



(51) International Patent Classification:
H04W 48/06 (2009.01)

(21) International Application Number:
PCT/CN2012/079640

(22) International Filing Date:
3 August 2012 (03.08.2012)

(25) Filing Language: English

(26) Publication Language: English

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW,

[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR MANAGING UPLINK OPERATIONS

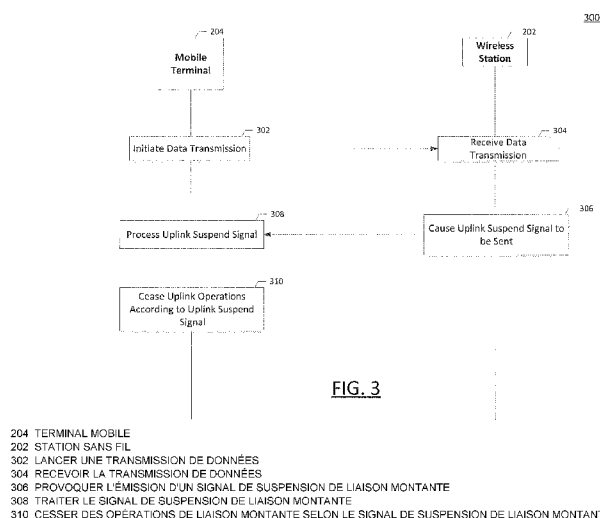


FIG. 3

(57) Abstract: A method, apparatus and computer program product are provided in order to manage uplink transmissions in a wireless network. In this regard, the method, apparatus, and computer program product may utilize a mobile terminal (204) to communicate with a wireless station (202). In response to the communications between the mobile terminal (204) and the wireless station (202), the mobile terminal (204) may receive an uplink suspend signal. The distance from the mobile terminal (204) to the wireless station (202) may be associated with a timing advance value related to a propagation delay between the mobile terminal (204) and the wireless station (202), such that the uplink suspend signal may be used by the mobile terminal (204) to disable uplink operations that might otherwise continue in circumstances where the timing advance value was zero.



SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

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

METHOD AND APPARATUS FOR MANAGING UPLINK OPERATIONS

TECHNOLOGICAL FIELD

[0001] An example embodiment of the present invention relates generally to wireless
5 communications, and, more particularly, to management of an uplink channel during wireless communications.

BACKGROUND

[0002] As cellular internet services have become more common, so too have mobile devices that can leverage connections to these services. It is increasingly common for smart phones,
10 laptops, and other devices to contain communications interfaces that are capable of interacting with wireless data services such as 3G, WiMax, and Long Term Evolution (LTE) networks. However, as the number of these devices increases, so does the strain on network resources.

[0003] One method of increasing network resources to meet this newfound demand that is being explored is adding additional cells to the network. As the number of cells increases, the
15 area served by each individual cell decreases. As the area of each cell decreases, the number of mobile devices served by the particular cell also tends to decrease. These smaller cells serve fewer devices, and thus share network resources among fewer users.

[0004] In order to allow mobile devices to communicate across long distances with time division protocols, networks may utilize a “timing advance” value to account for signal
20 propagation delay between a mobile terminal (e.g., a user equipment) and a cellular provider (e.g., an enhanced node-B) to ensure proper time slice synchronization across the terminal and provider. The timing advance value may be calculated by the cellular provider in response to a handshake process initiated by the mobile terminal, and then transmitted to the mobile terminal for configuring channel access by the mobile terminal. The timing advance value may be

monitored and maintained via a series of channel status uplink transmissions between the mobile terminal and the cellular provider, so as to maintain channel access as the mobile terminal travels throughout the cell.

[0005] However, as network size decreases, the maximum distance between the mobile terminal and the provider also decreases, resulting in a lower maximum propagation delay. In some circumstances, the propagation delay may be smaller than a minimum frame size or timing advance value. In order to streamline timing advance processing in such circumstances, the cellular provider may indicate a timing advance value of zero or a timing advance timer of infinity to the mobile terminal to notify the mobile terminal that no timing advance is necessary due to the size of the cell. However, in many circumstances, the TA value and/or timing advance timer may be used to release channel resources after termination of communications. In circumstances where the timing advance value is set to zero or the TA timer is set to infinity, the mobile terminal may always regard the channel link to the cellular provider as synchronized, even if the mobile terminal does not have service or a need to transmit any data. Thus, the mobile terminal may transmit unnecessary channel status messages to maintain the data uplink, thus wasting the power of the mobile terminal and the network resources of the cellular provider.

BRIEF SUMMARY

[0006] A method, apparatus and computer program product are therefore provided according to an example embodiment of the present invention in order to manage uplink transmissions in a cellular network. In this regard, the method, apparatus, and computer program product of an example embodiment may utilize a mobile terminal to communicate with a wireless station. In response to the communications between the mobile terminal and the wireless station (or termination thereof), the mobile terminal may receive an uplink suspend signal. The distance

from the mobile terminal to the wireless station may be associated with a timing advance value related to a propagation delay between the mobile terminal and the wireless station, such that the uplink suspend signal may be used by the mobile terminal to disable uplink operations that might otherwise continue in circumstances where the timing advance value was zero. In response to the uplink suspend signal, the mobile terminal may disable one or more uplink operations, such as channel state information messages, sounding reference signals, or the like. The uplink operations may be disabled on an individual basis (e.g., disabling only a channel state information message and leaving a sounding reference signal enabled) in the uplink suspend signal. For example, the uplink suspend signal may provide a bitmask with particular bits associated with particular uplink operations. Uplink operations may resume at the expiration of a timer, the receipt of an uplink resume signal at the mobile terminal, or in response to the mobile terminal requiring use of the channel to perform an uplink operation.

[0007] A method according to example embodiments of the invention may include negotiating access to a wireless channel using a processor, sending one or more data transmissions to a mobile terminal, the data transmissions transmitted over a wireless channel, receiving one or more channel status transmissions from the mobile terminal to facilitate the data transmissions, determining that the one or more data transmissions have ended, in response to determining that the one or more data transmissions have ended, generating an uplink suspend signal, the uplink suspend signal instructing the mobile terminal to suspend future channel status transmissions, and transmitting the uplink suspend signal to the mobile terminal. The channel negotiation process may include assigning one or more time slots to a mobile terminal to transmit data across the wireless channel.

[0008] Another method according to example embodiments of the invention may include accessing, using a mobile terminal, a wireless channel according to a wireless uplink protocol,

configuring the wireless channel using the plurality of transmissions, receiving an uplink suspend signal, and stopping the identified at least one of the plurality of transmissions in response to the uplink suspend signal. The wireless uplink protocol may define a plurality of transmissions to configure the wireless channel. The uplink suspend request may identify at least one of the plurality of transmissions to be stopped.

[0009] An apparatus according to example embodiments of the invention may include at least one processor and at least one memory including computer program instructions. The at least one memory and the computer program instructions may be configured to, with the at least one processor, cause the apparatus at least to negotiate access to a wireless channel, send one or more data transmissions to a mobile terminal, receive one or more channel status transmissions from the mobile terminal to facilitate the data transmissions, determine that the one or more data transmissions have ended, in response to determining that the one or more data transmissions have ended, generate an uplink suspend signal, and transmit the uplink suspend signal to the mobile terminal. The uplink suspend signal may instruct the mobile terminal to suspend future channel status transmissions. The data transmissions may be transmitted over a wireless channel. The channel negotiation process may include assigning one or more time slots to a mobile terminal to transmit data across the wireless channel.

[0010] Another apparatus according to example embodiments of the invention may include at least one processor and at least one memory including computer program instructions. The at least one memory and the computer program instructions may be configured to, with the at least one processor, cause the apparatus at least to access a wireless channel according to a wireless uplink protocol, configure the wireless channel using the plurality of transmissions, receive an uplink suspend signal, and stop the identified at least one of the plurality of transmissions in response to the uplink suspend signal. The wireless uplink protocol may define a plurality of

transmissions to configure the wireless channel. The uplink suspend request may identify at least one of the plurality of transmissions to be stopped.

[0011] Another apparatus according to example embodiments of the invention may include a processing means and a communications means for managing uplink operations. The processing means may access a wireless channel according to a wireless uplink protocol, the wireless uplink protocol defining a plurality of transmissions to configure the wireless channel. The processing means may further configure the wireless channel using the plurality of transmissions, receive an uplink suspend signal, the uplink suspend request identifying at least one of the plurality of transmissions to be stopped, and stop the identified at least one of the plurality of transmissions in response to the uplink suspend signal. The communications means may facilitate sending and receiving data across the wireless channel.

[0012] Yet another apparatus according to example embodiments of the invention may include a processing means and a communications means for managing uplink operations. The processing means may negotiate access to a wireless channel, cause one or more data transmissions to be sent to a mobile terminal, , receive one or more channel status transmissions from the mobile terminal to facilitate the data transmissions, determine that the one or more data transmissions have ended, in response to determining that the one or more data transmissions have ended, generate an uplink suspend signal, the uplink suspend signal instructing the mobile terminal to suspend future channel status transmissions, and transmit the uplink suspend signal to the mobile terminal. The data transmissions may be transmitted over a wireless channel. The channel negotiation process may include assigning one or more time slots to a mobile terminal to transmit data across the wireless channel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Having thus described certain embodiments of the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

5 [0014] Figure 1 is a block diagram of an apparatus that may be specifically configured in accordance with an example embodiment of the present invention;

[0015] Figure 2 is a schematic diagram of an example mobile terminal in communication with a cellular provider in accordance with an example embodiment of the present invention;

10 [0016] Figure 3 is a block diagram of a message flow between a mobile terminal and cellular provider to transmit an uplink suspend signal in accordance with an example embodiment of the present invention;

[0017] Figure 4 is a block diagram of a message flow between a mobile terminal and cellular provider to transmit an uplink resume signal in accordance with an example embodiment of the present invention;

15 [0018] Figure 5 is a schematic diagram depicting an example of a bit mask for disabling one or more uplink operations in accordance with an example embodiment of the present invention;

[0019] Figure 6 is a flow diagram depicting an example of a method for disabling one or more uplink operations in accordance with an example embodiment of the present invention;

20 [0020] Figure 7 is a flow diagram depicting an example of a method for resuming one or more uplink operations using an uplink resume signal in accordance with an example embodiment of the present invention;

[0021] Figure 8 is a flow diagram depicting an example of a method for resuming one or more uplink operations using an uplink resume timer in accordance with an example embodiment of the present invention;

[0022] Figure 9 is a flow diagram depicting an example of a method for resuming one or more uplink operations using uplink resume functionality of the mobile terminal in accordance with an example embodiment of the present invention;

[0023] Figure 10 is a block diagram of an apparatus that may be specifically configured in accordance with an example embodiment of the present invention; and

[0024] Figure 11 is a flow diagram depicting an example of a method for sending an uplink suspend signal in accordance with an example embodiment of the present invention.

DETAILED DESCRIPTION

[0025] Some embodiments of the present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all, embodiments of the invention are shown. Indeed, various embodiments of the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like reference numerals refer to like elements throughout. As used herein, the terms “data,” “content,” “information,” and similar terms may be used interchangeably to refer to data capable of being transmitted, received and/or stored in accordance with embodiments of the present invention. Thus, use of any such terms should not be taken to limit the spirit and scope of embodiments of the present invention.

[0026] Additionally, as used herein, the term ‘circuitry’ refers to (a) hardware-only circuit implementations (e.g., implementations in analog circuitry and/or digital circuitry); (b) combinations of circuits and computer program product(s) comprising software and/or firmware instructions stored on one or more computer readable memories that work together to cause an apparatus to perform one or more functions described herein; and (c) circuits, such as, for

example, a microprocessor(s) or a portion of a microprocessor(s), that require software or firmware for operation even if the software or firmware is not physically present. This definition of 'circuitry' applies to all uses of this term herein, including in any claims. As a further example, as used herein, the term 'circuitry' also includes an implementation comprising one or
5 more processors and/or portion(s) thereof and accompanying software and/or firmware. As another example, the term 'circuitry' as used herein also includes, for example, a baseband integrated circuit or applications processor integrated circuit for a mobile phone or a similar integrated circuit in a server, a cellular network device, other network device, and/or other computing device.

10 [0027] As defined herein, a "computer-readable storage medium," which refers to a non-transitory physical storage medium (e.g., volatile or non-volatile memory device), can be differentiated from a "computer-readable transmission medium," which refers to an electromagnetic signal.

[0028] A method, apparatus and computer program product are provided in accordance with
15 an example embodiment of the present invention in order to manage uplink operations for a mobile terminal in a wireless network. In this regard, a method, apparatus and computer program product of an example embodiment may receive a signal instructing a mobile terminal to cease one or more uplink operations. In response to the signal, the mobile terminal may cease the uplink operations indicated by the signal. The mobile terminal may resume uplink operations
20 according to one or more resume conditions, such as the expiration of an uplink resume timer or receipt of an uplink resume signal. By ceasing uplink transmissions, the mobile terminal may conserve device power and network resources in circumstances where such transmissions are not necessary to maintain network access.

[0029] The system of an embodiment of the present invention may include an apparatus 100 as generally described below in conjunction with Figure 1 for performing one or more of the operations set forth by Figures 2-9 and also described below. The apparatus will be described in terms of a mobile terminal for the purposes of example, but the apparatus 100 may also be embodied in another type of computing device, either mobile or fixed, such as a computer workstation, a personal computer, a laptop, a cellular phone, or a smart phone. In this embodiment, the mobile terminal may be in communication with a display and/or a data network, either directly, such as via a wireless or wireline connection, or indirectly via one or more intermediate computing devices. In this regard, the display and the mobile terminal may be parts of the same system in some embodiments. However, the apparatus 100 may alternatively be embodied by another computing device that is in communication with the display and the mobile terminal, such as via a wireless connection, a wireline connection or the like. For example, the apparatus may be a mobile telephone, a personal digital assistant (PDA), a pager, a laptop computer, a tablet computer or any of numerous other hand held or portable communication devices, computation devices, content generation devices, content consumption devices or combinations thereof.

[0030] It should also be noted that while Figure 1 illustrates one example of a configuration of an apparatus 100 for generating an AR interface, numerous other configurations may also be used to implement other embodiments of the present invention. As such, in some embodiments, although devices or elements are shown as being in communication with each other, hereinafter such devices or elements should be considered to be capable of being embodied within the same device or element and thus, devices or elements shown in communication should be understood to alternatively be portions of the same device or element.

[0031] Referring now to Figure 1, the apparatus 100 for managing uplink transmission in accordance with example embodiments may include or otherwise be in communication with one or more of a processor 102, a memory 104, a communication interface 106, a user interface 108, a camera 110 and a sensor 112. In some embodiments, the processor (and/or co-processors or
5 any other processing circuitry assisting or otherwise associated with the processor) may be in communication with the memory device via a bus for passing information among components of the apparatus. The memory device may include, for example, a non-transitory memory, such as one or more volatile and/or non-volatile memories. In other words, for example, the memory device may be an electronic storage device (e.g., a computer readable storage medium)
10 comprising gates configured to store data (e.g., bits) that may be retrievable by a machine (e.g., a computing device like the processor). The memory device may be configured to store information, data, content, applications, instructions, or the like for enabling the apparatus to carry out various functions in accordance with an example embodiment of the present invention. For example, the memory device could be configured to buffer input data for processing by the
15 processor. Additionally or alternatively, the memory device could be configured to store instructions for execution by the processor.

[0032] In some embodiments, the apparatus 100 may be embodied as a chip or chip set. In other words, the apparatus may comprise one or more physical packages (e.g., chips) including materials, components and/or wires on a structural assembly (e.g., a baseboard). The structural
20 assembly may provide physical strength, conservation of size, and/or limitation of electrical interaction for component circuitry included thereon. The apparatus may therefore, in some cases, be configured to implement an embodiment of the present invention on a single chip or as a single "system on a chip." As such, in some cases, a chip or chipset may constitute means for performing one or more operations for providing the functionalities described herein.

[0033] The processor 102 may be embodied in a number of different ways. For example, the processor may be embodied as one or more of various hardware processing means such as a coprocessor, a microprocessor, a controller, a digital signal processor (DSP), a processing element with or without an accompanying DSP, or various other processing circuitry including integrated circuits such as, for example, an ASIC (application specific integrated circuit), an FPGA (field programmable gate array), a microcontroller unit (MCU), a hardware accelerator, a special-purpose computer chip, or the like. As such, in some embodiments, the processor may include one or more processing cores configured to perform independently. A multi-core processor may enable multiprocessing within a single physical package. Additionally or alternatively, the processor may include one or more processors configured in tandem via the bus to enable independent execution of instructions, pipelining and/or multithreading.

[0034] In an example embodiment, the processor 102 may be configured to execute instructions stored in the memory device 104 or otherwise accessible to the processor. Alternatively or additionally, the processor may be configured to execute hard coded functionality. As such, whether configured by hardware or software methods, or by a combination thereof, the processor may represent an entity (e.g., physically embodied in circuitry) capable of performing operations according to an embodiment of the present invention while configured accordingly. Thus, for example, when the processor is embodied as an ASIC, FPGA or the like, the processor may be specifically configured hardware for conducting the operations described herein. Alternatively, as another example, when the processor is embodied as an executor of software instructions, the instructions may specifically configure the processor to perform the algorithms and/or operations described herein when the instructions are executed. However, in some cases, the processor may be a processor of a specific device configured to employ an embodiment of the present invention by further configuration of the processor by

instructions for performing the algorithms and/or operations described herein. The processor may include, among other things, a clock, an arithmetic logic unit (ALU) and logic gates configured to support operation of the processor.

[0035] Meanwhile, the communication interface 106 may be any means such as a device or
5 circuitry embodied in either hardware or a combination of hardware and software that is configured to receive and/or transmit data from/to a network and/or any other device or module in communication with the apparatus 100, such as by supporting communications with a display and/or a mobile terminal. In this regard, the communication interface may include, for example, an antenna (or multiple antennas) and supporting hardware and/or software for enabling
10 communications with a wireless communication network. Additionally or alternatively, the communication interface may include the circuitry for interacting with the antenna(s) to cause transmission of signals via the antenna(s) or to handle receipt of signals received via the antenna(s). In some environments, the communication interface may alternatively or also support wired communication. As such, for example, the communication interface may include
15 a communication modem and/or other hardware/software for supporting communication via cable, digital subscriber line (DSL), universal serial bus (USB) or other mechanisms. The communication interface 106 may serve to couple the apparatus 100 to a cellular network, such as a network operating according to a 3G or Long Term Evolution (LTE) protocol.

[0036] The apparatus 100 may include a user interface 108 that may, in turn, be in
20 communication with the processor 102 to provide output to the user and, in some embodiments, to receive an indication of a user input. For example, the user interface may include a display and, in some embodiments, may also include a keyboard, a mouse, a joystick, a touch screen, touch areas, soft keys, a microphone, a speaker, or other input/output mechanisms. In one embodiment, the display of the apparatus may be embodied by a liquid crystal display (LCD)

screen presented on one surface of the mobile terminal. For example, in an instance in which the display is an LCD screen embodied on one surface of the mobile terminal, the AR interface may be displayed on the screen for viewing by and interacting with the user of the mobile terminal. As the mobile terminal moves in physical space, the AR interface displayed on the screen may update as visual input to the mobile terminal changes. The processor 102 may comprise user interface circuitry configured to control at least some functions of one or more user interface elements such as a display and, in some embodiments, a speaker, ringer, microphone and/or the like. The processor 102 and/or user interface circuitry comprising the processor 102 may be configured to control one or more functions of one or more user interface elements through computer program instructions (e.g., software and/or firmware) stored on a memory accessible to the processor (e.g., memory 104, and/or the like).

[0037] In some example embodiments, the apparatus 100 may include an image capturing element, such as a camera 110, video and/or audio module, in communication with the processor 102. The image capturing element may be any means for capturing an image, video and/or audio for storage, display or transmission. For example, in an example embodiment in which the image capturing element is a camera, the camera may include a digital camera capable of forming a digital image file from a captured image. As such, the camera may include all hardware (for example, a lens or other optical component(s), image sensor, image signal processor, and/or the like) and software necessary for creating a digital image file from a captured image. Alternatively, the camera may include only the hardware needed to view an image, while a memory device 104 of the apparatus stores instructions for execution by the processor in the form of software necessary to create a digital image file from a captured image. In an example embodiment, the camera 110 may further include a processing element such as a co-processor which assists the processor in processing image data and an encoder and/or decoder

for compressing and/or decompressing image data. The encoder and/or decoder may encode and/or decode according to, for example, a joint photographic experts group (JPEG) standard, a moving picture experts group (MPEG) standard, or other format.

[0038] As shown in Figure 1, the apparatus 100 may also include one or more sensors 112, such as a location information receiver (e.g., a GPS receiver), an accelerometer, a gyroscope, a compass, or the like, that may be in communication with the processor 102 and may be configured to determine the location of the apparatus and to detect changes in motion and/or orientation of the apparatus.

[0039] The method, apparatus 100 and computer program product may now be described in conjunction with the operations illustrated in Figures 2-9. In this regard, the apparatus may include means, such as the processor 102, the communications interface 106, or the like, for managing uplink operations. An uplink suspend signal may be received in various manners. In some embodiments, the processor 102 may include and/or may execute an application for management of network operations, such as a network protocol stack, to receive a signal from a remote node of a network (e.g., a cellular provider located at a cellular tower) to disable one or more uplink operations of the mobile terminal. In some embodiments, the processor 102 may cause the one or more uplink operations identified by the signal to be disabled on the mobile terminal. For example, a processing means, such as the processor 102, may instruct a communications means, such as the communications interface 106 to cease the transmission of particular uplink signals upon receipt of the signal from the remote node of the network.

Although the processor 102 is described as a single element, the processor 102 may also be implemented as one or more applications executing on one or more processors including, for example, a dedicated network processor, in communication with one another.

[0040] Figure 2 is a schematic diagram of an example mobile terminal in communication with a cellular provider in accordance with an example embodiment of the present invention. Figure 2 depicts a wireless network 200 including a wireless station 202 in communication with a mobile terminal 204. The wireless network 200 may represent a single “cell” of a cellular network operated by a cellular provider. The wireless station 202 may be a tower or set of towers for providing coverage to the cell of the network. The wireless network 200 may be provided according to one or more wireless protocols, such as 3G or LTE. The communications range 206 of the wireless station 202 is denoted by the circle surrounding the wireless station 202.

[0041] In the instant example wireless network 200, the communications range 206 of the wireless network may be 78 meters. As such, the time required for a particular transmission between the mobile terminal 204 and the wireless station 202 is .52ms or less, as a longer propagation delay would require the mobile terminal 204 to be outside of the communications range 206 of the wireless station 202. For the purposes of this example, the network is assumed to be a uniform, contiguous space with no intervening elements or objects that might otherwise introduce propagation delay for reasons other than physical distance between the mobile terminal 204 and the wireless station 202. However, other example embodiments of the network may determine a maximum propagation delay or distance based on factors other than distance. For example, factors other than physical distance (e.g., changes in elevation, terrain or the presence of interference) may introduce propagation delay, and such networks may determine the maximum propagation delay of the network according to these factors. It should be readily appreciated that example embodiments of the invention may be employed in any circumstance where it is advantageous to disable uplink transmissions, rather than only in

situations where a mobile terminal is within a maximum physical proximity to the wireless station 202.

[0042] According to the LTE specification 36.211, it may be necessary to employ timing advance (TA) processing to account for propagation delay in networks where the propagation delay exceeds certain values. The value of such timing advance is given in multiples of T_s which is the basic timing unit defined in TS 36.211. An appropriate TA value may be determined when the mobile terminal 204 establishes a connection with the wireless station 202 to first receive channel access parameters. For example, a wireless station may determine that, based on the propagation delay for a particular mobile terminal, that mobile terminal should adjust its time slice requests by one or more frame lengths to ensure that the mobile terminal and wireless station remain in synchronization.

[0043] However, in wireless networks that are smaller than a particular size (e.g., smaller than 78 meters), such TA processing may not be necessary since the maximum propagation delay of the network is smaller than a single communication frame. For example, in the LTE specification, if propagation delay is less than $8 T_s$ (e.g., the size of the network is less than 78 meters), then none of the mobile terminals communicating with the wireless station 202 need to employ TA processing to synchronize with the wireless station 202. As such, during the initial channel access process, the wireless station 202 may set the TA value of the mobile terminal 204 to zero or a TA timer to infinity. In such an environment, the mobile terminal may not relinquish control of certain channel resources. For example, if the TA timer is set to infinity, the mobile terminal may continue transmitting channel status messages to the wireless station, since the timer will not expire to end the channel status transmissions. Embodiments of the invention allow for the wireless station 202 to further instruct the mobile terminal 204 to cease one or more uplink operations in order to conserve device power and network resources.

Uplink operations and the process by which the operations are ceased are described further below with respect to Figures 3-9.

[0044] Figure 3 is a block diagram of a message flow 300 between a mobile terminal and a wireless station to transmit an uplink suspend signal in accordance with an example embodiment of the present invention. According to example embodiments of the invention, a wireless station, such as the wireless station 202, may transmit an uplink suspend signal to a mobile terminal, such as the mobile terminal 204. The uplink suspend signal may allow for termination of unnecessary messages that would otherwise be sent in a scenario where a TA value is zero or a TA timer value is infinity. For example, in a legacy scenario (e.g., where a TA value is non-zero), when traffic from the mobile terminal ends, the TA timer will expire and channel resources will be relinquished by the mobile terminal and channel status transmissions will terminate. In circumstances where the TA timer never expires (e.g., a TA value of zero and/or a TA timer of infinity), the channel resources may not be properly relinquished and the channel status transmissions may continue. In order to properly release these resources and terminate unnecessary transmissions, the uplink suspend signal may instruct the mobile terminal to cease one or more uplink operations such as, for example, a channel state information (CSI) transmission or a sounding reference signal (SRS) transmission. At action 302, the mobile terminal 204 may initiate a data transmission communicate with the wireless station 202. For example, the mobile terminal 204 may initiate communication with the wireless station 202 to send or receive data for one or more applications executing on the mobile terminal, or for negotiating channel access for the mobile terminal.

[0045] At action 304, the wireless station 202 may receive the data transmitted by the mobile terminal at action 302, and continue communications. The interaction between the

mobile terminal 204 and the wireless station 202 may continue as the mobile terminal 204 and the wireless station 202 send and receive data to and from one another.

[0046] At action 306, the wireless station 202 sends an uplink suspend signal to the mobile terminal 204. The uplink suspend signal may be sent after a data communication between the mobile terminal 204 and the wireless station 202. For example, the wireless station 202 may send the uplink suspend signal after a data transmission to or from the mobile terminal is terminated. In some embodiments, the uplink stop signal may be sent in response to a determination that data transmissions have ended and the propagation delay is less than a minimum value (e.g., .52ms). The uplink suspend signal may be communicated to the mobile terminal 204 in different formats. For example, the uplink suspend signal may be sent according to a level 1 signaling protocol, in a predefined format. In some embodiments, the mobile terminal may respond to such a level 1 uplink suspend signal with a Hybrid Automatic Repeat Request Acknowledgement (HARQ-ACK). As another example, the uplink suspend signal could be sent according to medium access control (MAC) signaling. An uplink suspend signal sent according to MAC signaling may be sent at a particular subframe n , and the mobile terminal may disable uplink transmissions from subframe $n+k$, where k is a predefined value known to the mobile terminal.

[0047] At action 308, the mobile terminal 204 receives the uplink suspend signal from the wireless station 202, and processes the uplink suspend signal. Processing of the uplink suspend signal may include identifying one or more uplink operations to be ceased by the mobile terminal. For example, the uplink suspend signal may include a bitmask identifying a status of multiple uplink transmissions (see Figure 5). The mobile terminal may disable certain ones of the multiple uplink transmissions (e.g., one or more of a CSI transmission, an SRS transmission, a scheduling request (SR) transmission, a physical uplink shared channel (PUSCH) transmission,

or the like), according to the uplink suspend signal. In some embodiments, the mobile terminal may determine appropriate uplink signals to disable in response to receiving a certain type of uplink suspend signal.

[0048] At action 310, the mobile terminal 204 ceases the indicated uplink operations, such

5 as by halting the transmissions indicated within the uplink suspend signal processed at action 308. These transmissions may continue to be halted until uplink operations are resumed.

Methods for resuming uplink transmissions are described further below (see Figures 4, 7-9).

[0049] Figure 4 is a block diagram of a message flow 400 between a mobile terminal and a wireless station to transmit an uplink recovery signal in accordance with an example

10 embodiment of the present invention. As described with respect to Figure 3, the wireless station 202 may communicate with the mobile terminal 204 for managing uplink operations performed by the mobile terminal 204. In the instant example embodiment, the mobile terminal 204 has had one or more uplink operations disabled by the wireless station 202, such as by a process flow as described above with respect to Figure 4. The message flow 400
15 describes a messaging scheme whereby the wireless station 202 may reactive uplink transmissions on the mobile terminal 204 by sending an uplink recovery signal.

[0050] At action 402, the mobile terminal 204 may have one or more uplink operations suspended. For example, the mobile terminal 204 may suspend CSI and SRS transmissions as instructed by the wireless station 202. At action 404, the wireless station 202 may send an
20 uplink recovery signal to recover normal channel uplink operations. For example, if the wireless station 202 needs to schedule a data transmission to the mobile terminal 204, the wireless station 202 may preface the data transmission with an uplink recovery signal.

[0051] At action 406, the mobile terminal 204 receives and processes the recovery signal. For example, the recovery signal may indicate one or more uplink operations that the mobile

terminal should resume in a similar manner as the uplink suspend signal indicates one or more uplink operations to cease (see Figure 3). The mobile terminal 204 may process this signal to determine which uplink operations to resume. At action 408, the mobile terminal 204 may resume the uplink operations according to the uplink resume signal received at action 404.

[0052] Figure 5 is a schematic diagram depicting an example of a bit mask 500 for disabling one or more uplink operations in accordance with an example embodiment of the present invention. Rather than send a particular data value for each uplink operation to be enabled or disabled by the mobile terminal (e.g., a 1 byte value for each type of operation), uplink operations may be indicated to the mobile terminal through the use of a bit mask, such as the bit mask 500. Transmission of the uplink operational state in this manner may reduce the amount of data to be transmitted, allowing for the uplink suspend and resume signals to be sent as part of different and/or lower level protocols, such as part of a MAC header. A single byte of data may be reserved for identification of the uplink operations, allowing up to 8 different operations to be indicated by the byte. For example, the individual bits of data U_{1-5} may be allocated as follows:

Bit	Mapped UL transmission
U_1	SR transmission
U_2	CSI transmission
U_3	SRS transmission
U_4	Uplink HARQ Feedback
U_5	PUSCH transmission

Table 1

[0053] The values for R may be reserved, such as for future use.

[0054] In some embodiments, an uplink recovery signal may have the same or a similar message structure to an uplink suspend signal. For example, a wireless station may send the same message structure to a mobile terminal to both start and stop particular uplink operations.

Whether a particular uplink operation is started or stopped may be indicated by the value of the

bit corresponding to the uplink operation in the signal. In this manner, a single signal may simultaneously enable certain uplink operations and disable others.

[0055] Figure 6 is a flow diagram depicting an example of a method 600 for disabling one or more uplink operations in accordance with an example embodiment of the present invention.

5 The method 600 is operable to receive an uplink suspend signal, and to process the uplink suspend signal to cease one or more uplink operations. The method 600 may be performed by a mobile terminal, such as the apparatus 100 described with respect to Figure 1. As described, the mobile terminal and the apparatus 100 may be equipped with a processing means, such as the processor 102, and a communications means, such as the communications interface 106, for
10 receiving an uplink suspend signal and stopping one or more uplink operations in response to the uplink suspend signal. In some embodiments, the method 600 may be performed by the processing means.

[0056] At action 602, the method 600 may cause a communications interface, such as a communications interface coupled to a mobile terminal, to request access to a communications
15 channel. For example, a processing means such as the processor 102 may cause communications to be initiated with a wireless station via a communication means, such as the communications interface 106. The mobile terminal may utilize the channel to send and receive data, such as between the mobile terminal and a wireless station. The communications interface may be caused to access the channel via a processing means, such as the processor
20 102.

[0057] At action 604, an uplink suspend signal is received. The uplink suspend signal may be received from a wireless station in response to the channel access request caused at action 602, or in response to an end of transmission to or from the mobile terminal. For example, when the mobile terminal ends a data transmission, the mobile terminal may indicate as such to

a wireless station. In circumstances where a TA value is zero or a TA timer is infinity, the mobile terminal may not automatically cease channel status messages (e.g., CSI or SRS messages). As such, the mobile terminal may receive the uplink suspend signal to terminate transmission of these messages until further data transmissions are required. In some

5 embodiments, the wireless station may process the channel access request and determine that it is appropriate to send an uplink suspend request (see Figure 10). For example, the uplink suspend signal may be received via a communications means, such as the communications interface 106, and the reception of the signal may be caused by a processing means, such as the processor 102.

10 [0058] At action 606, the uplink suspend signal is processed. The uplink suspend signal may contain instructions for the mobile terminal to cease one or more uplink operations. As described above (see Figures 3 and 5), the uplink suspend signal may indicate that some particular uplink operations should be disabled, while others are continued. Processing of the uplink suspend signal may allow the mobile terminal to determine which uplink operations
15 should be disabled. In some embodiments, the uplink suspend signal may not indicate particular uplink operations, and instead indicate that all uplink transmissions should be disabled. In some embodiments, the uplink suspend signal may indicate that certain operations should be disabled based on an alternative criteria. Processing of the uplink suspend signal may be performed by a processing means, such as the processor 102.

20 [0059] At action 608, uplink operations are caused to be disabled according to the uplink suspend signal. For example, upon processing the uplink suspend signal, it may be determined that the uplink suspend signal indicates that the mobile terminal should disable CSI transmissions, SRS transmissions, and Hybrid Automatic Repeat Request (HARQ) Feedback transmissions. These transmissions may be caused to be disabled by a processing means, such

as the processor 102. The processing means may communicate with a communications means, such as the communications interface 106, to disable the uplink operations.

[0060] At action 610, the communications interface is caused to access the channel according to the new access parameters specified in the uplink suspend signal. For example, the operations identified in the uplink suspend signal may be ceased until normal uplink operations are resumed. For example, a processing means, such as the processor 102, may cause a communications means, such as the communications interface 106, to access the channel according to the new access parameters (e.g., cancelling CSI transmissions, SRS transmissions, and HARQ feedback transmissions as described in action 608).

[0061] Figure 7 is a flow diagram depicting an example of a method 700 for resuming one or more uplink operations using an uplink resume signal in accordance with an example embodiment of the present invention. It may be desirable in some circumstances to resume uplink operations after initially disabling such operations. For example, an initial uplink suspend signal may be sent to the mobile terminal after a data transmission completes, thus releasing channel resources. When a new data transmission is required, the wireless station 202 may send an uplink recovery signal to the mobile terminal to resume the previously suspended uplink operations such that the new data transmission may be performed. The method 700 describes a process by which an uplink recovery signal is received and uplink operations are resumed in response to receiving the uplink recovery signal. The method 700 may be performed by a mobile terminal, such as the apparatus 100 described with respect to Figure 1. As described, the mobile terminal and the apparatus 100 may be equipped with a processing means, such as the processor 102, and a communications means, such as the communications interface 106, for receiving the uplink recovery signal and causing uplink operations to be resumed. In some embodiments, the method 700 may be performed by the processing means 102.

[0062] At action 702, an uplink channel may be accessed according to a reduced set of uplink operations. For example, a mobile terminal may have CSI and SRS transmissions disabled as described above with respect to Figures 3 and 6. For example, a processing means, such as the processor 102, may enable a communications means, such as the communications interface 106, to access the channel with reduced uplink transmissions as described above.

[0063] At action 704, the method 700 determines whether an uplink recovery signal has been received. In some embodiments, the processor may periodically query a message queue to identify the presence of an uplink resume signal (e.g., as received via the communications interface). If an uplink recovery signal has been received, the method 700 may proceed to action 706. Otherwise, the method 700 may return to action 702 to continue uplink processing according to the reduced set of uplink operations. The determination as to whether an uplink recovery signal has been received may be performed by a processing means, such as the processor 102, a communications means, such as the communications interface 106, or both the processing means and communications means in communication with one another.

[0064] At action 706, if the uplink recovery signal has been received, one or more of the uplink operations may be resumed. The uplink recovery signal may indicate one or more uplink operations to be resumed, such as by setting a particular bit flag for each uplink operation. As described above, the uplink recovery signal may have the same or a similar structure to an uplink suspend signal, and in some aspects an uplink suspend and an uplink recovery signal may be the same signal. Resuming of the uplink operations may be performed by a processing means, such as the processor 102, a communications means, such as the communications interface 106, or both the processing means and communications means in communication with one another.

[0065] At action 708, the communications interface is caused to access the channel according to the uplink operations indicated in the uplink recovery signal. For example, the

uplink recovery signal may indicate that CSI and SRS transmissions should be resumed, and as such the mobile terminal may resume these transmissions. The channel may be caused to be accessed according to the parameters of the uplink recovery signal by a processing means, such as the processor 102, a communications means, such as the communications interface 106, or
5 both the processing means and communications means in communication with one another.

[0066] Figure 8 is a flow diagram depicting an example of a method 800 for resuming one or more uplink operations using an uplink resume timer in accordance with an example

embodiment of the present invention. As described with respect to Figure 7, it may be desirable to resume uplink operations that were previously disabled in accordance with an uplink suspend
10 signal. In some embodiments, the uplink operations may be resumed in response to expiration of

a timer, in order to provide an implicit recovery mechanism that does not require a transmission from the wireless station. The method 800 is operable to recover uplink operations after a predefined period of time elapses as measured by an uplink recovery timer. The method 800 may be performed by a mobile terminal, such as the apparatus 100 described with respect to

15 Figure 1. As described, the mobile terminal and the apparatus 100 may be equipped with a processing means, such as the processor 102, and a communications means, such as the communications interface 106, for monitoring the uplink recovery timer and for causing uplink operations to be resumed in response to expiration of the uplink recovery timer. In some embodiments, the method 700 may be performed by the processing means 102.

20 [0067] At action 802, an uplink channel may be accessed according to a reduced set of uplink operations. For example, a mobile terminal may have CSI and SRS transmissions disabled as described above with respect to Figures 3 and 6. In some embodiments, an uplink recovery timer may be instantiated at the time an uplink suspend signal is received, in order to recover uplink operations at a predefined future time. For example, a processing means, such as

the processor 102, may enable a communications means, such as the communications interface 106, to access the channel with reduced uplink transmissions as described above.

[0068] At action 804, the method 800 determines whether an uplink recovery timer has expired. In some embodiments, the processor may create a timer object or thread to measure an elapsed period for which the uplink operations have been disabled. If the uplink recovery timer has expired, the method 800 may proceed to action 806. Otherwise, the method 800 may return to action 802 to continue uplink processing according to the reduced set of uplink operations.

The determination as to whether the uplink recovery timer has expired may be performed by a processing means, such as the processor 102, a communications means, such as the communications interface 106, or both the processing means and communications means in communication with one another.

[0069] At action 806, if the uplink recovery timer has expired, one or more of the uplink operations may be resumed. The uplink recovery timer may resume all disabled uplink operations, or only a subset of uplink operations. For example, the uplink recovery timer may be created in response to an uplink suspend signal that only stops a subset of the uplink operations, and expiration of the timer may only resume those operations stopped by the uplink suspend signal. Resuming of the uplink operations may be performed by a processing means, such as the processor 102, a communications means, such as the communications interface 106, or both the processing means and communications means in communication with one another.

[0070] At action 808, the communications interface is caused to access the channel according to the uplink operations resumed after expiration of the uplink recovery timer. For example, expiration of the uplink recovery timer may indicate that CSI and SRS transmissions should be resumed, and as such the mobile terminal may resume these transmissions. The channel may be caused to be accessed according to the parameters of the expiration of the uplink

recovery timer by a processing means, such as the processor 102, a communications means, such as the communications interface 106, or both the processing means and communications means in communication with one another.

[0071] Figure 9 is a flow diagram depicting an example of a method 900 for resuming one or more uplink operations using uplink resume functionality of the mobile terminal in accordance with an example embodiment of the present invention. As described with respect to Figures 7 and 8, it may be desirable to resume uplink operations that were previously disabled in accordance with an uplink suspend signal. In some embodiments, the uplink operations may be resumed in response to an event occurring on the mobile terminal itself, such as a need to transmit certain data on the channel for which uplink operations were previously disabled. The method 900 is operable to recover uplink operations in response to the need for the stopped uplink operations being identified by the mobile terminal for which uplink operations were disabled. The method 900 may be performed by a mobile terminal, such as the apparatus 100 described with respect to Figure 1. As described, the mobile terminal and the apparatus 100 may be equipped with a processing means, such as the processor 102, and a communications means, such as the communications interface 106, for determining that the previously stopped uplink operations are required and for causing uplink operations to be resumed. In some embodiments, the method 900 may be performed by the processing means 102.

[0072] At action 902, an uplink channel may be accessed according to a reduced set of uplink operations. For example, a mobile terminal may have CSI and SRS transmissions disabled as described above with respect to Figures 3 and 6. In some embodiments, a monitoring thread may be created at the time an uplink suspend signal is received, in order to recover uplink operations in the event that the stopped uplink operations are required by the mobile terminal. For example, a processing means, such as the processor 102, may enable a communications

means, such as the communications interface 106, to access the channel with reduced uplink transmissions as described above.

[0073] At action 904, the method 900 determines whether an event that requires the disabled uplink operations has occurred. For example, the mobile terminal may need to send or receive data, thus requiring an uplink to the wireless station. In some embodiments, the processor may monitor actions of the mobile terminal to determine whether such an event has occurred. If such an event has occurred, the method 900 may proceed to action 906. Otherwise, the method 900 may return to action 902 to continue uplink processing according to the reduced set of uplink operations. The determination as to whether an event that requires the stopped uplink operations has occurred may be performed by a processing means, such as the processor 102, a communications means, such as the communications interface 106, or both the processing means and communications means in communication with one another.

[0074] At action 906, if an event that requires the stopped uplink operations has occurred, one or more of the uplink operations may be resumed. Resuming of the uplink operations may be performed by a processing means, such as the processor 102, a communications means, such as the communications interface 106, or both the processing means and communications means in communication with one another.

[0075] At action 908, the communications interface is caused to access the channel according to the uplink operations resumed after the occurrence of the event that required the stopped uplink operations. The channel may be caused to be accessed according to the parameters of the expiration of the uplink recovery timer by a processing means, such as the processor 102, a communications means, such as the communications interface 106, or both the processing means and communications means in communication with one another.

[0076] The system of an embodiment of the present invention may include an apparatus 1000 as generally described below in conjunction with Figure 10 for performing one or more of the operations set forth by Figure 11 and also described below. The apparatus 1000 may be a computing device configured with a processor 1002, memory 1004, and a communications interface 1006. The apparatus 1000 may further be in communication with a data network, such as the Internet, via a wireline or wireless connection, or indirectly via one or more intermediate computing devices. As described above with respect to the apparatus 100, the apparatus 1000 may be configured as any one or more computing devices or combination thereof. The processor 1002, memory 1004, and communications interface 1006 may be configured similarly to the processor 102, memory 104, and communications interface 106 described above with respect to Figure 1. The apparatus 1000 may be further configured with one or more antennae 1008, such as accessible via the communications interface 1006. In some embodiments, the antennae 1008 may be included within the communications interface 1006. The antennae 1008 may be operable to communicate via one or more wireless protocols, such as 3G, WiMax, and/or LTE, thus allowing the apparatus 1000 to be configured as a wireless station, such as the wireless station 202 described with respect to Figure 2.

[0077] Figure 11 is a flow diagram depicting a method 1100 for sending an uplink suspend signal according to embodiments of the present invention. As described above with respect to Figures 2-3 and 6, the wireless station may be configured to send an uplink suspend signal to a mobile terminal to disable one or more uplink operations performed by the mobile terminal. The method 1100 may be operable to generate such an uplink suspend signal and transmit the uplink suspend signal to the mobile terminal. In some embodiments, the method 1100 may further determine whether it is appropriate to generate the uplink suspend signal. For example, the method 1100 may determine that communications with the mobile terminal have ended, and the

mobile terminal should release channel resources. In a small cell environment (e.g., fewer than 78 meters), the mobile terminal may not be configured with an automatic timer (e.g., a TA timer) that will release channel resources after a period of time. As such, the uplink suspend signal may function to instruct the mobile terminal to cease uplink operations that are no longer required after completion of the data transmission. The method 1100 may be performed by a wireless station. In some embodiments, the wireless station may be a computing apparatus, such as the apparatus 1000 described with respect to Figure 10. As described, the wireless station may be equipped with a processing means, such as the processor 1002, and a communications means, such as the communications interface 1006 and/or the antenna 1008, for creating and/or sending the uplink suspend signal. In some embodiments, the method 1000 may be performed by the processing means 1002.

[0078] At action 1102, the wireless station 202 may communicate with a mobile terminal 204. For example, the wireless station and mobile terminal may exchange data relating to voice communication, application data, network access information, or any other data able to be transmitted over a wireless network. The communications may include network handshakes and channel access negotiations, such as accessing the channel in a time-divided format. The communications may be performed by a processing means such as the processor 1002, a communications means, such as the communications interface 1006, or both the processing means 1002 and communications means 1006 in communication with one another.

[0079] At action 1104, if the data transmission is complete the method 1100 may send an uplink suspend signal. For example, in an environment where the mobile terminal will not automatically relinquish channel resources (e.g., if the propagation delay is less than the duration of a single TA value), then it may be appropriate to disable uplink processing since the mobile terminal will continue sending uplink transmissions, wasting network and mobile terminal

resources. If the communications are complete, the method may proceed to action 1106.

Otherwise, communications may continue to occur at action 1102. Whether the communications have ended may be determined by a processing means, such as the processor 1002.

[0080] At action 1106, if the communications have ended, the method 1100 may be operable
5 to generate an uplink suspend signal as described above (see Figures 2-9). The method 1100
may determine whether one or more uplink operations may be disabled. Which uplink
operations may be disabled may depend upon the signaling protocol used to communicate
between the mobile terminal and wireless station. For example, if a Physical Uplink Control
Channel (PUCCH) format 1 protocol is used, then it may be appropriate to disable scheduling
10 request (SR) transmissions. If a PUCCH format 2, 2a, or 2b protocol is used, then it may be
appropriate to disable CSI transmissions. If a PUCCH format 1a/1b, 2a/2b, or 3 format is used,
it may be appropriate to disable uplink HARQ feedback. The uplink suspend signal may also
indicate that a HARQ buffer on the mobile terminal should not be flushed, or that PUCCH and
SRS configurations should not be released. The uplink suspend signal may be generated by a
15 processing means, such as the processor 1002.

[0081] At action 1108, the uplink suspend signal may be caused to be transmitted to the
mobile terminal. The uplink suspend signal may be caused to be sent by a processing means,
such as the processor 1002.

[0082] It will be understood that each block of the flowcharts, and combinations of blocks in
20 the flowcharts, may be implemented by various means, such as hardware, firmware, processor,
circuitry, and/or other devices associated with execution of software including one or more
computer program instructions. For example, one or more of the procedures described above
may be embodied by computer program instructions. In this regard, the computer program
instructions which embody the procedures described above may be stored by a memory 104 of

an apparatus employing an embodiment of the present invention and executed by a processor 102 of the apparatus. As will be appreciated, any such computer program instructions may be loaded onto a computer or other programmable apparatus (e.g., hardware) to produce a machine, such that the resulting computer or other programmable apparatus implements the functions specified in the flowchart blocks. These computer program instructions may also be stored in a computer-readable memory that may direct a computer or other programmable apparatus to function in a particular manner, such that the instructions stored in the computer-readable memory produce an article of manufacture the execution of which implements the function specified in the flowchart blocks. The computer program instructions may also be loaded onto a computer or other programmable apparatus to cause a series of operations to be performed on the computer or other programmable apparatus to produce a computer-implemented process such that the instructions which execute on the computer or other programmable apparatus provide operations for implementing the functions specified in the flowchart blocks.

[0083] Accordingly, blocks of the flowchart support combinations of means for performing the specified functions and combinations of operations for performing the specified functions for performing the specified functions. It will also be understood that one or more blocks of the flowchart, and combinations of blocks in the flowchart, can be implemented by special purpose hardware-based computer systems which perform the specified functions, or combinations of special purpose hardware and computer instructions.

[0084] In some embodiments, certain ones of the operations above may be modified or further amplified. Furthermore, in some embodiments, additional optional operations may be included. Modifications, additions, or amplifications to the operations above may be performed in any order and in any combination.

[0085] Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and
5 that modifications and other embodiments are intended to be included within the scope of the appended claims. Moreover, although the foregoing descriptions and the associated drawings describe example embodiments in the context of certain example combinations of elements and/or functions, it should be appreciated that different combinations of elements and/or functions may be provided by alternative embodiments without departing from the scope of the
10 appended claims. In this regard, for example, different combinations of elements and/or functions than those explicitly described above are also contemplated as may be set forth in some of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

WHAT IS CLAIMED IS:

1. A method comprising:
 - negotiating access to a wireless channel using a processor, the channel negotiation
 - 5 process including assigning one or more time slots to a mobile terminal to transmit data across a wireless channel;
 - sending one or more data transmissions to a mobile terminal, the data transmissions transmitted over the wireless channel;
 - receiving one or more channel status transmissions from the mobile terminal to facilitate
 - 10 the data transmissions;
 - determining that the one or more data transmissions have ended;
 - in response to determining that the one or more data transmissions have ended, generating an uplink suspend signal, the uplink suspend signal instructing the mobile terminal to suspend future channel status transmissions; and
 - 15 transmitting the uplink suspend signal to the mobile terminal.
2. The method of claim 1, wherein the one or more signal transmissions are uplink transmissions to be performed on a predefined uplink physical channel.
- 20 3. The method of any of claims 1 to 2, wherein the wireless network is a 3G network or a Long Term Evolution (LTE) network.
4. The method of any of claims 1 to 3, wherein the uplink suspend signal is transmitted as at least one of a physical signal or a medium access control (MAC) control element.
- 25 5. The method of any of claims 1 to 4, wherein the one or more signal transmissions are at least one of: a scheduling request transmission, a periodic channel state information transmission,

a periodic sounding reference signal transmission, an uplink hybrid automatic repeat request feedback transmission, or a physical uplink shared channel transmission.

5 6. The method of any of claims 1 to 5, wherein a propagation delay on the wireless channel is less than a threshold value, the threshold value being a minimum timing advance value, such that the mobile terminal is assigned timing advance value of zero when the one or more time slots are assigned.

10 7. The method of any of claims 1 to 6, further comprising:
generating an uplink recovery signal indicating one or more signal transmissions to be resumed by the mobile terminal; and
transmitting the uplink recovery signal to the mobile terminal.

15 8. The method of claim 7, wherein the uplink recovery signal has the same message structure as the uplink suspend signal.

9. The method of any of claims 1 to 8, wherein the uplink suspend signal further comprises a bitmask for identifying the one or more signal transmissions.

20 10. A method comprising:
accessing, using a mobile terminal, a wireless channel according to a wireless uplink protocol, the wireless uplink protocol defining a plurality of transmissions to configure the wireless channel;
configuring the wireless channel using the plurality of transmissions;
25 receiving an uplink suspend signal, the uplink suspend request identifying at least one of the plurality of transmissions to be stopped; and
stopping the identified at least one of the plurality of transmissions in response to the uplink suspend signal.

11. The method of claim 10, further comprising:
receiving an uplink recovery signal identifying at least one of the plurality of
transmissions to be resumed; and
5 resuming the identified at least one of the plurality of transmissions in response to
receiving the uplink recovery signal.
12. The method of any of claims 10 to 11, further comprising:
initializing an uplink recovery timer in response to the uplink suspend signal; and
10 resuming the identified at least one of the plurality of transmissions in response to
expiration of the uplink recovery timer.
13. The method of any of claims 10 to 12, further comprising:
determining that at least one of the stopped transmissions is required for a data
15 transmission operation to be performed by the mobile terminal;
resuming the determined at least one of the stopped transmissions; and
performing the data transmission operation.
14. The method of any of claims 10 to 13, wherein the plurality of transmissions are at least
20 one of: a scheduling request transmission, a channel state information transmission, a sounding
reference signal transmission, an uplink hybrid automatic repeat request feedback transmission,
or a physical uplink shared channel transmission.
15. An apparatus comprising at least one processor and at least one memory including
25 computer program instructions, the at least one memory and the computer program instructions
configured to, with the at least one processor, cause the apparatus at least to:
negotiate access to a wireless channel, the channel negotiation process including
assigning one or more time slots to a mobile terminal to transmit data across a wireless channel;

send one or more data transmissions to a mobile terminal, the data transmissions transmitted over the wireless channel;

receive one or more channel status transmissions from the mobile terminal to facilitate the data transmissions;

5 determine that the one or more data transmissions have ended;

in response to determining that the one or more data transmissions have ended, generate an uplink suspend signal, the uplink suspend signal instructing the mobile terminal to suspend future channel status transmissions; and

cause the uplink suspend signal to be transmitted to the mobile terminal.

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16. The apparatus of claim 15, wherein the one or more signal transmissions are uplink transmissions to be performed on a predefined uplink physical channel.

17. The apparatus of any of claims 15 to 16, wherein the wireless network is a 3G network or
15 a Long Term Evolution (LTE) network.

18. The apparatus of any of claims 15 to 17, wherein the apparatus is further configured to determine a propagation delay between the apparatus and the mobile terminal, and wherein the uplink suspend signal is sent in response to the propagation delay being less than .52ms.

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19. The apparatus of any of claims 15 to 18, wherein the one or more signal transmissions are at least one of: a scheduling request transmission, a channel state information transmission, a sounding reference signal transmission, an uplink hybrid automatic repeat request feedback transmission, or a physical uplink shared channel transmission.

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20. The apparatus of any of claims 15 to 20, further configured to:

generate an uplink recovery signal indicating one or more signal transmissions to be resumed by the mobile terminal; and

transmit the uplink recovery signal to the mobile terminal.

21. An apparatus comprising at least one processor and at least one memory including computer program instructions, the at least one memory and the computer program instructions
5 configured to, with the at least one processor, cause the apparatus at least to:

access a wireless channel according to a wireless uplink protocol, the wireless uplink protocol defining a plurality of transmissions to configure the wireless channel;

configure the wireless channel using the plurality of transmissions;

10 receive an uplink suspend signal, the uplink suspend request identifying at least one of the plurality of transmissions to be stopped; and

stop the identified at least one of the plurality of transmissions in response to the uplink suspend signal.

22. The apparatus of claim 21, further configured to:

15 receive an uplink recovery signal identifying at least one of the plurality of transmissions to be resumed; and

resume the identified at least one of the plurality of transmissions in response to receiving the uplink recovery signal.

20 23. The apparatus of any of claims 21 to 22, further comprising:

initialize an uplink recovery timer in response to the uplink suspend signal; and

resume the identified at least one of the plurality of transmissions in response to expiration of the uplink recovery timer.

25 24. The apparatus of any of claims 21 to 23, further comprising:

determine that at least one of the stopped transmissions is required for a data transmission operation to be performed by the mobile terminal;

resume the determined at least one of the stopped transmissions; and

performe the data transmission operation.

25. The apparatus of any of claims 21 to 24, wherein the plurality of transmissions are at least one of: a scheduling request transmission, a channel state information transmission, a
5 sounding reference signal transmission, an uplink hybrid automatic repeat request feedback transmission, or a physical uplink shared channel transmission.

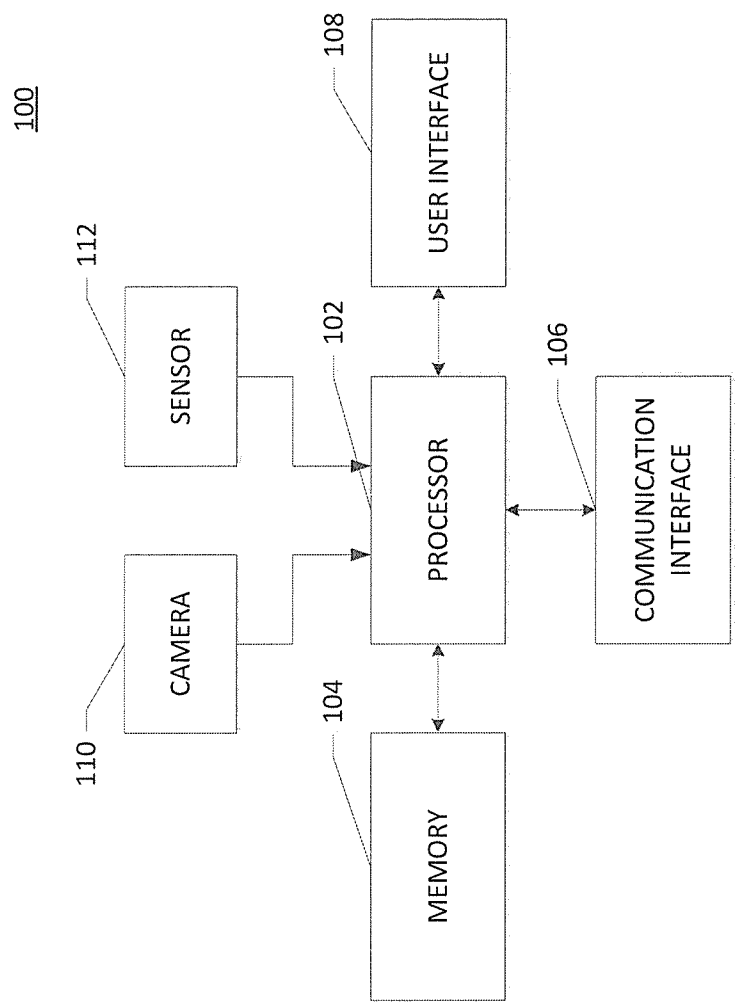


FIG. 1

200

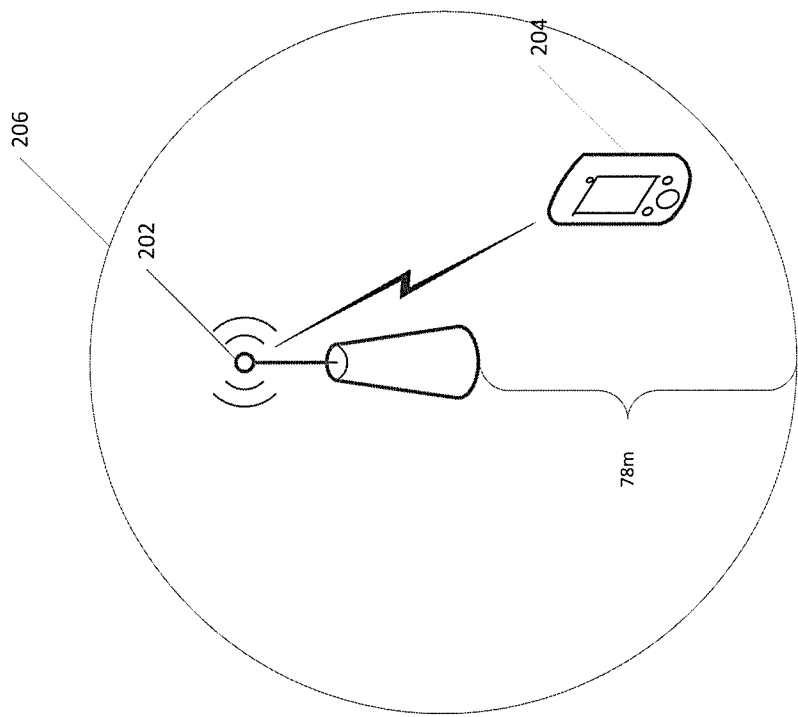


FIG. 2

300

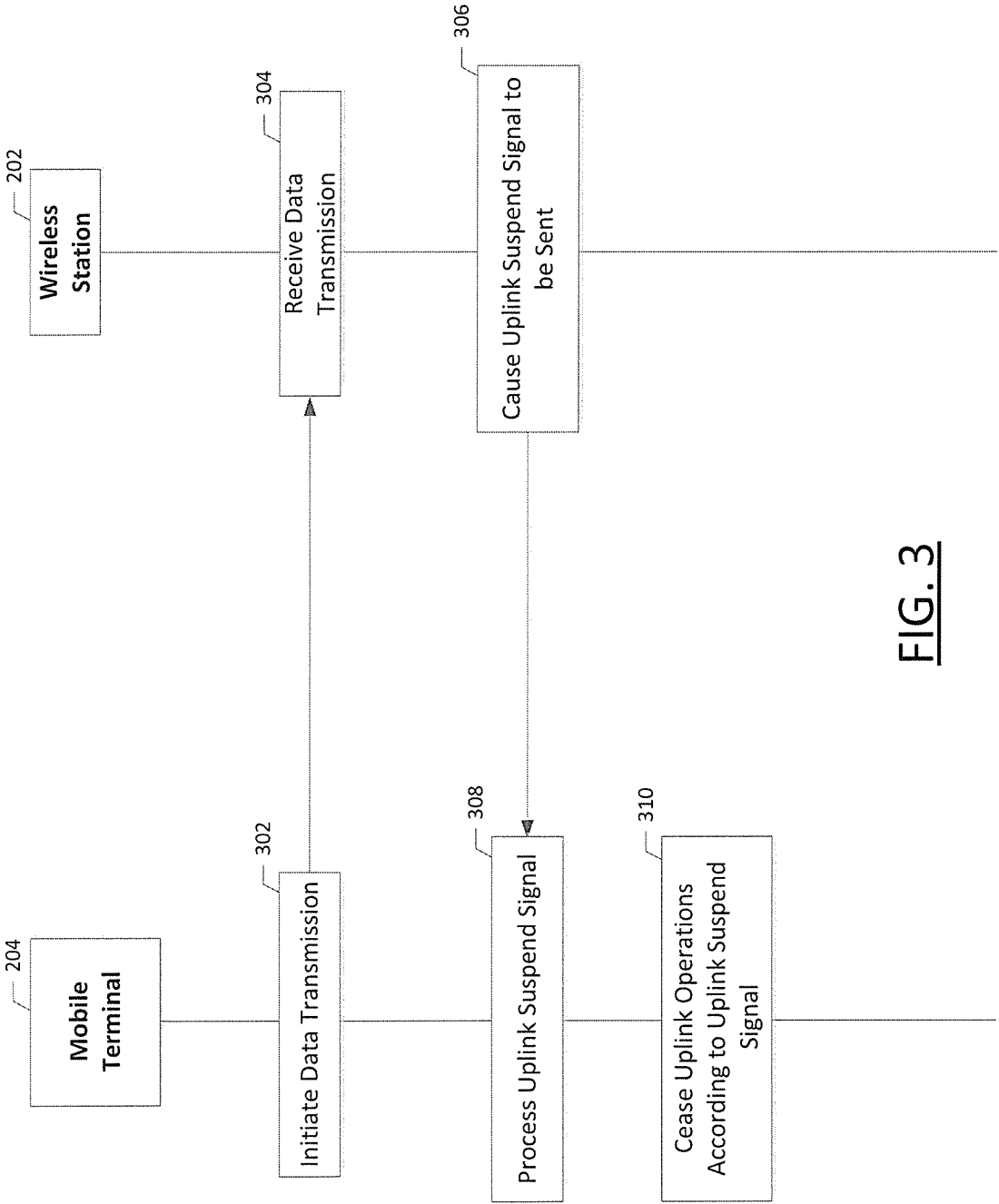


FIG. 3

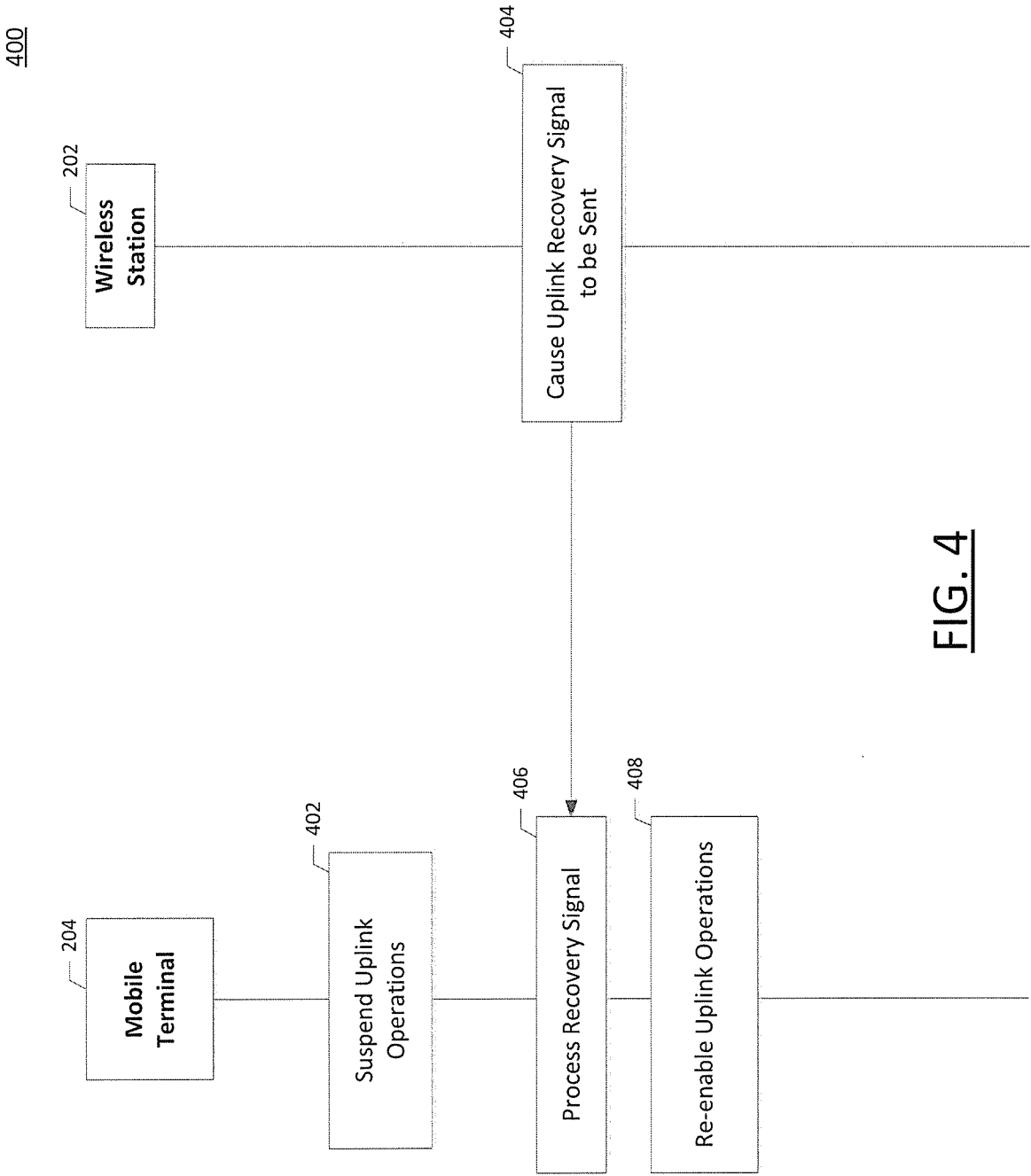


FIG. 4

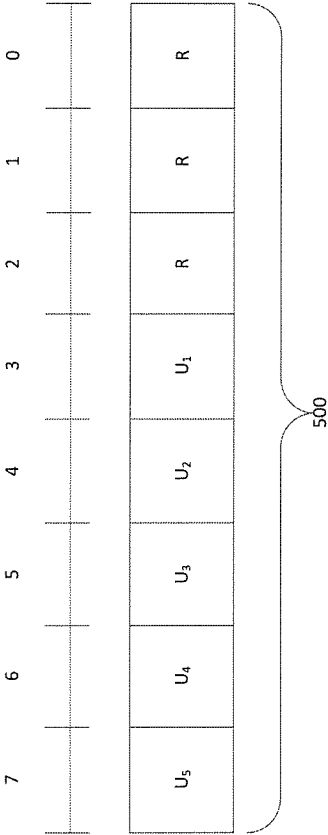


FIG. 5

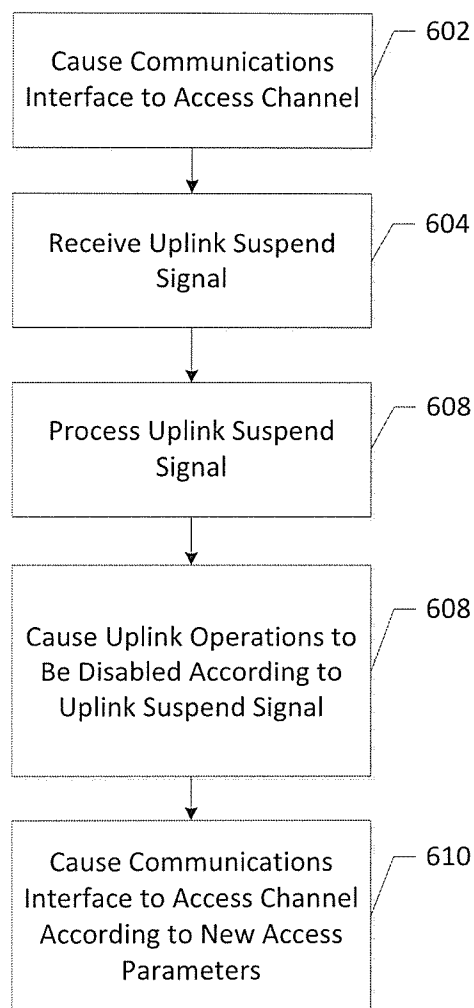
600

FIG. 6

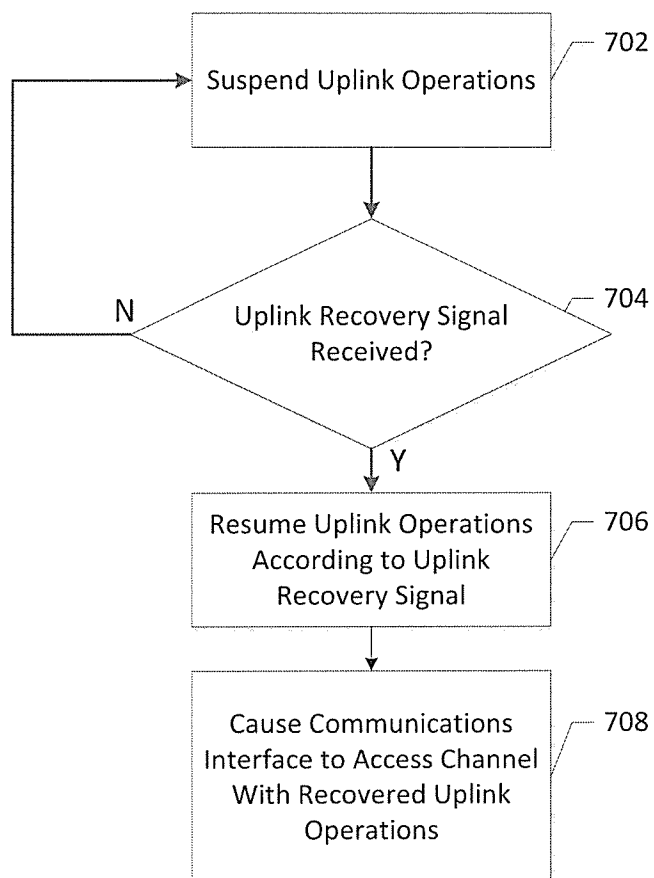
700

FIG. 7

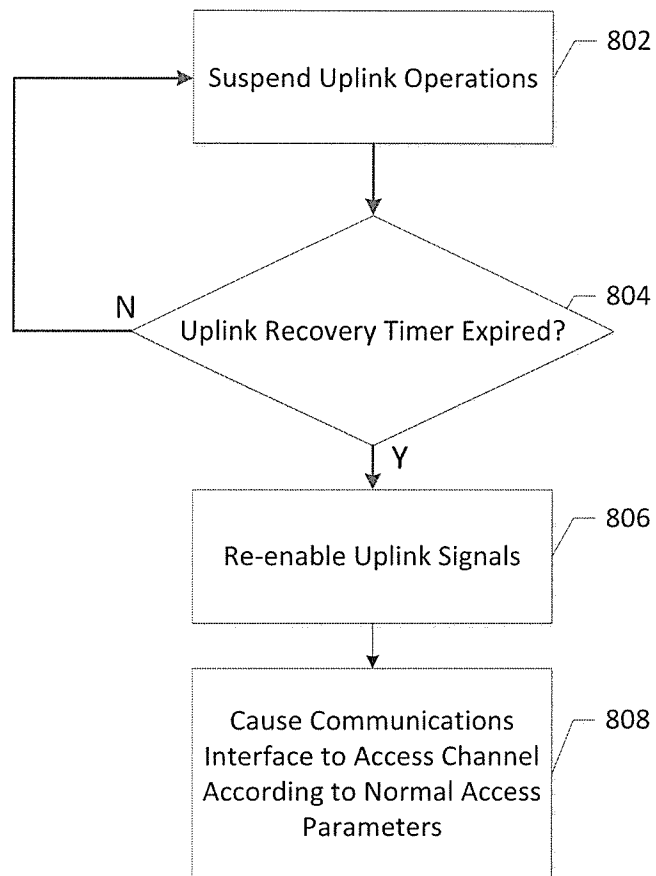
800

FIG. 8

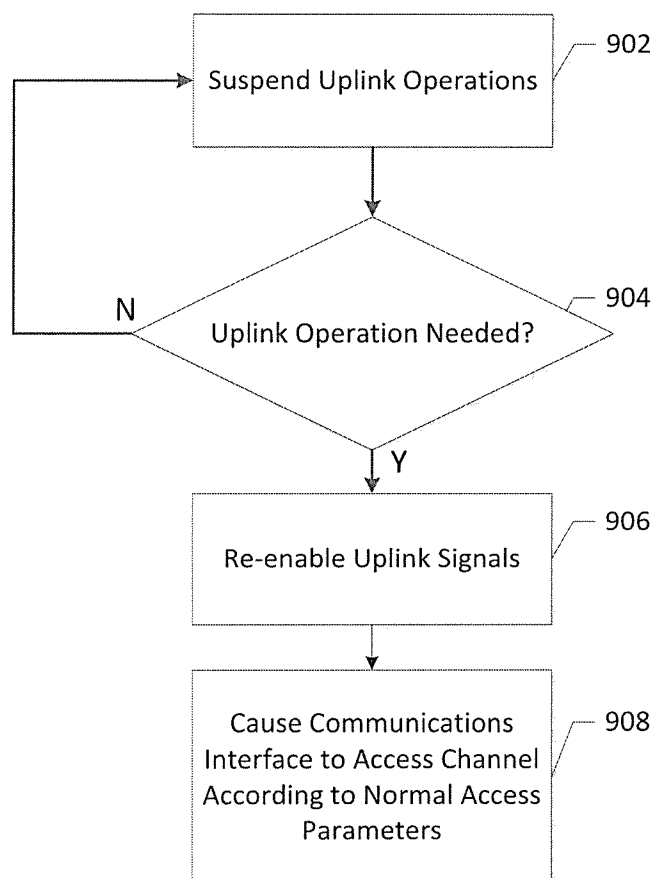
900

FIG. 9

1000

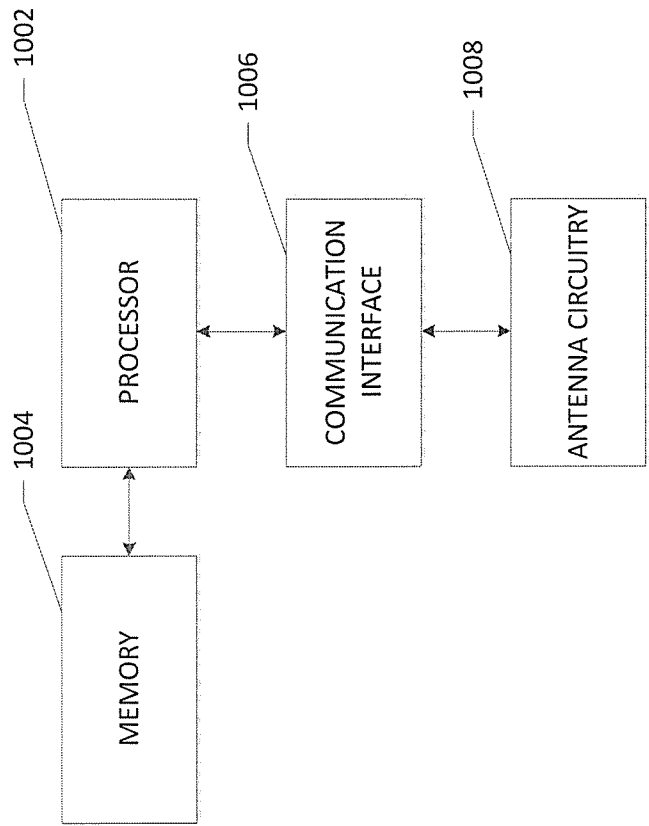


FIG. 10

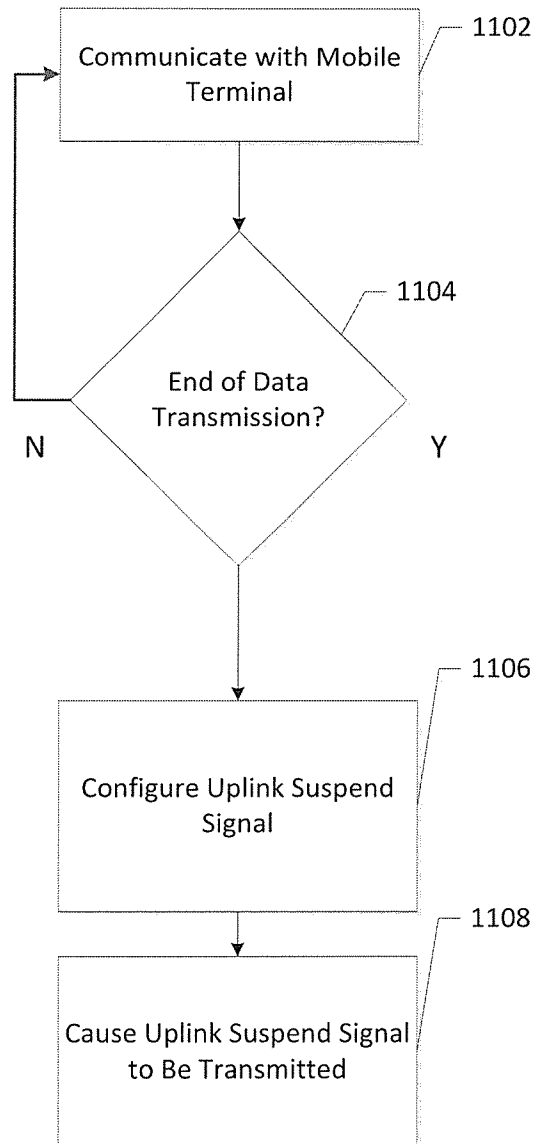
1100

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/079640

A. CLASSIFICATION OF SUBJECT MATTER

H04W 48/06 (2009.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04W;H04Q

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)

WPI, EPODOC, CNPAT, CNKI, IEEE: suspend, stop, cease, delay, put off, discontinue, status, channel, negotiation, slot, data, recover, resume, signal, instruct, CSI, HARQ, SRS, PUSCH, SR

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO2009/117671A2(RESEARCH IN MOTION LIMITED) 24 Sep.2009 (24.09.2009) page 6, line 14 to page 17, line 21, figures 4,5,8,9,description	1-25
Y	CN102595555A(ZTE CORP.) 18 Jul.2012 (18.07.2012) paragraphs 0027-0066, description	1-25
A	CN102378216A(POTEVIO INSTITUTE OF TECHNOLOGY CO., LTD.) 13 Mar.2012 (14.03.2012) the whole document	1-25
A	CN102215580A(HTC CORP.) 12 Oct.2011 (12.10.2011) the whole document	1-25

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

* Special categories of cited documents:	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
“A” document defining the general state of the art which is not considered to be of particular relevance	“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
“E” earlier application or patent but published on or after the international filing date	“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
“L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	“&”document member of the same patent family
“O” document referring to an oral disclosure, use, exhibition or other means	
“P” document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 10 Apr. 2013 (10.04.2013)	Date of mailing of the international search report 02 May 2013 (02.05.2013)
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100088
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Authorized officer

LI, Changlin

Telephone No. (86-10)62413334

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/079640

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