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(71) Applicant (for all designated States except US): **TELEFONAKTIEBOLAGET L M ERICSSON (PUBL)** [SE/SE]; S-164 83 Stockholm (SE).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **SUNELL, Kai-Erik** [FI/SE]; Synälsvägen 7, S-168 73 Bromma (SE). **JOHANSSON, Klas** [SE/SE]; Fredsgatan 4A, S-172 33 Sundbyberg (SE). **BERGMAN, Johan** [SE/SE]; Kungsholmsgatan 9, S-112 27 Stockholm (SE).

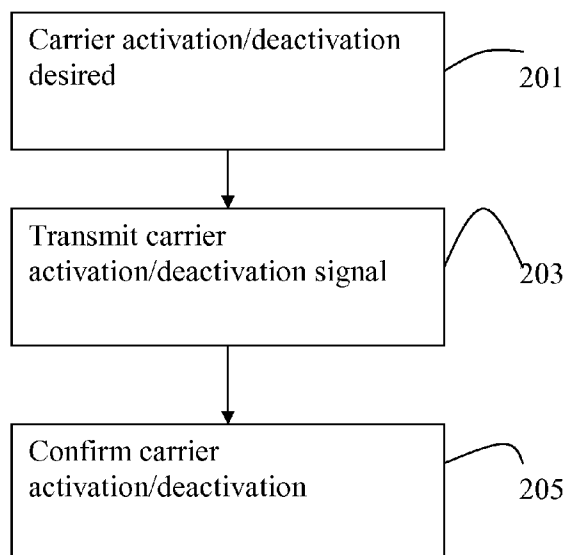
(74) Agent: **NILSSON, Charlotte**; Ericsson AB, Patent Unit 3G, Torshamnsgatan 21-23, S-164 80 Stockholm (SE).

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(54) Title: METHODS AND DEVICES FOR USE IN A MULTI CARRIER RADIO SYSTEM



(57) Abstract: A signaling mechanism is used for DC-HSUPA. The mechanism is used by the UE and RAN to allow the UE to perform secondary carrier activation or deactivation. The secondary carrier activation deactivation performed by a UE in a manner will ensures that the UE and RAN have the same view of the current activation state. In accordance with one embodiment, the UE transmits a request for carrier activation or deactivation to RAN over an activated carrier and awaits a positive or negative acknowledgement from RAN, or sends the signaling retroactively as a notification that a carrier has been deactivated.

Fig. 2



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METHODS AND DEVICES FOR USE IN A MULTI CARRIER RADIO SYSTEM

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TECHNICAL FIELD

The present invention relates to methods and devices for use in a multi carrier radio system.

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BACKGROUND

Dual-Carrier High-Speed Downlink Packet Access (DC-HSDPA, also known as Dual-Cell HSDPA) is currently being finalized within the 3rd Generation Partnership Project (3GPP) Release 8 (Rel-8). DC-HSDPA enables reception of data from two cells simultaneously, transmitted on two adjacent carriers in the same base station and sector, to individual terminals (or user equipment, UE).

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As a next step, Dual-Carrier High-Speed Uplink Packet Access (DC-HSUPA) is also envisioned and a 3GPP Rel-9 Work Item on the subject is to be finalized.

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Although the additional spectrum bandwidth associated with multi-carrier operation does not increase “spectral efficiency” (maximum achievable throughput per cell per Hz [bps/cell/Hz]), the experienced user data rates are increased significantly. In particular, for bursty packet data traffic at low and moderate load, the data rate is proportional to the number of carriers exploited. Moreover, power inefficient higher order modulation schemes such as 16 Quadrature Amplitude Modulation (QAM) can be avoided, which typically is important in the uplink, and the practical as well as theoretical peak data rate of the system are naturally increased.

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DC-HSUPA is specified as an aggregation of legacy (Rel-8, single-carrier) HSUPA. There is a constant desire to improve the performance in radio systems so that the efficiency in the systems can be improved. Hence there exists a need to improve the performance in a radio system employing multi carrier uplink transmissions.

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SUMMARY

It is an object of the present invention to provide improved methods and devices for transmission in a radio system employing multi carrier uplink transmissions.

10 This object and others are obtained by the methods and devices as set out in the appended claims.

Thus, in accordance with the invention a signaling mechanism is used for DC-HSUPA. The mechanism is used by the UE and RAN to allow the UE to perform secondary carrier
15 activation or deactivation. The secondary carrier activation deactivation performed by a UE in a manner will ensures that the UE and RAN have the same view of the current activation state. In accordance with one embodiment, the UE transmits a request for carrier activation or deactivation to RAN over an activated carrier and awaits a positive or negative acknowledgement from RAN, or sends the signaling retroactively as a notification that a
20 carrier has been deactivated.

In accordance with one embodiment a method in a user equipment is provide for signal interaction with a radio access network. The UE is configured for multi carrier uplink transmissions on a set of at least two carriers. In order to improve radio resource utilization,
25 the UE can transmit a signal to the RAN requesting a change in activation status of a carrier in said set of at least two carriers.

In accordance with one embodiment the signal is an Enhanced Dedicated Channel, E-DCH, Medium Access Control message wherein the requested change in activation status is indicated in the Enhanced Dedicated Channel Medium Access Control header.

- 5 In accordance with one embodiment the requested change in activation status is indicated using spare bits of a Medium Access Control-i header used for E-DCH Radio Network Temporary Identifier E-RNTI transmission.

- 10 In accordance with one embodiment the signal is transmitted on a E-DCH Dedicated Physical Control Channel, E-DPCCH, and the requested change in activation status is indicated by the setting of one or more of the E-DPCCH information fields E-DCH Transport Format Combination Index, E-TFCI, and Happy bit.

- 15 In accordance with one embodiment separate E-DPCCH channels and happy bits are associated with each carrier and the semantics of the happy bit associated with said carrier for which a change of activation status is requested is defined to indicate that a certain predefined bit value is a request for deactivation of the carrier.

- 20 In accordance with one embodiment separate E-DPCCH channels and E-TFCIs are associated with each carrier and the semantics of E-TFCI value 0 associated with said carrier for which change of activation status is requested is defined as a request for deactivation of said carrier.

- 25 In accordance with one embodiment the method comprises receiving a High-Speed Shared Control Channel, HS-SCCH, order indicating whether the request has been approved by the radio access network.

In accordance with one embodiment, if the radio access network approves the request, the UE detects a corresponding change in activation status of said carrier.

In accordance with one embodiment, in response to a request from the UE for a change of activation status, the UE receives a positive or negative acknowledgement from the radio access network on a downlink E-DCH Hybrid Indicator Channel, E-HICH, indicating
5 whether the request was approved.

In accordance with one embodiment the signal is a layer 3 message sent to a radio network controller the radio access network and wherein, if the request was approved, the UE receives an order to reconfigure said set of at least two carriers.

10 In accordance with one embodiment each carrier is associated with a UTRAN Absolute Radio Frequency Number, UARFCN, and said carrier for which a change in activation status is requested is indicated in said signal by a value indicating the position of said carriers associated UARFCN if sorting the UARFCNs of said at least two carriers according
15 to a predetermined scheme.

In accordance with one embodiment each carrier is associated with a UARFCN and said carrier for which a change in activation status is requested is indicated in said signal by its associated UARFCN.

20 In accordance with one embodiment each carrier in said set of at least two carriers is associated with a different E-RNTI and wherein said carrier for which a change in activation status is requested is indicated in said signal by its associated E-RNTI.

25 In accordance with one embodiment the UE is configured for dual carrier operation where one carrier is defined as a primary carrier and the other carrier is defined as a secondary carrier and said requested for change of activation status is always associated with said secondary carrier.

In accordance with one embodiment the change of activation status relates to deactivation of a carrier.

5 In accordance with one embodiment the change of activation status may be either activation or deactivation of a carrier.

In accordance with one embodiment the signal transmitted to the RAN requesting a change in activation status of a carrier in said set of at least two carriers is transmitted in response to determining (201) how to best use the current grant of multiple carriers.

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In accordance with one embodiment method in a user equipment for signal interaction with a radio access network is provided. The UE is configured for multi carrier uplink transmissions on a set of at least two carriers. The method comprises transmitting a signal to the RAN notifying the RAN of a change in activation status of a carrier in said set of at least
15 two carriers.

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In accordance with one embodiment a method in a node of a radio access network for signal interaction with a user equipment is provided. The RAN is configured for receiving multi carrier uplink transmissions on a set of at least two carriers. The method comprises
20 receiving a signal from the UE requesting a change in activation status of a carrier in said set of at least two carriers.

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In accordance with one embodiment the method comprises transmitting a High-Speed Shared Control Channel, HS-SCCH, order indicating whether the request has been approved
25 by the radio access network.

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In accordance with one embodiment a method in a node of a radio access network for signal interaction with user equipment is provided. The RAN is configured for receiving multi carrier uplink transmissions on a set of at least two carriers. The method comprises

receiving (203) a signal from the UE notifying the RAN of a change in activation status of a carrier in said set of at least two carriers.

5 In accordance with one embodiment a user equipment, UE, adapted for signal interaction with a radio access network is provided. The UE is configured for multi carrier uplink transmissions on a set of at least two carriers. The UE comprises means for transmitting a signal to the RAN requesting a change in activation status of a carrier in said set of at least two carriers.

10 In accordance with one embodiment the user equipment comprises means for receiving a High-Speed Shared Control Channel, HS-SCCH, order indicating whether the request has been approved by the radio access network.

15 In accordance with one embodiment the user equipment comprises means for detecting a change in activation status of a secondary carrier.

In accordance with one embodiment the user equipment comprises means for receiving a positive or negative acknowledgement from the radio access network on a downlink E-DCH Hybrid Indicator Channel, E-HICH, indicating whether a request has been approved.
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In accordance with one embodiment the user equipment comprises means for determining how to best use the current grant of multiple carriers.

25 In accordance with one embodiment a user equipment adapted for signal interaction with a radio access network is provided. The UE is configured for multi carrier uplink transmissions on a set of at least two carriers. The UE comprises means for transmitting a signal to the RAN notifying the RAN of a change in activation status of a carrier in said set of at least two carriers.

In accordance with one embodiment the user equipment comprises means for transmitting the signal to the RAN notifying the RAN of a change in activation status of a carrier in said set of at least two carriers as a Layer 3 message to a Radio Network Controller, RNC, in the RAN.

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In accordance with one embodiment a node of a radio access network for signal interaction with a user equipment is provided. The RAN is configured for receiving multi carrier uplink transmissions on a set of at least two carriers. The node comprises means for receiving a signal from the UE requesting a change in activation status of a carrier in said set of at least

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two carriers.

In accordance with one embodiment the node comprises means for transmitting a High-Speed Shared Control Channel, HS-SCCH, order indicating whether the request has been approved by the radio access network.

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In accordance with one embodiment a node of a radio access network for signal interaction with user equipment is provided. The RAN is configured for receiving multi carrier uplink transmissions on a set of at least two carriers. The node comprises means for receiving a signal from the UE notifying the RAN of a change in activation status of a carrier in said set

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BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described in more detail by way of non-limiting examples and with reference to the accompanying drawings, in which:

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- Fig. 1 is a general view of a cellular radio system, and
- Fig. 2 is a flowchart illustrating some procedural steps performed when activating/deactivating a secondary carrier for a user equipment.

DETAILED DESCRIPTION

The below description is given in the context of DC-HSUPA. However, all concepts are readily extendable to Multi-Carrier-HSUPA (MC-HSUPA) operation over more than two uplink carriers.

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In Fig. 1 a general view of a cellular radio system 100 is depicted. The system can for example be a HSDPA system adapted for data transmission using Multi-Carrier-HSUPA (MC-HSUPA), such as a DC-HSUPA system. The system comprises a number of radio base stations 101, here denoted NodeBs. A mobile station 103, here denoted User Equipment UE, that is in a geographical area covered by the radio base station can connect to a radio base station 101 over an air-interface. The mobile station 103 comprises a module 107 adapted to perform various tasks including the control of carrier allocation as described herein. The module 107 can for example be implemented using a micro controller or micro processor 108 operating on a set of computer software instructions stored on a memory 110 in the module 107. Further, the radio base stations 101 are connected to a central network controller such as a Radio Network Controller 105. The radio base station 101 and/or radio network controller 105 can comprise a modules 109 and 111, respectively adapted to perform various tasks including the control of carrier allocation as described herein. The module 109 can for example be implemented using a micro controller or micro processor 112 operating on a set of computer software instructions stored on a memory 114 in the module 109. The module 111 can for example be implemented using a micro controller or micro processor 116 operating on a set of computer software instructions stored on a memory 118 in the module 111.

25 Furthermore, handover and admission control is presumed to be conducted in the Radio Network Controller (RNC) based on measurements of path loss etc on a primary carrier (alternatively referred to as an anchor carrier). However, in case of a distributed RAN architecture where Node-B and RNC functionality as defined in 3GPP specifications are collocated in a base station, such as in a Long Term Evolution (LTE) system) the base

station would naturally handle also these functionalities. In a DC-HSUPA capable Node-B, the other carrier, which is referred to as a secondary carrier, is configured by the RNC for a given DC-HSUPA capable UE and then scheduled and activated by Node-B whenever feasible and useful. For example, a secondary carrier can typically be activated to maximize the supported traffic volumes, or aggregate system throughput, subject to fairness criteria and quality of service constraints, such as minimum bit rate or maximum latency requirements.

For each user equipment connected in DC-HSUPA mode, the serving Node-B controls whether or not a secondary carrier is activated, and a separate grant is selected for each activated carrier.

If a secondary carrier is activated by a radio base station Node-B, it can be assumed that the dedicated physical control channel (DPCCH) is transmitted on that carrier, and the Node-B hence tries to detect this signal.

However, even if a UE has been allocated a grant on multiple carriers, it may be the case that the grant on a secondary carrier can not be exploited. This could, for example, be because:

- The maximum transmit power available is limited and not sufficient to support all scheduled grants.
- The UE is (severely) interfering with a neighboring cell, which could be a consequence if cell plans are different on the primary carrier (on which mobility and handover control is based) and the secondary carrier.

Thus, the UE can be configured to determine how to best exploit the current grant taking into account parameters known by the UE, such as power limitation and interference with neighboring cells.

The inventors have recognized that at such occasions, it would be beneficial for the UE to disable transmission on a secondary carrier completely and autonomously. By turning off the secondary carrier completely, control channel overhead is minimized and it is possible for the UE to reconfigure its transmitter chain bandwidth, which in turn reduces co-channel interference and battery consumption.

In a first embodiment of the invention, in-band signaling where the UE requests are placed in the E-DCH MAC header is used. A special 2 bit field can be defined for this purpose in Rel-9 MAC header to convey the actual request and related information. One bit indicates the presence of the request and another bit indicates what kind of action is requested, i.e. activation or deactivation. The request field could be placed in the MAC header that corresponds to an entity that is terminated in the Node-B at the network side.

One benefit of this embodiment is that the UE request is transferred in a reliable manner due to both Layer (L1) forward error correction and Layer 2 (L2) backward error correction (i.e. retransmission protocols).

In addition to the indicators, the UE can inform the radio access network (RAN) about which one of the carriers that is activated or deactivated. This information can also be included in the E-DCH MAC header. In accordance with one embodiment numbers are assigned for the carriers. The radio interface is further implemented such that the numbering scheme is known by both sides of the interface. An example of a numbering scheme for dual carrier operation is to associate bit value 0 with the carrier that has the lowest UTRAN Absolute Radio Frequency Number (UARFCN) and further associate value 1 with the carrier that has the highest UARFCN. A similar kind of ascending or descending numbering scheme can be used for multiple carriers. Alternatively this kind of numbering scheme can be based on the absolute physical frequencies associated with the carriers (which in turn can be derived from the UARFCN numbers).

In another embodiment Rel-8 DC-HSDPA design principles are used, where the UE is assigned different Temporary Radio Network Identifiers (RNTI) for the different downlink carriers. For DC-HSUPA, the UE can be assigned different Enhanced dedicated channel (E-DCH) RNTIs (E-RNTI) that are associated with the different carriers. In accordance with one embodiment the E-RNTI are included in the same E-DCH MAC header that conveys the request. Since the association of E-RNTIs to different carriers is known by both RAN and UE side, there are no ambiguities which one of the carriers to be activated or deactivated. In accordance with one embodiment the RAN is configured to coordinate the allocation of E-RNTIs in order to ensure that the DC-HSUPA capable UE is not in error assigned the same E-RNTI for different carriers.

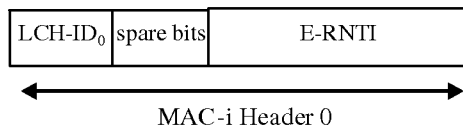
If the UE is never configured for operation with more than two carriers, it can be possible to avoid indication of carrier numbers or E-RNTIs sometimes. This is possible if the radio interface specifies one of the carriers as a primary carrier that must be always present to transfer user-data and necessary signaling, and the other carrier is, implicitly or explicitly defined as a secondary carrier that transfer only user-data and thereby it does not need to be used all the time. In this specific case, it is implicitly know by both UE and RAN which one of the carriers should be activated or deactivated when the UE determines to activate/deactivate, the secondary carrier.

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The current release of UMTS (Universal Mobile Telecommunications System) Terrestrial Radio Access (UTRA) standard specifies Medium Access Control (MAC)-i protocol sub-layer where the E-DCH MAC header field has 4 spare bits whenever E-RNTI transmission is needed. The purpose of these spare bits is to ensure octet aligned header length for E-RNTI transmission. In a variant of the first embodiment, these spare bits are used for the UE requests without redefining any new formats or protocols. Note that the MAC-i entity is terminated in Node-B at the network side as desired. Similarly, the UE needs to indicate its E-RNTI to Node-B anyway whenever it requests activation or deactivation of secondary carrier, which means that there is no increase in overhead with that respect either. The

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MAC-i format is illustrated below as specified in the normative part of 3GPP TS 25.321 v8.4.0 Figure 9.1.5.4c:



In an alternative embodiment, the UE request is transmitted over the E-DCH Dedicated Physical Control Channel (E-DPCCH) instead of in the E-DCH MAC header. This can be achieved by redefining one or more values in one or more of the E-DPCCH information fields (i.e. E-TFCI and Happy bit) as activation or deactivation requests.

Since not all signaling need to be duplicated for dual carrier operation, it is possible to redefine the semantics of some of these information fields such that they have a different meaning for dual carrier operation when compared to single carrier operation.

Similar to the first embodiment described above, the indication on E-DPCCH can carry information on which one of the carriers should be deactivated. In accordance with one embodiment separate E-DPCCH channels and happy bits are provided, which are associated with the different carriers. For example, the happy bit of the primary carrier can be set to indicate the “happiness” status for both carriers whereas the secondary carrier happy bit indicates whether the secondary carrier should be switched off (or maintained on). For example, the secondary carrier happy bit value 0 can be set to represent that the UE requests deactivation of the secondary carrier and the value 1 means that the UE prefer to keep the secondary carrier active. Also, the semantics of the bit values 0 or 1 can be defined the other way around.

In accordance with another embodiment the semantics of E-TFCI=0 for the secondary carrier is configured to represent a request to deactivate the secondary carrier. The downside of this alternative is that the UE can only request deactivation, i.e. the decision to activate the carrier again must then always be taken by RAN. In such an embodiment, one

possibility is to use the downlink channel E-DCH Hybrid Indicator Channel (E-HICH) to transmit the positive or negative acknowledgement from RAN. It is to be noted that in a conventionally configured system a Negative acknowledgement on E-DCH Hybrid Indicator Channel (E-HICH) normally means that data on E-DPDCH can not be decoded and that the UE should retransmit the data, but since there would not be any accompanying data transmission on E-DPDCH when (de)activation requests are transmitted on E-DPCCH, the meaning of the response on E-HICH can be redefined.

In yet another embodiment, the UE request is transmitted as a Layer 3 (L3) message to the RNC. Note that for some systems such as LTE the RNC is located in the radio base station (NodeB). In this embodiment, the same alternatives for indicating which carrier to activate/deactivate as in the first embodiment as described above can be used, i.e. based on numbering of UARFCN (or absolute physical frequencies) in an ascending or descending numbering scheme, including E-RNTI associated with the carrier or being implied due to the UE being configured for no more than two carriers ((DC-HSUPA) with one carrier being a primary carrier. In an alternative embodiment the UARFCN (or absolute physical frequency) of the carrier being activated/deactivated is included in the L3 message. If the RNC accepts the request, it reconfigures the UE and Node-B(s) to use the requested carrier configuration. This approach is slower than the L1- or L2-based solutions but assuming that there is enough time, the signaling will reach all involved nodes (UE, serving Node-B and non-serving Node-Bs) with very high reliability. Apart from the signaling between RAN and UE, this solution requires changes in the RNC-Node-B interfaces as well.

To confirm a request to activate or deactivate a secondary carrier, RAN can request the UE to activate or deactivate the secondary carrier, for example using an High-Speed Shared Control Channel (HS-SCCH) activation/deactivation order. The UE will, in turn acknowledge the HS-SCCH order and activate (or deactivate) the secondary carrier. In an alternative embodiment, an activation/deactivation of the secondary carrier is interpreted as a confirmation of said order.

To reject a request to activate or deactivate a secondary carrier, RAN can notify the UE for example by means of a specific HS-SCCH activation order. Alternatively, an HS-SCCH activation order is interpreted as a negative acknowledgement of a carrier deactivation request, and a HS-SCCH deactivation order as a negative acknowledgement of a carrier activation request. In yet another alternative embodiment, no response (via an HS-SCCH order) can also be interpreted as a reject of the said request.

In yet another embodiment, the UE does not wait for an acknowledgement from RAN but simply notifies (e.g. using E-DCH MAC, E-DPCCH or L3 message as discussed above) the RAN that a secondary carrier will be or has been deactivated or activated. In such an embodiment, the approval of the activation or deactivation can be viewed as delegated to the UE. This can be useful in situations where the e.g. the path loss situation varies quickly and the UE will not have time to wait for an acknowledgment and/or a negative acknowledgement will have fatal consequences for the ongoing communication due to UE transmit power starvation if the secondary carrier cannot be deactivated. Additional modifications of this embodiment can also be envisaged. For example, deactivation can be allowed to be performed autonomously by the UE without an approval from RAN, while activation requires approval from RAN.

In Fig. 2 a flow chart illustrating some procedural steps performed when providing a signaling mechanism for DC-HSUPA as described herein. The mechanism is used by the UE and RAN to allow the UE to perform secondary carrier activation or deactivation. First, in a step 201, a UE determines that an activation or deactivation of a secondary carrier is to be performed for example because one or many criteria are met. In particular the determination in step 201 can be based on how to best use the current grant of multiple carriers.

Next, in a step 203, signaling between the UE and a node of the RAN is performed for initiating the activation/deactivation of the secondary carrier. The RAN can then be

configured decide whether or not to perform the signaled activation/deactivation as described above. If the signaled activation/deactivation is approved by the RAN a confirmation can be sent back to the UE from a node of the RAN in a step 205. The UE can then start/stop using the activated/deactivated secondary carrier as the case may be.

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The methods and devices as described above will provide an improved allocation of radio resources because the RAN will have a clear view of the availability of a secondary carrier from a UE perspective. This facilitates more efficient radio and hardware resource

allocation. Moreover, the activation state of a secondary carrier can be solely controlled by
10 the RAN and not autonomously by the UE, which considerably simplifies carrier activation state logic in the RAN.

CLAIMS

1. A method in a user equipment, UE, for signal interaction with a radio access network, RAN, the UE being configured for multi carrier uplink transmissions on a set of at least two
5 carriers, the method comprising the step of:
transmitting (203) a signal to the RAN requesting a change in activation status of a carrier in said set of at least two carriers.
2. The method according to claim 1, wherein the signal is an Enhanced Dedicated Channel,
10 E-DCH, Medium Access Control message wherein the requested change in activation status is indicated in the Enhanced Dedicated Channel Medium Access Control, MAC, header.
3. The method according to claim 1, wherein the requested change in activation status is indicated using spare bits of a Medium Access Control-i header used for E-DCH Radio
15 Network Temporary Identifier, E-RNTI, transmission.
4. The method according to claim 1, wherein the signal is transmitted on a E-DCH Dedicated Physical Control Channel, E-DPCCH, and the requested change in activation status is indicated by the setting of one or more of the E-DPCCH information fields E-DCH
20 Transport Format Combination Index, E-TFCI, and Happy bit.
5. The method according to claim 4, wherein separate E-DPCCH channels and Happy bits are associated with each carrier and the semantics of the happy bit associated with said carrier for which a change of activation status is requested is defined to indicate that a
25 certain predefined bit value is a request for deactivation of the carrier.
6. The method according to claim 4, wherein separate E-DPCCH channels and E-TFCIs are associated with each carrier and the semantics of E-TFCI value 0 associated with said

carrier for which change of activation status is requested is defined as a request for deactivation of said carrier.

7. The method according to any of claims 1 - 6, further comprising the step of:

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- receiving (205) a High-Speed Shared Control Channel, HS-SCCH, order indicating whether the request has been approved by the radio access network.

8. The method according to any of claims 1 - 6, wherein if the radio access network
10 approves the request, the UE detects a corresponding change in activation status of said carrier.

9. The method according to any of claims 4 - 6, wherein in response to a request from the UE for a change of activation status, the UE receives a positive or negative
15 acknowledgement from the radio access network on a downlink E-DCH Hybrid Indicator Channel, E-HICH, indicating whether the request was approved.

10. The method according to claim 1, wherein the signal is a layer 3 message sent to a radio network controller the radio access network and wherein, if the request was approved, the
20 UE receives an order to reconfigure said set of at least two carriers.

11 The method according to any of claims 1 – 3 or 7 - 10, wherein each carrier is associated with a UTRAN Absolute Radio Frequency Number, UARFCN, and said carrier for which a change in activation status is requested is indicated in said signal by a value indicating the
25 position of said carriers associated UARFCN if sorting the UARFCNs of said at least two carriers according to a predetermined scheme.

12. The method according to any of claims 1 or 10, wherein each carrier is associated with a UARFCN and said carrier for which a change in activation status is requested is indicated in said signal by its associated UARFCN.

5 13. The method according to any of claims 1 – 3 or 7 - 10, wherein each carrier in said set of at least two carriers is associated with a different E-RNTI and wherein said carrier for which a change in activation status is requested is indicated in said signal by its associated E-RNTI.

10 14. The method according to any of claims 1 - 10, wherein said UE is configured for dual carrier operation where one carrier is defined as a primary carrier and the other carrier is defined as a secondary carrier and said requested for change of activation status is always associated with said secondary carrier.

15 15. The method according to any of claims 1 - 14, wherein the change of activation status relates to deactivation of a carrier.

16. The method according to any of claims 1 - 4, or 7 - 14, wherein the change of activation status may be either activation or deactivation of a carrier.

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17. The method according to any of claims 1 – 16, wherein the signal transmitted to the RAN requesting a change in activation status of a carrier in said set of at least two carriers is transmitted in response to determining (201) how to best use the current grant of multiple carriers.

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18. A method in a user equipment, UE, (103) for signal interaction with a radio access network, the UE being configured for multi carrier uplink transmissions on a set of at least two carriers, the method comprising the step of:

- transmitting (203) a signal to the RAN notifying the RAN of a change in activation status of a carrier in said set of at least two carriers.

19. The method according to claim 18, wherein the signal is an E-DCH MAC message
5 wherein the change in activation status is indicated in the E-DCH MAC header.

20. The method according to claim 19, wherein the change in activation status is indicated using spare bits of a MAC-i header used for E-RNTI transmission.

10 21. The method according to claim 18, wherein the signal is transmitted on a E-DPCCH and the change in activation status is indicated by the setting of one or more of the E-DPCCH information fields E-TFCI and Happy bit.

22. The method according to claim 21, wherein separate E-DPCCH channels and Happy bits
15 are associated with each carrier and the semantics of the happy bit associated with said carrier for which a change in activation status is notified is defined such that a certain predefined bit value indicates deactivation of said carrier.

23. The method according to claim 21, wherein separate E-DPCCH channels and E-TFCIs
20 are associated with each carrier and the semantics of E-TFCI value 0 associated with said carrier for which a change in activation status is notified is defined as indicating deactivation of said carrier.

24. The method according to claim 18, wherein the signal is a Layer 3 message sent to a
25 Radio Network Controller, RNC, (105) in the RAN.

25. The method according to any of claims 18 - 20 or 24, wherein each carrier is associated with a UARFCN and said carrier for which a change in activation status is notified is indicated in said signal by a value indicating the position of said carriers associated

UARFCN if sorting the UARFCNs of said at least two carriers according to a predetermined scheme.

26. The method according to any of claims 18 or 24, wherein each carrier is associated with a UARFCN and said carrier for which a change in activation status is notified is indicated in said signal by its associated UARFCN.

27. The method according to any of claims 18 - 20 or 24, wherein each carrier in said set of at least two carriers is associated with a different E-RNTI and wherein said carrier for which a change in activation status is notified is indicated in said signal by its associated E-RNTI.

28. The method according to any of claims 18 - 24, wherein said UE is configured for dual carrier operation where one carrier is defined as a primary carrier and the other carrier is defined as a secondary carrier and said change of activation status is always associated with said secondary carrier.

29. The method according to any of claims 18 - 28, wherein the change of activation status relates to deactivation of a carrier.

30. The method according to any of claims 18 - 21 or 24 - 28, wherein the change of activation status may be either activation or deactivation of a carrier.

31. A method in a node of a radio access network, RAN for signal interaction with a user equipment, UE, the RAN being configured for receiving multi carrier uplink transmissions on a set of at least two carriers, the method comprising the steps of:
receiving (203) a signal from the UE requesting a change in activation status of a carrier in said set of at least two carriers.

32. The method according to claim 31, wherein the signal is an Enhanced Dedicated Channel, E-DCH, Medium Access Control message wherein the requested change in activation status is indicated in the Enhanced Dedicated Channel Medium Access Control, MAC, header.

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33. The method according to claim 31, wherein the requested change in activation status is indicated using spare bits of a Medium Access Control-i header used for E-DCH Radio Network Temporary Identifier E-RNTI transmission.

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34. The method according to claim 31, wherein the signal is transmitted on a E-DCH Dedicated Physical Control Channel, E-DPCCH, and the requested change in activation status is indicated by the setting of one or more of the E-DPCCH information fields E-DCH Transport Format Combination Index, E-TFCI, and Happy bit.

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35. The method according to claim 34, wherein separate E-DPCCH channels and Happy bits are associated with each carrier and the semantics of the happy bit associated with said carrier for which a change of activation status is requested is defined to indicate that a certain predefined bit value is a request for deactivation of the carrier.

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36. The method according to claim 34, wherein separate E-DPCCH channels and E-TFCIs are associated with each carrier and the semantics of E-TFCI value 0 associated with said carrier for which change of activation status is requested is defined as a request for deactivation of said carrier.

25

37. The method according to any of claims 31 - 36, further comprising the step of:

- transmitting (205) a High-Speed Shared Control Channel, HS-SCCH, order indicating whether the request has been approved by the radio access network.

38. The method according to any of claims 31 - 37, wherein the change of activation status relates to deactivation of a carrier.

39. The method according to any of claims 31 - 34, wherein the change of activation status
5 may be either activation or deactivation of a carrier.

40. A method in a node of a radio access network, RAN, for signal interaction with user equipment, UE, the RAN being configured for receiving multi carrier uplink transmissions on a set of at least two carriers, the method comprising the step of:

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- receiving (203) a signal from the UE notifying the RAN of a change in activation status of a carrier in said set of at least two carriers.

41. The method according to claim 40, wherein the signal is an E-DCH MAC message
15 wherein the change in activation status is indicated in the E-DCH MAC header.

42 The method according to claim 41, wherein the change in activation status is indicated using spare bits of a MAC-i header used for E-RNTI transmission.

20 43 The method according to claim 40, wherein the signal is received on a E-DPCCH and the change in activation status is indicated by the setting of one or more of the E-DPCCH information fields E-TFCI and Happy bit.

44. The method according to claim 43, wherein separate E-DPCCH channels and Happy bits
25 are associated with each carrier and the semantics of the happy bit associated with said carrier for which a change in activation status is notified is defined such that a certain predefined bit value indicates deactivation of said carrier.

45. The method according to claim 43, wherein separate E-DPCCH channels and E-TFCIs are associated with each carrier and the semantics of E-TFCI value 0 associated with said carrier for which a change in activation status is notified is defined as indicating deactivation of said carrier.

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46. The method according to claim 40, wherein the signal is a Layer 3 message received by a Radio Network Controller, RNC, in the RAN.

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47. The method according to any of claims 40 - 46, wherein the change of activation status relates to deactivation of a carrier.

48. The method according to any of claims 40 – 43, wherein the change of activation status may be either activation or deactivation of a carrier.

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49. A user equipment, UE, (103) adapted for signal interaction with a radio access network, RAN, the UE being configured for multi carrier uplink transmissions on a set of at least two carriers, the UE comprising:

- means (107) for transmitting a signal to the RAN requesting a change in activation status of a carrier in said set of at least two carriers.

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50. The user equipment according to claim 49, wherein the signal is an Enhanced Dedicated Channel, E-DCH, Medium Access Control message wherein the requested change in activation status is indicated in the Enhanced Dedicated Channel Medium Access Control header.

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51. The user equipment according to claim 49, wherein the requested change in activation status is indicated using spare bits of a Medium Access Control-i header used for E-DCH Radio Network Temporary Identifier E-RNTI transmission.

52. The user equipment according to claim 49, comprising means for transmitting the signal on a E-DCH Dedicated Physical Control Channel, E-DPCCH, and the requested change in activation status is indicated by the setting of one or more of the E-DPCCH information fields E-DCH Transport Format Combination Index, E-TFCI, and Happy bit.

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53. The user equipment according to claim 52, wherein separate E-DPCCH channels and Happy bits are associated with each carrier and the semantics of the happy bit associated with said carrier for which a change of activation status is requested is defined to indicate that a certain predefined bit value is a request for deactivation of the carrier.

10

54. The user equipment according to claim 52, wherein separate E-DPCCH channels and E-TFCIs are associated with each carrier and the semantics of E-TFCI value 0 associated with said carrier for which change of activation status is requested is defined as a request for deactivation of said carrier.

15

55. The user equipment according to any of claims 49 - 54, further comprising:

- means (107) for receiving a High-Speed Shared Control Channel, HS-SCCH, order indicating whether the request has been approved by the radio access network.

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56. The user equipment according to any of claims 49 - 55, comprising means (107) for detecting a change in activation status of a secondary carrier.

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57. The user equipment according to any of claims 52 - 54, comprising means for receiving a positive or negative acknowledgement from the radio access network on a downlink E-DCH Hybrid Indicator Channel, E-HICH, indicating whether a request has been approved.

58. The user equipment according to claim 49, comprising means for transmitting a layer 3 message to a radio network controller the radio access network.

59. The user equipment according to any of claims 49 – 51 or 55 - 58, wherein each carrier is associated with a UTRAN Absolute Radio Frequency Number, UARFCN, and said carrier for which a change in activation status is requested is indicated in said signal by a value indicating the position of said carriers associated UARFCN if sorting the UARFCNs of said at least two carriers according to a predetermined scheme.

60. The user equipment according to any of claims 49 or 58, wherein each carrier is associated with a UARFCN and said carrier for which a change in activation status is requested is indicated in said signal by its associated UARFCN.

61. The user equipment according to any of claims 49 – 51 or 55 - 58, wherein each carrier in said set of at least two carriers is associated with a different E-RNTI and wherein said carrier for which a change in activation status is requested is indicated in said signal by its associated E-RNTI.

62. The user equipment according to any of claims 49 - 58, wherein said UE is configured for dual carrier operation where one carrier is defined as a primary carrier and the other carrier is defined as a secondary carrier and said requested for change of activation status is always associated with said secondary carrier.

63. The user equipment according to any of claims 49 - 61, wherein the change of activation status is deactivation of a carrier.

64. The user equipment according to any of claims 49 -52, or 55 - 62, wherein the change of activation status is either activation or deactivation of a carrier.

65. The user equipment according to any of claims 49 – 64, comprising means (107) for determining how to best use the current grant of multiple carriers.

66. A user equipment, UE, (103) adapted for signal interaction with a radio access network, the UE being configured for multi carrier uplink transmissions on a set of at least two carriers, the UE comprising:

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- means (107) for transmitting a signal to the RAN notifying the RAN of a change in activation status of a carrier in said set of at least two carriers.

67. The user equipment according to claim 66, wherein the signal is an E-DCH MAC
10 message wherein the change in activation status is indicated in the E-DCH MAC header.

68. The user equipment according to claim 67, wherein the change in activation status is indicated using spare bits of a MAC-i header used for E-RNTI transmission.

15 69. The user equipment according to claim 66, comprising means for transmitting the signal on a E-DPCCH where the change in activation status is indicated by the setting of one or more of the E-DPCCH information fields E-TFCI and Happy bit.

20 70. The user equipment according to claim 66, comprising means for transmitting the signal as a Layer 3 message to a Radio Network Controller, RNC, in the RAN.

71. The user equipment according to any of claims 66 – 70, wherein the UE is configured for dual carrier operation where one carrier is defined as a primary carrier and the other carrier is defined as a secondary carrier and said change of activation status is always
25 associated with said secondary carrier.

72. The user equipment according to any of claims 66 - 71, wherein the change of activation status relates to deactivation of a carrier.

73. The user equipment according to any of claims 66 – 69, wherein the change of activation status may be either activation or deactivation of a carrier.

74. A node (101, 105) of a radio access network, RAN for signal interaction with a user equipment, UE, the RAN being configured for receiving multi carrier uplink transmissions on a set of at least two carriers, the node comprising:

- means (109, 111) for receiving a signal from the UE requesting a change in activation status of a carrier in said set of at least two carriers.

75. The node according to claim 74, wherein the signal is an Enhanced Dedicated Channel, E-DCH, Medium Access Control message wherein the requested change in activation status is indicated in the Enhanced Dedicated Channel Medium Access Control header.

76. The node according to claim 74, wherein the requested change in activation status is indicated using spare bits of a Medium Access Control-i header used for E-DCH Radio Network Temporary Identifier E-RNTI transmission.

77. The node according to claim 74, wherein the signal is transmitted on a E-DCH Dedicated Physical Control Channel, E-DPCCH, and the requested change in activation status is indicated by the setting of one or more of the E-DPCCH information fields E-DCH Transport Format Combination Index, E-TFCI, and Happy bit.

78. The node according to any of claims 74 - 77, further comprising:

- means for transmitting a High-Speed Shared Control Channel, HS-SCCH, order indicating whether the request has been approved by the radio access network.

79. The node according to any of claims 74 - 78, wherein the change of activation status relates to deactivation of a carrier.

80. The node according to any of claims 74 - 77, wherein the change of activation status may be either activation or deactivation of a carrier.

5 81. A node (101, 105) of a radio access network, RAN, for signal interaction with user equipment, UE, the RAN being configured for receiving multi carrier uplink transmissions on a set of at least two carriers, the node comprising:

10 - means (109, 111) for receiving a signal from the UE notifying the RAN of a change in activation status of a carrier in said set of at least two carriers.

82. The node according to claim 81, wherein the signal is an E-DCH MAC message wherein the change in activation status is indicated in the E-DCH MAC header.

15 83 The node according to claim 82, wherein the change in activation status is indicated using spare bits of a MAC-i header used for E-RNTI transmission.

84. The node according to claim 81, comprising means for receiving the signal as a Layer 3 message.

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85. The node according to any of claims 81 - 84, wherein the change of activation status relates to deactivation of a carrier.

25 86. The node according to any of claims 81 - 85, wherein the change of activation status may be either activation or deactivation of a carrier.

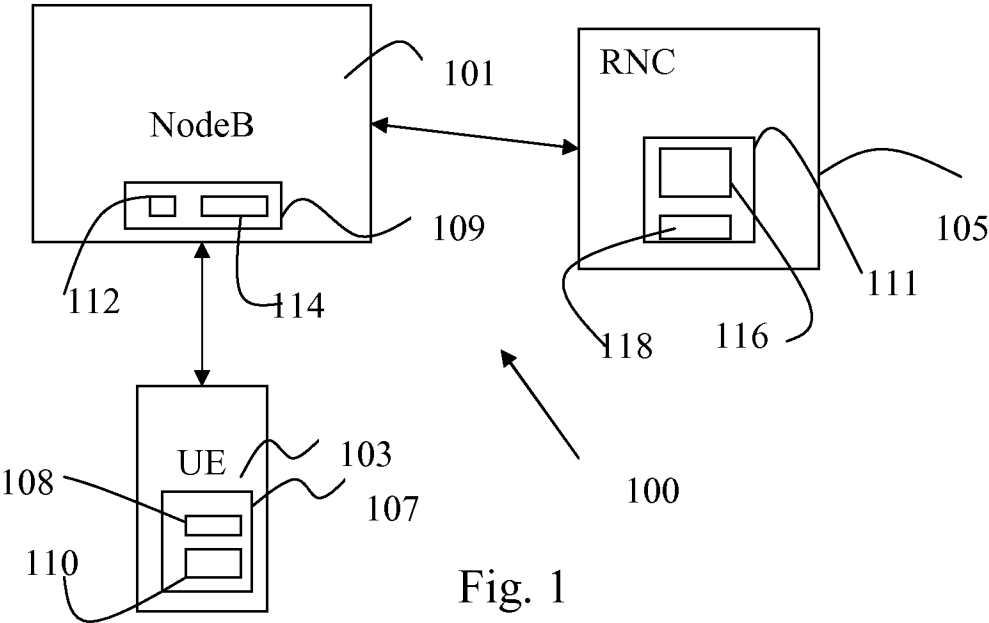


Fig. 1

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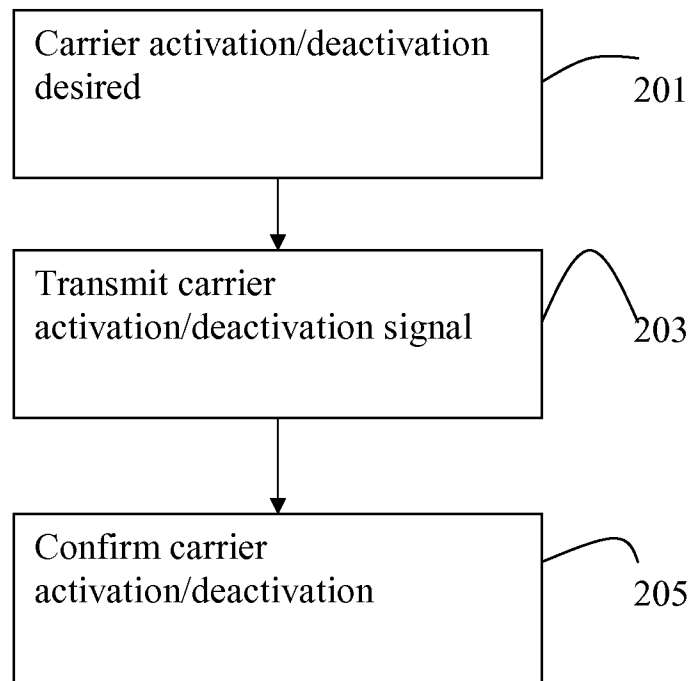


Fig. 2