0071] The apparatus 110-1 transmits (2050) to the apparatus 120-1 the message for the wake-up charging based on the transmission pattern. Alternatively or additionally, the apparatus 110-2 may transmit (2050') to the apparatus 120-1 the message for the wake-up charging based on the transmission pattern. For example, the message for the wake-up signal may be transmitted by the apparatus 110-1 and/or the apparatus 110-2 at timings 4301, 4401 and 4402. In other words, the apparatus 120-1 receives the message for the wake-up charging from at least one of: the apparatus 110-1 or the apparatus 110-2. In an example embodiment, if the reference signal received power level related to the wake-up signal received on the first occasion is above the threshold the apparatus 110-2 may transmit (2050') to the apparatus 120-1 the message for the wake-up charging.

[0072] In an example embodiment, a maximum transmission power limit may be applied to the wake-up charging. In other words, the message for the wake-up charging may be transmitted at a power which is smaller than or equal to the maximum transmission power, or not larger than the maximum transmission power. In this way, it can avoid interfering with regular sidelink transmissions.

[0073] In an example embodiment, the apparatus 120-1 may perform (2060) a sidelink transmission to one or more first apparatus, for example, the apparatus 110-1. That is, the apparatus 110-1 may receive the sidelink transmission from the apparatus 120-1. For example, the apparatus 120-1 may perform the sidelink transmission before the duration for monitoring the message expires. In this case, the sidelink transmission may implicitly or explicitly indicate that the wake-up charging is not needed by the apparatus 120-1. The sidelink transmission may be a unicast message. The apparatus 110-1 may transmit (2070) a sidelink message to stop the wake-up charging to other first apparatus, for example, the apparatus 110-2.

[0074] Alternatively or additionally, the apparatus 120-1 may broadcast (2060) an

indication to the apparatus 110-1 and other involved first apparatus, for example, the apparatus 110-2 to stop the wake-up charging. For example, the apparatus 120-1 may broadcast a notification in an inter-UE coordination message to stop the wake-up charging. Alternatively, the apparatus 120-1 may broadcast an announcement in a proximity service (ProSe) direct discovery message to the stop the wake-up charging.

[0075] The apparatus 110-1 may stop the wake-up charging based on the indication (received at 2060) from the apparatus 120-1. Alternatively, after the duration 430 expires (for example, the related timer run out), the apparatus 110-1 may stop the wake-up charging. In an example embodiment, after stopping the wake-up charging, the apparatus 110-1 may transmit/forward (2080) the paging message to the apparatus 120-1.

[0076] The apparatus 110-1 may transmit (2090) an indication indicating that the wake-up charging is completed to the apparatus 130. In some example embodiments, the indication may further include an amount of energy provided for the wake-up charging to the apparatus 120-1 by the apparatus 110-1. The apparatus 110-2 may also transmit (2090') the indication indicating that the wake-up charging is completed to the apparatus 130. In some example embodiments, the indication may further include an amount of energy provided for the wake-up charging to the apparatus 120-1 by the apparatus 110-2.

[0077] The apparatus 130 may determine (2092) a total amount of energy provided to the apparatus 120-1 based on the indication(s) (for example, received at 2090 and/or 2090'). The apparatus 130 may transmit (2095) another indication indicating the total amount of energy to a four apparatus 140. The apparatus 140 may be a session management function (SMF) which acts as a charging transfer function.

[0078] FIG. 5 shows a flowchart of an example method 500 implemented at a first device in accordance with some example embodiments of the present disclosure. For the purpose of discussion, the method 500 will be described from the perspective of the apparatus. For example, the first apparatus may be the apparatus 110-1 in FIG. 1.

[0079] At block 510, the first apparatus determines whether a transmission or reception of a wake-up signal is performed at the first apparatus.

[0080] At block 520, if the transmission or reception of the wake-up signal is performed, the first apparatus determines to transmit a message for a wake-up charging to at least one second apparatus.

[0081] At block 530, the first apparatus transmits, to the at least one second apparatus, the message for the wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal.

[0082] In some example embodiments, the method 500 further comprises: receiving, from a third apparatus, a paging message for the at least one second apparatus; and performing the transmission of the wake-up signal.

[0083] In some example embodiments, the paging message is used for triggering the first apparatus to provide the wake-up charging to the at least one second apparatus. Alternatively, the paging message is a paging message targeted for the at least one second apparatus which is monitored and forwarded to the at least one second apparatus by the first apparatus.

[0084] In some example embodiments, the method 500 further comprises: transmitting the wake-up signal on a first occasion configured for the transmission of the wake-up signal from the first apparatus to the at least one second apparatus or other first apparatus; and transmitting the wake-up signal on a second occasion configured for the transmission of the wake-up signal from the first apparatus to the at least one second apparatus or further first apparatus, the second occasion is after the first occasion and associated with the first occasion.

[0085] In some example embodiments, the method 500 further comprises: receiving the wake-up signal from at least one other first apparatus on a first occasion configured for the reception of the wake-up signal from the at least one other first apparatus; and transmitting the wake-up signal on the second occasion to the at least one second apparatus or further first apparatus.

[0086] In some example embodiments, the method 500 further comprises: determining whether a reference signal received power level related to the wake-up signal received on the first occasion is above a threshold; and based on a determination that the reference signal received power level is above the threshold, transmitting the wake-up signal on the second occasion.

[0087] In some example embodiments, the method 500 further comprises: determining whether a reference signal received power level related to the wake-up signal received on the first occasion is above a threshold; and based on a determination that the reference

signal received power level is above the threshold, transmitting the message for the wake-up charging.

[0088] In some example embodiments, the method 500 further comprises: receiving the wake-up signal from the at least one second apparatus on a third occasion configured for the reception of the wake-up signal from the at least one second apparatus; and transmitting the wake-up signal on a fourth occasion configured for the transmission of the wake-up signal from the first apparatus to other second apparatus and other first apparatus, the fourth occasion is after the third occasion and associated with the third occasion.

[0089] In some example embodiments, the wake-up signal comprises a first wake-up signal and a second wake-up signal, the first wake-up signal is transmitted to or received from another first apparatus and the second wake-up signal is received from the at least one second apparatus.

[0090] In some example embodiments, the second occasion is the same as the fourth occasion.

[0091] In some example embodiments, if the wake-up signal is received from the at least one second apparatus, the wake-up signal comprises a first sequence. Alternatively, if the wake-up signal is received from or transmitted to another first apparatus, the wake-up signal comprises a second sequence which is different from the first sequence.

[0092] In some example embodiments, the reception of the wake-up signal from at least one second apparatus is performed on different allocated resources than the transmission or reception of the wake-up signal to or from other first apparatus.

[0093] In some example embodiments, the transmission pattern indicates a duration for transmitting the message for the wake-up charging and a time interval between two adjacent transmissions of the message for the wake-up charging message.

[0094] In some example embodiments, a start of the transmission pattern is associated with timing of the transmission or reception of the wake-up signal.

[0095] In some example embodiments, the method 500 further comprises: obtaining a configuration comprising at least one of: the transmission pattern, a first set of resources for the transmission of the wake-up signal, or a second set of resources for the transmission of the message.

[0096] In some example embodiments, the method 500 further comprises: receiving, from the at least one second apparatus, a sidelink transmission indicating that the wake-up charging is not needed by the at least one second apparatus.

[0097] In some example embodiments, the method 500 further comprises: transmitting, to other first apparatus, a sidelink message to stop the wake-up charging.

[0098] In some example embodiments, the method 500 further comprises: transmitting, to the third apparatus, an indication indicating the wake-up charging is completed.

[0099] In some example embodiments, the indication comprises an amount of energy provided for the wake-up charging to the at least one second apparatus by the first apparatus.

[0100] In some example embodiments, the first apparatus is a terminal device capable of providing the wake-up charging, and wherein the at least one second apparatus is a passive Internet of Things device or a passive Internet of Things tag.

[0101] FIG. 6 shows a flowchart of an example method 600 implemented at a second device in accordance with some example embodiments of the present disclosure. For the purpose of discussion, the method 600 will be described from the perspective of the second apparatus. For example, the second apparatus may be the apparatus 120-1 shown in FIG. 1.

[0102] At block 610, the second apparatus determines whether a transmission or reception of a wake-up signal is performed at the second apparatus.

[0103] At block 620, if the transmission or reception of the wake-up signal is performed, the second apparatus monitors a message for a wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal.

[0104] At block 630, the second apparatus receives, from at least one first apparatus, the message for the wake-up charging.

[0105] In some example embodiments, the method 600 further comprises: receiving the wake-up signal from the at least one first apparatus on an occasion configured for the reception of the wake-up signal from the at least one first apparatus.

[0106] In some example embodiments, the method 600 further comprises: transmitting the wake-up signal to the at least one first apparatus on an occasion configured for the

transmission of the wake-up signal from the second apparatus.

[0107] In some example embodiments, the method 600 further comprises: transmitting the wake-up signal to the at least one first apparatus, based on a determination that at least one of the following conditions is fulfilled; an amount of stored energy at the second apparatus is below an energy threshold, an additional charging is needed by the second apparatus, or the second apparatus has no other capability for receiving wireless power transfer.

[0108] In some example embodiments, if the wake-up signal is transmitted to the at least one second apparatus, the wake-up signal comprises a first sequence, and wherein if the wake-up signal is received from the at least one first apparatus, the wake-up signal comprises a second sequence which is different from the first sequence.

[0109] In some example embodiments, the reception of the wake-up signal from at least one second apparatus is performed on different allocated resources than the transmission or reception of the wake-up signal to or from other first apparatus.

[0110] In some example embodiments, the transmission pattern indicates a duration for monitoring the message for the wake-up charging and a time interval between two adjacent receptions of the message for the wake-up charging.

[0111] In some example embodiments, a start of the transmission pattern is associated with timing of the transmission or reception of the wake-up signal.

[0112] In some example embodiments, the method 600 further comprises: obtaining a configuration comprising at least one of: the transmission pattern, a first set of resources for the transmission or reception of the wake-up signal, or a second set of resources for the reception of the message.

[0113] In some example embodiments, the method 600 further comprises: performing, to the at least one first apparatus, a sidelink transmission indicating that the wake-up charging is not needed by the second apparatus.

[0114] In some example embodiments, the sidelink transmission is broadcasted in an inter user equipment (UE) coordination message or an announcement message.

[0115] In some example embodiments, the at least one first apparatus is a terminal device capable of providing the wake-up charging, and wherein the second apparatus is a

passive Internet of Things device or a passive Internet of Things tag.

[0116] FIG. 7 shows a flowchart of an example method 700 implemented at a third device in accordance with some example embodiments of the present disclosure. For the purpose of discussion, the method 700 will be described from the perspective of the third apparatus. For example, the third apparatus may be the apparatus 130 shown in FIG. 1.

[0117] At block 710, the third apparatus transmits, to at least one first apparatus, a paging message for triggering the at least one first apparatus to provide a wake-up charging to at least one second apparatus.

[0118] At block 720, the third apparatus receives, from the at least one first apparatus, at least one indication indicating the wake-up charging is completed.

[0119] In some example embodiments, the at least one indication comprises an amount of energy provided to the at least one second apparatus by the at least one first apparatus.

[0120] In some example embodiments, the method 700 further comprises: determining a total amount of energy provided to the at least one second apparatus based on the at least one indication; and transmitting, to a fourth apparatus, another indication indicating the total amount of energy.

[0121] In some example embodiments, the paging message is used for triggering the at least one first apparatus to provide the wake-up charging to the at least one second apparatus, or wherein the paging message is a paging message targeted for the at least one second apparatus which is monitored and forwarded to the at least one second apparatus by the at least one first apparatus.

[0122] In some example embodiments, the method 700 further comprises: transmitting, to one or more of: the at least one first apparatus or the at least one second apparatus, a configuration comprising at least one of: a transmission pattern, a first set of resources for the transmission or reception of the wake-up signal, or a second set of resources for the transmission of the wake-up charging message.

[0123] In some example embodiments, the transmission pattern indicates a duration for transmitting a message for a wake-up charging to the at least one second apparatus and a time interval between two adjacent transmissions of the message for the wake-up charging.

[0124] In some example embodiments, a start of the transmission pattern is associated

with timing of the transmission or reception of the wake-up signal.

[0125] In some example embodiments, the at least one first apparatus is a terminal device capable of providing the wake-up charging, the at least one second apparatus is a passive Internet of Things device or a passive Internet of Things tag, and the third apparatus is a network device.

[0126] In some example embodiments, a first apparatus capable of performing any of the method 500 (for example, the apparatus 110-1 in FIG. 1) may comprise means for performing the respective operations of the method 500. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module. The first apparatus may be implemented as or included in the apparatus 110-1 in FIG. 1.

[0127] In some example embodiments, the first apparatus comprises means for determining whether a transmission or reception of a wake-up signal is performed at the first apparatus; means for based on a determination that the transmission or reception of the wake-up signal is performed, determining to transmit a message for a wake-up charging to at least one second apparatus; and means for transmitting, to the at least one second apparatus, the message for the wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal.

[0128] In some example embodiments, the first apparatus further comprises: means for receiving, from a third apparatus, a paging message for the at least one second apparatus; and means for performing the transmission of the wake-up signal.

[0129] In some example embodiments, the paging message is used for triggering the first apparatus to provide the wake-up charging to the at least one second apparatus.

[0130] In some example embodiments, the first apparatus further comprises: means for transmitting the wake-up signal on a first occasion configured for the transmission of the wake-up signal from the first apparatus to the at least one second apparatus or another first apparatus; and means for transmitting the wake-up signal on a second occasion configured for the transmission of the wake-up signal from the first apparatus to the at least one second apparatus or a further first apparatus, the second occasion is after the first occasion and associated with the first occasion.

[0131] In some example embodiments, the first apparatus further comprises: means for

receiving the wake-up signal from at least one other first apparatus on a first occasion configured for the reception of the wake-up signal from the at least one other first apparatus; and means for transmitting the wake-up signal on the second occasion to the at least one second apparatus or a further first apparatus.

[0132] In some example embodiments, the first apparatus further comprises: means for determining whether a reference signal received power level related to the wake-up signal received on the first occasion is above a threshold; and means for based on a determination that the reference signal received power level is above the threshold, transmitting the wake-up signal on the second occasion.

[0133] In some example embodiments, the first apparatus further comprises: means for determining whether a reference signal received power level related to the wake-up signal received on the first occasion is above a threshold; and means for based on a determination that the reference signal received power level is above the threshold, transmitting the message for the wake-up charging.

[0134] In some example embodiments, the first apparatus further comprises: means for receiving the wake-up signal from the at least one second apparatus on a third occasion configured for the reception of the wake-up signal from the at least one second apparatus; and means for transmitting the wake-up signal on a fourth occasion configured for the transmission of the wake-up signal from the first apparatus to other second apparatus and other first apparatus, the fourth occasion is after the third occasion and associated with the third occasion.

[0135] In some example embodiments, the wake-up signal comprises a first wake-up signal and a second wake-up signal, the first wake-up signal is transmitted to or received from another first apparatus and the second wake-up signal is received from the at least one second apparatus.

[0136] In some example embodiments, the second occasion is the same as the fourth occasion.

[0137] In some example embodiments, if the wake-up signal is received from the at least one second apparatus, the wake-up signal comprises a first sequence, and if the wake-up signal is received from or transmitted to another first apparatus, the wake-up signal comprises a second sequence which is different from the first sequence.

[0138] In some example embodiments, the reception of the wake-up signal from at least one second apparatus is performed on different allocated resources than the transmission or reception of the wake-up signal to or from other first apparatus.

[0139] In some example embodiments, the transmission pattern indicates a duration for transmitting the message for the wake-up charging and a time interval between two adjacent transmissions of the message for the wake-up charging message.

[0140] In some example embodiments, a start of the transmission pattern is associated with timing of the transmission or reception of the wake-up signal.

[0141] In some example embodiments, the first apparatus further comprises: means for obtaining a configuration comprising at least one of: the transmission pattern, a first set of resources for the transmission of the wake-up signal, or a second set of resources for the transmission of the message.

[0142] In some example embodiments, the first apparatus further comprises: means for receiving, from the at least one second apparatus, a sidelink transmission indicating that the wake-up charging is not needed by the at least one second apparatus.

[0143] In some example embodiments, the first apparatus further comprises: means for transmitting, to other first apparatus, a sidelink message to stop the wake-up charging.

[0144] In some example embodiments, the first apparatus further comprises: means for transmitting, to the third apparatus, an indication indicating the wake-up charging is completed.

[0145] In some example embodiments, the indication comprises an amount of energy provided for the wake-up charging to the at least one second apparatus by the first apparatus.

[0146] In some example embodiments, the first apparatus is a terminal device capable of providing the wake-up charging, and wherein the at least one second apparatus is a passive Internet of Things tag.

[0147] In some example embodiments, the first apparatus further comprises means for performing other operations in some example embodiments of the method 500 or the apparatus 110-1. In some example embodiments, the means comprises at least one processor; and at least one memory storing instructions that, when executed by the at least

one processor, cause the performance of the first apparatus.

[0148] In some example embodiments, a second apparatus capable of performing any of the method 600 (for example, the apparatus 120-1) may comprise means for performing the respective operations of the method 600. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module. The second apparatus may be implemented as or included in the apparatus 120-1.

[0149] In some example embodiments, the second apparatus comprises means for determining whether a transmission or reception of a wake-up signal is performed at the second apparatus; means for based on a determination that the transmission or reception of the wake-up signal is performed, monitoring a message for a wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal; and means for receiving, from at least one first apparatus, the message for the wake-up charging.

[0150] In some example embodiments, the second apparatus further comprises: means for receiving the wake-up signal from the at least one first apparatus on an occasion configured for the reception of the wake-up signal from the at least one first apparatus.

[0151] In some example embodiments, the second apparatus further comprises: means for transmitting the wake-up signal to the at least one first apparatus on an occasion configured for the transmission of the wake-up signal from the second apparatus.

[0152] In some example embodiments, the second apparatus further comprises: means for transmitting the wake-up signal to the at least one first apparatus, based on a determination that at least one of the following conditions is fulfilled; an amount of stored energy at the second apparatus is below an energy threshold, an additional charging is needed by the second apparatus, or the second apparatus has no other capability for receiving wireless power transfer.

[0153] In some example embodiments, if the wake-up signal is transmitted to the at least one second apparatus, the wake-up signal comprises a first sequence, and wherein if the wake-up signal is received from the at least one first apparatus, the wake-up signal comprises a second sequence which is different from the first sequence.

[0154] In some example embodiments, the reception of the wake-up signal from at least

one second apparatus is performed on different allocated resources than the transmission or reception of the wake-up signal to or from other first apparatus.

[0155] In some example embodiments, the transmission pattern indicates a duration for monitoring the message for the wake-up charging and a time interval between two adjacent receptions of the message for the wake-up charging.

[0156] In some example embodiments, a start of the transmission pattern is associated with timing of the transmission or reception of the wake-up signal.

[0157] In some example embodiments, the second apparatus further comprises: means for obtaining a configuration comprising at least one of: the transmission pattern, a first set of resources for the transmission or reception of the wake-up signal, or a second set of resources for the reception of the message.

[0158] In some example embodiments, the second apparatus further comprises: means for performing, to the at least one first apparatus, a sidelink transmission indicating that the wake-up charging is not needed by the second apparatus.

[0159] In some example embodiments, the sidelink transmission is broadcasted in an inter user equipment (UE) coordination message or an announcement message.

[0160] In some example embodiments, the at least one first apparatus is a terminal device capable of providing the wake-up charging, and wherein the second apparatus is a passive Internet of Things tag.

[0161] In some example embodiments, the second apparatus further comprises means for performing other operations in some example embodiments of the method 600 or the apparatus 120-1. In some example embodiments, the means comprises at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the performance of the second apparatus.

[0162] In some example embodiments, a third apparatus capable of performing any of the method 700 (for example, the apparatus 130 in FIG. 1) may comprise means for performing the respective operations of the method 700. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module. The third apparatus may be implemented as or included in the apparatus 130 in FIG. 1.

[0163] In some example embodiments, the third apparatus comprises means for transmitting, to at least one first apparatus, a paging message for triggering the at least one first apparatus to provide a wake-up charging to at least one second apparatus; and means for receiving, from the at least one first apparatus, at least one indication indicating the wake-up charging is completed.

[0164] In some example embodiments, the at least one indication comprises an amount of energy provided to the at least one second apparatus by the at least one first apparatus.

[0165] In some example embodiments, the third apparatus further comprises: means for determining a total amount of energy provided to the at least one second apparatus based on the at least one indication; and means for transmitting, to a fourth apparatus, another indication indicating the total amount of energy.

[0166] In some example embodiments, a start of the transmission pattern is associated with timing of the transmission or reception of the wake-up signal.

[0167] In some example embodiments, the at least one first apparatus is a terminal device capable of providing the wake-up charging, the at least one second apparatus is a passive Internet of Things tag, and the third apparatus is a network device.

[0168] In some example embodiments, the third apparatus further comprises means for performing other operations in some example embodiments of the method 700 or the apparatus 130. In some example embodiments, the means comprises at least one processor; and at least one memory storing instructions that, when executed by the at least one processor, cause the performance of the third apparatus.

[0169] FIG. 8 is a simplified block diagram of a device 800 that is suitable for implementing example embodiments of the present disclosure. The device 800 may be provided to implement a communication device, for example, the apparatus 110-1, the apparatus 110-2, the apparatus 120-1, the apparatus 120-2 or the apparatus 130. As shown, the device 800 includes one or more processors 810, one or more memories 820 coupled to the processor 810, and one or more communication modules 840 coupled to the processor 810.

[0170] The communication module 840 is for bidirectional communications. The communication module 840 has one or more communication interfaces to facilitate communication with one or more other modules or devices. The communication interfaces

may represent any interface that is necessary for communication with other network elements. In some example embodiments, the communication module 840 may include at least one antenna.

[0171] The processor 810 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 800 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.

[0172] The memory 820 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) 824, an electrically programmable read only memory (EPROM), a flash memory, a hard disk, a compact disc (CD), a digital video disk (DVD), an optical disk, a laser disk, and other magnetic storage and/or optical storage. Examples of the volatile memories include, but are not limited to, a random access memory (RAM) 822 and other volatile memories that will not last in the power-down duration.

[0173] A computer program 830 includes computer executable instructions that are executed by the associated processor 810. The instructions of the program 830 may include instructions for performing operations/acts of some example embodiments of the present disclosure. The program 830 may be stored in the memory, e.g., the ROM 824. The processor 810 may perform any suitable actions and processing by loading the program 830 into the RAM 822.

[0174] The example embodiments of the present disclosure may be implemented by means of the program 830 so that the device 800 may perform any process of the disclosure as discussed with reference to FIG. 2 to FIG. 7. The example embodiments of the present disclosure may also be implemented by hardware or by a combination of software and hardware.

[0175] In some example embodiments, the program 830 may be tangibly contained in a computer readable medium which may be included in the device 800 (such as in the memory 820) or other storage devices that are accessible by the device 800. The device 800 may load the program 830 from the computer readable medium to the RAM 822 for

execution. In some example embodiments, the computer readable medium may include any types of non-transitory storage medium, such as ROM, EPROM, a flash memory, a hard disk, CD, DVD, and the like. The term "non-transitory," as used herein, is a limitation of the medium itself (i.e., tangible, not a signal) as opposed to a limitation on data storage persistency (e.g., RAM vs. ROM).

[0176] FIG. 9 shows an example of the computer readable medium 900 which may be in form of CD, DVD or other optical storage disk. The computer readable medium 900 has the program 830 stored thereon.

[0177] 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, and other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device. Although 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.

[0178] Some example embodiments of the present disclosure also provide at least one computer program product tangibly stored on a computer readable medium, such as a non-transitory computer readable medium. The computer program product includes computer-executable instructions, such as those included in program modules, being executed in a device on a target physical or virtual processor, to carry out any of the methods as described above. 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.

[0179] Program code for carrying out methods of the present disclosure may be written in any combination of one or more programming languages. The program code 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 code, 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.

[0180] In the context of the present disclosure, the computer program code 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.

[0181] 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.

[0182] Further, although 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, although 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. Unless explicitly stated, certain features that are described in the context of separate embodiments may also be implemented in combination in a single embodiment. Conversely, unless explicitly stated, various features that are described in the context of a single embodiment may also be implemented in a plurality of embodiments separately or in any suitable sub-combination.

[0183] 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 apparatus comprising:

at least one processor; and

at least one memory storing instructions that, when executed by the at least one processor, cause the first apparatus to:

determine whether a transmission or reception of a wake-up signal is performed at the first apparatus;

based on a determination that the transmission or reception of the wake-up signal is performed, determine to transmit a message for a wake-up charging to at least one second apparatus; and

transmit, to the at least one second apparatus, the message for the wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal.

2. The first apparatus of claim 1, wherein the first apparatus is caused to:

receive, from a third apparatus, a paging message for the at least one second apparatus; and

perform the transmission of the wake-up signal.

3. The first apparatus of claim 2, wherein the paging message is used for triggering the first apparatus to provide the wake-up charging to the at least one second apparatus.

4. The first apparatus of any of claims 1-3, wherein the first apparatus is caused to:

transmit the wake-up signal on a first occasion configured for the transmission of the wake-up signal from the first apparatus to the at least one second apparatus or another first apparatus; and

transmit the wake-up signal on a second occasion configured for the transmission of the wake-up signal from the first apparatus to the at least one second apparatus or a further first apparatus, the second occasion is after the first occasion and associated with the first occasion.

5. The first apparatus of claim 1, wherein the first apparatus is caused to:

receive the wake-up signal from at least one other first apparatus on a first occasion configured for the reception of the wake-up signal from the at least one other first apparatus; and

transmit the wake-up signal on the second occasion to the at least one second apparatus or a further first apparatus.

6. The first apparatus of claim 5, wherein the first apparatus is caused to:

determine whether a reference signal received power level related to the wake-up signal received on the first occasion is above a threshold; and

based on a determination that the reference signal received power level is above the threshold, transmit the wake-up signal on the second occasion.

7. The first apparatus of claim 5, wherein the first apparatus is caused to:

determine whether a reference signal received power level related to the wake-up signal received on the first occasion is above a threshold; and

based on a determination that the reference signal received power level is above the threshold, transmit the message for the wake-up charging.

8. The first apparatus of claim 1, wherein the first apparatus is caused to:

receive the wake-up signal from the at least one second apparatus on a third occasion configured for the reception of the wake-up signal from the at least one second apparatus; and

transmit the wake-up signal on a fourth occasion configured for the transmission of the wake-up signal from the first apparatus to other second apparatus and other first apparatus, the fourth occasion is after the third occasion and associated with the third occasion.

9. The first apparatus of any claims 1-8, wherein the wake-up signal comprises a first wake-up signal and a second wake-up signal, the first wake-up signal is transmitted to or received from another first apparatus and the second wake-up signal is received from the at least one second apparatus.

10. The first apparatus of any claims 1-9, wherein the second occasion is the same as the fourth occasion.

11. The first apparatus of any of claims 1-10, wherein if the wake-up signal is received from the at least one second apparatus, the wake-up signal comprises a first sequence, and

wherein if the wake-up signal is received from or transmitted to another first apparatus, the wake-up signal comprises a second sequence which is different from the first sequence.

12. The first apparatus of any of claims 1-11, wherein the reception of the wake-up signal from at least one second apparatus is performed on different allocated resources than the transmission or reception of the wake-up signal to or from other first apparatus.

13. The first apparatus of any of claims 1-12, wherein the transmission pattern indicates a duration for transmitting the message for the wake-up charging and a time interval between two adjacent transmissions of the message for the wake-up charging message.

14. The first apparatus of any of claims 1-13, wherein a start of the transmission pattern is associated with timing of the transmission or reception of the wake-up signal.

15. The first apparatus of claim 13 or 14, wherein the first apparatus is caused to:

obtain a configuration comprising at least one of: the transmission pattern, a first set of resources for the transmission of the wake-up signal, or a second set of resources for the transmission of the message.

16. The first apparatus of any of claims 1-15, wherein the first apparatus is caused to:

receive, from the at least one second apparatus, a sidelink transmission indicating that the wake-up charging is not needed by the at least one second apparatus.

17. The first apparatus of claim 16, wherein the first apparatus is caused to:

transmit, to other first apparatus, a sidelink message to stop the wake-up charging.

18. The first apparatus of any of claims 1-17, wherein the first apparatus is caused to:

transmit, to the third apparatus, an indication indicating the wake-up charging is completed.

19. The first apparatus of claim 18, wherein the indication comprises an amount of energy provided for the wake-up charging to the at least one second apparatus by the first apparatus.

20. The first apparatus of any of claims 1-19, wherein the first apparatus is a terminal device capable of providing the wake-up charging, and wherein the at least one second apparatus is a passive Internet of Things tag.

21. A second apparatus comprising:

at least one processor; and

at least one memory storing instructions that, when executed by the at least one processor, cause the second apparatus to:

determine whether a transmission or reception of a wake-up signal is performed at the second apparatus;

based on a determination that the transmission or reception of the wake-up signal is performed, monitor a message for a wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal; and

receive, from at least one first apparatus, the message for the wake-up charging.

22. The second apparatus of claim 21, wherein the second apparatus is caused to:

receive the wake-up signal from the at least one first apparatus on an occasion configured for the reception of the wake-up signal from the at least one first apparatus.

23. The second apparatus of claim 21, wherein the second apparatus is caused to:

transmit the wake-up signal to the at least one first apparatus on an occasion configured for the transmission of the wake-up signal from the second apparatus.

24. The second apparatus of claim 23, wherein the second apparatus is caused to:

transmit the wake-up signal to the at least one first apparatus, based on a determination that at least one of the following conditions is fulfilled;

an amount of stored energy at the second apparatus is below an energy threshold,

an additional charging is needed by the second apparatus, or

the second apparatus has no other capability for receiving wireless power transfer.

25. The second apparatus of any of claims 21-24, wherein if the wake-up signal is transmitted to the at least one second apparatus, the wake-up signal comprises a first sequence, and

wherein if the wake-up signal is received from the at least one first apparatus, the wake-up signal comprises a second sequence which is different from the first sequence.

26. The second apparatus of any of claims 21-25, wherein the reception of the wake-up signal from at least one second apparatus is performed on different allocated resources than the transmission or reception of the wake-up signal to or from other first apparatus.

27. The second apparatus of any of claims 21-26, wherein the transmission pattern indicates a duration for monitoring the message for the wake-up charging and a time interval between two adjacent receptions of the message for the wake-up charging.

28. The second apparatus of any of claims 21-27, wherein a start of the transmission pattern is associated with timing of the transmission or reception of the wake-up signal.

29. The second apparatus of claim 27 or 28, wherein the second apparatus is caused to:

obtain a configuration comprising at least one of: the transmission pattern, a first set of resources for the transmission or reception of the wake-up signal, or a second set of resources for the reception of the message.

30. The second apparatus of any of claims 21-29, wherein the second apparatus is caused to:

perform, to the at least one first apparatus, a sidelink transmission indicating that the wake-up charging is not needed by the second apparatus.

31. The second apparatus of claim 30, wherein the sidelink transmission is broadcasted in an inter user equipment (UE) coordination message or an announcement message.

32. The second apparatus of any of claims 21-31, wherein the at least one first apparatus is a terminal device capable of providing the wake-up charging, and wherein the second apparatus is a passive Internet of Things tag.

33. A third apparatus comprising:

at least one processor; and

at least one memory storing instructions that, when executed by the at least one processor, cause the third apparatus to:

transmit, to at least one first apparatus, a paging message for triggering the at least one first apparatus to provide a wake-up charging to at least one second apparatus; and

receive, from the at least one first apparatus, at least one indication indicating the wake-up charging is completed.

34. The third apparatus of claim 33, wherein the at least one indication comprises an amount of energy provided to the at least one second apparatus by the at least one first apparatus.

35. The third apparatus of claim 33 or 34, wherein the third apparatus is caused to:

determine a total amount of energy provided to the at least one second apparatus based on the at least one indication; and

transmit, to a fourth apparatus, another indication indicating the total amount of energy.

36. The third apparatus of any one of claims 33-35, wherein the at least one first apparatus is a terminal device capable of providing the wake-up charging, the at least one second apparatus is a passive Internet of Things tag, and the third apparatus is a network device.

37. A method comprising:

determining, at a first apparatus, whether a transmission or reception of a wake-up signal is performed at the first apparatus;

based on a determination that the transmission or reception of the wake-up signal is performed, determining to transmit a message for a wake-up charging to at least one second apparatus; and

transmitting, to the at least one second apparatus, the message for the wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal.

38. A method comprising:

determining, at a second apparatus, whether a transmission or reception of a wake-up signal is performed at the second apparatus;

based on a determination that the transmission or reception of the wake-up signal is performed, monitoring a message for a wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal; and

receiving, from at least one first apparatus, the message for the wake-up charging.

39. A method comprising:

transmitting, at a third apparatus and to at least one first apparatus, a paging message for triggering the at least one first apparatus to provide a wake-up charging to at least one second apparatus; and

receiving, from the at least one first apparatus, an indication indicating the wake-up charging is completed.

40. A first apparatus comprising:

means for determining whether a transmission or reception of a wake-up signal is performed at the first apparatus;

means for based on a determination that the transmission or reception of the wake-up signal is performed, determining to transmit a message for a wake-up charging to at least one second apparatus; and

means for transmitting, to the at least one second apparatus, the message for the wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal.

41. A second apparatus comprising:

means for determining whether a transmission or reception of a wake-up signal is performed at the second apparatus;

means for based on a determination that the transmission or reception of the wake-up signal is performed, monitoring a message for a wake-up charging based on a transmission pattern associated with the transmission or reception of the wake-up signal; and

means for receiving, from at least one first apparatus, the message for the wake-up charging.

42. A third apparatus comprising:

means for transmitting, to at least one first apparatus, a paging message for triggering the at least one first apparatus to provide a wake-up charging to at least one second apparatus; and

means for receiving, from the at least one first apparatus, an indication indicating the wake-up charging is completed.

43. A computer readable medium comprising instruction stored thereon for causing an apparatus at least to perform the method of any of claims 37-39.

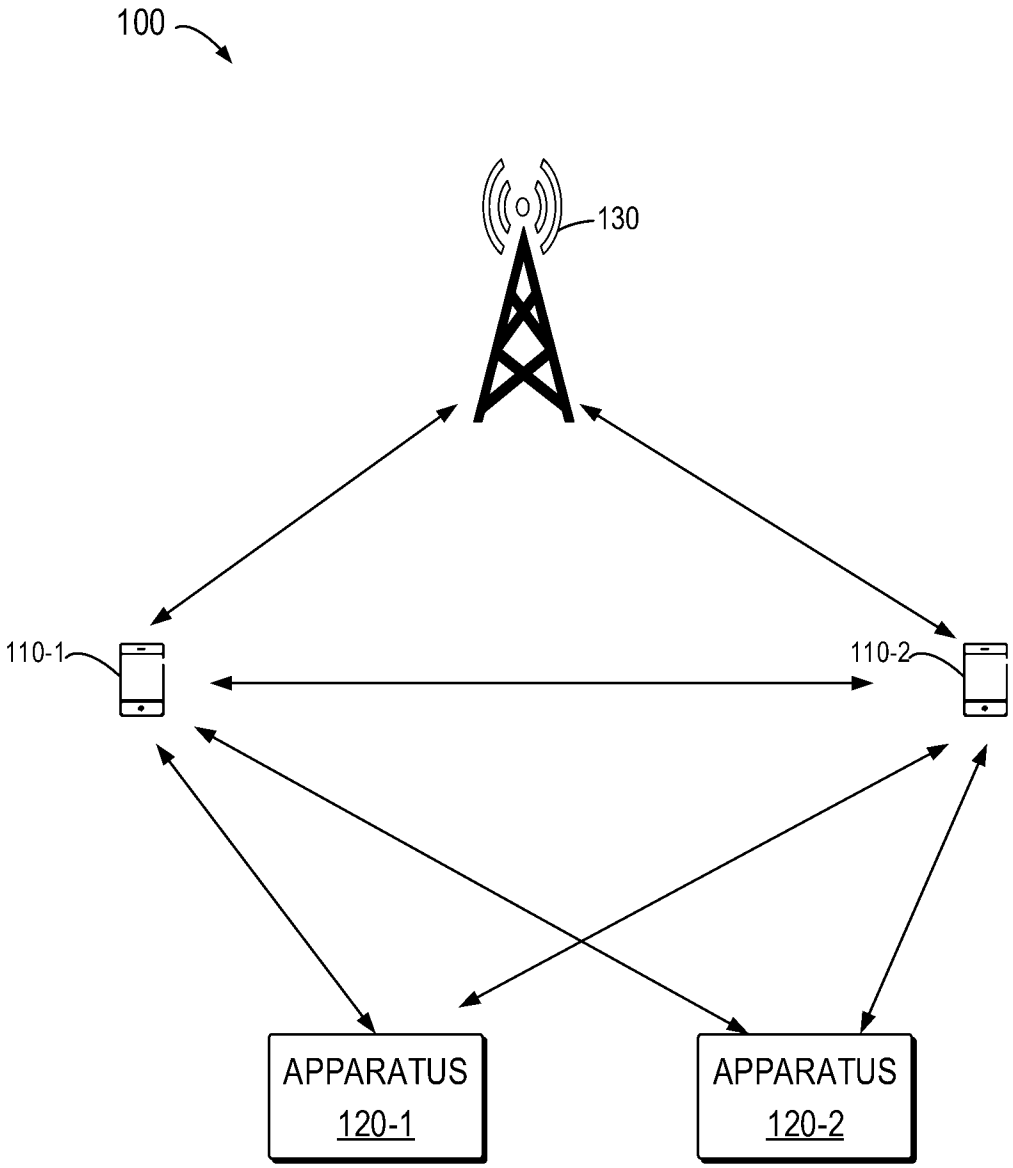

FIG. 1

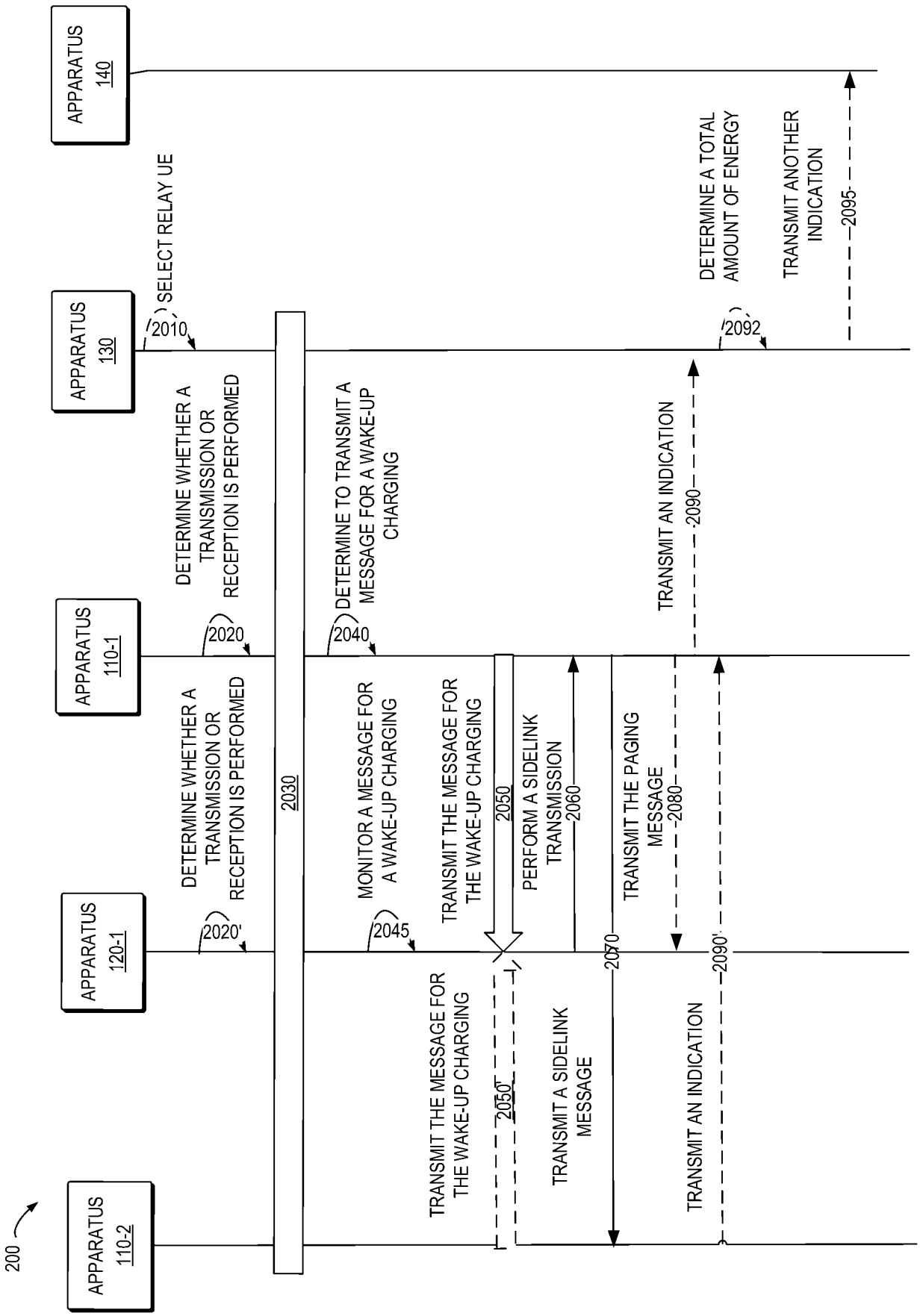
200
APPARATUS 110-2
APPARATUS 120-1
APPARATUS 110-1
APPARATUS 130
APPARATUS 140
SELECT RELAY UE
2010
DETERMINE WHETHER A TRANSMISSION OR RECEPTION IS PERFORMED
2020'
DETERMINE WHETHER A TRANSMISSION OR RECEPTION IS PERFORMED
2020
2030
DETERMINE TO TRANSMIT A MESSAGE FOR A WAKE-UP CHARGING
2040
MONITOR A MESSAGE FOR A WAKE-UP CHARGING
2045
TRANSMIT THE MESSAGE FOR THE WAKE-UP CHARGING
2050
TRANSMIT THE MESSAGE FOR THE WAKE-UP CHARGING
2050'
PERFORM A SIDELINK TRANSMISSION
2060
TRANSMIT A SIDELINK MESSAGE
2070
TRANSMIT THE PAGING MESSAGE
2080
TRANSMIT AN INDICATION
2090
TRANSMIT AN INDICATION
2090'
DETERMINE A TOTAL AMOUNT OF ENERGY
2092
TRANSMIT ANOTHER INDICATION
2095

FIG. 2

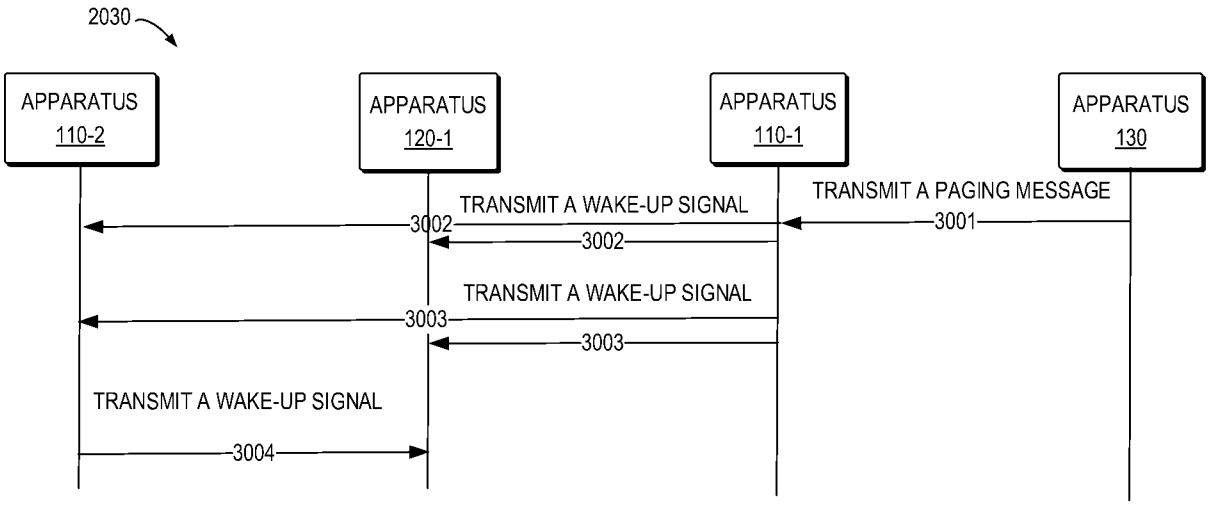

FIG. 3A

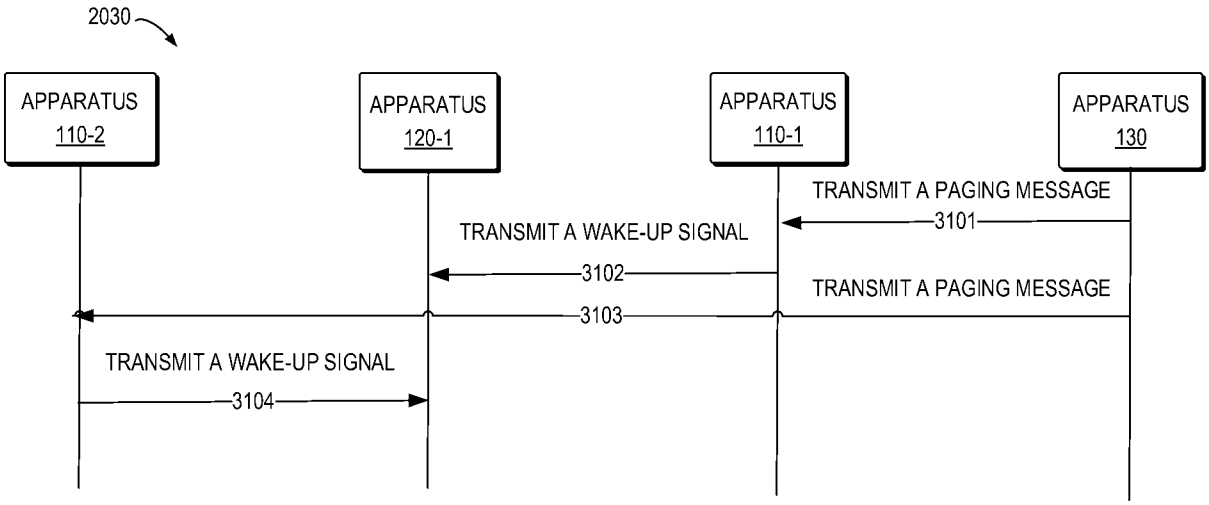

FIG. 3B

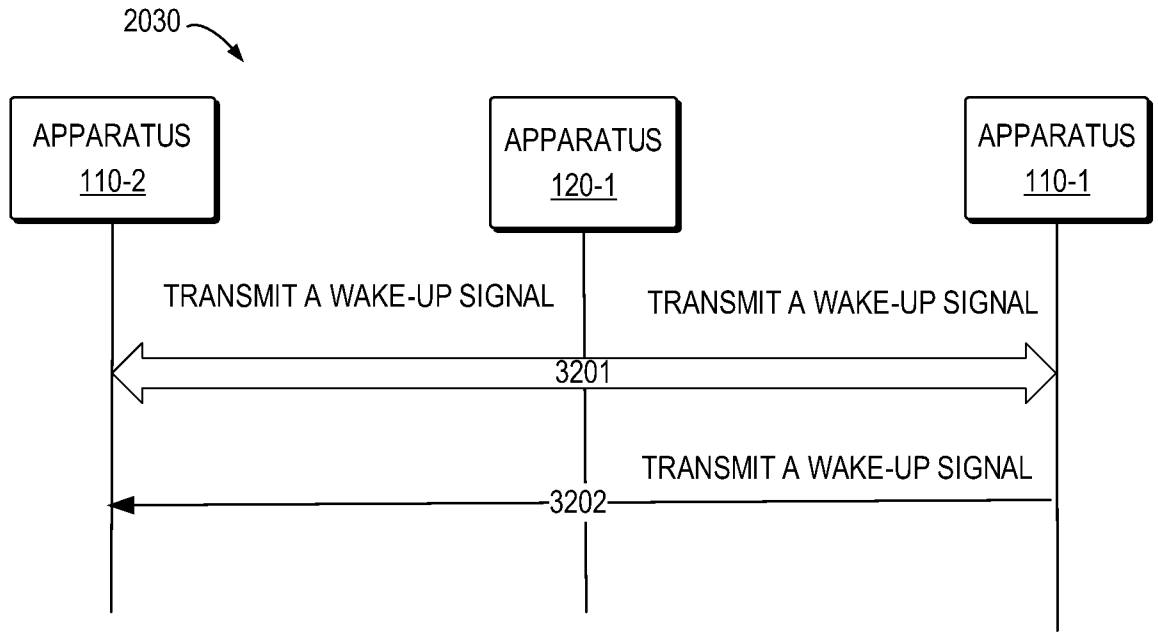

FIG. 3C

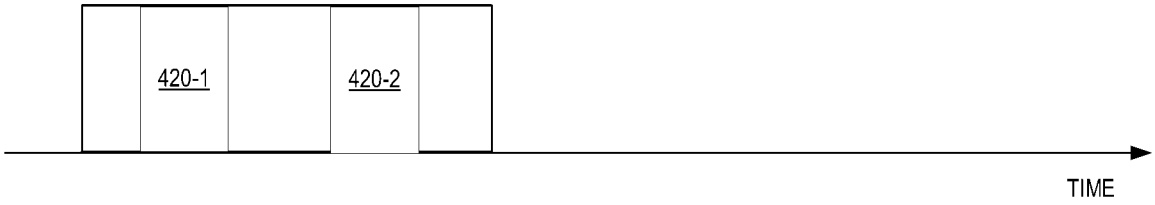

FIG. 4A

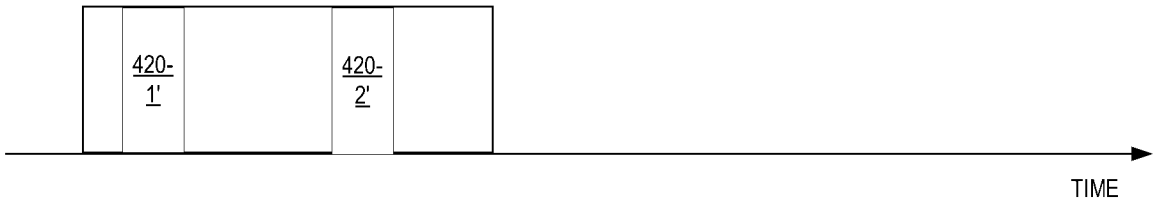

FIG. 4B

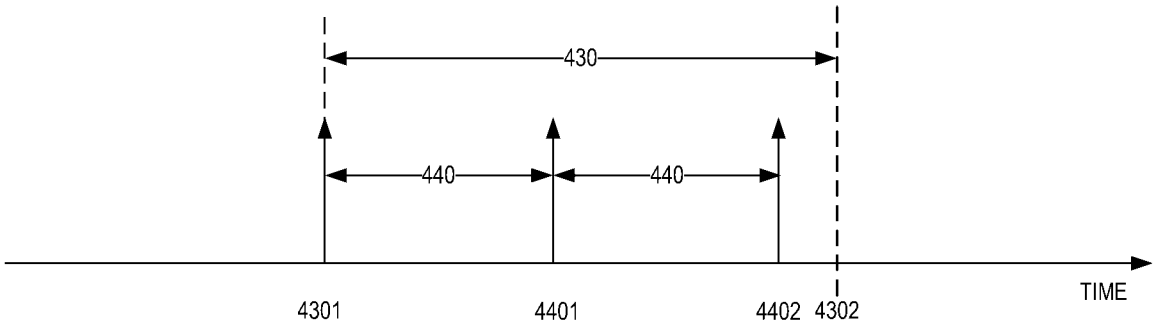

FIG. 4C

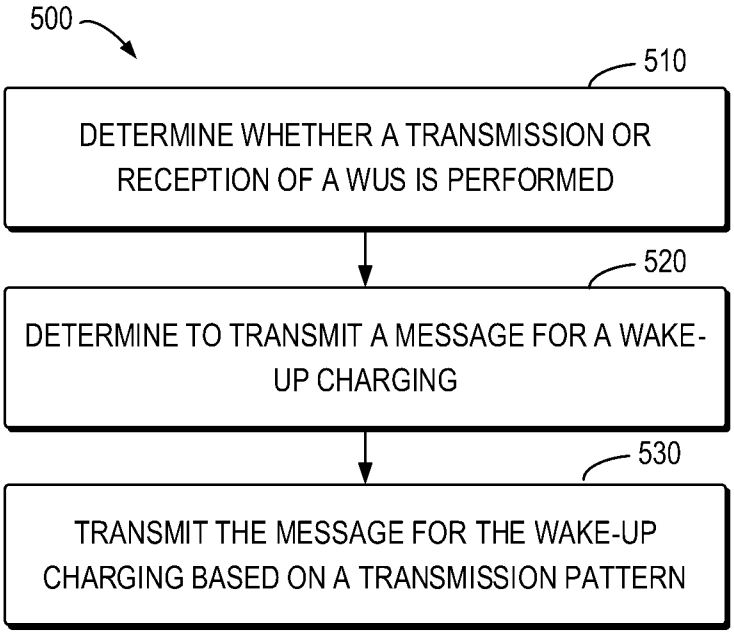
500
510
DETERMINE WHETHER A TRANSMISSION OR RECEPTION OF A WUS IS PERFORMED
520
DETERMINE TO TRANSMIT A MESSAGE FOR A WAKE-UP CHARGING
530
TRANSMIT THE MESSAGE FOR THE WAKE-UP CHARGING BASED ON A TRANSMISSION PATTERN

FIG. 5

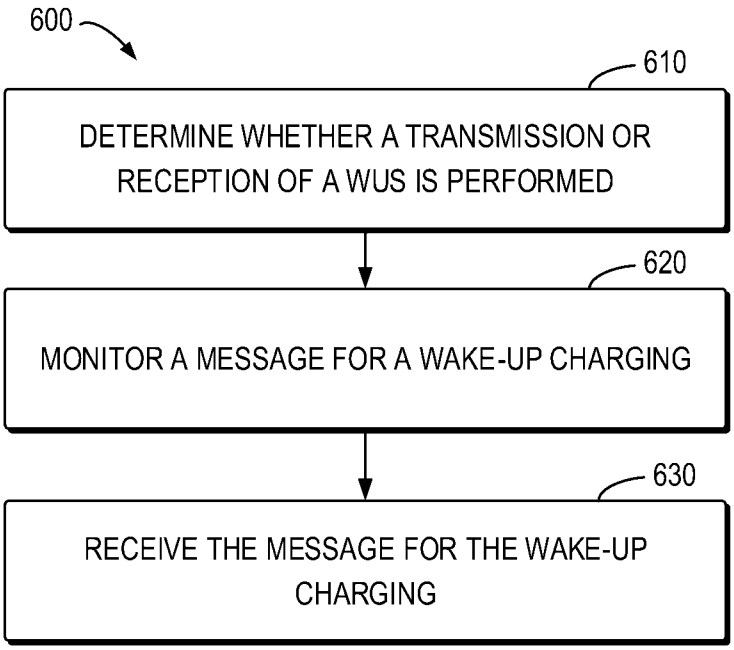
600
610
DETERMINE WHETHER A TRANSMISSION OR RECEPTION OF A WUS IS PERFORMED
620
MONITOR A MESSAGE FOR A WAKE-UP CHARGING
630
RECEIVE THE MESSAGE FOR THE WAKE-UP CHARGING

FIG. 6

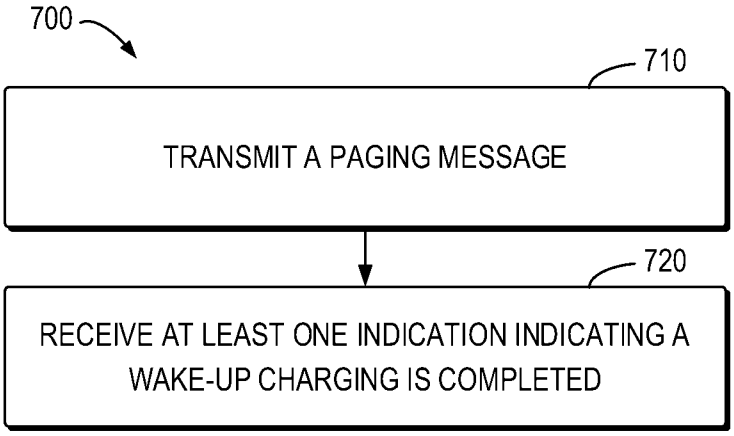
700
710
TRANSMIT A PAGING MESSAGE
720
RECEIVE AT LEAST ONE INDICATION INDICATING A WAKE-UP CHARGING IS COMPLETED

FIG. 7

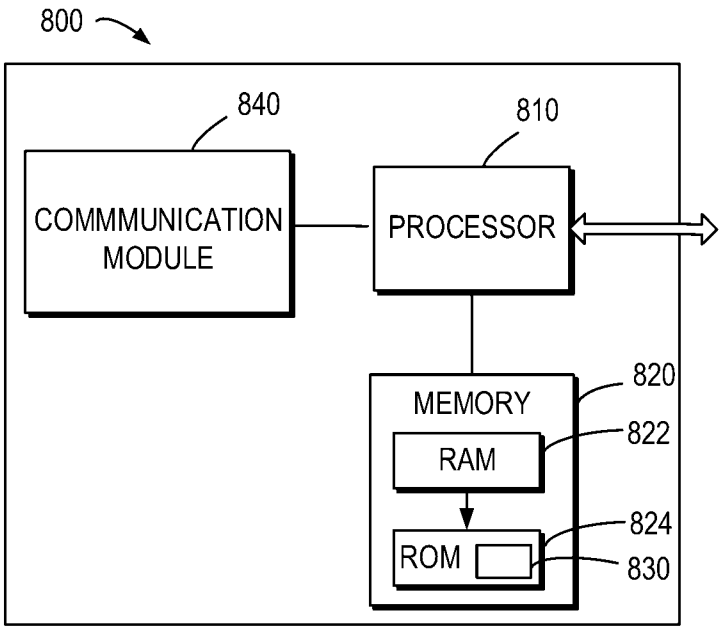
800
840
810
COMMMUNICATION MODULE
PROCESSOR
820
MEMORY
822
RAM
824
ROM
830

FIG. 8

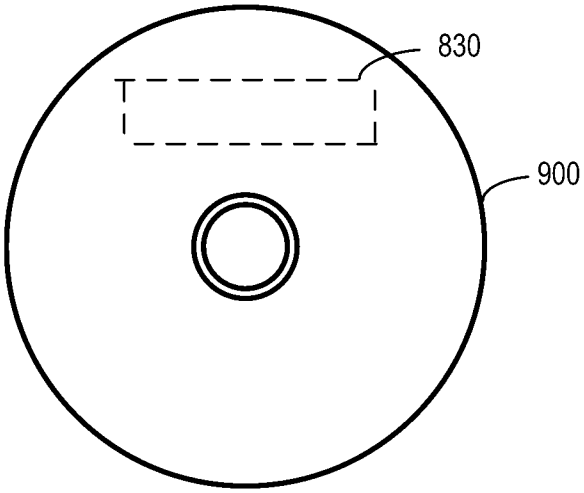

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/100419

A. CLASSIFICATION OF SUBJECT MATTER

H04W52/00(2009.01)i; G16Y20/30(2020.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04W G16Y

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)

WPABS,ENTXTC,CNTXT,ENTXT,CNKI,3GPP: wake-up signal, transmission, reception, wireless charging, trigger, paging, occasion, reference signal, power, supply, level, threshold, sequence, resources allocation, sidelink, completed, IOT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 109159680 A (BEIJING ELECTRIC VEHICLE CO., LTD.) 08 January 2019 (2019-01-08) description paragraphs [0036]-[0063]	1-43
A	CN 110691430 A (SPREADTRUM COMMUNICATIONS (SHANGHAI) INC.) 14 January 2020 (2020-01-14) the whole document	1-43
A	CN 111800244 A (INTEL CORPORATION) 20 October 2020 (2020-10-20) the whole document	1-43
A	CN 113580964 A (SHENZHEN VMAX NEW ENERGY CO., LTD.) 02 November 2021 (2021-11-02) the whole document	1-43
A	US 2012281547 A1 (KIM, Nam Yun et al.) 08 November 2012 (2012-11-08) the whole document	1-43

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
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"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
13 December 2023	**21 December 2023**

Name and mailing address of the ISA/CN	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/100419

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	VIVO. "Remaining aspects on configurations and procedures of wake-up signals for feNB-IoT" *3GPP TSG RAN WG1 Meeting #93 R1-1806032*, 25 May 2018 (2018-05-25), the whole document	1-43

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/100419

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 109159680 A	08 January 2019	None	
CN 110691430 A	14 January 2020	None	
CN 111800244 A	20 October 2020	None	
CN 113580964 A	02 November 2021	None	
US 2012281547 A1	08 November 2012	KR 20120125182 A	14 November 2012
		KR 20120125199 A	14 November 2012