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(54) **Title:** EXTENDED DISCONTINUOUS RECEPTION CYCLE FOR WIRELESS DEVICES

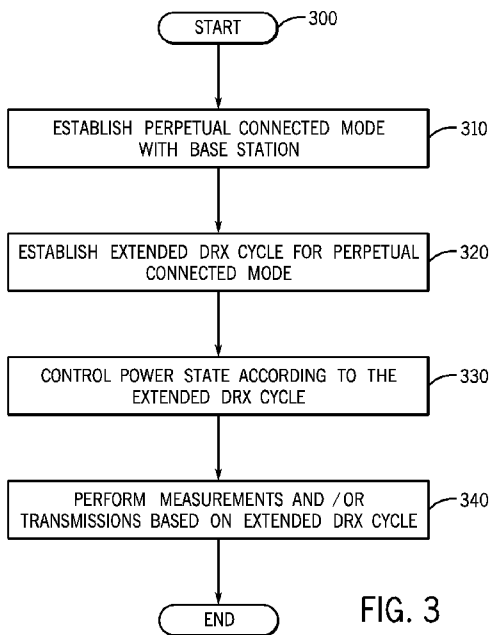


FIG. 3

(57) **Abstract:** A Machine Type Communication (MTC) device may establish a perpetual connected mode and an extended discontinuous reception (DRX) cycle with a base station. The perpetual connected mode may reduce the amount of signaling overhead required by the MTC device. The extended DRX cycle may enable the MTC device to reduce energy consumption while maintaining the perpetual connected mode. In addition, network overhead may be reduced by decreasing the frequency of scheduled measurements and/or transmissions performed by the MTC device.

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Extended Discontinuous Reception Cycle For Wireless Devices

Cross Reference To Related Applications

[0001] This application claims priority to provisional application 61/514,010, filed August 1, 2011, which application is hereby expressly incorporated herein.

Background

[0002] This relates generally to wireless communication networks.

[0003] Machine Type Communication (MTC), also known as Machine to Machine (M2M) communication, may refer to wireless communication between electronic devices, or between an electronic device and a base station. Some examples of wireless MTC devices may include intelligent utility meters, security/alarm devices, gas monitoring devices, vending machines, point of sale devices, inventory tracking sensors, medical monitors, etc.

Brief Description Of The Drawings

[0004] Some embodiments are described with respect to the following figures:

Figure 1 is a depiction of an example network configuration in accordance with one embodiment;

Figure 2 is a depiction of an example in accordance with one embodiment;

Figure 3 is a flow chart in accordance with one embodiment;

Figure 4 is a flow chart in accordance with one embodiment;

Figure 5 is a flow chart in accordance with one embodiment;

Figure 6 is a schematic depiction of a MTC device and/or a base station in accordance with one embodiment.

Detailed Description

[0005] Typical Machine Type Communication (MTC) networks will include a number of electronic devices having wireless networking capabilities (referred to herein as “MTC devices”). Conventionally, MTC devices may cycle between an idle mode and a connected mode. In the connected mode, the MTC device establishes a wireless connection with a base station. The wireless connection may include channels for transmitting control signals (e.g.,

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signaling radio bearers), for transmitting user data (e.g., data radio bearers), etc. Once established, the wireless connection may be used to send data to a destination (e.g., a remote server). In the idle mode, the MTC device does not use the wireless connection to transmit data, and thus one or more components of MTC device (e.g., a transceiver, a processor, etc.) shut down or hibernate in order to reduce power consumption.

[0006] Each time that a MTC device enters the connected mode, signaling overhead is required to establish the wireless connection. The signaling overhead includes numerous transmissions such as connection requests, connection setup or configuration messages, authentication or security requests, context information, acknowledgements, etc. In a network including a large number of MTC devices, the signaling overhead from the MTC devices may result in a substantial amount of traffic, potentially causing congestion or overloading of the network. In particular, in a typical MTC network, the signaling overhead may represent two-thirds or more of the network use by the MTC device.

[0007] In accordance with some embodiments, an MTC device may establish a perpetual connected mode and an extended discontinuous reception (DRX) cycle. The perpetual connected mode may reduce the amount of signaling overhead required by the MTC device. Further, the extended DRX cycle may enable the MTC device to reduce energy consumption while maintaining the perpetual connected mode. In addition, in some embodiments, network overhead may be reduced by decreasing the frequency of scheduled measurements and/or transmissions of measurement reports performed by the MTC device.

[0008] Referring to Figure 1, an example network configuration 100 may include a base station 110 and any number of MTC devices 150. The MTC devices 150 may include any wireless electronic device capable of Machine-Type Communications or Machine to Machine (M2M) connections (e.g., utility meters, security devices, environmental monitors, vending machines, medical monitors, etc.). Further, the MTC devices 150 may include any other wireless electronic devices temporarily acting as MTC devices, or running MTC applications. The base station 110 may provide a wireless interface to a larger network (not shown) such as a core network, a local area network, the Internet, etc. For example, the base station 110 may be an Evolved Node B (eNB), a wireless access point, a cellular tower, etc.

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[0009] In accordance with some embodiments, the base station 110 and MTC devices 150 may each include a transceiver 162, a processor 164, and a memory device 166. The base station 110 may also include the base station control module 115. In addition, the MTC device 150A may also include a MTC control module 155. Note that, while not shown in Figure 1 for the sake of simplicity, the other MTC devices 150B-150D may include similar components to those included in the MTC device 150A.

[0010] In one or more embodiments, the base station control module 115 may include functionality to enable the base station 110 to establish a wireless connection to a MTC device 150. Further, the MTC control module 155 may include functionality to enable a MTC device 150 to establish a wireless connection to base station 110 or to another MTC device 150. For example, as shown, MTC device 150C may connect to MTC device 150B. In this example, the MTC device 150B may act as a relay station or repeater for the MTC device 150C, thus enabling the MTC device 150C to establish a wireless connection to base station 110.

[0011] The wireless connections among the base station 110 and the MTC devices 150 may be based on any radio communications technologies and/or standards. For example, such wireless connections may include Long Term Evolution (LTE) connections (3rd Generation Partnership Project (3GPP) standards, TS36 version 10.0, published October 2010), Universal Mobile Telecommunications System (UMTS) connections (3GPP standards, TS25 version 10.0, published March 2011), Wi-Fi connections (IEEE (Institute of Electrical and Electronics Engineers) 802.11 standard, IEEE 802.11-2007, published June 12, 2007), Wi-MAX connections (IEEE 802.16 standard, IEEE 802.16-2004, published October 1, 2004), etc.

[0012] In one or more embodiments, the MTC control module 155 and/or the base station control module 115 may be implemented in hardware, software, and/or firmware. In firmware and software embodiments, they may be implemented by computer executed instructions stored in a non-transitory computer readable medium, such as an optical, semiconductor, or magnetic storage device.

[0013] In one or more embodiments, the MTC control module 155 and/or the base station control module 115 may include functionality to establish a perpetual connected mode

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between the MTC device 150 and the base station 110. As used herein, “perpetual connected mode” refers to a connected mode that is maintained continuously while the MTC device 150 is in normal operation (e.g., not disabled, not completely powered down, not malfunctioning, etc.). Thus, in some embodiments, the MTC device 150 in a perpetual connected mode does not switch to an idle mode during normal operation. Further, while in the perpetual connected mode, any of the configuration and/or resources allocated to the wireless connection (e.g., context, control channels, data channels, identifiers, timing parameters, memory, permissions, etc.) may be maintained during normal operation.

[0014] In accordance with some embodiments, the MTC control module 155 and/or the base station control module 115 may include functionality to establish an extended DRX cycle for the perpetual connected mode between the MTC device 150 and the base station 110. As used herein, “extended DRX cycle” refers to a DRX cycle having a cycle duration much longer than those of conventional DRX cycles. For example, an extended DRX cycle may have a cycle duration on the order of minutes (e.g., 1 minute, 2 minutes, 5 minutes, 10 minutes, 30 minutes, 50 minutes), hours (e.g., 1 hour, 2 hours, 5 hours, 10 hours, 20 hours), days, weeks, etc. In contrast, a conventional DRX cycle may have a cycle duration on the order of a few seconds (e.g., less than 3 seconds).

[0015] Referring to Figure 2, an example of an extended DRX cycle is shown in accordance to some embodiments. As shown, each cycle duration of the extended DRX cycle includes an ON duration and an OFF duration. In one or more embodiments, the MTC device 150 and the base station 110 may negotiate the length of the ON duration and the length of the OFF duration as part of establishing a wireless connection. The base station 110 may then only transmit messages to the MTC device 150 during the ON durations of the extended DRX cycle. In addition, the MTC device 150 may only listen for transmissions from the base station 110 during the ON cycle of the extended DRX cycle. Thus, in one or more embodiments, the MTC device 150 may deactivate (or otherwise reduce power to) any components related to radio reception (e.g., transceiver 162, processor 164, etc.) during the OFF cycle of the extended DRX cycle. In this manner, the extended DRX cycle may enable the MTC device 150 to reduce power consumption.

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[0016] Note that, for the sake of simplicity, the relative lengths of the ON duration and the OFF duration shown in Figure 2 are not drawn to scale. In particular, in accordance with one or more embodiments, the OFF duration of an extended DRX cycle is much longer relative to the ON duration than is shown in Figure 2. For example, in some embodiments, the ratio of the OFF duration to the ON duration of an extended DRX cycle may be equal to or greater than, e.g., 100:1, 500:1, 1000:1, 10000:1, 1000000:1, etc.

[0017] In accordance with some embodiments, the MTC control module 155 and/or the base station control module 115 may optionally include functionality to adjust measurements and/or transmissions schedules of monitoring functions performed by the MTC device 150. In some embodiments, these schedules and/or timing may be extended in accordance to the extended DRX cycle. For example, such functionality may include setting a Radio Link Monitoring (RLM) schedule to synchronize with the extended DRX cycle. In another example, such functionality may include setting a Radio Resource Management (RRM) (i.e., system level control of co-channel interference and other radio transmission characteristics) schedule to synchronize with the extended DRX cycle. In still other examples, such functionality may include setting a Time Alignment Timer (TAT) parameter and/or an uplink control channel transmission timing in accordance to the extended DRX cycle.

[0018] In one or more embodiments, the configuration of the extended DRX cycle may be performed using an operator policy. In some embodiments, the configuration of the extended DRX cycle may be performed dynamically based on device characteristics. The device characteristics may be set as part of a Non-Access Stratum (NAS) context in the MTC device 150, or may be set as part of subscription data in a Home Subscriber Server (HSS) or Home Location Register (HLR). Some example device characteristics may include degree of mobility, size of data transmission, etc. In some embodiments, the device characteristics may be configured using Over the Air (OTA) provisioning methods. In one or more embodiments, the device configuration can be specified in a subscription database and may be downloaded to the MTC device 150 during an attach procedure.

[0019] Note that the examples shown in Figures 1 and 2 are provided for the sake of illustration, and are not intended to limit embodiments of the invention. For example, embodiments of the invention may include any number and/or arrangement of MTC devices

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150 and/or base stations 110. Further, it is contemplated that specifics in the examples may be used anywhere in one or more embodiments.

[0020] Figure 3 shows a sequence 300 in accordance with one or more embodiments. In one embodiment, the sequence 300 may be part of the MTC control module 155 shown in Figure 1. In another embodiment, the sequence 300 may be implemented by any other component of a MTC device 150. The sequence 300 may be implemented in hardware, software, and/or firmware. In firmware and software embodiments it may be implemented by computer executed instructions stored in a non-transitory computer readable medium, such as an optical, semiconductor, or magnetic storage device.

[0021] At step 310, a perpetual connected mode may be established with a base station. For example, referring to Figure 1, the MTC control module 155 may establish a perpetual connected mode with the base station 110. In some embodiments, establishing the perpetual connected mode may include establishing a wireless connection to the base station 110. The MTC device 150, while in the perpetual connected mode, may not switch to an idle mode. Further, the configuration and/or resources allocated to the wireless connection between the MTC device 150 and the base station 110 are maintained during the perpetual connected mode.

[0022] At step 320, an extended DRX cycle may be established for the perpetual connected mode with the base station. For example, referring to Figure 1, the MTC control module 155 may establish an extended DRX cycle with the base station 110. In some embodiments, the extended DRX cycle may schedule repeating cycles of ON periods (i.e., periods during which the MTC device 150 may listen for transmissions from the base station 110) and OFF periods (i.e., periods during which the MTC device 150 does not listen for transmissions from the base station 110), as shown in Figure 2.

[0023] At step 330, the power state of the MTC device may be controlled according to the extended DRX cycle with the base station. For example, referring to Figure 1, the MTC control module 155 may shut down or hibernate one or more components of the MTC device 150 (e.g., radio components, sensors, processors, the entire device, etc.) during the OFF periods of the extended DRX cycle. Further, in one or more embodiments, the MTC control

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module 155 may activate the hibernating components of the MTC device 150 during the ON periods of the extended DRX cycle.

[0024] Optionally, at step 340, monitoring functions of the MTC device may be performed based on an extended schedule. For example, referring to Figure 1, the MTC control module 155 may perform measurement(s) and/or transmission(s) (e.g., RLM, RRM, uplink control channel transmission, TAT, etc.) in some manner synchronized or aligned with the extended DRX cycle. After step 340, the sequence 300 ends.

[0025] Figure 4 shows an optional sequence 400 in accordance with some embodiments. In some embodiments, sequence 400 may be optionally performed in addition to sequence 300 shown in Figure 3. In one embodiment, the sequence 400 may be part of the base station control module 115 shown in Figure 1. In another embodiment, the sequence 400 may be implemented by any other component of the base station 110 and/or the MTC device 150. The sequence 400 may be implemented in hardware, software, and/or firmware. In firmware and software embodiments it may be implemented by computer executed instructions stored in a non-transitory computer readable medium, such as an optical, semiconductor, or magnetic storage device.

[0026] At step 410, a determination is made about whether a MTC device is highly mobile. For example, referring to FIG. 1, the base station control module 115 may determine whether one or more measures of the expected movements of the MTC device 150 exceed a predefined threshold. This determination may be based on any movement information for the MTC device 150 such as, e.g., past movements, distance travelled within a given time period, wireless connection history, expected uses, design parameters, application profiles, subscription profiles, preference settings, expected mode of operation, etc.

[0027] If it is determined at step 410 that the MTC device is not highly mobile, then the process continues at step 310 shown in Figure 3. Stated differently, in some embodiments, a MTC device may implement a perpetual connected mode and an extended DRX cycle (as shown in Figure 3) only if the MTC device is determined to not be highly mobile.

[0028] However, if it is determined at step 410 that the MTC device is highly mobile, then at step 420, the MTC device may use a standard connected mode (i.e., a connected mode

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having a defined duration, and alternating with an idle mode according to a defined schedule). For example, referring to Figure 1, the base station control module 115 may establish an alternating cycle of standard connected modes and idle modes with the MTC device 150. Further, in one or more embodiments, the MTC device 150 using a standard connected mode may not implement an extended DRX cycle. Stated differently, in some embodiments, the MTC device will not implement a perpetual connected mode and an extended DRX cycle (as shown in Figure 3) if the MTC device is determined to be highly mobile.

[0029] Optionally, at step 430, monitoring functions of the MTC device may be performed based on standard schedules (i.e., not synchronized or aligned with an extended DRX cycle). For example, referring to Figure 1, the MTC control module 155 may perform network measurements and/or transmissions (e.g., RLM, RRM, uplink control channel transmission, TAT, etc.) based on a standard schedule or timing (e.g., in alignment with a standard DRX cycle). In some embodiments, such standard schedules may be defined according to defined protocols and/or industry standards. After step 430, the sequence 400 ends.

[0030] Figure 5 shows a sequence 500 in accordance with one or more embodiments. In one embodiment, the sequence 500 may be part of the base station control module 115 shown in Figure 1. In another embodiment, the sequence 500 may be implemented by any other component of a base station 110. The sequence 500 may be implemented in hardware, software, and/or firmware. In firmware and software embodiments it may be implemented by computer executed instructions stored in a non-transitory computer readable medium, such as an optical, semiconductor, or magnetic storage device.

[0031] At step 510, a perpetual connected mode may be established with a MTC device. For example, referring to Figure 1, the base station control module 115 may establish a perpetual connected mode with the MTC device 150. In some embodiments, the base station 110 may maintain the configuration and/or resources allocated to the wireless connection with the MTC device 150 during the perpetual connected mode.

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[0032] At step 520, an extended DRX cycle may be established for the perpetual connected mode with the MTC device. For example, referring to Figure 1, the base station control module 115 may establish an extended DRX cycle with the MTC device 150.

[0033] At step 530, transmissions to the MTC device may be performed based on the extended DRX cycle. For example, referring to Figure 1, the base station control module 115 may enable data transmissions to the MTC device 150 to occur during ON periods of the extended DRX cycle. Further, the base station control module 115 may not enable transmissions to the MTC device 150 to occur during OFF periods of the extended DRX cycle. After step 530, the sequence 500 ends.

[0034] Figure 6 depicts a computer system 630, which may be the MTC device 150 and/or the base station 110 shown in Figure 1. The computer system 630 may include a hard drive 634 and a removable storage medium 636, coupled by a bus 604 to a chipset core logic 610. A keyboard and mouse 620, or other conventional components, may be coupled to the chipset core logic via bus 608. The core logic may couple to the graphics processor 612 via a bus 605, and the applications processor 600 in one embodiment. The graphics processor 612 may also be coupled by a bus 606 to a frame buffer 614. The frame buffer 614 may be coupled by a bus 607 to a display screen 618, such as a liquid crystal display (LCD) touch screen. In one embodiment, the graphics processor 612 may be a multi-threaded, multi-core parallel processor using single instruction multiple data (SIMD) architecture.

[0035] The chipset logic 610 may include a non-volatile memory port to couple the main memory 632. Also coupled to the core logic 610 may be a radio transceiver and antenna(s) 621, 622. Speakers 624 may also be coupled through core logic 610.

[0036] The following clauses and/or examples pertain to further embodiments. One example embodiment may be a method for controlling a wireless device, including: establishing a perpetual connected mode with a base station; establishing an extended discontinuous reception (DRX) cycle for the connected mode with the base station; and controlling a power state of the wireless device according to the extended DRX cycle. Establishing the extended DRX cycle may include setting an OFF period of the extended DRX cycle to greater than one minute. Establishing the extended DRX cycle may also include setting an OFF period of the extended DRX cycle to greater than five minutes. The

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method may include determining an expected mobility of the wireless device. The method may include establishing the extended DRX cycle based on an expected mobility of the wireless device. Controlling the power state of the wireless device may include deactivating at least one component of the wireless device during an OFF period of the extended DRX cycle. Controlling the power state of the wireless device may include activating at least one component of the wireless device during an ON period of the extended DRX cycle. The method may include adjusting a measurement schedule based on the extended DRX cycle. The method may include performing at least one measurement according to the adjusted measurement schedule. Performing the at least one measurement function may include performing a Radio Link Monitoring (RLM) measurement. Performing the at least one monitoring function may include performing a Radio Resource Management (RRM) measurement. The method may include adjusting a transmission timing based on the extended DRX cycle. Adjusting the transmission timing may include adjusting a Time Alignment Timer (TAT) parameter. Adjusting the transmission timing may also include adjusting an uplink control channel transmission timing. The method may include establishing the perpetual connected mode using an antenna.

[0037] Another example embodiment may be a machine readable medium including a plurality of instructions that in response to being executed by a computing device, cause the computing device to carry out the above described method.

[0038] Yet another example embodiment may be a wireless device including an antenna; and a control module coupled to the antenna, the control module to: establish a perpetual connected mode with a base station; establish an extended discontinuous reception (DRX) cycle for the connected mode with the base station; and control a power state of the wireless device according to the extended DRX cycle. The wireless device may be a Machine Type Communication (MTC) device. The wireless device may be a personal communication device. The control module may be to control the power state of the wireless device by deactivating at least one component of the wireless device during an OFF period of the extended DRX cycle. The control module may also be to control the power state of the wireless device by activating at least one component of the wireless device during an ON period of the extended DRX cycle. The control module may also be to receive a measurement schedule based on the extended DRX cycle. The control module may also be to

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perform at least one measurement according to the received measurement schedule. The control module may also be to perform the at least one measurement function by performing a Radio Link Monitoring (RLM) measurement. The control module may also be to perform the at least one measurement function by performing a Radio Resource Management (RRM) measurement.

[0039] Still another example embodiment may be a base station including an antenna and a control module coupled to the antenna, the control module to: establish a perpetual connected mode with a wireless device; establish an extended discontinuous reception (DRX) cycle for the connected mode with the wireless device; and transmit to the wireless device according to the extended DRX cycle. The control module may also be to determine an expected mobility of the wireless device. The control module may also be to establish the extended DRX cycle based on the expected mobility of the wireless device. The control module may also be to determine a measurement schedule based on the extended DRX cycle. The control module may also be to transmit the measurement schedule to the wireless device.

[0040] References throughout this specification to “one embodiment” or “an embodiment” mean that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one implementation encompassed within the present invention. Thus, appearances of the phrase “one embodiment” or “in an embodiment” are not necessarily referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be instituted in other suitable forms other than the particular embodiment illustrated and all such forms may be encompassed within the claims of the present application.

[0041] While the present invention has been described with respect to a limited number of embodiments for the sake of illustration, those skilled in the art will appreciate numerous modifications and variations therefrom. For example, it is contemplated that the above described processes may be performed at any location(s) in the network (e.g., at a MTC device 150 level, at a base station 110 level, at a network level, or any combination thereof). In another example, the above described functionality of the MTC device 150 and/or the base

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station 110 may be implemented in any other wireless device(s) (e.g., user equipment, mobile telephone, personal communication device, computer, node, relay, repeater, router, etc.). It is intended that the appended claims cover all such modifications and variations as fall within the true spirit and scope of this present invention.

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What is claimed is:

1. A method for controlling a wireless device, comprising:
establishing a perpetual connected mode with a base station;
establishing an extended discontinuous reception (DRX) cycle for the connected mode with the base station; and
controlling a power state of the wireless device according to the extended DRX cycle.
2. The method of claim 1 wherein establishing the extended DRX cycle comprises setting an OFF period of the extended DRX cycle to greater than one minute.
3. The method of claim 1 wherein establishing the extended DRX cycle comprises setting an OFF period of the extended DRX cycle to greater than five minutes.
4. The method of claim 1 including determining an expected mobility of the wireless device.
5. The method of claim 1 including establishing the extended DRX cycle based on an expected mobility of the wireless device.
6. The method of claim 1 wherein controlling the power state of the wireless device comprises deactivating at least one component of the wireless device during an OFF period of the extended DRX cycle.
7. The method of claim 1 wherein controlling the power state of the wireless device comprises activating at least one component of the wireless device during an ON period of the extended DRX cycle.
8. The method of claim 1 including adjusting a measurement schedule based on the extended DRX cycle.

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9. The method of claim 8 including performing at least one measurement according to the adjusted measurement schedule.
10. The method of claim 9 wherein performing the at least one measurement function comprises performing a Radio Link Monitoring (RLM) measurement.
11. The method of claim 9 wherein performing the at least one monitoring function comprises performing a Radio Resource Management (RRM) measurement.
12. The method of claim 1 including adjusting a transmission timing based on the extended DRX cycle.
13. The method of claim 12 wherein adjusting the transmission timing comprises adjusting a Time Alignment Timer (TAT) parameter.
14. The method of claim 12 wherein adjusting the transmission timing comprises adjusting an uplink control channel transmission timing.
15. The method of claim 1 including establishing the perpetual connected mode using an antenna.
16. At least one machine readable medium comprising a plurality of instructions that in response to being executed by a computing device, cause the computing device to carry out a method according to any of claims 1 to 15.
17. A wireless device comprising:
 - an antenna; and
 - a control module coupled to the antenna, the control module to:
 - establish a perpetual connected mode with a base station;
 - establish an extended discontinuous reception (DRX) cycle for the connected mode with the base station; and

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control a power state of the wireless device according to the extended DRX cycle.

18. The wireless device of claim 17, wherein the wireless device is a Machine Type Communication (MTC) device.

19. The wireless device of claim 17, wherein the wireless device is a personal communication device.

20. The wireless device of claim 17, wherein the control module is to control the power state of the wireless device by deactivating at least one component of the wireless device during an OFF period of the extended DRX cycle.

21. The wireless device of claim 17, wherein the control module is to control the power state of the wireless device by activating at least one component of the wireless device during an ON period of the extended DRX cycle.

22. The wireless device of claim 17, wherein the control module is to receive a measurement schedule based on the extended DRX cycle.

23. The wireless device of claim 22, wherein the control module is to perform at least one measurement according to the received measurement schedule.

24. The wireless device of claim 23, wherein the control module is to perform the at least one measurement function by performing a Radio Link Monitoring (RLM) measurement.

25. The wireless device of claim 23, wherein the control module is to perform the at least one measurement function by performing a Radio Resource Management (RRM) measurement.

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26. A base station comprising:
 - an antenna; and
 - a control module coupled to the antenna, the control module to:
 - establish a perpetual connected mode with a wireless device;
 - establish an extended discontinuous reception (DRX) cycle for the connected mode with the wireless device; and
 - transmit to the wireless device according to the extended DRX cycle.
27. The base station of claim 26, wherein the control module is also to determine an expected mobility of the wireless device.
28. The base station of claim 27, wherein the control module is to establish the extended DRX cycle based on the expected mobility of the wireless device.
29. The base station of claim 26, wherein the control module is to determine a measurement schedule based on the extended DRX cycle.
30. The base station of claim 29, wherein the control module is to transmit the measurement schedule to the wireless device.

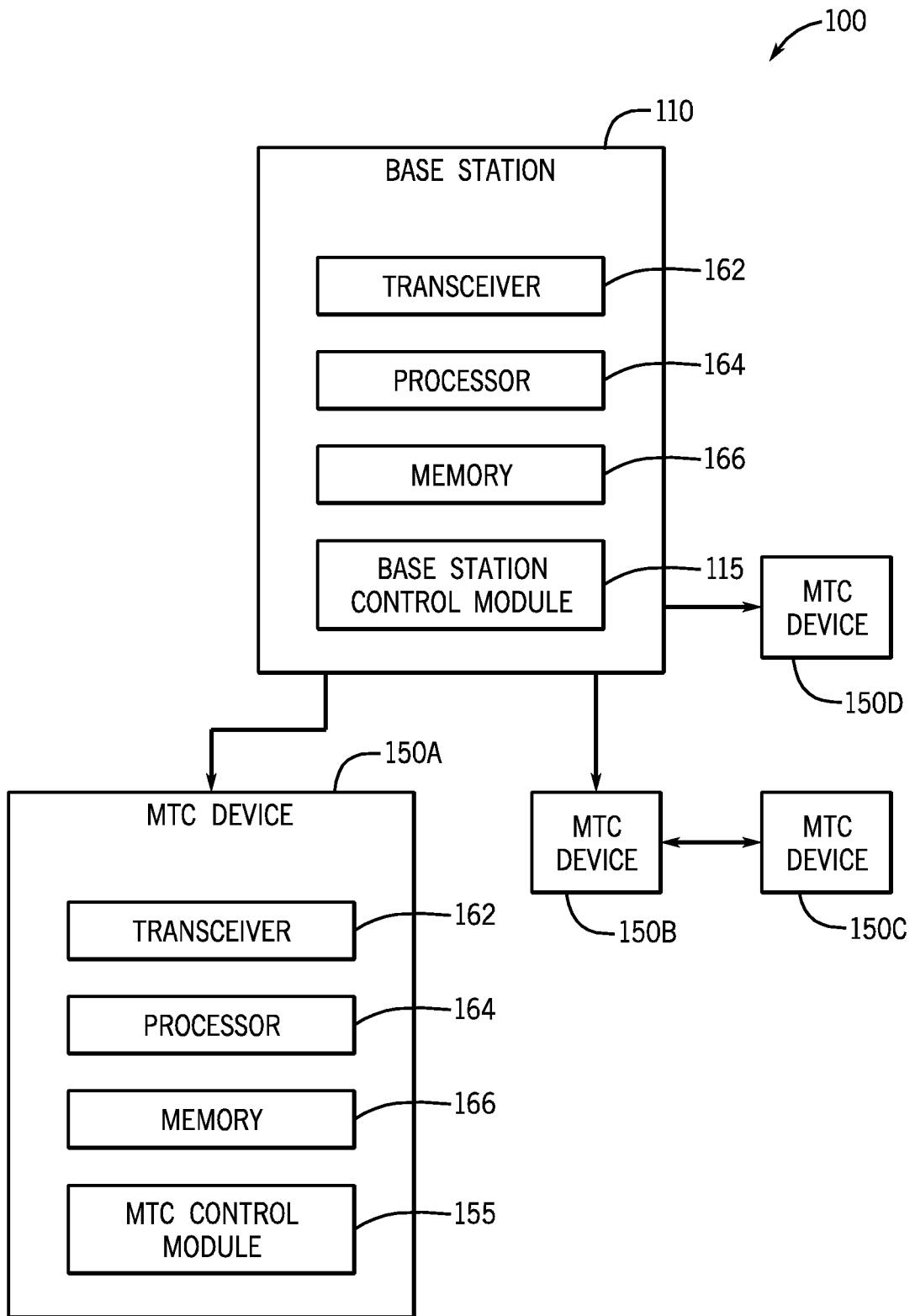


FIG. 1

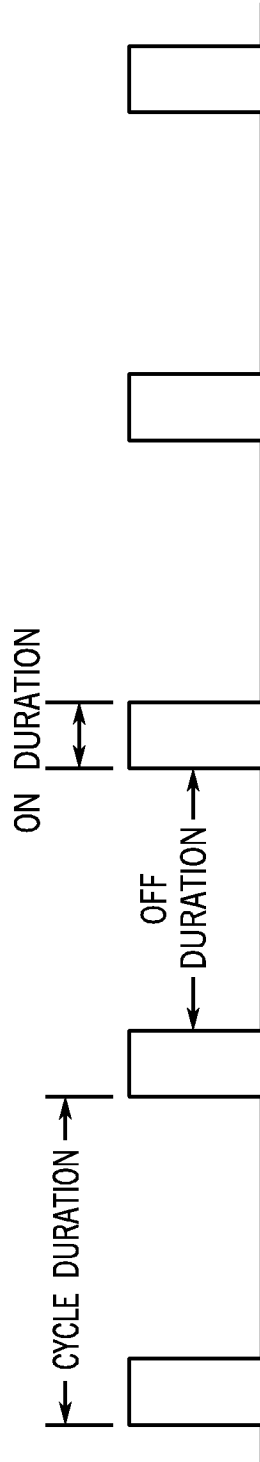


FIG. 2

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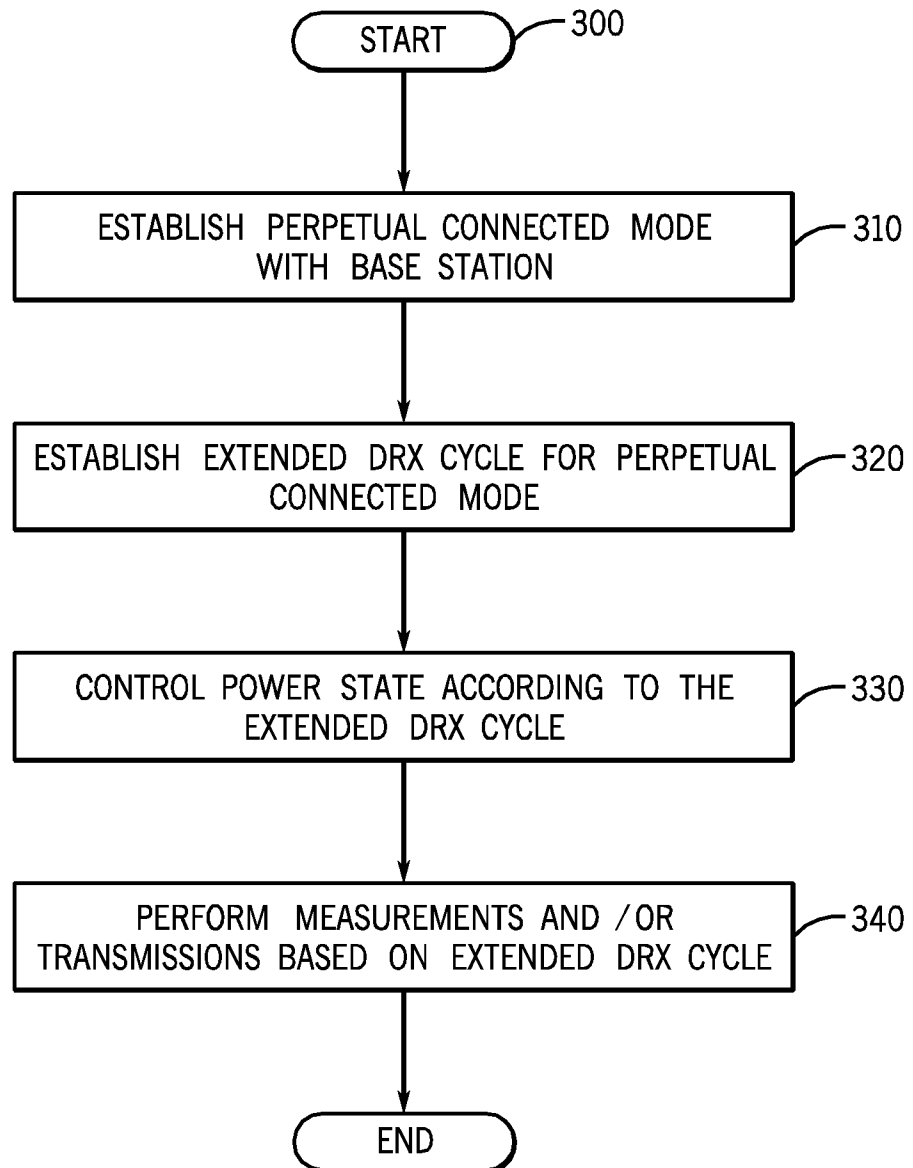


FIG. 3

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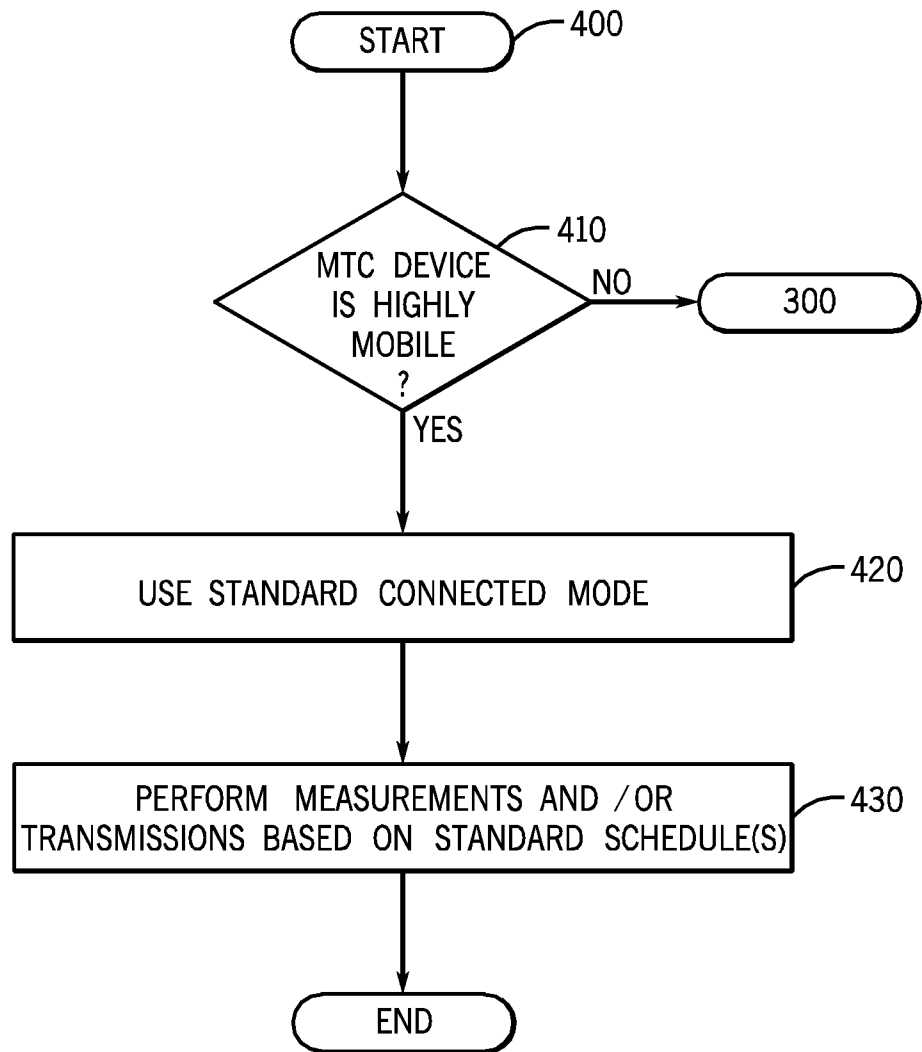


FIG. 4

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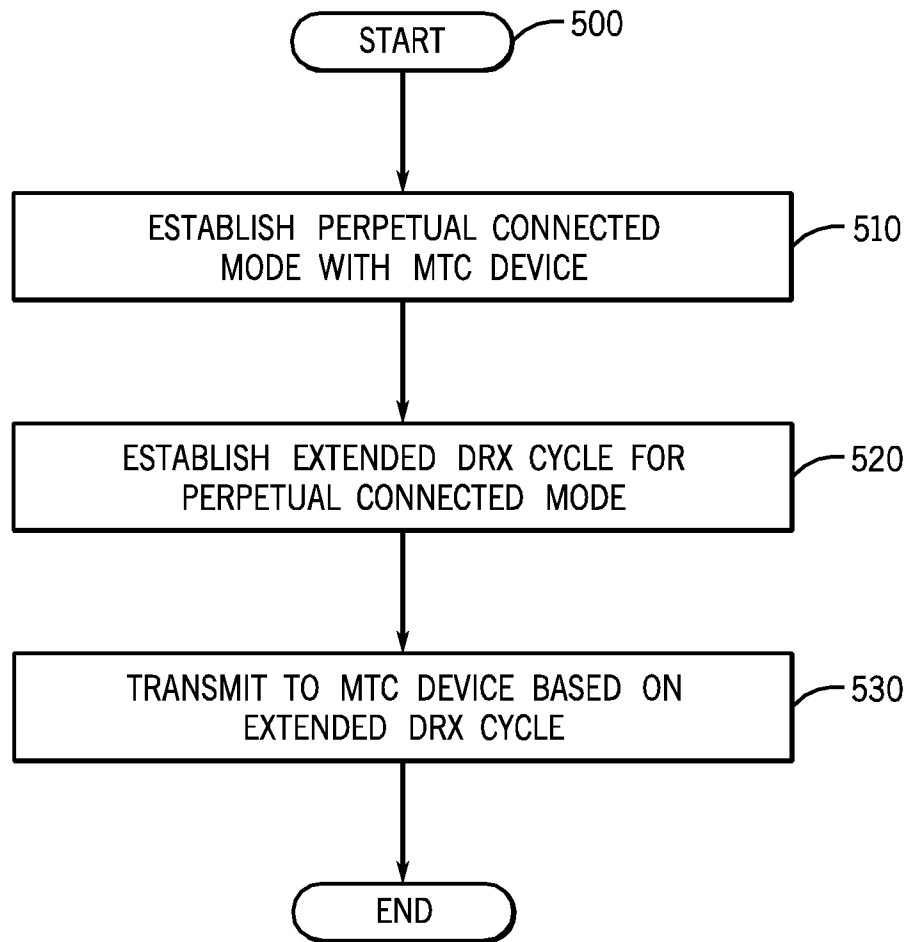


FIG. 5

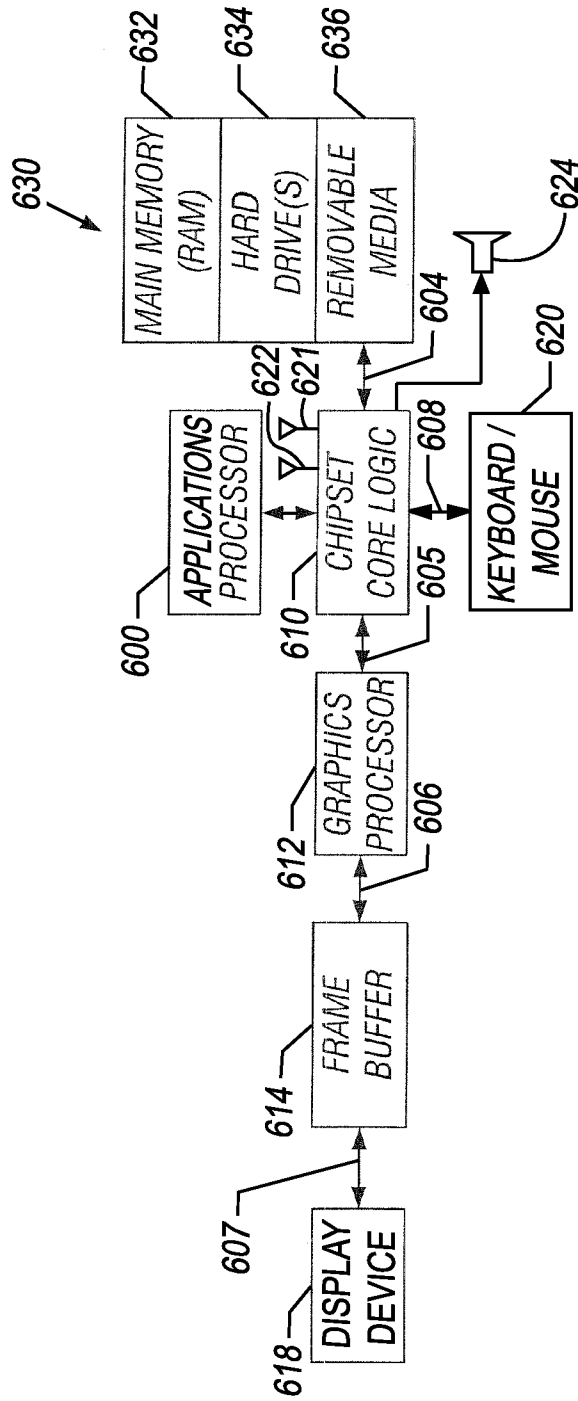


FIG. 6

A. CLASSIFICATION OF SUBJECT MATTER**H04W 52/02(2009.01)i, H04W 72/12(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)

H04W 52/02; H04W 68/00; H04W 68/02; H04B 1/40

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: perpetual connection mode, extended DRX, power control

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	US 2007-0293162 A1 (JUSSI JAATINEN et al.) 20 December 2007 See description paragraph [0055].	1-3, 6-9, 12, 16-17 , 19-21, 26, 29 4-5, 10-11, 13-15, 18 , 22-25, 27-28, 30
Y A	US 2010-0184458 A1 (GABOR FODOR et al.) 22 July 2010 See description paragraphs [0002], [0043].	1-3, 6-9, 12, 16-17 , 19-21, 26, 29
A	US 2010-0165899 A1 (JAMES A. VAN BOSCH et al.) 01 July 2010 See description paragraphs [0014], [0016], [0020].	1-30
A	KR 10-2011-0081724 A (SAMSUNG ELECTRONICS CO., LTD.) 14 July 2011 See claims 1-10 and figures 1-8.	1-30

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

* Special categories of cited documents:

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"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

30 AUGUST 2012 (30.08.2012)

Date of mailing of the international search report

30 AUGUST 2012 (30.08.2012)

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INTERNATIONAL SEARCH REPORT

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International application No.

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