acquiring secondary downlink carrier activation and deactivation information for a combination of a primary and at least one secondary downlink carriers of a terminal device, said primary downlink carrier and said secondary downlink carrier operating with different radio technologies

determining whether secondary downlink carrier power saving mode is to be switched ON or OFF based on the secondary downlink carrier activation and deactivation information

Figure 1

Title: SECONDARY CELL ACTIVATION AND DEACTIVATION IN CARRIER AGGREGATION SCENARIOS

Abstract: There are provided measures for realizing secondary cell activation and deactivation in carrier aggregation scenarios. Such measures may exemplarily comprise acquiring secondary downlink carrier activation and deactivation information for a combination of a primary and at least one secondary downlink carrier of a terminal device, said primary downlink carrier and said secondary downlink carrier operating with different radio technologies, and determining whether secondary downlink carrier power saving mode is to be switched ON or OFF based on the secondary downlink carrier activation and deactivation information.
SECONDARY CELL ACTIVATION AND DEACTIVATION IN CARRIER AGGREGATION SCENARIOS

Field

The present invention relates to secondary cell activation and deactivation in carrier aggregation scenarios. More specifically, the present invention relates to measures (including methods, apparatuses and computer program products) for realizing secondary cell activation and deactivation in carrier aggregation scenarios.

Background

Mobile data transmission and data services are constantly making progress. With the increasing penetration of such services, a need for increased bandwidth for conveying the data is emerging. One currently favored technical solution to achieve this increased bandwidth is known as carrier aggregation (CA). Carrier aggregation affords increased bandwidth providable to a terminal like a User Equipment (UE). To achieve this effect, multiple carriers known as component carriers (CC) are aggregated.

Generally, one CC serves as a primary carrier. The primary carrier represents the frequency block, on which the primary cell operates. The primary cell is the cell, in which the UE performs the initial connection establishment procedure and in which essential control information are communicated. Once such initial connection is established, the UE may connect to further cells, known as secondary cells. The secondary cells operate on secondary carriers which represent further frequency blocks. In a CA, one primary carrier and at least one secondary carrier are aggregated to form coexistent primary and secondary cells.

CA includes contiguous aggregation of adjacent carriers and non-contiguous aggregation, wherein the respective carriers are not adjacent to each other. Such non-contiguous aggregation can be realized with component carriers of one frequency band (Intra-band non-contiguous aggregation) or with
component carriers of two or more frequency bands (Inter-band non-contiguous aggregation).

On the field of mobile data transmission, currently, a system known as Long Term Evolution (LTE) is being further developed. The following explanation is performed on the basis of LTE only as an example. In this system, a terminal as a user equipment, i.e. a UE communicates with a base station like an evolved Node B, i.e. an eNodeB (eNB).

In general, mobile data transmission can be operated on licensed frequency bands and on unlicensed frequency bands. Unlicensed or bands describe a spectrum band that has rules pre-defined for both the hardware and deployment methods of devices operating on that bands in such a manner that interference is mitigated by the technical rules defined for the bands. On the other hand, with respect to licensed bands interference is mitigated by restricting its use.

The ISM (industrial, scientific and medical) radio bands are unlicensed bands, which were originally reserved internationally for radio applications for industrial, scientific and medical purposes other than communications. However, in recent years these bands have also been shared with error-tolerant communications applications such as Wireless LANs (WLAN) and cordless phones in the 915 MHz, 2.450 GHz, and 5.800 GHz bands, that is, in unlicensed bands. A main usage on these ISM bands is 'WiFi'.

'WiFi' is not a technical term. However, the WiFi Alliance has generally enforced its use to describe only a narrow range of connectivity technologies including wireless local area network (WLAN) based on the IEEE 802.11, which is a set of standards carrying out WLAN communication in the 2.4, 3.6 and 5 GHz frequency bands. In particular, 2.4 GHz ISM band is used for applications implementing the standards WiFi 802.11b or 802.11g/n. Further, 5GHz ISM band is used for applications implementing the standard WiFi 802.11a/n/ac.
The 802.11 standard defines a power-saving mode (PSM) as a status of a power management mode, which aims for reduction of the energy consumption of mobile devices. This mechanism supports, among others, the process of establishment and maintenance of the power management mode of a station (STA).

In particular, stations changing power management mode (e.g. to PSM) shall inform the access point (AP) of this fact using power management bits within the frame control field of transmitted frames. If the AP receives such information regarding a performed PSM, the AP shall not arbitrarily transmit MAC service data units (MSDUs), that is, any payload data, to stations operating in a PSM. In contrary, in such case the AP shall buffer MSDUs and transmit the buffered MSDUs at designated times.

Carrier aggregation (CA) in LTE-Advanced extends the maximum bandwidth in the uplink (UL) and/or downlink (DL) directions by aggregating multiple carriers within a frequency band (intra-band CA) or across frequency bands (inter-band CA).

A primary cell carrier (PCC) is a frequency band on which a primary cell is operated. A secondary cell carrier (SCC) is a frequency band on which a secondary cell is operated. A PCC using LTE technology may be configured on the licensed band for primary access providing mobility, security and state management for user terminals. On the other hand a SCC using WiFi technology is opportunistically configured, activated and operated on the unlicensed band for secondary access to provide additional data transport capacity.

A CA scenario aggregating LTE and WiFi bands with high DL traffic load but low UL traffic load is considered. In such scenario, the low UL traffic load can be handled by the LTE band in UL direction. However, in order to enable handle high DL traffic load, a CA scenario aggregating LTE and WiFi DL bands is considered in particular.
From the above arises a need to provide secondary cell activation and deactivation in carrier aggregation scenarios.

**Summary**

Various exemplary embodiments of the present invention aim at addressing at least part of the above issues and/or problems and drawbacks.

Various aspects of exemplary embodiments of the present invention are set out in the appended claims.

According to an exemplary aspect of the present invention, there is provided a method comprising acquiring secondary downlink carrier activation and deactivation information for a combination of a primary and at least one secondary downlink carriers of a terminal device, said primary downlink carrier and said secondary downlink carrier operating with different radio technologies, and determining whether secondary downlink carrier power saving mode is to be switched ON or OFF based on the secondary downlink carrier activation and deactivation information.

According to a further exemplary aspect of the present invention, there is provided an apparatus comprising at least one processor, at least one memory including computer program code, and at least one interface configured for communication with at least another apparatus, the at least one processor, with the at least one memory and the computer program code, being arranged/configured to cause the apparatus to perform acquiring secondary downlink carrier activation and deactivation information for a combination of a primary and at least one secondary downlink carriers of a terminal device, said primary downlink carrier and said secondary downlink carrier operating with different radio technologies, and determining whether secondary downlink carrier power saving mode is to be switched ON or OFF based on the secondary downlink carrier activation and deactivation information.
According to a further exemplary aspect of the present invention, 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 the aforementioned method-related exemplary aspect of the present invention.

Such computer program product may comprise or be embodied as a (tangible) computer-readable (storage) medium or the like on which the computer-executable computer program code is stored, and/or the program may be directly loadable into an internal memory of the computer or a processor thereof.

By virtue of any one of the aforementioned exemplary aspects of the present invention, secondary cell activation and deactivation in carrier aggregation scenarios is achievable, which is effective in terms of power consumption control of a terminal.

By way of exemplary embodiments of the present invention, there is provided secondary cell activation and deactivation in carrier aggregation scenarios. More specifically, by way of exemplary embodiments of the present invention, there are provided measures and mechanisms for realizing secondary cell activation and deactivation in carrier aggregation scenarios.

Thus, enhancements and/or improvements are achieved by methods, apparatuses and computer program products capable of realizing secondary cell activation and deactivation in carrier aggregation scenarios, namely scenarios in which a primary carrier and at least one secondary carrier are aggregated.

**Brief description of drawings**

For a more complete understanding of exemplary embodiments of the present invention, reference is now made to the following description taken in connection with the accompanying drawings in which:
Figure 1 shows a flowchart of an example of a procedure at a terminal side according to exemplary embodiments of the present invention,

Figure 2 shows a flowchart of an example of a procedure at a terminal side according to exemplary embodiments of the present invention,

Figure 3 shows a flowchart of an example of a procedure at a terminal side according to exemplary embodiments of the present invention,

Figure 4 shows a flowchart of an example of a procedure at a terminal side according to exemplary embodiments of the present invention,

Figure 5 shows a flowchart of an example of a procedure at a terminal side according to exemplary embodiments of the present invention,

Figure 6 shows a flowchart of an example of a procedure at a terminal side according to exemplary embodiments of the present invention, and

Figure 7 shows a schematic block diagram illustrating exemplary apparatuses according to exemplary embodiments of the present invention.

**Description of exemplary embodiments**

Exemplary aspects of the present invention will be described herein below. More specifically, exemplary aspects of the present invention are described hereinafter with reference to particular non-limiting examples and to what are presently considered to be conceivable embodiments of the present invention. A person skilled in the art will appreciate that the invention is by no means limited to these examples, and may be more broadly applied.

It is to be noted that the following description of the present invention and its embodiments mainly refers to specifications being used as non-limiting examples for certain exemplary network configurations and deployments. Namely, the present invention and its embodiments are mainly described in
relation to 3GPP specifications being used as non-limiting examples for certain exemplary network configurations and deployments. In particular, a LTE/LTE-Advanced communication system is used as a non-limiting example for the applicability of thus described exemplary embodiments. As such, the description of exemplary embodiments given herein specifically refers to terminology which is directly related thereto. Such terminology is only used in the context of the presented non-limiting examples, and does naturally not limit the invention in any way. Rather, any other network configuration or system deployment, etc. may also be utilized as long as compliant with the features described herein.

In particular, the present invention and its embodiments may be applicable in any (cellular) communication system and/or network deployment in which carrier aggregation, particularly carrier aggregation of a primary carrier and at least one secondary carrier, are operable.

Hereinafter, various embodiments and implementations of the present invention and its aspects or embodiments are described using several alternatives. It is generally noted that, according to certain needs and constraints, all of the described alternatives may be provided alone or in any conceivable combination (also including combinations of individual features of the various alternatives).

According to exemplary embodiments of the present invention, in general terms, there are provided mechanisms, measures and means for secondary cell activation and deactivation in carrier aggregation scenarios, in particular mechanisms, measures and means for activation and deactivation of secondary cell power saving mode in carrier aggregation scenarios.

In the following, exemplary embodiments of the present invention are described with reference to methods, procedures and functions, as well as with reference to structural arrangements and configurations.

Generally, any procedures according to exemplary embodiments of the present invention are operable at a carrier aggregation capable user entity
and/or at a carrier aggregation capable TX and/or between the same. As described herein below, a carrier aggregation capable user entity may be implemented at/in/by any terminal side entity of a cellular communication system, such as a UE or the like, and a carrier aggregation capable TX point may be implemented at/in/by any network side entity of a cellular communication system, such as an eNB or the like.

Any procedures according to exemplary embodiments of the present invention or, stated in other words, the underlying carrier aggregation capable system comprising a carrier aggregation capable user entity and a carrier aggregation capable TX point, are operable in any conceivable carrier aggregation capable scenario.

As stated above, for the present invention, the WiFi secondary cell activation and deactivation is considered in a CA scenario aggregating LTE and WiFi DL bands focusing scenario with high DL traffic load but low UL traffic load, where low UL traffic load can be handled via LTE UL.

In order to enable support of WIFI secondary cell in such CA scenario it is aimed for proposals for configuration/deconfiguration and activation/deactivation of the WiFi secondary cell in a CA scenario aggregating LTE and WiFi DL bands. Therefore, configuration/deconfiguration and activation/deactivation mechanism of LTE needs to be revisited considering WiFi’s properties.

With respect to configuration and de-configuration, when there is a need for offload DL traffic from the primary cell to a WiFi secondary cell due to high DL traffic load, and the terminal is not connected to a WiFi secondary cell, the eNB of the primary cell does not know whether the WiFi module of the terminal is able to connect to a WiFi access point. In this case, eNB should send a signaling to tell the terminal to power on its WiFi module to receive beacon from WiFi AP. This means that terminal needs to interpret signaling to enable/disable WIFI, which may be implemented as radio resource control (RRC) message.
However, when there is a need for offload DL traffic from the primary cell to a WiFi secondary cell due to high DL traffic load, and the terminal is connected to a WiFi secondary cell, the eNB of the primary cell is able to get to know the certain WiFi address of the terminal and linking the same to the cell-radio network temporary identifier (C-RNTI) of the terminal, since the LTE eNB itself and the respective WiFi AP are exchanging such info. Thus, when high DL traffic is only offloaded to terminals whose WiFi modules are associating with its WiFi AP, the eNB knows which terminals are also in WiFi AP's coverage.

Therefore, it seems that the configuration/deconfiguration is just to enable or disable packet offload to WiFi in LTE's adaptation layer, and can be directly applicable to WiFi secondary cell with some minor change in implementation.

However, a problem occurs since it is uncertain on how to perform deactivation/activation of the terminal, i.e. the WiFi module of the terminal, for WiFi secondary cell, since the activation or deactivation of normal secondary cell cannot be directly applied to WiFi secondary cell,

Figure 1 shows a flowchart of an example of a procedure at a terminal side according to exemplary embodiments of the present invention.

As shown in Figure 1, a corresponding procedure according to exemplary embodiments of the present invention, at the terminal side, comprises an acquiring secondary downlink carrier activation and deactivation information for a combination of a primary and at least one secondary downlink carriers of a terminal device, said primary downlink carrier and said secondary downlink carrier operating with different radio technologies, and an operation of determining whether secondary downlink carrier power saving mode is to be switched ON or OFF based on the secondary downlink carrier activation and deactivation information.

According to exemplary embodiments of the present invention, the secondary downlink carrier activation and deactivation information
comprises information which can be used for determining whether secondary downlink carrier is to be activated or deactivated, and accordingly, whether secondary downlink carrier power saving mode is to be switched OFF or ON. It is to be noted that, according to exemplary embodiments of the present invention, for operating in power saving mode (PSM) with respect to a WiFi secondary cell as stated above, secondary downlink carrier is to be deactivated, and for not operating in power saving mode (PSM) with respect to a WiFi secondary cell as stated above, secondary downlink carrier is to be activated.

According to exemplary embodiments of the present invention, in case of operating in PSM, the WiFi module of the terminal is switched off or deactivated, or may fall in a standby mode. Accordingly, in case of not operating in PSM, the WiFi module of the terminal is switched on or activated, or may awake from the standby mode.

According to exemplary embodiments of the present invention, the primary downlink carrier and the secondary downlink carrier are operating with radio technologies different from each other. That is, as an exemplary scenario according to exemplary embodiments of the present invention the primary carrier may operate with LTE or LTE-A radio technology and the secondary carrier may operate with WiFi radio technology. However, the mentioned scenario is not limiting. The present invention is also applicable in a combination of LTE and Bluetooth or in a combination with future radio technologies as long as the radio technology used for the secondary carrier differs from the radio technology used for the primary carrier.

Figure 2 shows a flowchart of an example of a procedure at a terminal side according to exemplary embodiments of the present invention.

The procedure according to Figure 2 represents a variation of the procedure according to Figure 1, in which exemplary details of the acquiring operation are given, which is inherently independent from each other as such.
According to Figure 2, an exemplary acquiring operation according to exemplary embodiments of the present invention may comprise an operation of deriving the secondary downlink carrier activation and deactivation information from a pre-configuration. That is, the WiFi module of the terminal is pre-configured at an arbitrary time. Such pre-configuration may include setting the WiFi module of the terminal in PSM, or setting the WiFi module of the terminal in active mode. Further, such configuration may be implemented in form of a tag which is added in secondary cell definition of a WiFi secondary cell configuration in a RRC message. According to this variation, once configured the state of the secondary downlink carrier, and accordingly the state of the secondary carrier power saving mode, can not be changed by the network entity, i.e. the eNB on demand.

That is, according to this variation, activation/deactivation is not applied to WiFi secondary cell. According to this variation, if offloading is not needed for a moment from the network entities view, the eNB just does not use secondary cell, that is, does not give WiFi AP or WiFi modules any packet to be transmitted.

Accordingly, the WiFi module of the terminal keeps observing the WiFi channel even if no packets are transmitted using the secondary cell. It is to be noted that the continuous observing ends on de-configuration with respect to the WiFi secondary cell.

Further, according to Figure 2, an exemplary acquiring operation according to exemplary embodiments of the present invention may comprise an operation of receiving a signaling from a network side on said primary downlink carrier, and an operation of deriving the secondary downlink carrier activation and deactivation information from the signaling. Such variation performs re-interpretation of known explicit activation and de-activation of LTE for WiFi secondary cell and adjusting the same to a use in WiFi secondary cell.
Further, according to Figure 2, an exemplary acquiring operation according to exemplary embodiments of the present invention may comprise an operation of observing a predetermined secondary downlink carrier deactivation timer, and an operation of detecting expiry of said predetermined secondary downlink carrier deactivation timer. Such predetermined secondary downlink carrier deactivation timer may be predefined in RRC signaling. Such variation performs re-interpretation of known implicit de-activation of LTE for WiFi secondary cell and adjusting the same to a use in WiFi secondary cell.

Figure 3 shows a flowchart of an example of a procedure at a terminal side according to exemplary embodiments of the present invention.

The procedure according to Figure 3 represents a variation of the procedure according to Figure 2, in which exemplary details of the deriving operation and exemplary details of the determining operation are given, which are inherently independent from each other as such.

According to Figure 3, an exemplary deriving operation according to exemplary embodiments of the present invention may comprise deriving a request for activating said secondary downlink carrier. Further, an exemplary determining operation according to exemplary embodiments of the present invention may comprise an operation of deciding that secondary downlink carrier power saving mode is to be switched OFF, if a request for activating said secondary downlink carrier is included in said received signaling. In this case, usage of the WiFi secondary downlink carrier is explicitly requested, that is, explicitly activated. Such request may be implemented by use of the known activation MAC control element (MAC CE). In such case, the intended behavior is that the WiFi module of the terminal finishes PSM if such PSM was applied. Thus, according to exemplary embodiments of the present invention, such explicit activation of the secondary downlink carrier is responded by switching OFF the secondary carrier power saving mode.
Further, according to Figure 3, an exemplary deriving operation according to exemplary embodiments of the present invention may comprise deriving a request for de-activating said secondary downlink carrier. Further, an exemplary determining operation according to exemplary embodiments of the present invention may comprise an operation of deciding that secondary downlink carrier power saving mode is to be switched ON, if a request for de-activating said secondary downlink carrier is included in said received signaling. In this case the WiFi secondary downlink carrier is explicitly de-activated. Such request may be implemented by use of the known activation/deactivation MAC control element (MAC CE). Otherwise, a new MAC signaling may be introduced in LTE side standardization. However, when the terminal receives this MAC signaling, the intended behavior is to switch ON PSM in the WiFi module of the terminal, that is, to de-activate the WiFi module of the terminal. Thus, according to exemplary embodiments of the present invention, such explicit request of deactivating the secondary downlink carrier is responded by switching on the secondary carrier power saving mode.

Further, according to Figure 3, an exemplary deriving operation according to exemplary embodiments of the present invention may comprise deriving a value corresponding to a holding interval and a request for de-activating said secondary downlink carrier after expiration of said holding interval. Further, an exemplary determining operation according to exemplary embodiments of the present invention may comprise an operation of deciding that secondary downlink carrier power saving mode is to be switched ON, if a value corresponding to a holding interval and a request for de-activating said secondary downlink carrier after expiration of said holding interval is included in said received signaling, and if said holding interval is expired. In addition to the preceding exemplary deriving operation according to exemplary embodiments of the present invention a holding value indicating an interval after which secondary carrier is to be deactivated is received by the terminal. Such value may be included in a newly introduced MAC signaling. Further, such holding value may be included in involved RRC configuration. However, when the terminal receives this MAC signaling, the intended behavior is to switch ON PSM in...
the WiFi module of the terminal, thereby considering the interval corresponding to the received holding value, that is, the intended behavior is to switch ON PSM in the WiFi module of the terminal after the interval corresponding to the received holding value is expired after receiving the corresponding signaling. Thus, according to exemplary embodiments of the present invention, such explicit request of deactivating the secondary downlink carrier after an advised interval is responded by switching ON the secondary carrier power saving mode after expiry of said interval.

Figure 4 shows a flowchart of an example of a procedure at a terminal side according to exemplary embodiments of the present invention.

The procedure according to Figure 4 represents a variation of the procedure according to Figure 2, in which exemplary details of the acquiring operation and exemplary details of the determining operation are given, which are inherently independent from each other as such.

According to Figure 4, an exemplary acquiring operation according to exemplary embodiments of the present invention may comprise an operation of observing a predetermined secondary downlink carrier deactivation timer, and an operation of detecting expiry of said predetermined secondary downlink carrier deactivation timer. Further, an exemplary determining operation according to exemplary embodiments of the present invention may comprise an operation of deciding that secondary downlink carrier power saving mode is to be switched ON, if said predetermined secondary downlink carrier deactivation timer is expired. As a result, according to exemplary embodiments of the present invention, the LTE module of the terminal is capable to inform WiFi module of the terminal to operate in PSM, that is, to de-activate the secondary downlink carrier. Said predetermined deactivation timer may be implemented as the sCellDeactivationTimer. Thus, when sCellDeactivationTimer expires, the WiFi module of the terminal is switched to PSM. Furthermore, the predetermined deactivation timer can be predefined in RRC signaling. Thus, in this case the de-activation of the WiFi secondary downlink carrier is implicitly requested, that is, the PSM is implicitly requested.
Figure 5 shows a flowchart of an example of a procedure at a terminal side according to exemplary embodiments of the present invention.

The procedure according to Figure 5 represents a variation of the procedure according to Figure 4, in which exemplary additional operations are given, which are inherently independent from each other as such.

According to Figure 5, the predetermined secondary downlink carrier deactivation timer can be affected in terms of resetting the same on predetermined events.

According to Figure 5, the exemplary procedure according to exemplary embodiments of the present invention may comprise an operation of receiving a signaling from a network side on said primary downlink carrier, and an operation of resetting the predetermined secondary downlink carrier deactivation timer, if a request for activating said secondary downlink carrier is included in said received signaling. That is, the $s\text{CellDeactivationtimer}$ observed in e.g. the LTE module of the terminal can be redefined, i.e. reset. After resetting the predetermined secondary downlink carrier deactivation timer, the deciding that secondary downlink carrier is to be de-activated based on the $s\text{CellDeactivationtimer}$ can not be made until expiration of the full deactivation timer value. Thus, according to the exemplary procedure, the $s\text{CellDeactivationtimer}$ is reset on receiving of activation MAC CE.

Further, according to Figure 5, the exemplary procedure according to exemplary embodiments of the present invention may comprise an operation of receiving a transmission from a network side on said secondary downlink carrier, and an operation of resetting the predetermined secondary downlink carrier deactivation timer, if said transmission from a network side on said secondary downlink carrier is received before expiration of said predetermined secondary downlink carrier deactivation timer. That is, the $s\text{CellDeactivationtimer}$ observed in e.g. the LTE module of the terminal can be redefined, i.e. reset. After resetting the predetermined secondary
downlink carrier deactivation timer, the deciding that secondary downlink carrier is to be deactivated based on the \textit{sCellDeactivationTimer}, can not be made until expiration of the full deactivation timer value. Thus, according to the exemplary procedure, the \textit{sCellDeactivationTimer} is reset if WiFi module of the terminal receives new packets from WiFi air interface, that is, from the AP using the secondary downlink carrier.

To sum up, of explicit activation and deactivation command and implicit deactivation known from LTE may be newly interpreted according to the present invention. Thereby, the intended new behavior is switching ON or OFF of PSM in the (WiFi module of the) terminal, since WIFI PSM is triggered by WiFi station side (i.e. terminal) only.

Hence, according to exemplary embodiments of the present invention, the requests for activating and de-activating the secondary downlink carrier can be re-used for causing switching OFF or ON of the secondary downlink carrier power saving mode. That is, if activation of the secondary downlink carrier is requested, such request can be reused to cause switching OFF of the secondary downlink carrier power saving mode, and if de-activation of the secondary downlink carrier is requested, such request can be reused to cause switching ON of the secondary downlink carrier power saving mode.

Figure 6 shows a flowchart of an example of a procedure at a terminal side according to exemplary embodiments of the present invention.

The procedure according to Figure 6 represents a variation of the procedure according to Figure 1, in which exemplary additional operations are given, which are inherently independent from each other as such.

According to Figure 6, the exemplary procedure according to exemplary embodiments of the present invention may comprise an operation of transmitting, on said secondary downlink carrier, a request for switching ON or OFF of said secondary downlink carrier power saving mode based on the determination result, that is, if the determination result reads that that secondary downlink carrier power saving mode is to be switched ON, a
request for switching ON of said secondary downlink carrier power saving mode is transmitted, and if the determination result reads that that secondary downlink carrier power saving mode is to be switched OFF, a request for switching OFF of said secondary downlink carrier power saving mode is transmitted. The intended recipient of such request may be an AP of the WiFi connection using the secondary downlink carrier. The AP may subsequently change its behavior in delivery of transmissions to the considered terminal and may transmit a permission or a denial of switching ON or OFF a PSM of the considered terminal. Furthermore, the exemplary procedure according to exemplary embodiments of the present invention may comprise an operation of receiving, on said secondary downlink carrier, permission or denial for switching ON or OFF of said secondary downlink carrier power saving mode. Furthermore, the exemplary procedure according to exemplary embodiments of the present invention may comprise an operation of switching ON or OFF of said secondary downlink carrier power saving mode on the basis of the determination result, if permission is received, that is, if the intended switching operation (ON or OFF) is permitted, it is then executed.

According to exemplary embodiments of the present invention switching ON or OFF of said secondary downlink carrier power saving mode may be commanded from the LTE module of the terminal, thus, signaling between LTE module and WiFi module of the terminal are generated.

The exemplary procedure at a terminal side according to exemplary embodiments provides that, when activation for WiFi secondary cell is received in LTE module of the terminal, a command for switching OFF the PSM, i.e. a PSM OFF trigger, is sent from LTE module of the terminal to WiFi module of the terminal. As a result, the WiFi module, after permitted request, switches OFF the PSM and may further send a message indicating change from secondary cell PSM to secondary cell active mode.

Further, the exemplary procedure at a terminal side according to exemplary embodiments provides that, when deactivation for WiFi secondary cell is received in LTE module of the terminal, or implicit deactivation happens, a
command for switching ON the PSM, i.e. a PSM ON trigger, is sent from LTE module of the terminal to WiFi module of the terminal. As a result, after permitted request, the WiFi module may inform the AP through a successful frame exchange initiated by the station of the intended switching ON of the PSM. The power management bit in the frame control field of the frame sent by the station in this exchange indicates the power management mode that the station is intended to adopt upon successful completion of the entire frame exchange. After that, the WiFi module switches the PSM ON.

It is to be noted that there could be module-to-module internal confirmation messages on both triggers, the PSM OFF trigger, i.e. the command for switching OFF the PSM, and the PSM ON trigger i.e. the command for switching ON the PSM, from WiFi module of the terminal back to LTE module of the terminal.

In view of the above, specific features and/or effects according to exemplary embodiments of the present invention may be summarized as follows this summary is noted to be non-exhaustive but merely illustrative/exemplary).

Exemplary embodiments of the present invention provide for secondary cell activation and deactivation in carrier aggregation scenarios. That is, there is provided secondary cell activation and deactivation in carrier aggregation scenarios, which is effective in terms of power consumption control of a terminal.

Accordingly, by virtue of the common feedback framework according to exemplary embodiments of the present invention, implementation synergy with existing communication systems and/or network deployments (e.g. LTE releases/specifications) may be maximized. That is, the secondary cell activation and deactivation according to exemplary embodiments of the present invention supports e.g. power consumption control of a terminal without the need for (major) redesign of UL control signaling structures.
Generally, the above-described procedures and functions may be implemented by respective functional elements, processors, or the like, as described below.

While in the foregoing exemplary embodiments of the present invention are described mainly with reference to methods, procedures and functions, corresponding exemplary embodiments of the present invention also cover respective apparatuses, network nodes and systems, including both software, algorithms, and/or hardware thereof.

Respective exemplary embodiments of the present invention are described below referring to Figure 7, while for the sake of brevity reference is made to the detailed description with regard to Figures 1 to 6.

In Figure 7 below, which is noted to represent a simplified block diagram, the solid line blocks are basically configured to perform respective operations as described above. The entirety of solid line blocks are basically configured to perform the methods and operations as described above, respectively. With respect to Figure 7, it is to be noted that the individual blocks are meant to illustrate respective functional blocks implementing a respective function, process or procedure, respectively. Such functional blocks are implementation-independent, i.e. may be implemented by means of any kind of hardware or software, respectively. The arrows and lines interconnecting individual blocks are meant to illustrate an operational coupling there-between, which may be a physical and/or logical coupling, which on the one hand is implementation-independent (e.g. wired or wireless) and on the other hand may also comprise an arbitrary number of intermediary functional entities not shown. The direction of arrow is meant to illustrate the direction in which certain operations are performed and/or the direction in which certain data is transferred.

Further, in Figure 7, only those functional blocks are illustrated, which relate to any one of the above-described methods, procedures and functions. A skilled person will acknowledge the presence of any other conventional functional blocks required for an operation of respective structural
arrangements, such as e.g. a power supply, a central processing unit, respective memories or the like. Among others, memories are provided for storing programs or program instructions for controlling the individual functional entities to operate as described herein.

Figure 7 shows a schematic block diagram illustrating exemplary apparatuses according to exemplary embodiments of the present invention.

In view of the above, the thus illustrated apparatuses 10 and 20 are suitable for use in practicing the exemplary embodiments of the present invention, as described herein.

The thus described apparatus 10 may represent a (part of a) device or terminal such as a mobile station MS or user equipment UE or a modem (which may be installed as part of a MS or UE, but may be also a separate module, which can be attached to various devices), and may be configured to perform a procedure and/or functionality as described in conjunction with any one of Figures 1 to 6. The thus described apparatus 20 may represent a (part of a) network entity, such as a base station or access node or any network-based controller, e.g. an eNB, and may be configured to perform a procedure and/or functionality as indicated above, while no further details thereof are given.

As indicated in Figure 7, according to exemplary embodiments of the present invention, the apparatus 10 comprises a processor 11, a memory 12 and an interface 13, which are connected by a bus 14 or the like, and the apparatuses may be connected via link 30, respectively.

The processor 11 and/or the interface 13 may also include a modem or the like to facilitate communication over a (hardwire or wireless) link, respectively. The interface 13 may include a suitable transceiver coupled to one or more antennas or communication means for (hardwire or wireless) communications with the linked or connected device(s), respectively. The interface 13 is generally configured to communicate with at least one other apparatus, i.e. the interface thereof.
The memory 12 may store respective programs assumed to include program instructions or computer program code that, when executed by the respective processor, enables the respective electronic device or apparatus to operate in accordance with the exemplary embodiments of the present invention.

In general terms, the respective devices/apparatuses (and/or parts thereof) may represent means for performing respective operations and/or exhibiting respective functionalities, and/or the respective devices (and/or parts thereof) may have functions for performing respective operations and/or exhibiting respective functionalities.

When in the subsequent description it is stated that the processor (or some other means) is configured to perform some function, this is to be construed to be equivalent to a description stating that at least one processor, potentially in cooperation with computer program code stored in the memory of the respective apparatus, is configured to cause the apparatus to perform at least the thus mentioned function. Also, such function is to be construed to be equivalently implementable by specifically configured means for performing the respective function (i.e. the expression "processor configured to [cause the apparatus to] perform xxx-ing" is construed to be equivalent to an expression such as "means for xxx-ing").

According to exemplary embodiments of the present invention, an apparatus representing the apparatus 10 comprises at least one processor 11, at least one memory 12 including computer program code, and at least one interface 13 configured for communication with at least another apparatus. The apparatus 10, i.e. the processor (namely, the at least one processor 11, with the at least one memory 12 and the computer program code), is configured to perform acquiring secondary downlink carrier activation and deactivation information for a combination of a primary and at least one secondary downlink carriers of a terminal device, said primary downlink carrier and said secondary downlink carrier operating with different radio technologies, and to perform determining whether secondary
downlink carrier power saving mode is to be switched ON or OFF based on the secondary downlink carrier activation and deactivation information.

In its most basic form, stated in other words, the apparatus 10 may thus comprise respective means for acquiring secondary downlink carrier activation and deactivation information and means for determining whether secondary downlink carrier is to be switched ON or OFF.

As outlined above, in enhanced forms, the apparatus 10 may comprise one or more of respective means for deriving the secondary downlink carrier activation and deactivation information, means for receiving a signaling from a network side on said primary downlink carrier, means for observing a predetermined secondary downlink carrier deactivation timer, means for detecting expiry of said predetermined secondary downlink carrier deactivation timer, means for deciding that secondary downlink carrier power saving mode is to be switched ON or OFF, means for resetting the predetermined secondary downlink carrier deactivation timer, means for receiving a transmission from a network side on said secondary downlink carrier, means for transmitting, on said secondary downlink carrier, a request for switching ON or OFF of said secondary downlink carrier power saving mode based on the determination result, means for receiving, on said secondary downlink carrier, permission or denial for switching ON or OFF of said secondary downlink carrier power saving mode, and means for switching ON or OFF of said secondary downlink carrier power saving mode on the basis of the determination result, if permission is received.

For further details of specifics regarding functionalities according to exemplary embodiments of the present invention, reference is made to the foregoing description in conjunction with Figures 1 to 6.

According to exemplarily embodiments of the present invention higher power efficiency in WiFi module of the terminal can be achieved.

According to exemplarily embodiments of the present invention, a system may comprise any conceivable combination of the thus depicted
devices/apparatuses and other network elements, which are configured to cooperate as described above.

In general, it is to be noted that respective functional blocks or elements according to above-described aspects can be implemented by any known means, either in hardware and/or software, respectively, if it is only adapted to perform the described functions of the respective parts. The mentioned method steps can be realized in individual functional blocks or by individual devices, or one or more of the method steps can be realized in a single functional block or by a single device.

Generally, any structural means such as a processor or other circuitry may refer to one or more of the following: (a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and (b) combinations of circuits and software (and/or firmware), such as (as applicable): (i) a combination of processor(s) or (ii) portions of processor(s)/software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions) and (c) circuits, such as a microprocessor(s) or a portion of a microprocessor(s), that require software or firmware for operation, even if the software or firmware is not physically present. Also, it may also cover an implementation of merely a processor (or multiple processors) or portion of a processor and its (or their) accompanying software and/or firmware, any integrated circuit, or the like.

Generally, any procedural step or functionality is suitable to be implemented as software or by hardware without changing the idea of the present invention. Such software may be software code independent and can be specified using any known or future developed programming language, such as e.g. Java, C++, C, and Assembler, as long as the functionality defined by the method steps is preserved. Such hardware may be hardware type independent and can be implemented using any known or future developed hardware technology or any hybrids of these, such as MOS (Metal Oxide Semiconductor), CMOS (Complementary MOS), BiMOS (Bipolar MOS), BiCMOS (Bipolar CMOS), ECL (Emitter Coupled Logic), TTL (Transistor-
Transistor Logic), etc., using for example ASIC (Application Specific IC (Integrated Circuit)) components, FPGA (Field-programmable Gate Arrays) components, CPLD (Complex Programmable Logic Device) components or DSP (Digital Signal Processor) components. A device/apparatus may be represented by a semiconductor chip, a chipset, system in package, or a (hardware) module comprising such chip or chipset; this, however, does not exclude the possibility that a functionality of a device/apparatus or module, instead of being hardware implemented, be implemented as software in a (software) module such as a computer program or a computer program product comprising executable software code portions for execution/being run on a processor. A device may be regarded as a device/apparatus or as an assembly of more than one device/apparatus, whether functionally in cooperation with each other or functionally independently of each other but in a same device housing, for example.

Apparatuses and/or means or parts thereof can be implemented as individual devices, but this does not exclude that they may be implemented in a distributed fashion throughout the system, as long as the functionality of the device is preserved. Such and similar principles are to be considered as known to a skilled person.

Software in the sense of the present description comprises software code as such comprising code means or portions or a computer program or a computer program product for performing the respective functions, as well as software (or a computer program or a computer program product) embodied on a tangible medium such as a computer-readable (storage) medium having stored thereon a respective data structure or code means/portions or embodied in a signal or in a chip, potentially during processing thereof.

The present invention also covers any conceivable combination of method steps and operations described above, and any conceivable combination of nodes, apparatuses, modules or elements described above, as long as the above-described concepts of methodology and structural arrangement are applicable.
In view of the above, the present invention and/or exemplary embodiments thereof provide measures for realizing secondary cell activation and deactivation in carrier aggregation scenarios. Such measures may exemplarily comprise acquiring secondary downlink carrier activation and deactivation information for a combination of a primary and at least one secondary downlink carriers of a terminal device, said primary downlink carrier and said secondary downlink carrier operating with different radio technologies, and determining whether secondary downlink carrier power saving mode is to be switched ON or OFF based on the secondary downlink carrier activation and deactivation information.

The measures according to exemplary embodiments of the present invention may be applied for any kind of network environment, such as for example for communication systems in accordance with any one of 3GPP standards, LTE standards of release 11/12/... (including LTE-Advanced and its evolutions), UMTS standards, WCDMA standards, and WiFi standards. In particular, the measures according to exemplary embodiments of the present invention may be applied to any carrier aggregation techniques which are a feature e.g. of 3GPP LTE standards of release 11/12 and onwards.

Even though the present invention and/or exemplary embodiments are described above with reference to the examples according to the accompanying drawings, it is to be understood that they are not restricted thereto. Rather, it is apparent to those skilled in the art that the present invention can be modified in many ways without departing from the scope of the inventive idea as disclosed herein.

List of acronyms and abbreviations

<p>| CC   | Component Carrier |
| CQI  | Channel Quality Information |
| CRS  | Common Reference Signal |
| DCI  | Downlink Control Information |</p>
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DL</td>
<td>Downlink</td>
</tr>
<tr>
<td>eNB</td>
<td>Enhanced Node B, Name for Node B in LTE</td>
</tr>
<tr>
<td>HARQ</td>
<td>Hybrid Acknowledge Request</td>
</tr>
<tr>
<td>LTE</td>
<td>Long Term Evolution</td>
</tr>
<tr>
<td>5</td>
<td>LTE-A, Long Term Evolution Advanced</td>
</tr>
<tr>
<td>PCC</td>
<td>Primary Cell Carrier</td>
</tr>
<tr>
<td>PCFICH</td>
<td>Physical Control Format Indicator Channel</td>
</tr>
<tr>
<td>PDCCH</td>
<td>Physical Downlink Control Channel</td>
</tr>
<tr>
<td>PDSCH</td>
<td>Physical Downlink Shared Channel</td>
</tr>
<tr>
<td>10</td>
<td>PHICH, Physical HARQ Indicator Channel</td>
</tr>
<tr>
<td>PS</td>
<td>Power Saving</td>
</tr>
<tr>
<td>PUCCH</td>
<td>Physical UL Control Channel</td>
</tr>
<tr>
<td>PUSCH</td>
<td>Physical UL Shared Channel</td>
</tr>
<tr>
<td>RRC</td>
<td>Radio Resource Control</td>
</tr>
<tr>
<td>15</td>
<td>SCC, Secondary Cell Carrier</td>
</tr>
<tr>
<td>SFN</td>
<td>System Frame Number</td>
</tr>
<tr>
<td>SPS</td>
<td>Semi-persistent Packet Scheduling</td>
</tr>
<tr>
<td>SRS</td>
<td>Sounding Reference Signal</td>
</tr>
<tr>
<td>TB</td>
<td>Transport Block</td>
</tr>
<tr>
<td>20</td>
<td>UE, User Equipment</td>
</tr>
<tr>
<td>UL</td>
<td>Uplink</td>
</tr>
<tr>
<td>CCE</td>
<td>Channel Channel Element</td>
</tr>
<tr>
<td>REG</td>
<td>Resource Element Group</td>
</tr>
</tbody>
</table>
What is claimed is:

1. A method comprising
   acquiring secondary downlink carrier activation and deactivation information for a combination of a primary and at least one secondary downlink carriers of a terminal device, said primary downlink carrier and said secondary downlink carrier operating with different radio technologies, and
   determining whether secondary downlink carrier power saving mode is to be switched ON or OFF based on the secondary downlink carrier activation and deactivation information.

2. The method according to claim 1, wherein
   said acquiring comprises deriving the secondary downlink carrier activation and deactivation information from a pre-configuration.

3. The method according to claim 1, wherein
   said acquiring comprises receiving a signaling from a network side on said primary downlink carrier, and
   deriving the secondary downlink carrier activation and deactivation information from the signaling.

4. The method according to claim 1, wherein
   said acquiring comprises observing a predetermined secondary downlink carrier deactivation timer, and
   detecting expiry of said predetermined secondary downlink carrier deactivation timer.

5. The method according to claim 3, wherein said signaling includes one of a request for activating said secondary downlink carrier, a request for de-activating said secondary downlink carrier, and a value corresponding to a holding interval and a request for de-activating said secondary downlink carrier after expiration of said holding interval
as the secondary downlink carrier activation and deactivation information.

6. The method according to claim 5, wherein

  said determining comprises at least one of
  deciding that secondary downlink carrier power saving mode is to be
  switched OFF, if a request for activating said secondary downlink carrier is
  included in said received signaling,
  deciding that secondary downlink carrier power saving mode is to be
  switched ON, if a request for de-activating said secondary downlink carrier
  is included in said received signaling, and
  deciding that secondary downlink carrier power saving mode is to be
  switched ON, if a value corresponding to a holding interval and a request for
  de-activating said secondary downlink carrier after expiration of said holding
  interval is included in said received signaling, and if said holding interval is
  expired.

7. The method according to claim 4, wherein said determining comprises
  deciding that secondary downlink carrier power saving mode is to be
  switched ON, if said predetermined secondary downlink carrier deactivation
  timer is expired.

8. The method according to claim 7, further comprising
  receiving a signaling from a network side on said primary downlink
  carrier, and
  resetting the predetermined secondary downlink carrier deactivation
  timer, if a request for activating said secondary downlink carrier is included
  in said received signaling.

9. The method according to any one of claims 7 and 8, further comprising
  receiving a transmission from a network side on said secondary
  downlink carrier, and
  resetting the predetermined secondary downlink carrier deactivation
  timer, if said transmission from a network side on said secondary downlink
  carrier is included in said received signaling.
carrier is received before expiration of said predetermined secondary
downlink carrier deactivation timer.

10. The method according to any one of claims 1 to 9, further comprising

transmitting, on said secondary downlink carrier, a request for
switching ON or OFF of said secondary downlink carrier power saving mode
based on the determination result,

receiving, on said secondary downlink carrier, permission or denial for
switching ON or OFF of said secondary downlink carrier power saving mode,

and

switching ON or OFF of said secondary downlink carrier power saving
mode on the basis of the determination result, if permission is received.

11. An apparatus for use on a terminal side of a cellular system comprising

at least one processor,

at least one memory including computer program code, and

at least one interface configured for communication with at least

another apparatus,

the at least one processor, with the at least one memory and the

computer program code, being arranged to cause the apparatus to perform:

acquiring secondary downlink carrier activation and deactivation
information for a combination of a primary and at least one secondary
downlink carriers of a terminal device, said primary downlink carrier and
said secondary downlink carrier operating with different radio technologies,

and

determining whether secondary downlink carrier power saving mode
is to be switched ON or OFF based on the secondary downlink carrier
activation and deactivation information.

12. The apparatus according to claim 11, wherein the at least one processor
is arranged to cause the apparatus to perform:

deriving the secondary downlink carrier activation and deactivation
information from a pre-configuration.
13. The apparatus according to claim 11, wherein the at least one processor is arranged to cause the apparatus to perform:

- receiving a signaling from a network side on said primary downlink carrier, and
- deriving the secondary downlink carrier activation and deactivation information from the signaling.

14. The apparatus according to claim 11, wherein the at least one processor is arranged to cause the apparatus to perform:

- observing a predetermined secondary downlink carrier deactivation timer, and
- detecting expiry of said predetermined secondary downlink carrier deactivation timer.

15. The apparatus according to claim 13, wherein said signaling includes one of

- a request for activating said secondary downlink carrier,
- a request for de-activating said secondary downlink carrier, and
- a value corresponding to a holding interval and a request for de-activating said secondary downlink carrier after expiration of said holding interval

as the secondary downlink carrier activation and deactivation information.

16. The apparatus according to claim 15, wherein the at least one processor is arranged to cause the apparatus to perform:

- deciding that secondary downlink carrier power saving mode is to be switched OFF, if a request for activating said secondary downlink carrier is included in said received signaling, and/or
- deciding that secondary downlink carrier power saving mode is to be switched ON, if a request for de-activating said secondary downlink carrier is included in said received signaling, and/or
- deciding that secondary downlink carrier power saving mode is to be switched ON, if a value corresponding to a holding interval and a request for de-activating said secondary downlink carrier after expiration of said holding interval is included in said received signaling, and/or
interval is included in said received signaling, and if said holding interval is expired.

17. The apparatus according to claim 14, wherein the at least one processor is arranged to cause the apparatus to perform:
   deciding that secondary downlink carrier power saving mode is to be switched ON, if said predetermined secondary downlink carrier deactivation timer is expired.

18. The apparatus according to claim 17, wherein the at least one processor is arranged to cause the apparatus to perform:
   receiving a signaling from a network side on said primary downlink carrier, and
   resetting the predetermined secondary downlink carrier deactivation timer, if a request for activating said secondary downlink carrier is included in said received signaling.

19. The apparatus according to any one of claims 17 and 18, wherein the at least one processor is arranged to cause the apparatus to perform:
   receiving a transmission from a network side on said secondary downlink carrier, and
   resetting the predetermined secondary downlink carrier deactivation timer, if said transmission from a network side on said secondary downlink carrier is received before expiration of said predetermined secondary downlink carrier deactivation timer.

20. The apparatus according to any one of claims 11 to 19, wherein the at least one processor is arranged to cause the apparatus to perform:
   transmitting, on said secondary downlink carrier, a request for switching ON or OFF of said secondary downlink carrier power saving mode based on the determination result,
   receiving, on said secondary downlink carrier, permission or denial for switching ON or OFF of said secondary downlink carrier power saving mode, and
switching ON or OFF of said secondary downlink carrier power saving mode on the basis of the determination result, if permission is received.

21. The apparatus according to any one of claims 11 to 20, wherein

the apparatus is operable as or at a terminal, user equipment, mobile station or modem, and/or

the apparatus is operable in at least one of a LTE and a LTE-A cellular system, and/or

the secondary carrier is operating on un-licensed ISM radio band.

22. 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 1 to 10.

23. The computer program product according to claim 22, embodied as a computer-readable medium.
acquiring secondary downlink carrier activation and deactivation information for a combination of a primary and at least one secondary downlink carriers of a terminal device, said primary downlink carrier and said secondary downlink carrier operating with different radio technologies

determining whether secondary downlink carrier power saving mode is to be switched ON or OFF based on the secondary downlink carrier activation and deactivation information

Figure 1
acquiring secondary downlink carrier mode activation and deactivation information

- deriving the secondary downlink carrier activation and deactivation information from a pre-configuration
- receiving a signaling from a network side on said primary downlink carrier
  - deriving the secondary downlink carrier activation and deactivation information from the signaling
  - observing a predetermined secondary downlink carrier deactivation timer
    - detecting expiry of said predetermined secondary downlink carrier deactivation timer

determining whether secondary downlink carrier power saving mode is to be switched ON or OFF based on the secondary downlink carrier activation and deactivation information

Figure 2
Figure 3

- Request for de-activating said secondary downlink carrier after expiration of holding interval
- Request for activating said secondary downlink carrier
- Determining that secondary downlink carrier power saving mode is to be switched ON
- Determining that secondary downlink carrier power saving mode is to be switched OFF
- Holding interval
- Deciding that secondary downlink carrier power saving mode is to be switched ON, if holding interval is expired

-derived from signaling
acquiring

observing a predetermined secondary downlink carrier deactivation timer

detecting expiry of said predetermined secondary downlink carrier deactivation timer

determining

deciding that secondary downlink carrier power saving mode is to be switched ON, if said predetermined secondary downlink carrier deactivation timer is expired

Figure 4
observing a predetermined secondary downlink carrier deactivation timer

receiving a signaling from a network side on said primary downlink carrier

resetting the predetermined secondary downlink carrier deactivation timer, if a request for activating said secondary downlink carrier is included in said received signaling

receiving a transmission from a network side on said secondary downlink carrier

resetting the predetermined secondary downlink carrier deactivation timer, if said transmission from a network side on said secondary downlink carrier is received before expiration of said predetermined secondary downlink carrier deactivation timer

Figure 5
acquiring secondary downlink carrier activation and deactivation information for a combination of a primary and at least one secondary downlink carriers of a terminal device, said primary downlink carrier and said secondary downlink carrier operating with different radio technologies

determining whether secondary downlink carrier power saving mode is to be switched ON or OFF based on the secondary downlink carrier activation and deactivation information

transmitting, on said secondary downlink carrier, a request for switching ON of said secondary downlink carrier power saving mode

transmitting, on said secondary downlink carrier, a request for switching OFF of said secondary downlink carrier power saving mode

receiving permission

receiving denial

receiving permission

receiving denial

switching ON of said secondary downlink carrier power saving mode

switching OFF of said secondary downlink carrier power saving mode

Figure 6
INTERNATIONAL APPLICATION No. PCT/CN2012/073023

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/04 (2009.01)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04W; H04Q; H04L; H04B

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

WPI, EPODOC, CNPAT: secondary, cell, carrier, primary, downlink, DL, activate, deactivate, aggregation, component, CC, CA, power, saving, mode, PSM, sleep, standby, signaling, radio technology

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>WO2011/063244A2 (INTERDIGITAL PATENT HOLDINGS, INC.) 26 May 2011(26.05.2011) paragraphs [0017]-[0018], [0021], [0042]-[0043], [0046], [0056]-[0057] of the description</td>
<td>1-23</td>
</tr>
<tr>
<td>Y</td>
<td>WO2010/013942A2 (LG ELECTRONICS INC.) 04 Feb. 2010(04.02.2010) page 28 line 1 to page 29 line 8, page 34 line 20 to page 35 line 5, page 36 line 10 to page 39 line 9 of the description</td>
<td>1-23</td>
</tr>
<tr>
<td>A</td>
<td>US2011/0053658A1 (LG ELECTRONICS INC.) 03 Mar. 2011(03.03.2011) the whole document</td>
<td>1-23</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.

Date of the actual completion of the international search
01 Nov. 2012 (01.11.2012)

Date of mailing of the international search report
29 Nov. 2012 (29.11.2012)

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
YAN, Yan
Telephone No. (86-10)62413507

Form PCT/ISA /210 (second sheet) (July 2009)
<table>
<thead>
<tr>
<th>Patent Documents referred in the Report</th>
<th>Publication Date</th>
<th>Patent Family</th>
<th>Publication Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CN201967138U</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN102668669A</td>
<td>12.09.2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TW40406324U</td>
<td>21.06.2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TW201141285A</td>
<td>16.11.2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN102113290A</td>
<td>29.06.2011</td>
</tr>
<tr>
<td>WO2012/023839A2</td>
<td>23.02.2012</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>US2011/0053658A1</td>
<td>03.03.2011</td>
<td>KR20110025015A</td>
<td>09.03.2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO2011028012A2</td>
<td>10.03.2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN102484856A</td>
<td>30.05.2012</td>
</tr>
<tr>
<td>US201/0243008A1</td>
<td>06.10.2011</td>
<td>KR20110109148A</td>
<td>06.10.2011</td>
</tr>
</tbody>
</table>