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(54) **Title**: UPLINK GRANT DETECTION WITH DISCONTINUOUS RECEPTION

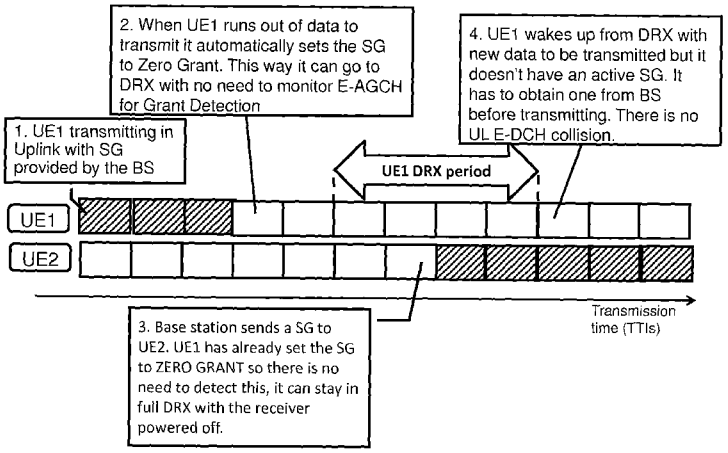


Fig. 2

(57) **Abstract**: It is provided a method, comprising monitoring if a serving grant for a terminal is active, wherein the serving grant is received via a grant channel; making the terminal continue to monitor the grant channel if the serving grant is active, regardless of whether or not the terminal discontinues monitoring a downlink channel different from the grant channel. In addition, it is provided a method, comprising monitoring if there are uplink data to be transmitted by the terminal; setting a serving grant for the terminal to zero-grant or inactive if there are no uplink data to be transmitted by the terminal. In addition, it is provided a method, comprising monitoring if a terminal discontinues monitoring a grant channel, wherein a serving grant is transmitted via the grant channel; setting the serving grant for the terminal to zero-grant or inactive if the terminal discontinues monitoring the grant channel.

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DESCRIPTION

Title:

Uplink grant detection with discontinuous reception

Field of the invention

The present invention relates to an apparatus, a method, and a computer program product related to mobile communication. More particularly, the present invention relates to an apparatus, a method, and a computer program product related to uplink grant detection.

Background of the invention

Abbreviations

3GPP	3rd generation Partnership Project
DRX	Discontinuous Reception
ACK	[positive] Acknowledgement
SG	Serving Grant
TDM	Time Division Multiplexing
HSUPA	High Speed Uplink Packet Access
Node B	base station in 3GPP terminology
UE	User Equipment
RoT	Rise over the Thermal
TTI	Transmission Time Interval
E-AGCH	E-DCH Absolute Grant Channel
HARQ	Hybrid Automatic Repeat Request
RAN	Radio Access Network
WCDMA	Wideband Code Division Multiple Access
HSPA	High Speed Packet Access
E-RGCH	E-DCH Relative Grant Channel
E-ROCH	E-DCH Rank and Offset Channel
BS	Base Station
HS-SCCH	High Speed Shared Control Channel
DL	Downlink
EDGE	Enhanced Datarate for GSM Evolution
eNB	evolved NodeB
GPRS	Global Packet Radio Service
LTE	Long Term Evolution
LTE-A	LTE Advanced
UTRAN	Universal Terrestrial Radio Access Network
WiFi	Wireless Fidelity

Time division multiplexing (TDM) operation in High Speed Uplink Packet Access (HSUPA) is one of the topics considered within the Work Item on Further Enhancements to Enhanced Uplink being held in 3GPP RAN1 [1]. The TDM scheduling refers to a situation in which one

or several selected User Equipment entities (UEs) in a given cell consume most of the Rise over the Thermal (RoT) budget by transmitting with a high data rate for the duration of a scheduling period (which may last from several Transmission Time Intervals (TTIs) to several tens/hundreds of TTIs) while at the same time other UEs either stop their transmission, or their transmission consumes significantly less power resources (low data rate). In the purest form of TDM operation, at any given time only one UE is transmitting data, and the other UEs with active connection are awaiting for their turn to transmit, and typically each transmission duration is allowed to continue only for a short period of time so that the data flows of all active users still appear as simultaneous from the users' perspective.

In the TDM mode the UEs would be scheduled in such a way that they take turns in transmitting the uplink data and their transmission do not interfere with each other. Since it has been proven that uplink TDM operation can bring substantial performance gains in WCDMA/HSPA uplink, several standard changes have been proposed within the Work Item in order to facilitate efficient TDM operation in HSUPA, one of the proposals being proposed by Nokia Solutions and Networks™ (NSN™) [2].

Based on this proposal of NSN, TDM Grant Detection is the working assumption in 3GPP. That is, in the grant detection mode, the HSUPA operates in such a way that the NodeB manages a Serving Grant (SG) of each UE. By the SG of a UE it is controlled which the data rate the UE is allowed to transmit. The SG of a UE is changed with Absolute Grant and Relative Grant commands transmitted on E-AGCH and E-RGCH channels, respectively.

According to the proposal made by NSN, in the grant detection mode, there is no gap between transmissions of two different UEs because the same scheduler command (transmitted on E-AGCH) allowing a new UE to start transmitting is interpreted by the currently active UE to stop transmitting at the same time. Additionally, the signaling overhead of constantly changing the UEs' Serving Grants (SG) controlling the data rate is minimized as only one E-AGCH command is needed to move the permission to transmit from one UE to another one (as opposed to two commands, one telling the currently active UE to stop and another one to tell the next UE to start). This is achieved by UE not only monitoring the E-AGCH channel for SGs addressed to it but also detecting SG transmissions addressed to other UEs in a cell and stopping its transmission automatically upon detection of such a E-AGCH transmission.

NSN also proposed a solution on handling HARQ retransmission in grant detection mode [3].

References:

[1] RP-132078, "New Work Item proposal: Further EUL enhancements", Ericsson, RAN #62.

[2] Patent application PCT/EP2013/059565 "Grant detection for TDM scheduling", Maciej Januszewski, Michał Panek, Karri Ranta-Aho

[3] Patent application PCT/EP2014/055720 "HARQ optimization for TDM mode", Alexey Trushanin, Grigory Serebryakov, Karri Ranta-aho, Maciej Januszewski

Summary of the invention

It is an object of the present invention to improve the prior art.

According to a first aspect of the invention, there is provided an apparatus, comprising serving grant monitoring means adapted to monitor if a serving grant for a terminal is active, wherein the serving grant is received via a grant channel; continuing means adapted to make the terminal continue to monitor the grant channel if the serving grant is active, regardless of whether or not the terminal discontinues monitoring a downlink channel different from the grant channel.

The apparatus may further comprise data monitoring means adapted to monitor if there are uplink data to be transmitted by the terminal; discontinuing means adapted to allow the terminal discontinuing monitoring the downlink channel if there are no data to be transmitted by the terminal.

The discontinuing means may be further adapted to allow the terminal discontinuing monitoring the grant channel if the serving grant is not active and there are no data to be transmitted by the terminal.

According to a second aspect of the invention, there is provided an apparatus, comprising data monitoring means adapted to monitor if there are uplink data to be transmitted by the terminal; setting means adapted to set a serving grant for the terminal to zero-grant or inactive if there are no uplink data to be transmitted by the terminal.

According to a third aspect of the invention, there is provided an apparatus, comprising discontinuation monitoring means adapted to monitor if a terminal discontinues monitoring a grant channel, wherein a serving grant is transmitted via the grant channel; setting means adapted to set the serving grant for the terminal to zero-grant or inactive if the terminal discontinues monitoring the grant channel.

The apparatus may further comprise data monitoring means adapted to monitor if there are uplink data to be transmitted by the terminal; discontinuation means adapted to allow the terminal discontinuing monitoring the grant channel if there are no uplink data to be transmitted by the terminal.

The apparatus according to the second or third aspect may further comprise serving grant monitoring means adapted to monitor if the serving grant for the terminal is active; inhibiting means adapted to inhibit the setting means from setting the serving grant to zero-grant or inactive if the serving grant is not active.

According to a fourth aspect of the invention, there is provided an apparatus, comprising serving grant monitoring circuitry configured to monitor if a serving grant for a terminal is active, wherein the serving grant is received via a grant channel; continuing circuitry configured to make the terminal continue to monitor the grant channel if the serving grant is active, regardless of whether or not the terminal discontinues monitoring a downlink channel different from the grant channel.

The apparatus may further comprise data monitoring circuitry configured to monitor if there are uplink data to be transmitted by the terminal; discontinuing circuitry configured to allow the terminal discontinuing monitoring the downlink channel if there are no data to be transmitted by the terminal.

The discontinuing circuitry may be further configured to allow the terminal discontinuing monitoring the grant channel if the serving grant is not active and there are no data to be transmitted by the terminal.

According to a fifth aspect of the invention, there is provided an apparatus, comprising data monitoring circuitry configured to monitor if there are uplink data to be transmitted by the

terminal; setting circuitry configured to set a serving grant for the terminal to zero-grant or inactive if there are no uplink data to be transmitted by the terminal.

According to a sixth aspect of the invention, there is provided an apparatus, comprising discontinuation monitoring circuitry configured to monitor if a terminal discontinues monitoring a grant channel, wherein a serving grant is transmitted via the grant channel; setting circuitry configured to set the serving grant for the terminal to zero-grant or inactive if the terminal discontinues monitoring the grant channel.

The apparatus may further comprise data monitoring circuitry configured to monitor if there are uplink data to be transmitted by the terminal; discontinuation circuitry configured to allow the terminal discontinuing monitoring the grant channel if there are no uplink data to be transmitted by the terminal.

The apparatus according to the fifth or sixth aspect may further comprise serving grant monitoring circuitry configured to monitor if the serving grant for the terminal is active; inhibiting circuitry configured to inhibit the setting circuitry from setting the serving grant to zero-grant or inactive if the serving grant is not active.

The apparatus according to any of the first to sixth aspects may comprise the terminal.

According to a seventh aspect of the invention, there is provided a method, comprising monitoring if a serving grant for a terminal is active, wherein the serving grant is received via a grant channel; making the terminal continue to monitor the grant channel if the serving grant is active, regardless of whether or not the terminal discontinues monitoring a downlink channel different from the grant channel.

The method may further comprise monitoring if there are uplink data to be transmitted by the terminal; allowing the terminal discontinuing monitoring the downlink channel if there are no data to be transmitted by the terminal.

The method may further comprise allowing the terminal discontinuing monitoring the grant channel if the serving grant is not active and there are no data to be transmitted by the terminal.

According to an eighth aspect of the invention, there is provided a method, comprising monitoring if there are uplink data to be transmitted by the terminal; setting a serving grant for the terminal to zero-grant or inactive if there are no uplink data to be transmitted by the terminal.

According to a ninth aspect of the invention, there is provided a method, comprising monitoring if a terminal discontinues monitoring a grant channel, wherein a serving grant is transmitted via the grant channel; setting the serving grant for the terminal to zero-grant or inactive if the terminal discontinues monitoring the grant channel.

The method may further comprise monitoring if there are uplink data to be transmitted by the terminal; allowing the terminal discontinuing monitoring the grant channel if there are no uplink data to be transmitted by the terminal.

The method according to any of the eights and ninth aspects may further comprise monitoring if the serving grant for the terminal is active; inhibiting the setting of the serving grant to zero-grant or inactive if the serving grant is not active.

The method of each of the seventh to ninth aspects may be a method of uplink grant detection.

According to a tenth aspect, there is provided a computer program product comprising a set of instructions which, when executed on an apparatus, is configured to cause the apparatus to carry out the method according to any one of the seventh to ninth aspects. The computer program product may be embodied as a computer-readable medium or directly loadable into a computer.

According to some embodiments of the invention, at least one of the following advantages may be achieved: A UE may be enabled to operate in DRX mode even in case of TDM grant detection mode. Thus, the DRX battery savings may be achieved while the performance gain of TDM grant detection mode is at least maintained. TDM performance may even be improved. Potentially the base station need not to be modified due to the interworking.

It is to be understood that any of the above modifications can be applied singly or in combination to the respective aspects to which they refer, unless they are explicitly stated as excluding alternatives.

Brief description of the drawings

Further details, features, objects, and advantages are apparent from the following detailed description of the preferred embodiments of the present invention which is to be taken in conjunction with the appended drawings, wherein

Fig. 1 illustrates a problem arising from the coexistence of grant detection and DRX on a UE according to the prior art;
Fig. 2 illustrates a first solution to the coexistence problem according to an embodiment of the invention;
Fig. 3 shows an apparatus according to an embodiment of the invention;
Fig. 4 shows a method according to an embodiment of the invention;
Fig. 5 illustrates a second solution to the coexistence problem according to an embodiment of the invention;
Fig. 6 shows an apparatus according to an embodiment of the invention;
Fig. 7 shows a method according to an embodiment of the invention;
Fig. 8 shows an apparatus according to an embodiment of the invention;
Fig. 9 shows a method according to an embodiment of the invention; and
Fig. 10 shows an apparatus according to an embodiment of the invention.

Detailed description of certain embodiments

Herein below, certain embodiments of the present invention are described in detail with reference to the accompanying drawings, wherein the features of the embodiments can be freely combined with each other unless otherwise described. However, it is to be expressly understood that the description of certain embodiments is given for by way of example only, and that it is by no way intended to be understood as limiting the invention to the disclosed details.

Moreover, it is to be understood that the apparatus is configured to perform the corresponding method, although in some cases only the apparatus or only the method are described.

The interworking of UE DRX and grant detection mode operation by the UE DRX needs to be designed. If UE DRX is implemented the UE may periodically shut down its receiver and save battery power. However, in this case, it cannot monitor if on the E-AGCH a serving grant is issued to another UE.

When a UE goes to DRX it stops monitoring the DL (including the DL control channels) from the base station to the UE in order to save battery. In case of grant detection mode, if a UE has a Serving Grant (active Serving Grant that allows it to transmit data in the uplink) and then goes to DRX it could miss the E-AGCH transmission addressed to a different UE from the same cell (it does not perform the "grant detection" within the meaning explained hereinabove). Accordingly, this UE retains its Serving Grant while, according to the Grant Detection principle according to NSN's proposal, it should detect the E-AGCH transmission delivering a Serving Grant to another UE, and set its own SG to ZERO_GRANT or inactive. Notably, while the UE is transmitting data in the uplink it cannot DRX its downlink due to the need to receive power control and HARQ feedback in the downlink, but when it stops transmitting data in the uplink it may start DRXing (i.e. go into the DRX mode) the downlink too. Hence the problem may occur when the UE runs out of data to transmit while having an active Serving Grant.

In this case, the UE not being aware that another UE has been scheduled could severely interfere the transmission of the other UE after waking up from DRX with new data to be transmitted in the uplink because the Node B scheduler scheduling the transmission of the other UE assumes that the active grant of the present UE is no longer valid, as it assumes that the grant sent to the other UE caused this UE to revert to Zero_Grant, but due to DRX this UE did not detect the grant sent to this other UE. In TDM operation, both transmissions are likely to be performed with a high Serving Grant value (high data rate), thus the collision is likely to make both transmissions unsuccessful. Additionally, such an erratic behavior would negatively impact the RoT stability and thus decrease the performance in the cell, and potentially in the neighboring cells as well. The described problem is illustrated in Fig. 1.

Fig. 1 shows two UEs (UE1 and UE2) of the same cell and their transmission behavior over several transmission time intervals. In the beginning (step 1), UE1 has an active grant and transmits data (illustrated by hashed TTIs in Figs. 1 to 3), whereas UE2 is not transmitting (illustrated by white TTIs in Figs. 1 to 3). After some TTIs (e.g. 3 TTIs, as illustrated), UE1 does not have new data to be transmitted. After a certain period of no transmission in the uplink (e.g. 2 TTIs, as illustrated), UE1 starts discontinuous reception (DRX) in the downlink in order to save battery power (step 2).

While UE1 is in DRX mode, the base station sends a SG to UE2 (step 3). Then UE2 starts transmitting data.

Since UE1 is in DRX mode, it does not detect the SG for UE2. Accordingly, UE1 still assumes that it has an active grant. Accordingly, when there are new data to be transmitted by UE1, UE1 wakes up from DRX (i.e. starts again monitoring downlink channels) and transmits its data in the uplink (step 4). As may be seen from Fig. 1, both UE1 and UE2 transmit simultaneously such that these transmissions are likely to interfere rather strongly.

This document proposes two solutions which solve this issue and further improve Grant Detection mechanism in order to provide better TDM performance.

Fig. 2 shows a first solution to this coexistence issue according to an embodiment of the invention.

According to the first solution, UE1 continues to monitor the E-AGCH for grant detection even if it is in DRX. That is, E-AGCH is monitored, regardless of whether or not the UE1 has discontinued monitoring one, some, or all downlink channels different from E-AGCH (DRX mode). Thus, UE1 observes that an active grant is issued to UE2 (step 3). Accordingly, UE1 sets its active grant to zero-grant or inactive when the active grant is issued to UE2. In some embodiments, UE1 would only be allowed to fully DRX its downlink when its grant does not allow it to transmit any data.

When UE1 is ready to wake up because it has new data to transmit, it knows that it does not have an active grant. Accordingly, it does not transmit data (step 4) until it is scheduled to do so by the base station. Thus, interference between transmissions of UE1 and UE2 as according to Fig. 1 is avoided.

Fig. 3 shows an apparatus according to an embodiment of the invention. The apparatus may be a terminal such as a user equipment, or an element thereof. Fig. 4 shows a method according to an embodiment of the invention. The apparatus according to Fig. 3 may perform the method of Fig. 4 but is not limited to this method. The method of Fig. 4 may be performed by the apparatus of Fig. 3 but is not limited to being performed by this apparatus.

The apparatus comprises serving grant monitoring means 10, and continuing means 20.

The serving grant monitoring means 10 monitors if a serving grant for a terminal is active (S10). The serving grant is received by the terminal via a grant channel such as E-AGCH.

The continuing means 20 makes the terminal continue to monitor the grant channel if the serving grant is active (i.e. not Inactive or Zero_Grant) (S20). In particular, it makes the terminal continue to monitor the grant channel not only in normal mode (i.e. when UE is not in DRX mode) but even in DRX mode, too. That is, the continuing means 20 takes care that the terminal continues to monitor the grant channel regardless of whether or not the terminal discontinues monitoring one, some, or all downlink channels different from the grant channel. A downlink channel is a channel to transmit from the base station to the terminal.

The first solution assures that both features (TDM and DRX) can work simultaneously without negative effects thanks to effectively limiting transition into the DRX mode for the E-AGCH to periods when a UE doesn't have an active Serving Grant. The UE can still perform a legacy DRX on other DL control channels to save battery power by not having to decode those.

The implementation in the 3GPP standard for the first solution would be an additional condition (added text highlighted in *italics*) in the grant monitoring part of TS25.214:

1. The UE shall monitor E-AGCH and E-ROCH transmission from the serving E-DCH cell in the following cases:
    - If UE_DRX_Grant_Monitoring is TRUE and the E-AGCH/E-ROCH subframe (in case of a 2ms TTI) or E-AGCH frame (in case of a 10ms TTI) overlaps with the start of an HS-SCCH reception subframe as defined in the HS-SCCH reception pattern,

- When conditions defined in subclause 11.8.1.8 of [9] are fulfilled.
- *When the UE is in E-AGCH_Grant_Detection_Mode and its SG is not equal to Zero_Grant or Inactive*

Fig. 5 shows a second solution to the coexistence issue illustrated in Fig. 1 according to an embodiment of the invention.

According to the second solution, UE1 sets its grant to zero-grant or inactive, when it does not have data to transmit (step 2). Thus, there is no need to monitor E-AGCH when UE1 goes into DRX. That is, when UE1 is ready to wake because it has again data to transmit, it does not have an active SG and has to wait until it is scheduled by the base station for transmission. In detail, since the uplink transmission may wake up the downlink from DRX, and since the uplink transmission does not start because the UE has no grant, UE does not wake up from DL DRX yet. Thus, UE1 does not transmit simultaneously with UE2 such that interference as according to Fig. 1 does not occur.

Fig. 6 shows an apparatus according to an embodiment of the invention. The apparatus may be a terminal such as a user equipment, or an element thereof. Fig. 7 shows a method according to an embodiment of the invention. The apparatus according to Fig. 6 may perform the method of Fig. 7 but is not limited to this method. The method of Fig. 7 may be performed by the apparatus of Fig. 6 but is not limited to being performed by this apparatus.

The apparatus comprises data monitoring means 110 and setting means 120.

The data monitoring means 110 monitors if there are uplink data to be transmitted by a terminal (S110).

If there are no uplink data to be transmitted by the terminal (S110: “no”), the setting means 120 sets the serving grant for the terminal to zero (zero_grant) or inactive (S120).

In embodiments of the second solution, the UE is allowed to go into DRX mode when it sets its serving grant to zero_grant or inactive. I.e., in some embodiments of the second solution, the UE is not allowed to go into DRX mode (inhibited from going into DRX mode) while its serving grant is zero_grant or inactive, and allowed to go into DRX mode (not inhibited from going into DRX mode) when its serving grant is zero_grant or inactive.

The terminal discontinues monitoring the downlink channel(s) (goes into DRX mode) if there are no data to be transmitted by the terminal. Therefore, according to a variant of the second solution, which is another embodiment of the invention, the condition to set the grant of the UE to zero_grant or inactive is that the terminal go into DRX mode.

The second solution makes the UE set the SG to zero (zero-grant or inactive) automatically after running out of data. This way a UE has more opportunities for doing DRX as it does not have to count on the Base Station to provide a Zero Grant in time. At the same time the risk of UE waking up from the DRX not being aware that its Serving Grant is "cancelled" (not active anymore) and starting data transmission interfering with other transmissions is eliminated.

The implementation in the 3GPP standard for solution 2) would be an additional condition somewhere in the Serving Grant Update section 11.8.1.3 of TS25.321 stating that if the UE is in E-AGCH_Grant_Detection_Mode and it has no more data in the buffer it will set its Serving Grant to Zero_Grant. E.g. (added parts in *italics*):

> *1> if the UE is in E-AGCH_Grant_Detection_Mode and it has no more data to transmit in the buffer:*
> *2> set Serving_Grant to Zero_Grant.*

In some cases, monitoring if the terminal is in DRX mode may be easier and less power consuming than monitoring if data are available for transmission. On the other hand, typically, as shown in Figs. 1 to 3, the terminal goes into the DRX mode only some time after no data are available for transmission. Therefore, earlier setting of the grant to zero_grant or inactive might be favorable from a cell's performance point of view.

Fig. 8 shows an apparatus according to an embodiment of the invention. The apparatus may be a terminal such as a user equipment, or an element thereof. Fig. 9 shows a method according to an embodiment of the invention. The apparatus according to Fig. 8 may perform the method of Fig. 9 but is not limited to this method. The method of Fig. 9 may be performed by the apparatus of Fig. 8 but is not limited to being performed by this apparatus.

The apparatus comprises discontinuation monitoring means 210 and setting means 220.

The discontinuation monitoring means 210 monitors if the terminal discontinues monitoring a grant channel (S210). I.e., the discontinuation monitoring means 210 monitors if the terminal goes into a DRX mode. A serving grant is received by the terminal via the grant channel, such as E-AGCH.

If the terminal discontinues monitoring the grant channel (i.e. goes into the DRX mode; S210: "yes"), the setting means 220 sets the serving grant for the terminal to zero-grant or inactive (S220).

I.e., in embodiments of the variant, the UE is allowed to go into the DRX mode even if its serving grant is active. However, when the UE goes into DRX mode, it has to set its serving grant to zero_grant or inactive. In general, this setting to zero_grant or inactive should be done immediately but at least prior to the first opportunity of the UE to transmit uplink data with an active serving grant again.

In some embodiments, the setting means 120 or 220, respectively, sets the serving grant to zero_grant or inactive only if the serving grant is active before, i.e. only if there is a need to modify the serving grant.

Fig. 10 shows an apparatus according to an embodiment of the invention. The apparatus comprises at least one processor 310, at least one memory 320 including computer program code, and the at least one processor, with the at least one memory and the computer program code, being arranged to cause the apparatus to at least perform at least one of the methods according to Figs. 4, 7, and 9.

In general, whether or not the UE really goes into DRX mode when it is allowed to go into the DRX mode may depend on other reasons, too. In some embodiments, allowing the UE to go into DRX mode may make the UE go into DRX mode.

Typically, in a DRX mode, a UE discontinues monitoring all downlink channels. However, according to embodiments of the invention, in the DRX mode, the terminal may continue to monitor one or some of the downlink channels, as long as it discontinues monitoring of at least one downlink channel which is otherwise monitored under the same conditions (apart from the condition triggering the transition into DRX mode such as no data to be transmitted).

Typically, a terminal goes into DRX mode if it does not have data to transmit and it has not received any data in the downlink in the recent past. However, embodiments of the invention are not restricted to this reason of going into the DRX mode. Embodiments of the invention may be applied regardless of the reason for going into the DRX mode.

Embodiments of the invention may be employed in a LTE-A network. They may be employed also in other mobile networks such as CDMA, EDGE, LTE, UTRAN, WiFi networks, etc, where DRX is implemented.

A terminal may be a user equipment such as a mobile phone, a smart phone, a PDA, a laptop, a tablet PC, or any other device which may be connected to the respective mobile network.

One piece of information may be transmitted in one or plural messages from one entity to another entity. Each of these messages may comprise further (different) pieces of information.

Names of network elements, protocols, and methods are based on current standards. In other versions or other technologies, the names of these network elements and/or protocols and/or methods may be different, as long as they provide a corresponding functionality.

If not otherwise stated or otherwise made clear from the context, the statement that two entities are different means that they perform different functions. It does not necessarily mean that they are based on different hardware. That is, each of the entities described in the present description may be based on a different hardware, or some or all of the entities may be based on the same hardware. It does not necessarily mean that they are based on different software. That is, each of the entities described in the present description may be based on different software, or some or all of the entities may be based on the same software.

According to the above description, it should thus be apparent that exemplary embodiments of the present invention provide, for example a terminal, e.g. a user equipment, or a component thereof, an apparatus embodying the same, a method for controlling and/or

operating the same, and computer program(s) controlling and/or operating the same as well as mediums carrying such computer program(s) and forming computer program product(s).

Implementations of any of the above described blocks, apparatuses, systems, techniques or methods include, as non limiting examples, implementations as hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

It is to be understood that what is described above is what is presently considered the preferred embodiments of the present invention. However, it should be noted that the description of the preferred embodiments is given by way of example only and that various modifications may be made without departing from the scope of the invention as defined by the appended claims.

Claims

1. Apparatus, comprising

serving grant monitoring means adapted to monitor if a serving grant for a terminal is active, wherein the serving grant is received via a grant channel;

continuing means adapted to make the terminal continue to monitor the grant channel if the serving grant is active, regardless of whether or not the terminal discontinues monitoring a downlink channel different from the grant channel.

2. The apparatus according to claim 1, further comprising

data monitoring means adapted to monitor if there are uplink data to be transmitted by the terminal;

discontinuing means adapted to allow the terminal discontinuing monitoring the downlink channel if there are no data to be transmitted by the terminal.

3. The apparatus according to claim 2, wherein

the discontinuing means is further adapted to allow the terminal discontinuing monitoring the grant channel if the serving grant is not active and there are no data to be transmitted by the terminal.

4. Apparatus, comprising

data monitoring means adapted to monitor if there are uplink data to be transmitted by the terminal;

setting means adapted to set a serving grant for the terminal to zero-grant or inactive if there are no uplink data to be transmitted by the terminal.

5. Apparatus, comprising

discontinuation monitoring means adapted to monitor if a terminal discontinues monitoring a grant channel, wherein a serving grant is transmitted via the grant channel;

setting means adapted to set the serving grant for the terminal to zero-grant or inactive if the terminal discontinues monitoring the grant channel.

6. The apparatus according to claim 5, further comprising

data monitoring means adapted to monitor if there are uplink data to be transmitted by the terminal;

discontinuation means adapted to allow the terminal discontinuing monitoring the grant channel if there are no uplink data to be transmitted by the terminal.

7. The apparatus according to any of claims 4 to 6, further comprising

serving grant monitoring means adapted to monitor if the serving grant for the terminal is active;

inhibiting means adapted to inhibit the setting means from setting the serving grant to zero-grant or inactive if the serving grant is not active.

8. The apparatus according to any of claims 1 to 7, wherein the apparatus comprises the terminal.

9. Method, comprising

monitoring if a serving grant for a terminal is active, wherein the serving grant is received via a grant channel;

making the terminal continue to monitor the grant channel if the serving grant is active, regardless of whether or not the terminal discontinues monitoring a downlink channel different from the grant channel.

10. The method according to claim 9, further comprising

monitoring if there are uplink data to be transmitted by the terminal;

allowing the terminal discontinuing monitoring the downlink channel if there are no data to be transmitted by the terminal.

11. The method according to claim 10, further comprising

allowing the terminal discontinuing monitoring the grant channel if the serving grant is not active and there are no data to be transmitted by the terminal.

12. Method, comprising

monitoring if there are uplink data to be transmitted by the terminal;

setting a serving grant for the terminal to zero-grant or inactive if there are no uplink data to be transmitted by the terminal.

13. Method, comprising

monitoring if a terminal discontinues monitoring a grant channel, wherein a serving grant is transmitted via the grant channel;

setting the serving grant for the terminal to zero-grant or inactive if the terminal discontinues monitoring the grant channel.

14. The method according to claim 13, further comprising

monitoring if there are uplink data to be transmitted by the terminal;

allowing the terminal discontinuing monitoring the grant channel if there are no uplink data to be transmitted by the terminal.

15. The method according to any of claims 12 to 14, further comprising

monitoring if the serving grant for the terminal is active;

inhibiting the setting of the serving grant to zero-grant or inactive if the serving grant is not active.

16. A computer program product comprising a set of instructions which, when executed on an apparatus, is configured to cause the apparatus to carry out the method according to any one of claims 9 to 15.

17. The computer program product according to claim 16, embodied as a computer-readable medium or directly loadable into a computer.

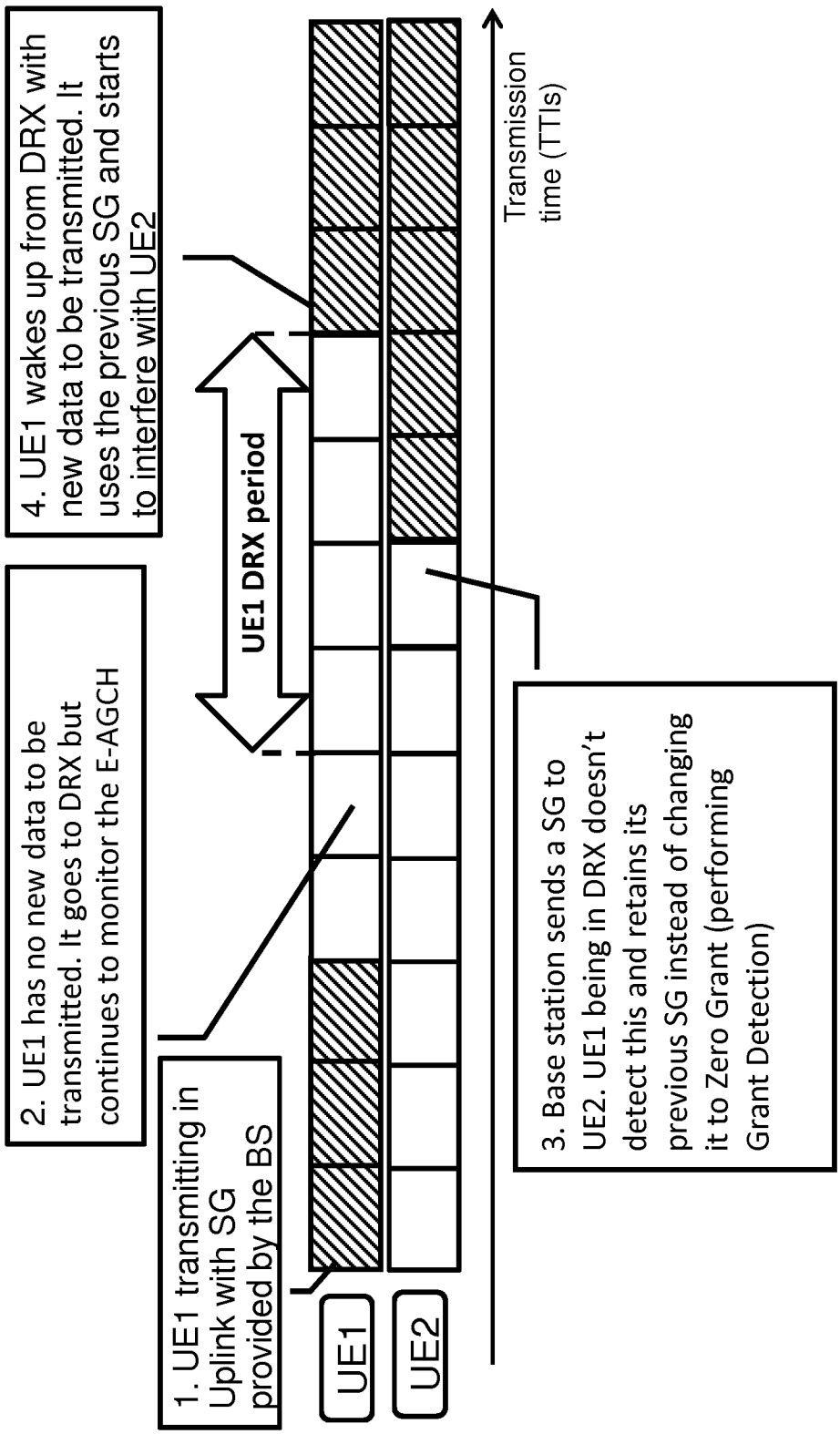

1. UE1 transmitting in Uplink with SG provided by the BS
2. UE1 has no new data to be transmitted. It goes to DRX but continues to monitor the E-AGCH
3. Base station sends a SG to UE2. UE1 being in DRX doesn't detect this and retains its previous SG instead of changing it to Zero Grant (performing Grant Detection)
4. UE1 wakes up from DRX with new data to be transmitted. It uses the previous SG and starts to interfere with UE2
UE1 DRX period
UE1
UE2
Transmission time (TTIs)

Fig. 1

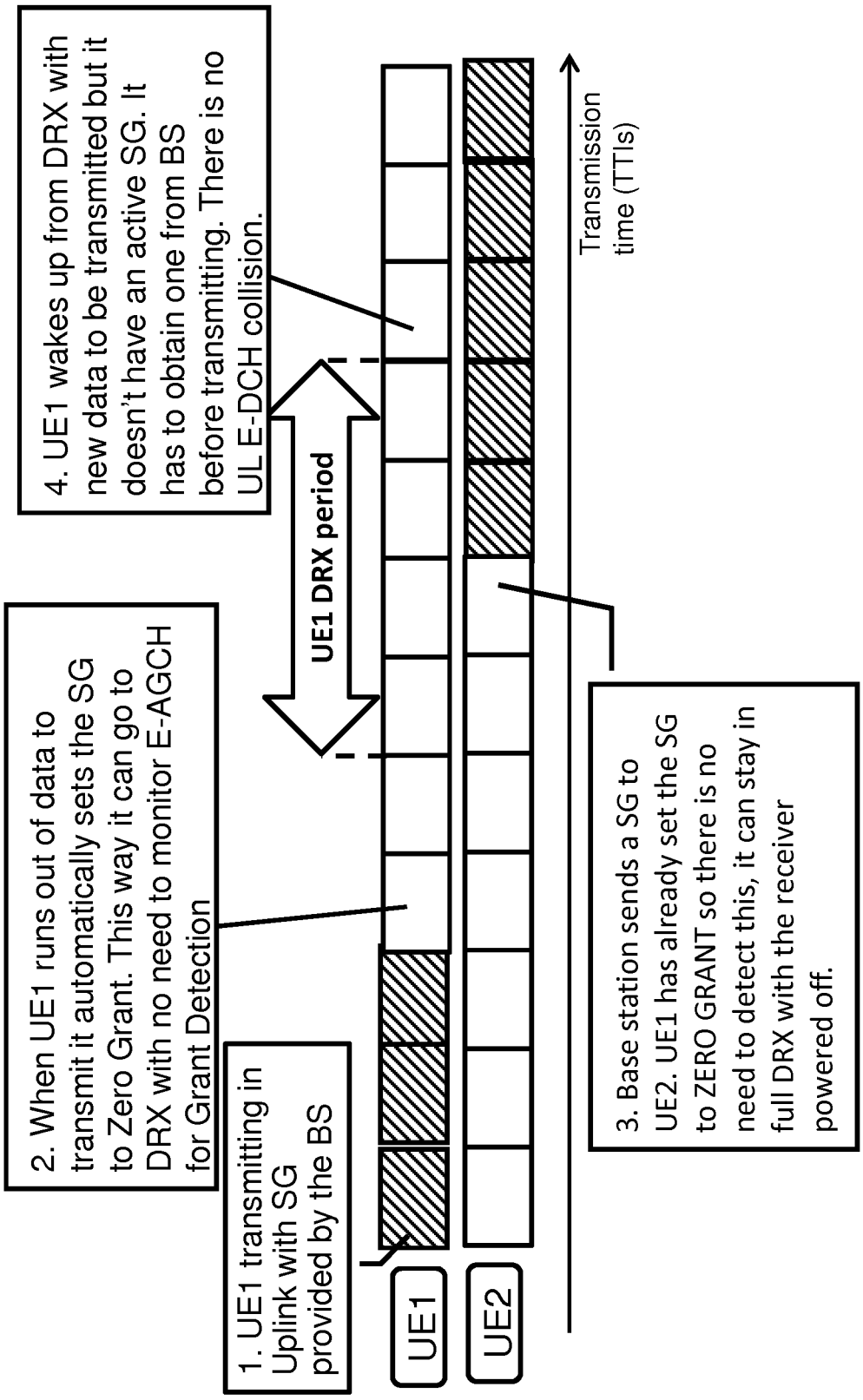

4. UE1 wakes up from DRX with new data to be transmitted but it doesn't have an active SG. It has to obtain one from BS before transmitting. There is no UL E-DCH collision.
2. When UE1 runs out of data to transmit it automatically sets the SG to Zero Grant. This way it can go to DRX with no need to monitor E-AGCH for Grant Detection
UE1 DRX period
Transmission time (TTIs)
1. UE1 transmitting in Uplink with SG provided by the BS
UE1
UE2
3. Base station sends a SG to UE2. UE1 has already set the SG to ZERO GRANT so there is no need to detect this, it can stay in full DRX with the receiver powered off.

Fig. 2

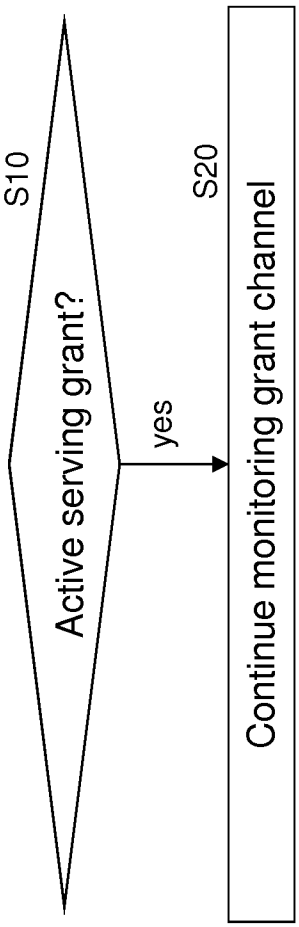

S10
Active serving grant?
yes
S20
Continue monitoring grant channel

Fig. 4

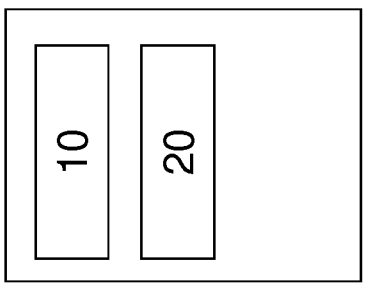

10
20

Fig. 3

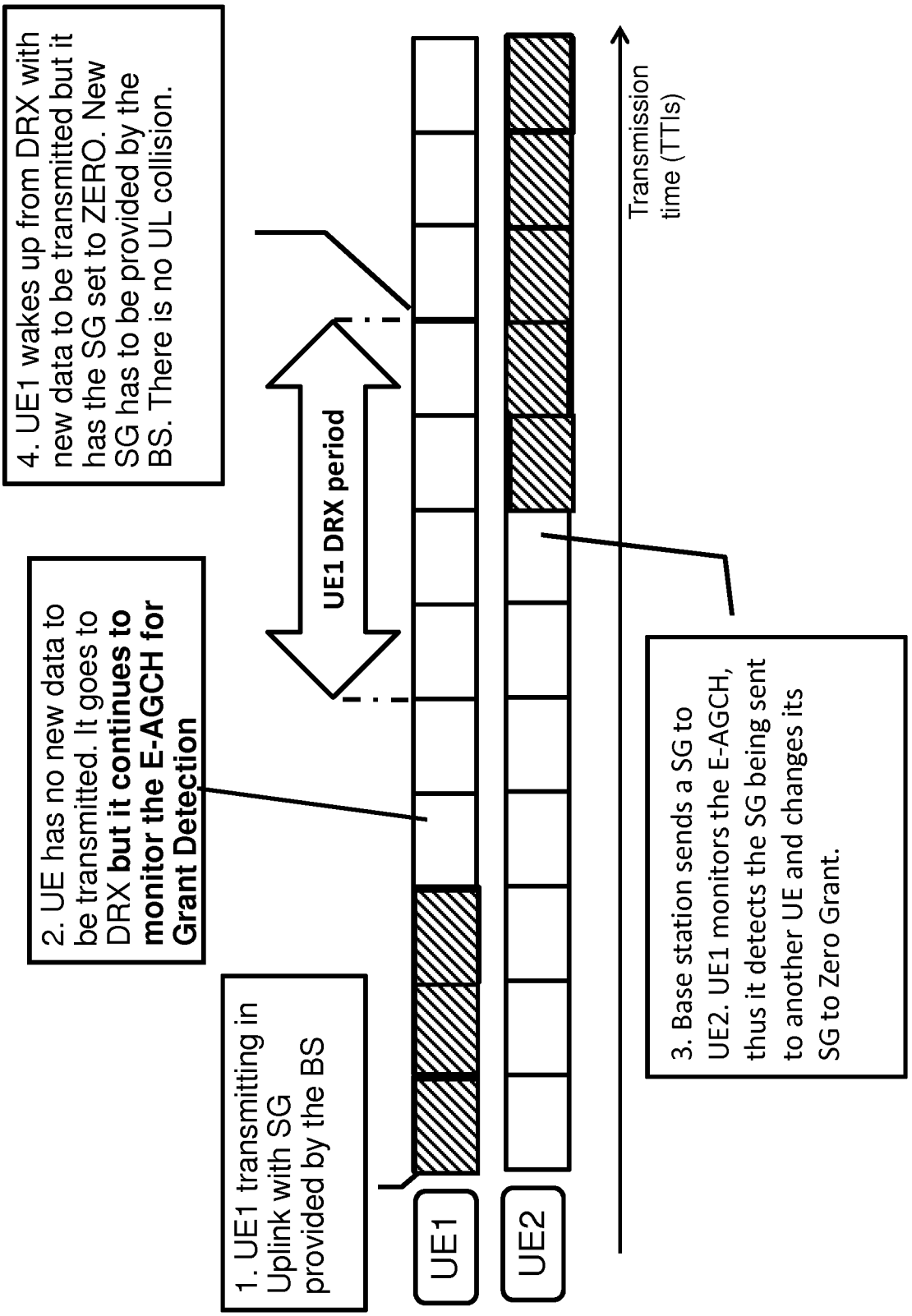

4. UE1 wakes up from DRX with new data to be transmitted but it has the SG set to ZERO. New SG has to be provided by the BS. There is no UL collision.
2. UE has no new data to be transmitted. It goes to DRX **but it continues to monitor the E-AGCH for Grant Detection**
UE1 DRX period
Transmission time (TTIs)
1. UE1 transmitting in Uplink with SG provided by the BS
UE1
UE2
3. Base station sends a SG to UE2. UE1 monitors the E-AGCH, thus it detects the SG being sent to another UE and changes its SG to Zero Grant.

Fig. 5

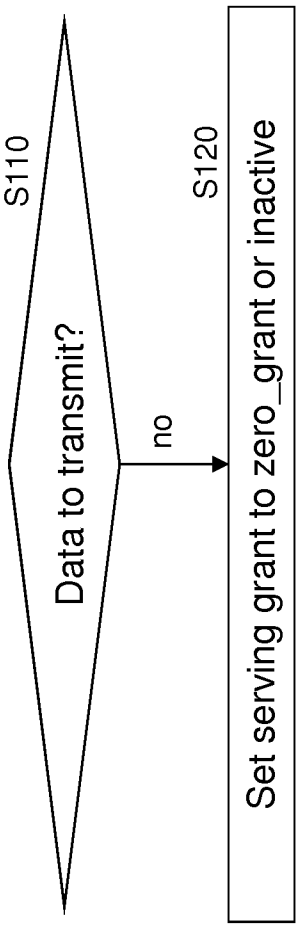


Fig. 7

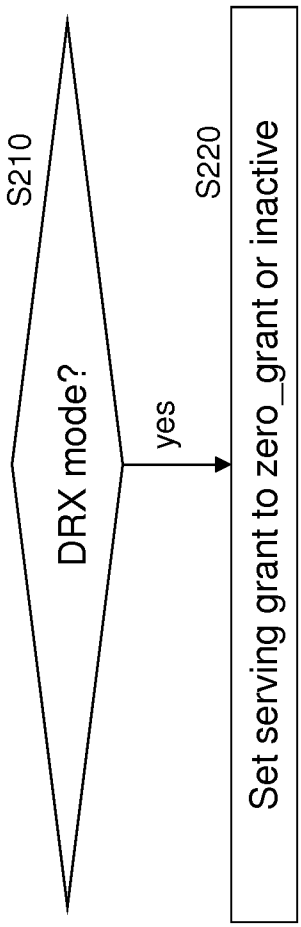


Fig. 9

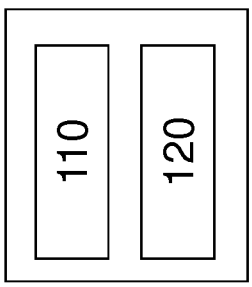


Fig. 6

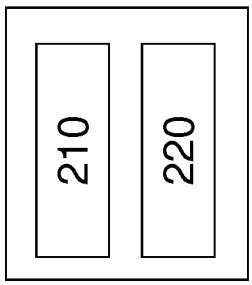


Fig. 8

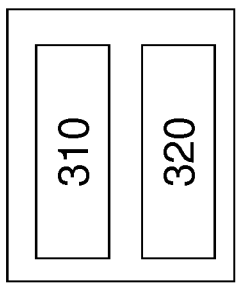


Fig. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/059352

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W76/04 H04W72/14
ADD.

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

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)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/049669 A1 (LUNDBY STEIN ARNE [US] ET AL MONTOJO JUAN [US] ET AL) 28 February 2008 (2008-02-28) paragraph [0009] paragraph [0056] - paragraph [0064] paragraph [0067] - paragraph [0070] paragraph [0073] - paragraph [0076] paragraph [0078] - paragraph [0083] paragraph [0087] - paragraph [0089] paragraph [0091] - paragraph [0092] figures 4, 6, 7	1-17
X	KR 2009 0084691 A (LG ELECTRONICS INC [KR]) 5 August 2009 (2009-08-05) See the last 2 sentences of paragraph 16.; paragraph [0016]	5,13

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 February 2015	09/03/2015

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Bagge af Berga, Hans

1

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	ERICSSON: "Need for testing of DTX/DRX cycles and timers", 3GPP DRAFT; R4-070196, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG4, no. St. Louis, MO; 20070207, 7 February 2007 (2007-02-07), XP050176682, [retrieved on 2007-02-07] See heading 2.4 "UE DRX cycle", second bullet point. -----	1
A	QUALCOMM EUROPE: "Monitoring of HSUPA grant channels", 3RD GENERATION PARTNERSHIP PROJECT (3GPP); TECHNICALSPECIFICATION GROUP (TSG) RADIO ACCESS NETWORK (RAN); WORKINGGROUP 2 (WG2), XX, XX, no. R1-062393, 28 August 2006 (2006-08-28) , pages 1-3, XP002466502, See heading 2.1 "Monitoring of uplink control channels", third bullet point. -----	2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2014/059352

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		CN 101507316 A	12-08-2009
		EP 2062449 A2	27-05-2009
		JP 5456469 B2	26-03-2014
		JP 2010502126 A	21-01-2010
		JP 2014039290 A	27-02-2014
		KR 20090045370 A	07-05-2009
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		WO 2008024889 A2	28-02-2008
KR 20090084691 A	05-08-2009	NONE	