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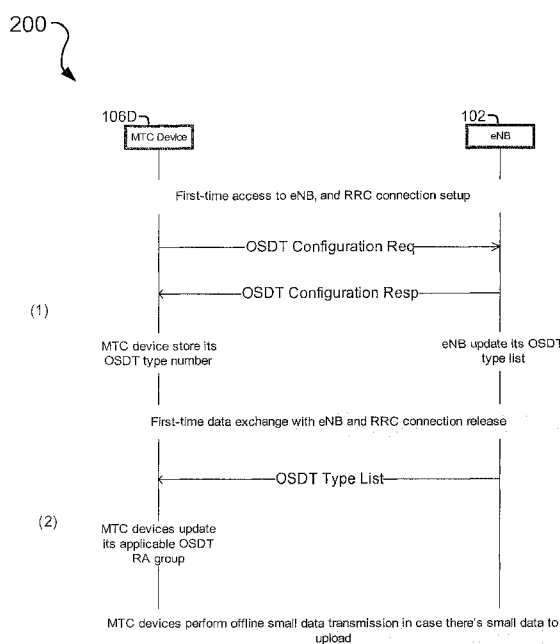
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(54) **Title:** METHODS AND APPARATUS FOR FACILITATING OFFLINE SMALL DATA TRANSMISSION

(57) **Abstract:** A base station providing services to devices, including machine type communication (MTC) devices in a wireless communication cell to machine to machine communication (MTC) devices initiates and ceases service to MTC devices. An MTC device initiating service is assigned an offline small data transmission (OSDT) type, and an OSDT type list maintained by the base station is updated if the OSDT type assigned to the MTC device is a new OSDT device type. The presence of a new OSDT type results in a reallocation of random access sequences among OSDT types. Similarly, the base station detects the cessation of service to an MTC device, updates its OSDT type list if the OSDT type of the MTC device is no longer represented in the cell, and reallocates RA sequences among OSDT types to account for the reduced number of OSDT types needing to be served.

METHODS AND APPARATUS FOR FACILITATING OFFLINE SMALL DATA TRANSMISSION

TECHNICAL FIELD:

5 [0001] The exemplary and non-limiting embodiments of this invention relate generally to wireless communication systems, methods, devices and computer programs, and more specifically relate to small data transmissions such as might be sent by machine-type communication devices which need not have a continuous connection with a host network.

10 BACKGROUND:

[0002] The following abbreviations that may be found in the specification and/or the drawing figures are defined as follows:

	CDMA	code division multiple access
	eNodeB	evolved Node B
15	LTE	long term evolution
	M2M	machine-to-machine
	MTC	machine-type communication
	OSDT	offline small data transmission
	RA	random access
20	RACH	random access channel
	UE	user equipment

[0003] Machine to machine (M2M) communication is the networking of intelligent, communications-enabled remote assets. It allows important information to be exchanged automatically without human intervention, and covers a broad range of
25 technologies and applications which connect the physical world – whether machines or monitored physical conditions – to a back-end information technology infrastructure. M2M communications can be used for a variety of purposes, such as immediate feedback on a remote asset, feature popularity, and specifics of errors and breakdowns, to name a few.

[0004] M2M communications are made possible by the use of intelligent sensors or microprocessors that are embedded in the remote asset. These sensors are connected to a wireless modem, slightly different to the one in conventional mobile phones, which is able to receive and transmit data wirelessly to a central server where it can be analyzed and acted upon. Wireless communications technologies used to enable this connectivity include GSM, GPRS, CDMA, 3G, LTE, Wi-Fi and WiMAX, and M2M communications can be conducted over a relatively short range or a distance of many miles. Since M2M communications vary widely in both the types of data reported and the radio access technologies used, the traffic models are quite diverse and no single networking model is efficient for all of them. For example, if M2M is applied to monitor natural disasters, a huge number of M2M devices may initiate services simultaneously, with each reporting a small amount of data to the application layer when triggered by an appropriate event. This is classified as an infrequent small data transmission. In conventional cellular systems a mobile terminal typically goes through a control signaling procedure to establish a data connection with the network before it can send user data. This is inefficient for infrequent small data transmissions since the conventional signaling overhead in setting up a data channel for the user terminal is high relative to the small volume of user data being reported by an M2M device.

20 SUMMARY:

[0005] The foregoing and other problems are overcome, and other advantages are realized, by the use of the exemplary embodiments of this invention.

[0006] In a first embodiment of the invention, an apparatus comprises at least one processor and at least one memory storing a computer program. The at least one memory with the computer program is configured with the at least one processor to

25

cause the apparatus to send a configuration request to a base station, store an offline small data transmission type identifier indicating an offline small data transmission type assigned to the apparatus by the base station in response to the configuration request, and receive an offline small data transmission type list broadcast by the base station. The list is updated to indicate a new allocation of resources among offline small data transmission types after a change in the number of offline small data transmission types being served by the base station.

[0007] In a second embodiment of the invention, an apparatus comprises at least one processor and at least one memory storing a computer program. The at least one memory with the computer program is configured with the at least one processor to cause the apparatus to determine if a change has occurred to a number of offline small data communication types requiring service by the apparatus, and, if a change has occurred to the number of offline small data communication types requiring service by the apparatus, to reallocate resources among offline small data transmission types.

[0008] In a third embodiment of the invention, a method comprises sending a configuration request from a device to a base station, storing an offline small data transmission type identifier indicating an offline small data transmission type assigned to the device by the base station in response to the configuration request, and receiving an offline small data transmission type list broadcast by the base station. The list is updated to indicate a new allocation of resources among offline small data transmission types after a change in the number of offline small data transmission type being served by the base station.

[0009] In a fourth embodiment of the invention, a method comprises determining if a change has occurred to a number of offline small data communication types requiring service by the apparatus, and, if a change has occurred to the number of offline small

data communication types requiring service by the apparatus, reallocating resources among offline small data transmission types.

[0010] These and other embodiments and aspects are detailed below with particularity.

5 BRIEF DESCRIPTION OF THE DRAWINGS:

[0011] Figure 1 illustrates a wireless network cell serving one or more machine-type communication (MTC) devices;

[0012] Fig. 2 is a diagram illustrating communication and events relating to entry of an MTC device into a cell.

10 [0013] Fig. 3 is a diagram illustrating allocation of random access (RA) space among offline small data transmission types in a cell.

[0014] Fig. 4 is a diagram illustrating communication and events relating to exit of an MTC device from a cell as a result of handover; and

[0015] Fig. 5 is a diagram illustrating communication and events relating to exit of an
15 MTC device from a cell as a result of explicit deactivation.

DETAILED DESCRIPTION:

[0016] The present invention recognizes that the nature of machine to machine communication by machine-type communication devices often involves infrequent transmission of small amounts of data at unexpected times, by devices that may spend
20 extended periods disconnected from a central communication device. The invention also recognizes that very large numbers of such devices may enter into operation at approximately the same time upon the occurrence of a triggering event. The invention further recognizes that numerous different types of MTC devices may exist and may begin communication at the same time. The invention still further
25 recognizes that a central communication device to which MTC devices deliver data

may be expected to also serve numerous other devices. For example, MTC devices may be designed so as to operate within a wireless network. A wireless network comprises a plurality of base stations, with each base station typically serving numerous user equipments (UEs), providing voice and data communication on a
5 constant basis.

[0017] The invention recognizes that these and other considerations indicate that efficiency in signaling, particularly in signaling used to introduce MTC devices to a central communication device, is an important factor. If, for example, control signaling and resource allocation are not managed carefully, the control signaling will
10 consume much more resources than will the data being delivered, and excessive resources will be allocated to accommodate infrequent events. For example, if a channel is held open for each type of MTC device in each cell of a cellular network, numerous channels will be opened that will be unused for much of the time, allocating resources away from current users or requiring the installation of excessive
15 infrastructure.

[0018] The invention further recognizes that each cell is relatively small when compared to a network as a whole, with many long-term evolution (LTE) cells having a radius of 1 km, and with cells such as micro-cells having even smaller radii. One mechanism by which MTC devices communicate with a base station serving a cell is
20 through a random access channel procedure (RACH) in which an MTC device presents an initial signal to the central communication device, with the central communication device responding to the initial signal and allowing the MTC device to transmit its data. The invention recognizes that a number of different MTC device types may exist in a network, but that not every device type will necessarily be
25 present in a cell. Therefore, providing resources, such as random access sequences,

for device types that are not present in a cell may waste resources by requiring unused resources to be provided, impair operation by failing to dedicate sufficient resources to device types actually in a cell, or both.

[0019] Therefore, various embodiments of the present invention provide systems and techniques for entry into and exit from cells. A base station, which may take the form of an evolved Node B (eNodeB), serves the cell and allocates resources to provide communication with each type of MTC present in the cell. When an MTC enters or leaves the cell, the base station determines if the MTC represents a new MTC type in the case of entry, or represents the last example of a particular MTC type in the case of departure. In the case of a new or no longer present type, the central communication device reallocates the resources devoted to different MTC types. Periodically, the central communication device broadcasts a message indicating its allocation of resources to the different MTC types.

[0020] Fig. 1 illustrates a cell 100 representing a geographic area served by a cellular communications network. The cell 100 is served by a base station, which in the present exemplary embodiment is an eNodeB 102. Various devices served by the eNodeB 102 operate within the cell 100, including various UEs 104A, . . . , 104N, which are not further addressed here but which represent devices making demands on the resources provided by the eNodeB 100. The devices served by the eNodeB 102 also include a number of machine type communication (MTC) devices 106A, . . . , 106N. The devices 106A, . . . , 106N may be of various types requiring different communication mechanisms, in particular, different small data sizes, and being allocated different resources by the eNodeB 102. The device 106A may be a seismic sensor, the device 106B may be an anemometer, the device 106C may be a sensor detecting whether a security gate is open or closed, and the device 106D may

an engine sensor reporting the fault status of an engine. The various devices 106A-106D are represented here for convenience as both making and reporting their various measurements and sensed events. It will be recognized, however, that devices such as the devices 106A-106D and others of the devices 106A, . . ., 106N may simply receive and report measurements and events delivered to them by devices with which they communicate, such as through a direct connection.

[0021] For example, the device 106B may be, or may be thought of as, an attachment to an anemometer, receiving and reporting a wind speed measurement made by the anemometer, rather than as part of the anemometer itself. In any event, each of the devices 106A, . . ., 106N send short data transmissions to the eNodeB 102 at unpredictable times, and remains offline during most of the time which it is not transmitting such data.

[0022] In one convenient operation mechanism, the various MTC devices 106A, . . ., 106N use a random access channel (RACH) procedure. Conventionally, a mobile terminal not having a connection with a network will establish a connection by sending a randomly selected preamble on the RACH. The network's normal response to the preamble is to allocate some uplink radio resource to the terminal, on which the terminal then sends a connection request. This connection request is then granted by establishing a connection with the network and only then does the terminal have an opportunity to send any uplink user data. MTC devices such as the devices 106A, . . ., 106N may operate in this fashion, using a preamble that provides an indication of the resources to be allocated to the incoming transmission. Such an indication may be an explicit indication of the resources required, or may simply identify the type of transmission. One of the mechanisms by which MTC devices communicate is offline small data transmission (OSDT), and various characteristics of

an OSDT transmission may be specified as being associated with a particular OSDT type. For example, different MTC devices may differ from one another by the data size of their OSDT communications, and so their OSDT communications may be defined as belonging to different OSDT types. The eNodeB 102 may suitably
5 maintain a list of OSDT types in order to minimize the control signaling required, and each MTC device may store its own OSDT type identifier, such as an OSDT type number.

[0023] In RACH operations, servicing each OSDT transmission type requires a number of random access (RA) sequences. Only a finite number of RA sequences is
10 available in a cell such as the cell 100. In addition, not all of the available RA sequences are allocated to OSDT transmissions. A portion of the available RA space is allocated to normal user equipment (UE) communication, and a portion of the available RA space is allocated to MTC access other than OSDT transmissions. For example, some MTC devices may occupy a channel and communicate over the
15 channel for a relatively extended period in the same manner as other UEs.

[0024] In order to accommodate different OSDT types using transmissions having different characteristics such as different small data sizes, it is advantageous to define a number of different RA sequence groups, with one RA sequence group being assigned to each OSDT type. When an MTC device needs to initiate communication
20 with an eNodeB, it suitably randomly selects a sequence belonging to the RA group assigned to its OSDT type and transmits it to the eNodeB. The eNodeB recognizes the group to which the RA sequence belongs and thus identifies the OSDT type of the MTC device. The eNodeB allocates appropriate radio resources to the MTC device. It is desirable to provide sufficient RA sequences for each OSDT type to minimize the
25 possibility of contention between MTC devices. A number of MTC devices may be

present in a cell such as the cell 100, and may initiate contact with an eNodeB 102 at the same time. The more RA sequences can be allocated to an OSDT type, the smaller the chances of contention between devices.

[0025] As previously noted, an MTC device seeking to initiate contact with the eNodeB 102 randomly selects an RA sequence belonging to the RA group assigned to its OSDT type. Thus, providing a larger number of RA sequences reduces the chance that multiple MTC devices will simultaneously select the same RA sequence.

[0026] When an MTC device seeks to communicate with an eNodeB such as the eNodeB 102, the device sends a first message including an RA sequence. The eNodeB responds by sending an acknowledgement message designating an allocation of radio resources to be used by the device. The allocation of radio resources may, for example, accommodate the message size used by the OSDT type associated with the group to which the RA sequence belongs, and may prescribe parameters of transmission, such as a modulation and coding method to be used. The device sends a third message using the allocated resources.

[0027] If two MTC devices using the same OSDT type seek to initiate contact at the same time, each will randomly choose a sequence from the same group. If the MTC devices choose different sequences, they will be separately recognized by the eNodeB 102 using a mechanism such as CDMA. The eNodeB 102 will allocate radio resources separately to the MTC devices, and they will transmit to the eNodeB in a distinguishable way. However, if two MTC devices choose the same RA sequence, they will both transmit the same RA sequence to the eNodeB, and the eNodeB will respond to the transmission of the RA sequence by allocating resources in response to the transmission and sending an acknowledgement message which will be received and acted on by both MTC devices. Each MTC device will see the

acknowledgement message as directed to itself, and both MTC devices will seek to transmit at the same time using the same resources. Therefore it is desirable to allocate a relatively large number of RA sequences to each RA group, and it is certainly highly desirable that the RA sequences made available by a base station serving a cell be allocated to groups associated with OSDT types used by MTC devices that are actually present in the cell. Allocation of sequences to a group associated with an OSDT type used by devices that are present in a network but not in a particular cell reduces the number of sequences that can be made available to MTC devices.

10 [0028] Therefore, the eNodeB 102 allocates its available RA space among OSDT types for which representative MTC devices are actually present in the cell 100, and changes this allocation as MTC devices enter or leave the cell 100, or otherwise begin to be served or cease being served by the eNodeB 102. The available RA sequences that can be used by an MTC to initiate contact with the eNodeB 102 will therefore
15 change over time because the available RA space will be reallocated among OSDT types as the number of OSDT types in the cell 100 increases or decreases.

[0029] It will be recognized that the discussion of RACH operation and allocation of RA sequences is by way of example only, and does not limit the operation of the invention. The eNodeB 102 suitably includes a transmitter 108, a receiver 110, a
20 radiocontroller 112, and one or more antennas such as the antenna 114. The eNodeB 102 also suitably includes a processor 116, memory 118, and storage 120, communicating with one another and with the radiocontroller over a bus 122. The eNodeB 102 suitably maintains an OSDT communication module 124 and an OSDT type list 126. The OSDT type list 126 suitably stores an identifier, such as an OSDT
25 type number, for each OSDT type, as well as information indicating the RA-sequence

resources allocated to each OSDT type. Such an allocation may be an equal sharing of resources between types, but allocation is not limited to such equal sharing and may be devised in any way desired. Resource allocation may be in terms of the RA group allocated to each OSDT type, and the number of RA sequences allocated to each RA group, but again, such an allocation is exemplary only.

[0030] The device 106A similarly includes a transmitter 128, a receiver 130, a radiocontroller 132, and one or more antennas such as the antenna 134. The device 106A also suitably includes a processor 136, memory 138, and storage 140, communicating with one another and with the radiocontroller over a bus 142. These additional details are not shown for the other devices 106B, . . . , 106N, but they may be configured similarly to the device 106A. The device 106A suitably employs an OSDT communication module 144, used to communicate with the eNodeB 102, and suitably stores an OSDT type identifier 146, which may be received from the eNodeB 102 in a manner detailed below.

[0031] Fig. 2 illustrates a signaling diagram 200, presenting information flow between the eNodeB 102 and an MTC device 106D, whose OSDT transmissions do not belong to any of the OSDT types represented by the MTC devices 106A, . . . , 106N of Fig. 1. The operations portrayed in the diagram 200 may conveniently be thought of as encompassing a first step of initializing a MTC device entering the cell 100, and a second step of updating the devices in the cell 100 and uploading of information from the devices.

[0032] When the MTC device 106D enters the cell 100 or otherwise needs to initiate contact with the eNodeB 102, it presents itself to the eNodeB 102 through an OSDT configuration request. The request suitably includes information indicating desired characteristics of the OSDT communications of the device 106D, such as an OSDT

type request, or an explicit request for the use of characteristics such as a particular data size. The eNodeB 102 examines the request and determines the characteristics that are to be designated for OSDT transmissions for the device 106D. The eNodeB 102 then transmits an OSDT configuration response to the MTC device 106D, specifying the OSDT type granted. Typically, the OSDT type will be associated with a data size, and will be chosen by the eNodeB. The choice of the OSDT type may be based on the request of the MTC device, but may not necessarily conform to the request. For example, the MTC device may request a data size of 6, but may be assigned an OSDT type with a data size of 8. The details may suitably include an OSDT type identifier, such as an OSDT type number. One mechanism for transmitting the OSDT configuration request and the OSDT configuration response is through radio resource control unicast signaling, but it will be recognized that any appropriate signaling mechanism may be used.

[0033] The MTC 106D stores its OSDT type identifier, suitably in persistent storage, so that the type number will be retained after a power-off and power-on cycle. If the OSDT type represented by the MTC 106D is one not currently included in the cell, the eNodeB 102 updates its stored OSDT type list 126. Updating of the OSDT type list 126 may also suitably include updating the allocation of RA-sequence resources to each OSDT type. In particular, updating the OSDT type list may include updating of the RA group associated with each OSDT type and also the RA sequences assigned to each RA group.

[0034] In the second step, the eNodeB 102 periodically broadcasts the OSDT type list 126 to MTC devices in the cell 100, so that after an update occurs, each MTC device will receive an updated list. The updated list indicates an update of the allocation of RA-sequence resources dedicated to each OSDT type. The number of RA sequences

assigned to each RA group may be allocated according to some predetermined mechanism, such as through equal distribution. Thus, the number of RA sequences allocated to each group can be computed simply by dividing the total number of available RA sequences by the number of OSDT types, and the specific sequences assigned to each group might be determined through a predetermined mechanism such as a sequential ordering in the OSDT type list sent from the eNodeB. Thus, the broadcast OSDT type list inherently indicates the detailed RA sequences associated with each OSDT type. Such a procedure reduces the signaling and storage needed. The OSDT type list may be broadcast relatively infrequently, however, such as on a time scale of every 1 to 100 seconds, so that even if relatively detailed information is broadcast, the signaling burden may not be excessive.

[0035] After receiving the OSDT type list, each MTC device updates the resource allocation associated with the OSDT type to which it belongs. When an MTC device such as the device 106D or the devices 106A,...,106N has small data to transmit, it transmits the data to the eNodeB 102 according to the RA sequences associated with its OSDT type.

[0036] One mechanism for allocating RA sequences between OSDT types is to divide the available RA sequences between RA groups and to rank each RA group. Fig. 3 illustrates a diagram 300 showing such an approach. The allocation 302 presents a division of available RA sequences, 256 in this example, between OSDT types A, B, and C, according to the order in the OSDT type list. In this example, in the case of 256 sequences allocated among the groups A, B, and C, type A devices will use the first 85 sequences, type B devices will use the next 85 sequences, and type C devices will use the last 85 sequences, as indicated in the allocation 302.

[0037] The present invention, as noted above, provides mechanisms for detecting a

new OSDT type in a cell and for reallocating RA-sequence resources to accommodate the new OSDT type. Suppose, then, that the MTC device 106D is a device of an OSDT type D not currently included in the cell. When the device 106D enters the cell, the eNodeB 102 will find that it is of a new OSDT type and reallocate the RA sequences, increasing the number of RA groups and allocating sequences between the new number of groups. For example, if type D is placed in order ahead of type C, as illustrated in the allocation 304, the first 64 sequences will be allocated to type A, the next 64 to type B, the next 64 to type D, and the last 64 to type C. This allocation will take effect after the eNodeB 102 has broadcast its updated OSDT type list.

Before the broadcast, the eNodeB 102 may allocate resources based on the allocation 302, that is, between three types.

[0038] When an MTC device has small data to deliver to the eNodeB 102, the device determines its applicable RA group based on its OSDT type identifier, the predefined RA space allocated to OSDT transmission, and the order of its OSDT type in the current OSDT type list. It selects a sequence from its group and initiates an RACH small data process. Upon receiving an RA sequence, the eNodeB 102 identifies the group to which the sequence belongs so that it can determine the small data size associated with the RA sequence, that is, the small data size used by the OSDT type of the device transmitting the sequence. The eNodeB 102 then allocates radio resources for the message according to the determined small data size. Once the message has been received, the eNodeB 102 drops the radio resource control connection and waits for another small data transmission.

[0039] If an MTC device leaves the cell 100, the eNodeB 102 deletes the OSDT type from its OSDT type list if there is no other device present in the cell using the same OSDT type, and a shorter OSDT type list will be used after the OSDT type list is next

broadcast. This has the effect of increasing the size of the RA group allocated to each OSDT type. For example, if the MTC device 106D leaves the cell 100, and is the sole representative of type D, the allocation will change back from the allocation 304 to the allocation 302.

5 [0040] Fig. 4 is a diagram 400 illustrating events taking place upon departure of the device 106D from the cell 100 through handover to another cell. Upon detecting the handover the eNodeB determines whether the device departing the cell is the sole representative of its OSDT type. The device 106D is the sole representative of type D, so the eNodeB 102 updates its OSDT type list and broadcasts it to the MTC
10 devices in the cell according to its broadcast schedule. Each MTC device receiving the broadcast updates its RA-sequence allocation, such as the OSDT RA group allocated to its OSDT type. The MTC devices then perform small data transmission when they have small data to deliver.

[0041] The OSDT type in a cell can also change upon the request of a MTC device,
15 even when it is not going to depart from the cell. Fig. 5 is a diagram 500 illustrating events taking place through explicit deactivation. The MTC device 106D sends an OSDT deactivation request to the eNodeB 102, and the eNodeB sends an OSDT deactivation response to the MTC device 106D. The eNodeB determines whether the being deactivated is the sole representative of its OSDT type. Again, the device
20 106D is the sole representative of type D, so the eNodeB 102 updates its OSDT type list and broadcasts it to the MTC devices in the cell according to its broadcast schedule. Each MTC device receiving the broadcast updates its resource allocation, such as the OSDT RA group allocated to its OSDT type. The MTC devices then perform small data transmission as they have data to deliver.

25 [0042] Various modifications and adaptations to the foregoing exemplary

embodiments of this invention may become apparent to those skilled in the relevant arts in view of the foregoing description. While various exemplary embodiments have been described above it should be appreciated that the practice of the invention is not limited to the exemplary embodiments shown and discussed here.

- 5 [0043] Further, some of the various features of the above non-limiting embodiments may be used to advantage without the corresponding use of other described features. The foregoing description should therefore be considered as merely illustrative of the principles, teachings and exemplary embodiments of this invention, and not in limitation thereof.

What is claimed is:

1. An apparatus, comprising:
at least one processor; and
at least one memory storing a computer program;
5 characterized in that the at least one memory with the computer program is configured with the at least one processor to cause the apparatus to at least:
send a configuration request to a base station;
store an offline small data transmission type identifier indicating an offline
small data transmission type assigned to the apparatus by the base station in response
10 to the configuration request; and
receive an offline small data transmission type list periodically broadcast by
the base station, wherein the list is updated to indicate a new allocation of resources
among offline small data transmission types after a change in the number of offline
small data transmission types being served by the base station.
- 15 2. The apparatus of claim 1, wherein the configuration request comprises
a preamble transmitted over a random access channel.
3. The apparatus of claim 1 or 2, wherein the configuration request
includes a request for a desired allocation of resources by the base station.
4. The apparatus of claim 1 or 2, wherein the new allocation of resources
20 indicated by the offline small data transmission type list received by the apparatus
includes a reallocation of random access sequences among random access sequence
groups.
5. The apparatus of any of claims 1-4, wherein the memory with the
computer program is configured with the at least one processor to further cause the
25 apparatus to conduct small data transmission to the base station using a data size

associated with the stored offline small data transmission type identifier.

6. The apparatus of claim 1, wherein the apparatus is a machine type communication device.

7. An apparatus, comprising:

5 at least one processor; and

at least one memory storing a computer program;

characterized in that in the at least one memory with the computer program is configured with the at least one processor to cause the apparatus to at least:

10 determine if a change has occurred to a number of offline small data communication types requiring service by the apparatus; and

if a change has occurred to the number of offline small data communication types requiring service by the apparatus, reallocate resources among offline small data transmission types.

8. The apparatus of claim 7, wherein the at least one memory with the 15 computer program is further configured with the at least one processor to cause the apparatus to update an offline small data transmission type list maintained by the apparatus.

9. The apparatus of claim 7 or 8, wherein reallocation of resources 20 comprises reallocating random access sequences among random access sequence groups.

10. The apparatus of any of claims 7-9, wherein the at least one memory with the computer program is further configured with the at least one processor to cause the apparatus to periodically broadcast the offline small data transmission type list to devices being served by the apparatus.

25 11. The apparatus of any of claims 7-10, wherein determining if a change

has occurred to the number of offline small data communication types requiring service by the apparatus comprises:

detection of cessation of service to a device by the apparatus; and

determining whether the offline small data transmission type associated with the device to which cessation of service is detected is associated with any devices still requiring service by the apparatus.

12. The apparatus of claim 11, wherein detection of cessation of service to the device comprises detection of handover of the device.

13. The apparatus of claim 11, wherein detection of cessation of service to the device comprises receiving a deactivation request from the device.

14. A method comprising:
sending a configuration request from a device to a base station;
storing an offline small data transmission type identifier indicating an offline small data transmission type assigned to the device by the base station in response to the configuration request; and

characterized by receiving an offline small data transmission type list broadcast by the base station, wherein the list is updated to indicate a new allocation of resources among offline small data transmission types after a change in the number of offline small data transmission type being served by the base station.

15. The method of claim 14, wherein the configuration request comprises a preamble transmitted over a random access channel.

16. The method of claim 14 or 15, wherein the configuration request includes a request for a desired allocation of resources by the base station.

17. The method of any of claims 14-16, wherein the new allocation of resources indicated by the received offline small data transmission type list includes a

reallocation of random access sequences among random access sequence groups.

18. A method comprising:

determining if a change has occurred to a number of offline small data communication types associated with machine type communication devices present in
5 a cell of a wireless communication network; and

characterized by reallocating resources among offline small data transmission types if a change has occurred to the number of offline small data communication types requiring service by the apparatus.

19. The method of claim 18, wherein determining if a change has occurred
10 to a number of offline small data communication types associated with machine type communication devices present in a cell of a wireless communication network comprises:

detecting cessation of service to a device; and

determining whether the offline small data transmission type associated with
15 the device to which cessation of service is detected is associated with any devices still requiring service.

20. The method of claim 19, wherein detection of cessation of service to the device comprises detection of handover of the device.

21. The apparatus of claim 19, wherein detection of cessation of service to
20 the device comprises receiving a deactivation request from the device.

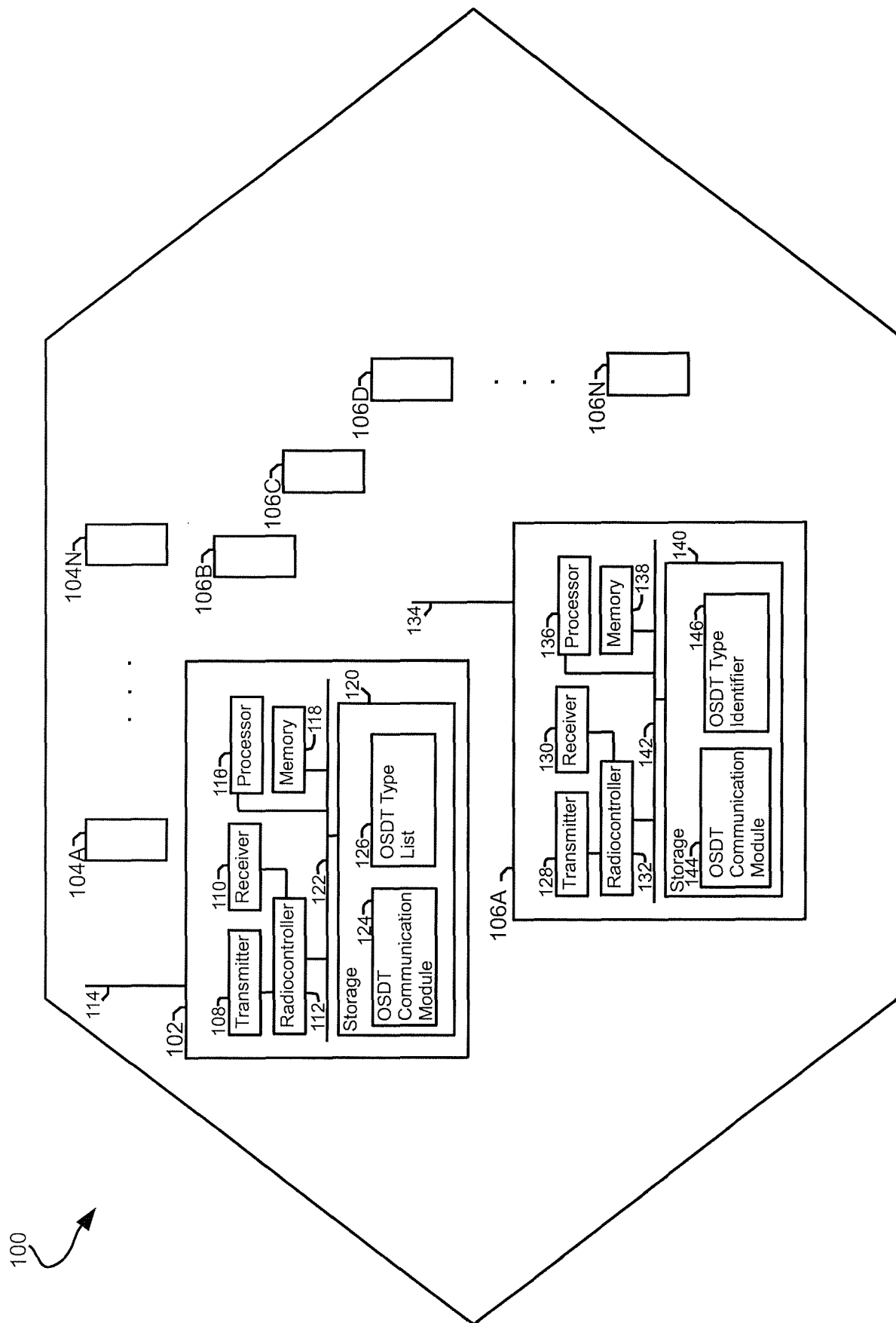


Fig. 1

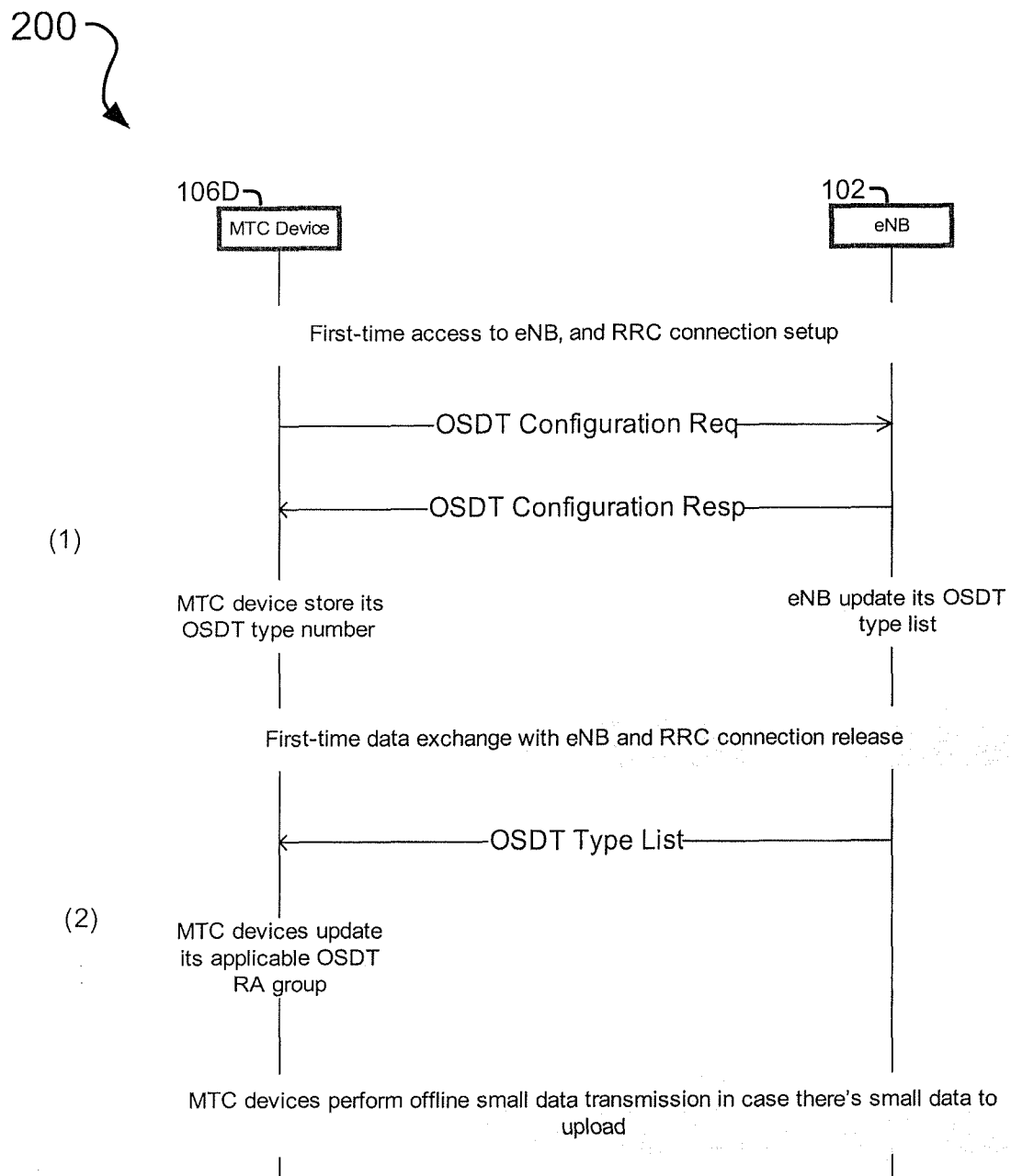


Fig. 2

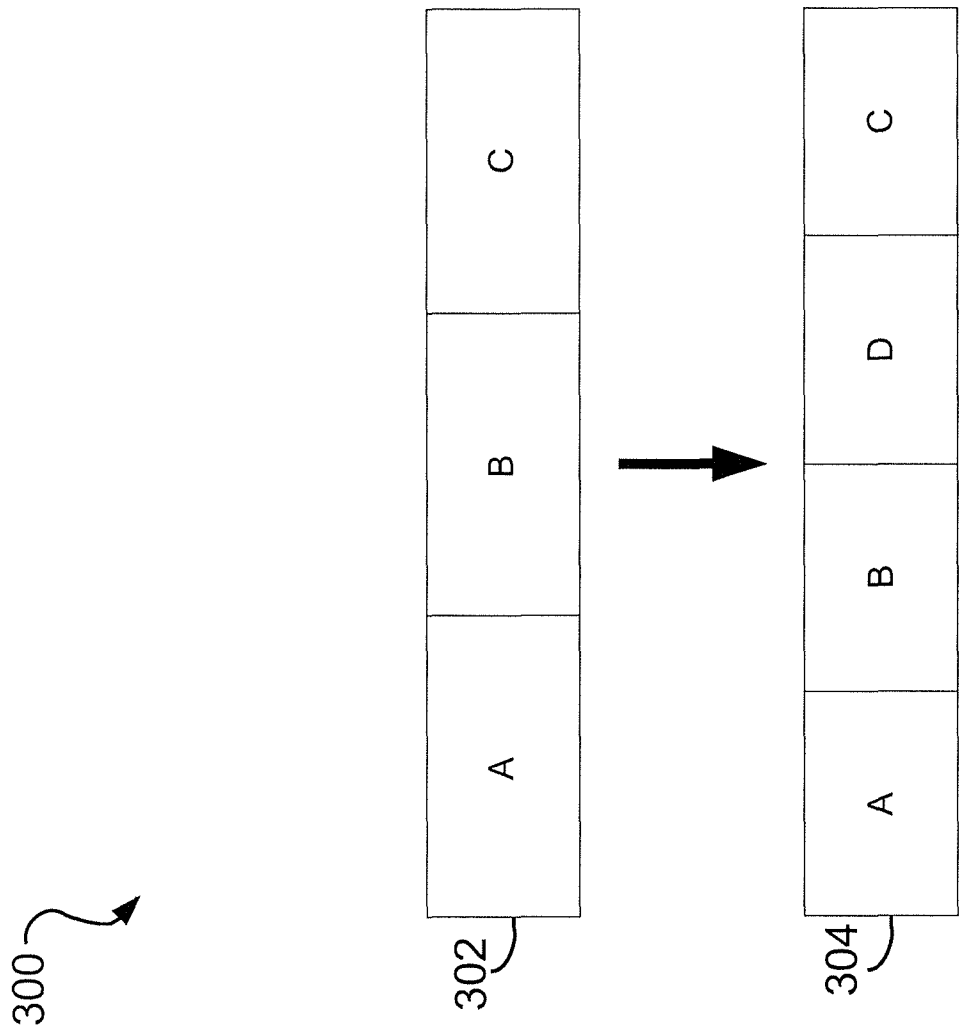


Fig. 3

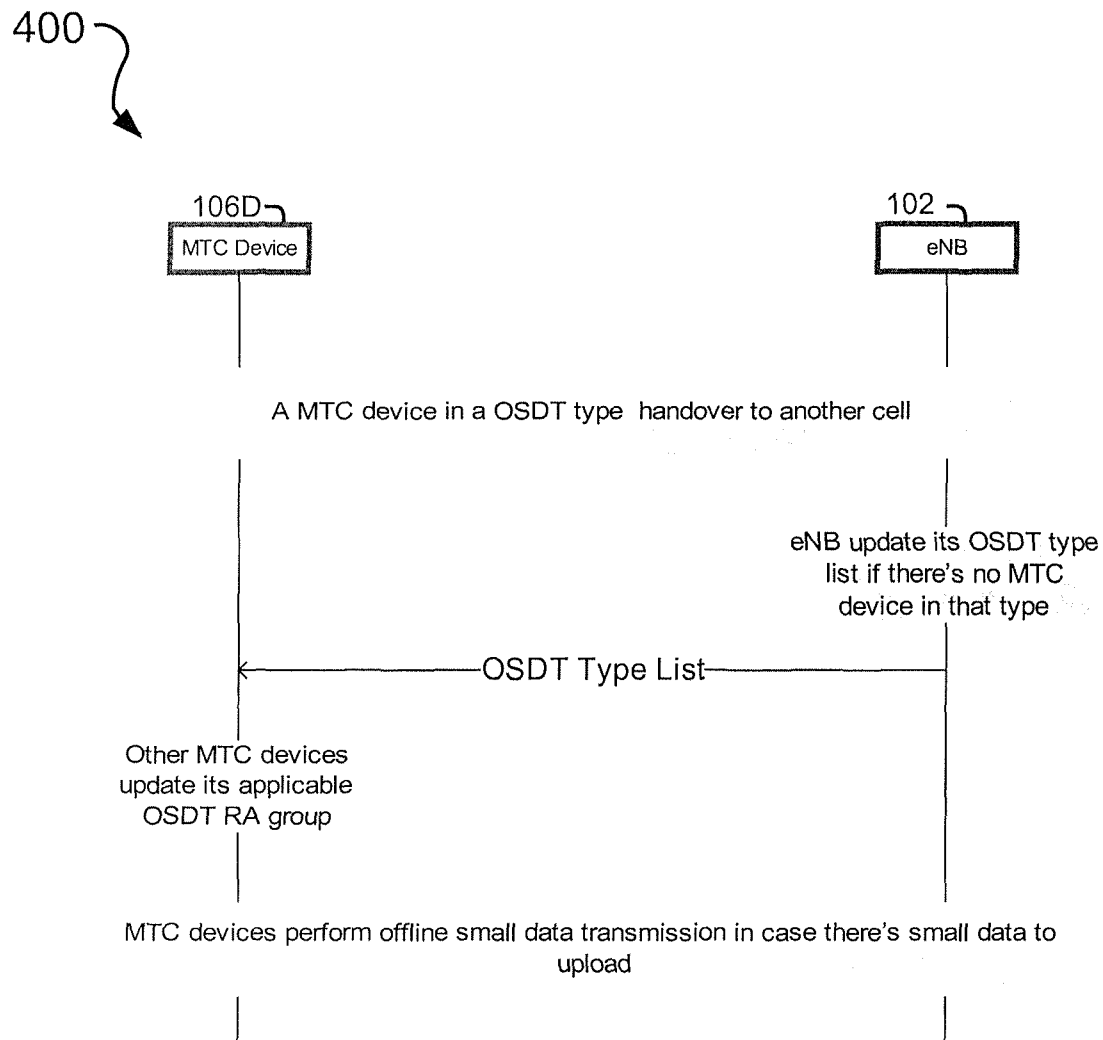


Fig. 4

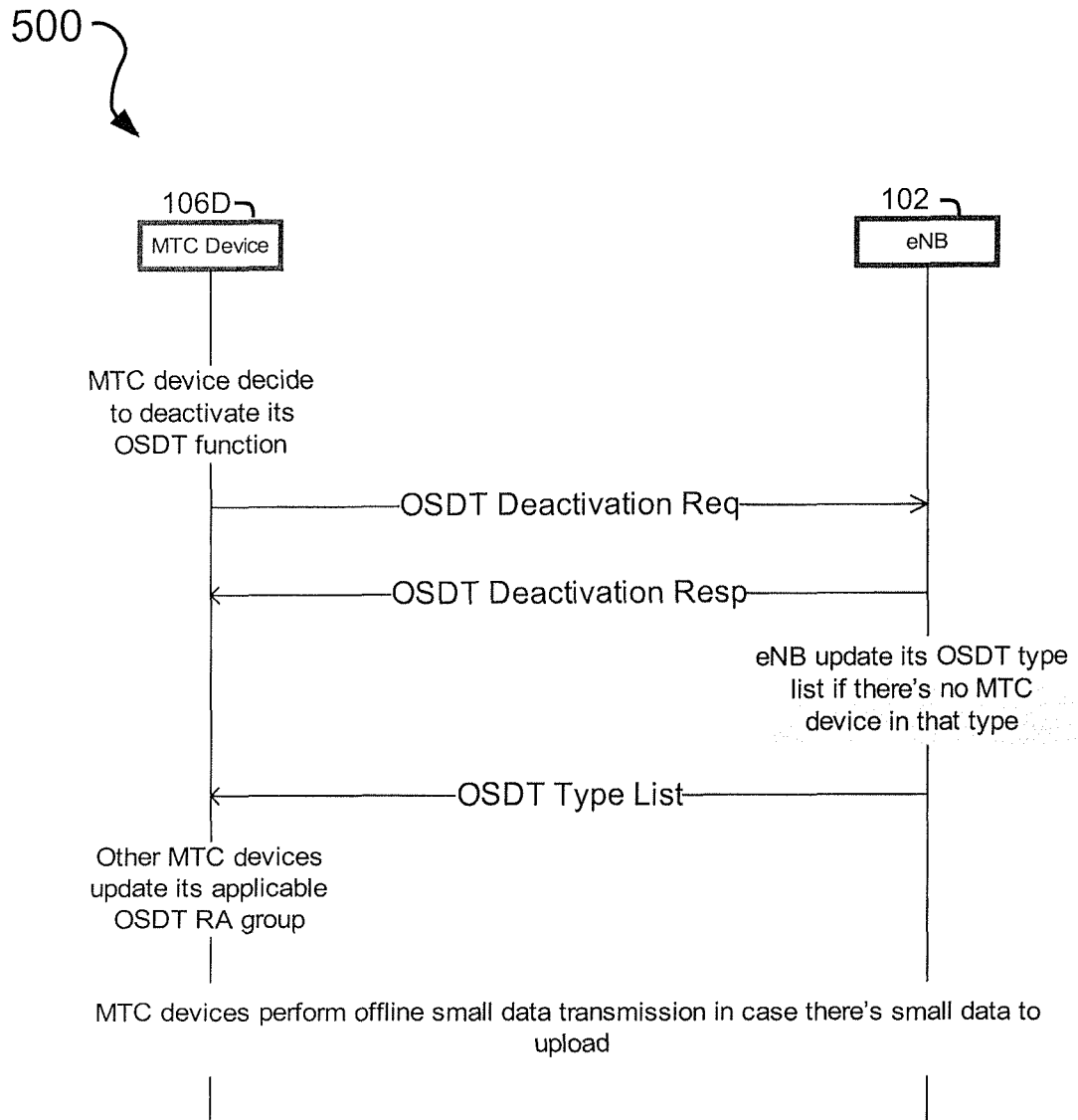


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2011/076020

A. CLASSIFICATION OF SUBJECT MATTER

See the extra sheet

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)

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

IPC: H04Q; H04W

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

CNTXT;CNABS;CPRSABS;USTXT;EPTXT;WOTXT;DWPI;VEN;CNKI: base; station?; basestation?; ???NB?; ??node???; BS; small; transfer+; transmit+; transmiss+; updat+; offline; data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN102088770A(ZTE CORP) 08 Jun. 2011(08.06.2011) the whole document	1-21
A	US2010153088A1(ELECTRONICS & TELECOM RES INST) 17 Jun. 2010(17.06.2010) the whole document	1-21

☐ 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 Mar. 2012(10.03.2012)	Date of mailing of the international search report 29 Mar. 2012 (29.03.2012)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer YANG Haiyang Telephone No. (86-10)62411342

International application No.
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Form PCT/ISA /210 (patent family annex) (July 2009)

INTERNATIONAL SEARCH REPORT

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CLASSIFICATION OF SUBJECT MATTER

H04W 8/22 (2009.01) i

H04W 48/06 (2009.01) i