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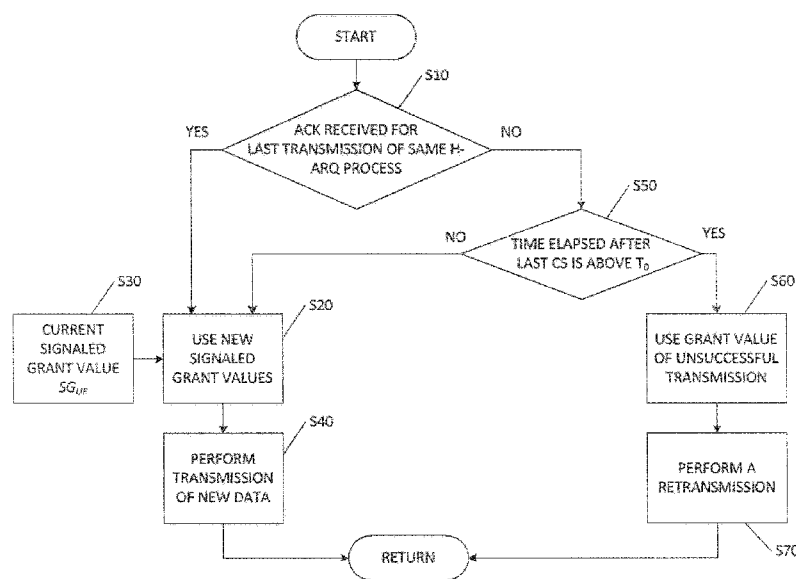


Fig. 3

(57) Abstract: There is provided a mechanism for controlling a communication in UL direction where a load balancing mechanism such as carrier switching is conducted. When a carrier switching for switching a communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier is executed, it is determined whether a retransmission of data is required. In case a time being measured beginning from a switching time where the carrier switching is executed is below a threshold, the retransmission of the data is disabled.

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MECHANISM FOR CONTROLLING AN UPLINK COMMUNICATION

DESCRIPTION

5 BACKGROUND OF THE INVENTION

Field of the invention

10 The present invention relates to a mechanism for controlling a communication. Specifically, the present invention is related to an apparatus, a method, a system and a computer program product which allow, for example, a control of a communication in uplink direction with measures providing a fast load balancing in situations where there is a high load e.g. in the uplink direction.

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The following meanings for the abbreviations used in this specification apply:

	ACK:	acknowledgement
20	BLER:	block error rate
	BS:	base station
	CPU:	central processing unit
	CS:	carrier switch
	DL:	downlink
25	DPCCH:	dedicated physical control channel
	eNB:	evolved node B
	E-AGCH:	enhanced absolute grant channel
	E-DPDCH:	enhanced dedicated physical data channel
	E-RGCH:	enhanced relative grant channel
30	FCS:	fast carrier switching
	FDD:	frequency division duplex
	H-ARQ:	hybrid automatic repeat request
	HO:	handover
	HSPA:	high speed packet access
35	HSUPA:	high-speed uplink packet access

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ILPC: inner loop power control

LTE: Long Term Evolution

LTE-A: LTE Advanced

Node B: base station in 3GPP, with a Serving Node B as a base station
 5 that the UE is associated to, and a Non-serving Node B as a
 base station that is included in the active set of the UE for soft-
 HO operation but is not the serving Node B

OLPC: outer loop power control

RoT: rise over thermal

10 RX: receiver

S-E-DPDCH: secondary E-DPDCH

SG: scheduling grant

SIR: signal-to-interference ratio

TDD: time division duplex

15 TTI: transmission timing interval

TX: transmitter

WCDMA : wideband code division multiple access

UE: user equipment

UL: uplink

20 UMTS: Universal Mobile Telecommunication Services

UTRA: UMTS terrestrial radio access

UTRAN: UMTS terrestrial radio access network

25 In the last years, an increasing extension of communication networks, e.g.
 of wire based communication networks, such as the Integrated Services
 Digital Network (ISDN), DSL, or wireless communication networks, such as
 the cdma2000 (code division multiple access) system, cellular 3rd
 generation (3G) and fourth generation (4G) communication networks like
 the Universal Mobile Telecommunications System (UMTS), enhanced
 30 communication networks based e.g. on LTE or LTE-A, cellular 2nd
 generation (2G) communication networks like the Global System for Mobile
 communications (GSM), the General Packet Radio System (GPRS), the
 Enhanced Data Rates for Global Evolution (EDGE), or other wireless
 communication system, such as the Wireless Local Area Network (WLAN),
 35 Bluetooth or Worldwide Interoperability for Microwave Access (WiMAX), took
 place all over the world. Various organizations, such as the 3rd Generation

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Partnership Project (3GPP), Telecoms & Internet converged Services & Protocols for Advanced Networks (TISPAN), the International Telecommunication Union (ITU), 3rd Generation Partnership Project 2 (3GPP2), Internet Engineering Task Force (IETF), the IEEE (Institute of Electrical and Electronics Engineers), the WiMAX Forum and the like are working on standards for telecommunication network and access environments.

Generally, for properly establishing and handling a communication connection between terminal devices such as a user equipment (UE) and another communication network element or user equipment, a database, a server, etc., one or more intermediate network elements such as communication network control elements, such as base stations, control nodes, support nodes or service nodes are involved which may belong to different communication network.

Communications between a communication element such as a UE and a communication network control element such as a BS or NodeB in the UL and DL direction are conducted via one or more carriers. The increasing demand for wireless broadband access leads to an ongoing development of enhanced radio network systems, wherein the 3GPP WCDMA-based UTRA is one example. As one approach for increasing the performance of the communication systems, measures like HSPA are further employed, both in the UL and DL direction. Specifically, HSUPA is aimed at efficiently supporting packet traffic in the UL direction, wherein for an error correction a H-ARQ process is used.

The physical channel structure of HSUPA uses for example the DPCCH pilot channel as a reference channel for channel estimation and transmit power control processing. Also other channels are used, such as an E-DPCCH (enhanced DPCCH) which can be used for carrying HSUPA-related control information and also as an additional reference channel for improved channel estimation, or an E-DPDCH which is used for data transmission. In a conventional HSUPA implementation, all of these channels are spread by orthogonal spreading codes.

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Two power control loops can be used to control the BLER experienced by the transport blocks originating from the UE. A first one, referred to as OLPC, is used to adjust the target SIR of the reference channel (DPCCH). Furthermore, as a second one, an inner loop power control (ILPC) is used to
5 adjust the radiated power in the UE, so that the target SIR is met.

However, in systems such as a HSUPA system, all users share the same physical resource, but are separated in the code domain (through WCDMA). That is, the users are transmitting on top of each other with different codes
10 which causes interferences with regard to each other. In a conventional HSUPA system, the user is fixed on the carrier configured or selected during the initial access for the duration of the packet call (or the entire session). However, in case there is a relative high load in the UL direction, the system performance is degraded, and it may become necessary to take measures
15 against this, for example to do some load balancing or the like.

SUMMARY OF THE INVENTION

It is an object of the invention to overcome at least some of the above
20 described problems and to provide an enhanced mechanism for controlling a communication. Specifically, it is an object of the present invention to provide an improved apparatus, method, system and computer program product which allow, for example, to control a communication in the UL direction wherein measures are taken for providing a fast load balancing in
25 high load situations in the UL direction.

These objects are achieved by the measures defined in the attached claims.

According to an example of an embodiment of the proposed solution, there
30 is provided, for example, an apparatus comprising at least one processor, at least one interface to at least one other network element, and at least one memory for storing instructions to be executed by the processor, wherein the at least one memory and the instructions are configured to, with the at least one processor, cause the apparatus at least to perform: a carrier
35 switching function configured to conduct a carrier switching for switching a

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communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier, a switching determining function configured to determine whether a carrier switching is executed, a retransmission determining function configured to determine whether a retransmission of data is required, and a time measuring function configured to measure a time beginning from a switching time where the carrier switching is executed, wherein the retransmission determining function is further configured to disable the retransmission of the data in case the time measured by the time measuring function is below a predetermined time threshold.

Furthermore, according to an example of an embodiment of the proposed solution, there is provided, for example, a method comprising determining whether a carrier switching for switching a communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier is executed, measuring a time beginning from a switching time where the carrier switching is executed, determining whether a retransmission of data is required, and disabling the retransmission of the data in case the time being measured is below a predetermined time threshold.

According to further refinements, these examples may comprise one or more of the following features:

- a current scheduling grant for a current uplink communication may be determined, and a transmission of new data by using the current scheduling grant may be caused when a retransmission of data is not required, or a transmission of new data by using the current scheduling grant may be caused when the retransmission is disabled;

- the retransmission of data may be determined to be required when at least one of the following is valid: an acknowledgement for a successful transmission in a preceding transmission cycle in one hybrid automatic repeat request process is not determined to be received, and an incorrect transmission or decoding of a transport block in a preceding transmission cycle is detected, wherein the disabling of the retransmission may be achieved by stopping the hybrid automatic repeat request process;

- when it is determined that the retransmission is not to be disabled, the retransmission of the data by using a preceding scheduling grant valid

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for a communication may be caused before the switching of the at least one frequency carrier;

- a value of the predetermined time threshold may be one of a preset time value being stored, and a time value signaled by a communication network control element as policy information, wherein the predetermined time threshold may be based on a time where a power level of a reference control channel is converged to a target level;

- a condition on a frequency carrier to which the communication is switched in comparison to a condition on a frequency carrier from which the communication is switched may be detected, and the disabling of the retransmission may be cancelled in case it is detected that a total power gain on the frequency carrier to which the communication is switched is lower than a total power gain on the frequency carrier from which the communication is switched;

- the communication may be a high speed packet access based communication, wherein the carrier switching may be conducted for switching the communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier in a same cell or in a different cell of a communication network on the basis of one of a command received from a communication network control element, and a processing result of an internal determination processing for determining whether the carrier switching is to be conducted;

- the above measures may be implemented in a communication element comprising at least one of a terminal device or user equipment communicating with a communication network control element, wherein the communication may be conducted with the communication network control element which may comprise at least one of a base station or an access node of a cellular communication network.

According to an example of an embodiment of the proposed solution, there is provided, for example, an apparatus comprising at least one processor, at least one interface to at least one other network element, and at least one memory for storing instructions to be executed by the processor, wherein the at least one memory and the instructions are configured to, with the at least one processor, cause the apparatus at least to perform: a carrier switching detecting function configured to detect that a carrier switching for

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switching a communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier is executed, a time measuring function configured to measure a time beginning from a switching time where the carrier switching is executed, and a scheduling grant processing function configured to conduct a scheduling grant procedure after the carrier switching is detected, wherein the scheduling grant procedure includes: determining a current scheduling grant value for an uplink communication, wherein the current scheduling grant value is determined on the basis of whether or not the time measured by the time measuring function is below a predetermined time threshold, and causing a transmission of an update message indicating the current scheduling grant value.

Furthermore, according to an example of an embodiment of the proposed solution, there is provided, for example, a method comprising detecting that a carrier switching for switching a communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier is executed, measuring a time beginning from a switching time where the carrier switching is executed, and conducting a scheduling grant procedure after the carrier switching is detected, wherein the scheduling grant procedure includes: determining a current scheduling grant value for an uplink communication, wherein the current scheduling grant value is determined on the basis of whether or not the time measured by the time measuring function is below a predetermined time threshold, and causing a transmission of an update message indicating the current scheduling grant value.

According to further refinements, these examples may comprise one or more of the following features:

- the scheduling grant procedure may further include: in case the time being measured is equal to or greater than the predetermined time threshold, calculating a new scheduling grant value on the basis of a target power level allowed for the communication and a currently measured power level of a reference control channel, and setting the new scheduling grant value as the current scheduling grant value; and in case the measured time is below the predetermined time threshold, obtaining a former scheduling

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grant value on the basis of a scheduling grant value determined in at least one previous scheduling grant procedure being conducted before the carrier switching is executed, and setting the former scheduling grant value as the current scheduling grant value.

5 - the scheduling grant procedure may further include: calculating a new scheduling grant value on the basis of a target power level allowed for the communication and a currently measured power level of a reference control channel, obtaining a former scheduling grant value on the basis of a scheduling grant value determined in a previous scheduling grant procedure
10 being conducted before the carrier switching is executed, setting the former scheduling grant value as the current scheduling grant value, in case the measured time is below the predetermined time threshold and the new scheduling grant value is equal to or greater than the former scheduling grant value, and setting the new scheduling grant value as the current
15 scheduling grant value, in case the measured time is equal to or greater than the predetermined time threshold or in case the new scheduling grant value is lower than the former scheduling grant value;

 - the scheduling grant procedure may further include: obtaining the former scheduling grant value by one of retrieving a last scheduling grant
20 value determined immediately before the detection of the carrier switching and setting the last scheduling grant value as the former scheduling grant value, and conducting an arithmetic processing on plural scheduling grant values determined before the detection of the carrier switching and setting the result of the arithmetic processing as the former scheduling grant value;

25 - the scheduling grant procedure may further include: in case the measured time is equal to or greater than the predetermined time threshold, calculating a new scheduling grant value on the basis of a target power level allowed for the communication and a currently measured power level of a reference control channel, and setting the new scheduling grant
30 value as the current scheduling grant value; and in case the measured time is below the predetermined time threshold, calculating an alternative scheduling grant value on the basis of a target power level allowed for the communication and a former power value of the reference control channel detected in at least one previous scheduling grant procedure being
35 conducted before the carrier switching is executed, and setting the alternative scheduling grant value as the current scheduling grant value;

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- the scheduling grant procedure may further include: obtaining a currently measured power level of a reference control channel and a former power value of the reference control channel detected in at least one previous scheduling grant procedure being conducted before the carrier switching is executed, calculating a new scheduling grant value on the basis of a target power level allowed for the communication and the former power level of the reference control channel, in case the measured time is below the predetermined time threshold and the currently measured power level of the reference control channel is equal to or below the former power level of the reference control channel, or calculating a new scheduling grant value on the basis of a target power level allowed for the communication and the currently measured power level of the reference control channel, in case the measured time is equal to or greater than the predetermined time threshold or the currently measured power level of the reference control channel is greater than the former power level of the reference control channel, and setting the new scheduling grant value as the current scheduling grant value;

- the scheduling grant procedure may further include: obtaining the former power level of the reference control channel by one of retrieving a last power level of the reference control channel detected in the scheduling grant procedure being conducted immediately before the detection of the carrier switching and setting the last power level of the reference control channel as the former power level of the reference control channel, and conducting an arithmetic processing on plural power levels of the reference control channel determined before the detection of the carrier switching and setting the result of the arithmetic processing as the former scheduling grant value;

- the power level of the reference control channel may be a power level of a dedicated physical control channel;

- the predetermined time threshold may be based on a time where a power level of a reference control channel is converged to a target level;

- the communication may be a high speed packet access based communication, wherein the carrier switching may be conducted for switching the communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier in a same cell or in a different cell of a communication network;

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5 - the above described measures may be implemented in a communication network control element comprising at least one of a base station or an access node of a cellular communication network, wherein the communication may be conducted with a communication element comprising at least one of a terminal device or user equipment communicating with the communication network control element.

10 Moreover, according to an example of an embodiment of the proposed solution, there is provided, for example, a communication system comprising communication element comprising at least one a terminal device or user equipment communicating in an uplink direction and being capable of conducting a carrier switching for switching a communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier, and a communication network control element comprising
15 at least one of a base station or an access node, wherein the communication is conducted between the communication element and the communication network control element.

20 In addition, according to examples of the proposed solution, there is provided, for example, a computer program product for a computer, comprising software code portions for performing the steps of the above defined methods, when said product is run on the computer. The computer program product may comprise a computer-readable medium on which said software code portions are stored. Furthermore, the computer program
25 product may be directly loadable into the internal memory of the computer and/or transmittable via a network by means of at least one of upload, download and push procedures.

30 By virtue of the proposed solutions, it is possible to provide an enhanced mechanism for controlling a communication e.g. in the UL direction wherein measures are taken for providing a fast load balancing in high load situations in the UL direction. In particular, by means of the measures according to some examples of the embodiments of the invention, a probability of data loss is significantly reduced after conducting a measure
35 for load balancing, such as a carrier switching, while an interference surge caused by a sudden TX power increase after such a load balancing measure

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is eliminated or reduced as well. Hence, a higher system stability is achieved. For example, according to some examples of embodiments of the invention, sudden jumps in scheduling grants after a carrier switching is avoided, e.g. when a current frequency carrier has a lower total power gain of the radio channel than a previous carrier, so that a scheduling grant stabilization is achieved as well.

The above and still further objects, features and advantages of the invention will become more apparent upon referring to the description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a diagram illustrating a communication network configuration where some examples of embodiments of the invention are implemented.

Fig. 2 shows a flowchart illustrating a processing executed in a communication element for controlling a communication in the UL direction according to one example.

Fig. 3 shows a flowchart illustrating a processing executed in a communication element for controlling a communication in the UL direction according to an example of an embodiment of the invention.

Fig. 4 shows a flowchart illustrating a processing executed in a communication network control element for providing a resource indication for controlling a communication in the UL direction according to one example.

Fig. 5 shows a flowchart illustrating a processing executed in a communication network control element for providing a resource indication for controlling a communication in the UL direction according to an example of an embodiment of the invention.

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Fig. 6 shows a flowchart illustrating a processing executed in a communication network control element for providing a resource indication for controlling a communication in the UL direction according to another example of an embodiment of the invention.

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Fig. 7 shows a flowchart illustrating a processing executed in a communication network control element for providing a resource indication for controlling a communication in the UL direction according to another example of an embodiment of the invention.

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Fig. 8 shows a flowchart illustrating a processing executed in a communication network control element for providing a resource indication for controlling a communication in the UL direction according to another example of an embodiment of the invention.

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Fig. 9 shows a time chart illustrating a system behavior in case of conducting load balancing measures in an UL communication using a carrier switching according to a comparative example.

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Fig. 10 shows a time chart illustrating a system behavior in case of conducting load balancing measures in an UL communication using a carrier switching according to examples of embodiments of the invention.

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Fig. 11 shows a flowchart illustrating a processing executed in a communication element for controlling a communication in the UL direction according to examples of embodiments of the invention.

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Fig. 12 shows a flowchart illustrating a processing executed in a communication network control element for controlling a communication in the UL direction according to examples of embodiments of the invention.

Fig. 13 shows a block circuit diagram of a communication element including processing portions conducting functions according to examples of embodiments of the invention.

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Fig. 14 shows a block circuit diagram of a communication network control element including processing portions conducting functions according to examples of embodiments of the invention.

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DESCRIPTION OF PREFERRED EMBODIMENTS

In the following, examples and embodiments of the present invention are described with reference to the drawings. For illustrating the present invention, the examples and embodiments will be described in connection with a cellular communication network based on a 3GPP based communication system using WCDMA FDD technology, for example an UTRAN based system. However, it is to be noted that the present invention is not limited to an application using such types of communication system, but is also applicable in other types of communication systems and the like, for example an LTE or LTE-A based communication system, in TDD based systems and the like, as long as load balancing mechanisms like carrier switching are applicable in a communication conducted therein.

20 A basic system architecture of a communication network where examples of embodiments of the invention are applicable may comprise a commonly known architecture of one or more communication systems comprising a wired or wireless access network subsystem and a core network. Such an architecture may comprise one or more access network control elements, radio access network elements, access service network gateways or base transceiver stations, such as a base station, a NodeB etc., which control a coverage area also referred to as a cell and with which one or more communication elements or terminal devices such as a UE or another device having a similar function, such as a modem chipset, a chip, a module etc., which can also be part of a UE or attached as a separate element to a UE, or the like, are capable to communicate via one or more channels for transmitting several types of data. Furthermore, core network elements such as gateway network elements, policy and charging control network elements, mobility management entities and the like may be comprised.

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The general functions and interconnections of the described elements, which also depend on the actual network type, are known to those skilled in the art and described in corresponding specifications, so that a detailed description thereof is omitted herein. However, it is to be noted that several additional network elements and signaling links may be employed for a communication to or from a communication element or terminal device like a UE and a communication network control element like a BS or NodeB, besides those described in detail herein below.

Furthermore, the described network elements, such as terminal devices like UEs, communication network control elements, like an BS, a NodeB and the like, as well as corresponding functions as described herein may be implemented by software, e.g. by a computer program product for a computer, and/or by hardware. In any case, for executing their respective functions, correspondingly used devices, nodes or network elements may comprise several means and components (not shown) which are required for control, processing and communication/signaling functionality. Such means may comprise, for example, one or more processor units including one or more processing portions for executing instructions, programs and for processing data, memory means for storing instructions, programs and data, for serving as a work area of the processor or processing portion and the like (e.g. ROM, RAM, EEPROM, and the like), input means for inputting data and instructions by software (e.g. floppy disc, CD-ROM, EEPROM, and the like), user interface means for providing monitor and manipulation possibilities to a user (e.g. a screen, a keyboard and the like), interface means for establishing links and/or connections under the control of the processor unit or portion (e.g. wired and wireless interface means, an antenna, etc.) and the like. It is to be noted that in the present specification processing portions should not be only considered to represent physical portions of one or more processors, but may also be considered as a logical division of the referred processing tasks performed by one or more processors.

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As indicated above, examples of embodiments of the invention are related to a communication control where load balancing measures are taken e.g. in an UL communication. For example, such a load balancing measure is based on a carrier switching procedure, which is referred to hereinafter as a FCS operation (FCS: fast carrier switching or fast cell switching or fast carrier selection). According to examples of embodiments of the invention, a case is considered where multiple UL carriers are provided from a system for communications from the UE to the network, wherein it is assumed that one UE is capable to use one carrier frequency at a time.

FCS is usable as an extension of e.g. existing 3GPP WCDMA FDD technology (but is also applicable in other FDD or TDD based communication systems), and in particular in connection with HSUPA. As indicated above, HSUPA is usually related to an operation mode where all users are sharing the same physical resource, but are separated in the code domain (e.g. through WCDMA). Carrier switching, such as FCS, is considered to provide a technique which makes it possible to introduce fast load balancing operation for situations where there is a relative high load in the uplink direction, which is achieved by switching the communication from e.g. the UE to the NodeB (UL direction) from one (or more) frequency carrier to another (or plural other) frequency carrier while maintaining the communication (session) as such. The frequency carrier on which the UE is transmitting after the carrier switching is also referred to as "current carrier" (wherein parameters related to the communication on this current carrier are also referred to as „current“ parameters (such as current SG, to be described later)), while the carrier on which the transmission took place before the carrier switching is referred to as hereinafter as "previous carrier" (wherein parameters related to the communication on this previous carrier are referred to as „previous“ or „former“ parameters (such as previous or former SG, to be described later)).

It has been found that an application of carrier switching by using e.g. an FCS operation can cause adverse impacts on the system performance and stability of operation. The reason is that a sudden change in radio channel

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conditions after each switch of the UL transmission from one carrier to another can be caused. In particular, it has been found that as one of these cases where adverse impacts take place is caused by an inefficient operation of the power-based scheduling algorithm directly after a switch.

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The power-based scheduling is a scheduling approach used e.g. in HSUPA systems where the transmission grant is defined as the allowed increase of the TX power (which is to be used by data channels) over the current DPCCH power level (i.e. reference channel power level) so as to fill the provided RX power budget.

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Therefore, one of the specific objective problems to be solved by examples of embodiments of the invention is to provide a mechanism allowing to compensate for the adverse impacts on system performance and stability caused by the carrier switching.

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With regard to Fig. 1, a diagram illustrating a general configuration of a communication network is shown where some examples of embodiments of the invention are implemented. It is to be noted that the configuration shown in Fig. 1 shows only those devices, network elements and parts which are useful for understanding principles underlying the examples of embodiments of the invention. As also known by those skilled in the art there may be several other network elements or devices involved in a communication between the communication device (UE) and the network which are omitted here for the sake of simplicity. It is to be noted that the general functions of the elements described in connection with Fig. 1 as well as of reference points/interfaces therebetween are known to those skilled in the art so that a detailed description thereof is omitted here for the sake of simplicity.

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As shown in Fig. 1, in the exemplary communication network configuration, a communication network control element 20, such as a NodeB, is provided which establishes, for example, a connection to the core network of the

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communication network (not shown). Reference sign 10 denotes a communication element such as a UE which communicates with the NodeB 20 via plural channels. As indicated in Fig. 1, in the UL direction, plural carriers are provided for the communication between the UE 10 and the NodeB 20 (one DL carrier is also shown, wherein more than this one DL carrier is also possible to be provided).

Fig. 2 shows an example of an operation conducted in the UE 10 for controlling the UL communication towards the NodeB 20 when HSUPA is used, wherein a single carrier case is assumed.

First, in step S510, the UE 10 checks whether it has received an ACK message for the last (previous) transmission (in the same HARQ process). If the previous transmission was successful, step S520 is conducted.

In step S520, for every TTI when allowed to transmit, the UE prepares a transmission of new data by determining in step S530 corresponding serving or scheduling grants, referred to as current SG (SG_{UE}), that it can use. The SG indicates all relevant scheduling information for the UL communication.

The SG is retrieved in step S530 from a communication to the UE by the serving NodeB 20 (described later) and can be adjusted by information from non-serving NodeBs (e.g. by overload indicators).

In step S540, new data are transmitted in the UL direction on the basis of the current SG (SG_{UE}) prepared in step S520.

On the other hand, in case the decision in step S510 is negative, i.e. the UE 10 has not received an ACK for its previous transmission of the same HARQ process, it decides that a retransmission is required (HARQ retransmission). HARQ introduces the possibility to have automatic repeat requests when an UL transmission fails wherein the UE 10 will retransmit the failed data packet.

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Therefore, in step S550, parallel to step S520, the UE prepares the former or previous SG which was used for previous and unsuccessful transmission instead of the current SG. On the basis of this former SG, a retransmission is conducted in step S560.

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It is to be noted that the leg formed by steps S510, S550 and S560 forms a so-called non-adaptive principle of the HSUPA HARQ operation.

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Fig. 4 shows an example of an operation conducted in the NodeB 20 for controlling the UL communication from the UE 10 when HSUPA is used, wherein again a single carrier case is assumed. In particular, a procedure for determining and providing the serving or scheduling grant (SG) for the power-based scheduling is shown.

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In step S610, the SG value is determined. The serving grant is calculated such that a predicted total received power P does not exceed the power budget (target power level P_{target}) allocated for UE 10 which is determined and provided in step S630.

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The total received power level is predicted, for example, on the basis of a current measurement of the power level of the reference channel, e.g. the received DPCCH power (which is used as a reference for setting the power levels of other physical channels which are set relative to the DPCCH power level), which is obtained and provided in step S620 as P_{DPCCH} .

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Thus, the current SG value in step S610 is determined by considering a relation between the predicted total received power P (as a function of the received DPCCH power P_{DPCCH}) and the target power level P_{target} .

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After the current SG value is calculated in step S610, the NodeB 20 sends (updates) the current SG value to the UE 10 by a suitable communication channel, such as E-AGCH and E-RGCH, in step S640.

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However, as indicated above, when using load balancing mechanisms employing a carrier switch, there are impacts on the system performance

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when using the operations indicated in Figs. 2 and 4. This is explained in the following by referring to Fig. 9.

Fig. 9 shows time-domain diagrams illustrating a possible system behavior after a carrier switch when the current carrier (i.e. the carrier used after the switch) has a lower total power gain of the radio channel than the previous carrier (i.e. the carrier used before the switch). It is to be noted that Fig. 9 (like Fig. 10 discussed later) shows only a theoretical example of a system behavior which is to be understood only as a support for the reader to understand effects of communication control schemes according to conventional examples and according to some examples of embodiments of the invention. Fig. 9 (like Fig. 10) is not to be understood as a real implementation example of a communication control procedure related to the present application (even though a real implementation example may lead to a similar result). Furthermore, also the units used for indicating the respective results shown in Fig. 9 (and correspondingly in Fig. 10) are only for illustrative purpose and do not limit a measurement of system properties to corresponding units, when implementing a communication control procedure related to the present application.

Generally, with regard to the example shown in Fig. 9, changes of the power level of the carriers occur because of a path loss difference (when the carriers are located at different frequency bands) and/or due to small-scale fading that leads to essential received power level variations even if the carriers are allocated in the same band.

Specifically, the upper diagram in Fig. 9 shows with a curve E.1 a target total RX E_c/N_o and with a curve E.2 an actual total RX E_c/N_o (in dB), and with a curve F a DPCCH RX E_c/N_o (in dB), i.e. a respective received chip energy-to-noise level over the time, while the lower diagram in Fig. 9 shows with a curve G the SG value (in dB) over the time. Indicated by a dashed line at time instance 14ms, a carrier switch event is indicated, so that the system behavior before and after the carrier switching is illustrated. The graphs illustrate a (theoretical) system performance for one realization of channels when switching from a powerful carrier to a less powerful carrier has occurred (TX power is assumed to be approximately constant during the

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switching). Powerful carrier and less powerful carrier in this connection are to be understood such that when comparing conditions on two carriers, on one (the powerful carrier) it is possible to achieve higher RX power / SIR than on the other (less powerful) carrier, provided that the same TX power is used. Furthermore, an ILPC delay is assumed to be e.g. 2 slots and an OLPC delay is assumed to be e.g. 4 TTI, while a scheduler delay is assumed to be 2 TTI.

As indicated in the upper diagram of Fig. 9, when the carrier switching is executed, it is assumed that the switch leads to a discontinuous drop of the DPCCH RX power level from the UE 10 undergoing the carrier switching, see level F.1 before carrier switching and level F.2 after the switching. In connection with the drop, corresponding drops of the DPCCH SIR, E-DPDCH (S-E-DPDCH) SIR and, consequently, data BLER increase.

From the power-based scheduler perspective, it is assumed that such a DPCCH RX power drop allows to schedule higher scheduling grants (SG, see lower diagram in Fig. 9) so as to achieve the same overall RX power budget assigned for the UE 10 as before the switch, since the RX power target is unchanged. But from the power control perspective, as the DPCCH SIR and BLER are increased, the joint operation of the OLPC and ILPC loops leads to a gradual increase of the TX power from the corresponding UE up to the value providing the required DPCCH SIR and, consequently, the data BLER. The final DPCCH RX power value after the adjustment is assumed to be typically at least not lower than the last DPCCH value measured on the previous carrier. Hence, a sudden jump of the DPCCH RX power down together with OLPC and ILPC loops inertia are assumed to cause significant increase of SG values granted to the UE for some time interval (with the duration depending on ILPC and OLPC parameters) after the carrier switching. As the DPCCH SIR is lower than the target during this interval, data BLER is assumed to be higher than the target which leads to high probability of data loss in this time interval.

On the other hand, the significant surge of SG for a short time interval is assumed to cause significant surges of the TX and RX powers and,

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consequently, interference level to other system nodes. That leads to additional adverse impacts on system performance and stability.

As can be seen in the lower diagram, at G.1, the power granted by the SG is assumed to be changed significantly some time after the switch, due to a scheduling delay. In the carrier switch to a (current) carrier having a lower total power gain of the radio channel than the previous carrier, causing a discontinuous DPCCH RX power drop as described above, the drop is assumed to be generally compensated by the power control loops during some time interval (~ 15 ms) after the switch. However, for a time interval immediately after the switch (~ 5 ms), the low DPCCH RX level is assumed to lead to schedule high SG values (G.1) which start to be applied after the time interval equal to the scheduling delay. Then, since the DPCCH RX power is already partially increased by ILPC by the moment when the new increased grants are applied, the total RX Ec/No (RoT) is assumed to significantly exceed the target level. It is assumed that this causes a first surge (upper diagram, see E.2a) of RX Ec/No. Hence, the observed behavior is assumed to be a consequence of finite delays and inertia of the ILPC, OLPC and scheduler loops disturbed by an instantaneous change of the channel conditions.

Furthermore, as the increased SGs were scheduled taking a non-converged DPCCH level, it is assumed that the corresponding transmissions have a high probability of being incorrectly decoded and then HARQ retransmissions occur. As the HARQ algorithm in the HSUPA system is non-adaptive, as indicated above, the retransmissions are conducted with the same SG level (lower diagram, see G.2), and it is assumed that this causes a second RX Ec/No surge (upper diagram, see E.2b), which is even higher than the first one (i.e. E.2a), because the DPCCH power is practically fully adjusted by the moment of the first retransmission.

As described above, when conducting the load balancing using carrier switching, there are impacts on the system performance and stability. Therefore, according to some examples of embodiments of the invention, mechanisms are proposed which modify the scheduling algorithm.

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One example of embodiments of the invention is described in connection with Fig. 3. Fig. 3 shows an example of an operation conducted in the UE 10 for controlling the UL communication towards the NodeB 20 when HSUPA is used, wherein a carrier switching is conducted for load balancing.

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According to the present example of the embodiments of the invention, the UE 10 is configured, within some predefined time period after the carrier switch, to not perform a retransmission for TBs being transmitted and decoded incorrectly, even if this would normally be required, e.g. by a HARQ process. In other words, for example, a HARQ process is disabled.

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That is, in some examples of embodiments of the invention, HARQ retransmissions for erroneous transmissions are disabled within some predefined time period after the CS. By means of this, it is possible to suppress unwanted TX and RX Ec/No surges happening because of non-adaptive H-ARQ retransmissions. Instead, for example, transmission of new data with a current SG value is conducted (instead of a retransmission of an unsuccessful attempt).

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Referring to Fig. 3, hence, in step S10, the UE 10 checks whether it has received an ACK message for the last (previous) transmission (in the same HARQ process). If the previous transmission was successful, step S20 is conducted.

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That is, as described beforehand, in case no retransmission is to be conducted at all, in step S20, for every TTI when allowed to transmit, the UE prepares a transmission of new data by determining in step S30 the corresponding serving or scheduling grants, i.e. the current SG (SG_{UE}), that it can use, wherein the current SG is retrieved in step S30 from a communication to the UE by the serving NodeB 20 (again adjustable by information from non-serving NodeBs, e.g. by overload indicators).

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In step S40, new data are transmitted in the UL direction on the basis of the current SG (SG_{UE}) prepared in step S20.

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On the other hand, in case the decision in step S10 is negative, i.e. the UE 10 has not received an ACK for its previous transmission of the same HARQ process, step S50 is follows.

5 In step S50, it is determined whether a time measured since the carrier switching event is below or above a predetermined threshold T0. That is, it is determined in S50 whether a time T0 has elapsed since the CS.

10 The time T0 is, for example, a time which is determined by experiences or calculated by corresponding algorithms and which is required for allowing the system to be stabilized after the CS, e.g. that the DPCCH level has converged towards a target level in a sufficient manner. The parameter indicating the time T0 is, according to some examples of embodiments of the invention, a preset parameter or, according to some further examples of
15 embodiments of the invention, a parameter calculated and provided from the network side (e.g. the NodeB 20) to the UE 10.

Depending on the decision in step S50, it is decided in the UE 10 whether a retransmission is allowed. In case the decision is that the time is elapsed
20 (the measured time is above the threshold), step S60 is conducted where the retransmission (HARQ retransmission) is prepared. That is, the former SG value of the not-successful transmission is derived and prepared for a retransmission (instead of the current SG). On the basis of this former SG, the retransmission is conducted in step S70.

25 Otherwise, in case the decision in step S50 is that the time T0 is not elapsed (the measured time is below the threshold), the processing jumps to step S20, i.e. when allowed to transmit, the UE 10 prepares a transmission of new data by using the current SG (SG_{UE}). Consequently, the
30 retransmission mechanism (HARQ process) is disabled until T0 is elapsed since the CS.

According to additional examples of embodiments of the invention, an additional decision step is made regarding whether or not the disabling of
35 the retransmission is required. For example, a condition on the current frequency carrier compared to the condition on the previous frequency

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carrier can be considered, wherein information on the frequency carrier are retrieved, for example, by own measurements, from information provided by the network (the NodeB 20) or from information being previously stored/configured. For example, in case the condition on the current frequency carrier indicates that a total power gain of the current frequency carrier is lower than that of the previous frequency carrier, the adverse impacts described above are not to be expected so that a freezing of a retransmission in a HARQ process is not required. In this case, the decision to disable the retransmission based on the value of the time elapsed since the CS can be cancelled, and the retransmission is allowed also in the predetermined time period based on T0

Next, a further example of embodiments of the invention is described in connection with Fig. 5. Fig. 5 shows an example of an operation conducted in the NodeB 20 for controlling the UL communication from the UE 10 when HSUPA is used, wherein a carrier switching for load balancing is conducted. In particular, a procedure for determining and providing the current serving or scheduling grant (SG) for the power-based scheduling is described.

According to the present examples of embodiments of the invention, the scheduling algorithm is modified in such a manner that the SG value used for the current SG value is fixed or frozen for a predetermined time interval after a CS, i.e. that a value based on one or more former SG values being scheduled before the CS is used instead of a new SG value.

In other words, in a scheduling algorithm operation conducted on the NodeB side, a new SG value is calculated when a time T0 is elapsed after the last CS. In case the elapsed time is below T0, an SG value based on previous or former SG values is set. For example, the SG value being set as the current SG value is the last SG value calculated by the NodeB 20 before the CS event as a scheduling decision for the serving grant. According to some further examples of embodiments of the invention, the former SG value to be used as the current SG value is derived by a value being calculated by using a predefined algorithm with plural previous SG values being calculated in several TTI before the CS, e.g. an averaging algorithm or the like.

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That is, according to Fig. 5, in step S110, it is determined whether a time measured since the CS event is below or above a predetermined threshold T0. That is, it is determined in S110 whether a time T0 has elapsed since the CS. The time T0 is, for example, a time which is determined by experiences or calculated by corresponding algorithms and which is required for allowing the system to be stabilized after the CS, e.g. that the DPCCH level has converged towards a target level in a sufficient manner. The parameter indicating the time T0 is, according to some examples of embodiments of the invention, a preset parameter or, according to some further examples of embodiments of the invention, a parameter calculated on the network side (e.g. in the NodeB 20).

If the decision in step S110 is positive, i.e. the time T0 has been elapsed, step S120 follows. Here, a new SG value is determined. The new SG is calculated such that a predicted total received power P does not exceed the power budget (target power level P_{target}) allocated for UE 10 which is determined and provided in step S140. Furthermore, the total received power level is predicted, for example, on the basis of a current measurement of the power level of the reference channel, e.g. the received DPCCH power, which is obtained and provided in step S130 as P_{DPCCH} . Thus, the new SG value which is determined by considering a relation between the predicted total received power P (as a function of the received DPCCH power P_{DPCCH}) and the target power level P_{target} is calculated and set as the current SG value to be provided to the UE in step S120.

After the current SG value is set in step S120 to the new SG value, the NodeB 20 sends (updates) the current SG value to the UE 10 by a suitable communication channel, such as E-AGCH and E-RGCH, in step S170.

On the other hand, in case the decision in step S110 is negative, i.e. the time T0 is not elapsed since the CS, step S150 follows.

In step S150, a former SG value is used, i.e. set as the current SG value to be provided to the UE 10. The former SG value is obtained in step S160, e.g. by referring to the last SG value before the CS or by calculating the former SG value with a corresponding algorithm, as described above.

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Then, the former SG value, which is set as the current SG value in step S150, is used in step S170 for sending (updating) the current SG value to the UE 10 by a suitable communication channel, such as E-AGCH and E-RGCH.

A further example of embodiments of the invention is described in connection with Fig. 6. Similar to Fig. 5, Fig. 6 shows an example of an operation conducted in the NodeB 20 for controlling the UL communication from the UE 10 when HSUPA is used, wherein a carrier switching for load balancing is conducted. In particular, a procedure for determining and providing the current serving or scheduling grant (SG) for the power-based scheduling is described.

According to the present examples of embodiments of the invention, the scheduling algorithm is modified in such a manner that the SG value used for the current SG value only allowed to be increased, for a predetermined time interval after a CS, when a certain condition applies. Otherwise, increasing is inhibited, i.e. a value based on one or more former SG values being scheduled before the CS is used instead of a new SG value. In other words, an SG increase is prohibited for a predetermined time interval after a CS, where the minimum value of a former scheduled SG value (before the CS) and a new SG value (calculated according to current condition like power level of DPCCH, after the CS) is to be used.

Examples of embodiments of the invention according to Fig. 6 are a further development of the examples of embodiments of the invention according to Fig. 5. Here, in the time interval determined by T0, the former SG (SG before the CS) is used only in case the new SG selected according to the current conditions is above the former SG before the CS. Hence, it is possible to switch to both better and worse channels conditions as it is allowed to decrease the SG before the time T0 is elapsed.

That is, according to Fig. 6, in step S210, a new SG value is determined. The new SG is calculated such that a predicted total received power P does not exceed the power budget (target power level P_{target}) allocated for UE 10

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which is determined and provided in step S230. Furthermore, the total received power level is predicted, for example, on the basis of a current measurement of the power level of the reference channel, e.g. the received DPCCH power, which is obtained and provided in step S220 as P_{DPCCH} . Thus, the new SG value is determined by considering a relation between the predicted total received power P (as a function of the received DPCCH power P_{DPCCH}) and the target power level P_{target} .

Then, in step S240, it is determined whether a time measured since the CS event is below or above a predetermined threshold T_0 . That is, it is determined in S240 whether a time T_0 has elapsed since the CS. The time T_0 is, for example, a time which is determined by experiences or calculated by corresponding algorithms and which is required for allowing the system to be stabilized after the CS, e.g. that the DPCCH level has converged towards a target level in a sufficient manner. The parameter indicating the time T_0 is, according to some examples of embodiments of the invention, a preset parameter or, according to some further examples of embodiments of the invention, a parameter calculated on the network side (e.g. in the NodeB 20).

If the decision in step S240 is positive, i.e. the time T_0 has been elapsed, step S250 follows. Here, the new SG value determined in step S210 is used or set as the current SG value.

After the current SG value is set in step S250 to the new SG value, the NodeB 20 sends (updates) the current SG value to the UE 10 by a suitable communication channel, such as E-AGCH and E-RGCH, in step S290.

On the other hand, in case the decision in step S240 is negative, i.e. the time T_0 is not elapsed since the CS, step S260 follows.

In step S260, the new SG value determined in step S210 is compared with a former SG value, which is obtained in step S270, e.g. by referring to the last SG value before the CS or by calculating the former SG value with a corresponding algorithm, as described above.

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If the decision in step S260 results that the new SG value is smaller than the former SG value, the processing jumps to step S250, i.e. the new SG value is set as the current SG value.

5 Otherwise, in case the decision in step S260 results that the former SG value is smaller than the new SG value determined in step S210, the processing jumps to step S280. In step S280, the former SG value is used, i.e. set as the current SG value to be provided to the UE 10.

10 Then, the former SG value, which is set as the current SG value in step S280, is used in step S290 for sending (updating) the current SG value to the UE 10 by a suitable communication channel, such as E-AGCH and E-RGCH.

15 A still further example of embodiments of the invention is described in connection with Fig. 7. Fig. 7 shows an example of an operation conducted in the NodeB 20 for controlling the UL communication from the UE 10 when HSUPA is used, wherein a carrier switching for load balancing is conducted. In particular, a procedure for determining and providing the current serving or scheduling grant (SG) for the power-based scheduling is described.
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According to the present examples of embodiments of the invention, the scheduling algorithm is modified in such a manner that the former measured reference channel power level, such as a former DPCCH RX power value measured in at least one scheduling procedure before the CS is used for a predetermined time interval after the CS for calculating a SG value to be used as a current SG value.
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According to the present examples of embodiments of the invention, a scheduling algorithm is proposed which modifies the DPCCH power input. In case the predetermined time is not elapsed since the last CS (meaning that the system has not yet converged), the received DPCCH power level that was measured in at least one previous scheduling algorithm (e.g. the last time interval, slot or TTI) before the CS is used by the grant calculation procedure. Otherwise, in case the required time period has elapsed (i.e. the
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system has converged) then the current received DPCCH power level is used.

For example, the former DPCCH RX power value used for calculating the SG value being set as the current SG value is the last DPCCH RX power value measured by the NodeB 20 before the CS event. According to some further examples of embodiments of the invention, the former DPCCH RX power value to be used for the SG calculation is derived from a value being calculated by using a predefined algorithm with plural previous DPCCH RX power values, e.g. by a weighted averaging process of DPCCH RX power levels being measured in several intervals before the CS.

That is, according to Fig. 7, in step S310, it is determined whether a time measured since the CS event is below or above a predetermined threshold T0. That is, it is determined in S310 whether a time T0 has elapsed since the CS. The time T0 is, for example, a time which is determined by experiences or calculated by corresponding algorithms and which is required for allowing the system to be stabilized after the CS, e.g. that the DPCCH level has converged towards a target level in a sufficient manner. The parameter indicating the time T0 is, according to some examples of embodiments of the invention, a preset parameter or, according to some further examples of embodiments of the invention, a parameter calculated on the network side (e.g. in the NodeB 20).

In case the decision in step S310 is positive, i.e. the time T0 has been elapsed, step S320 follows. Here, it is determined that a currently measured DPCCH RX power level, which is measured in step S330, is to be used for a calculation of a current SG value.

Otherwise, in case the decision in step S310 is negative, i.e. the time T0 has not been elapsed, step S340 follows. Here, it is determined that a former DPCCH RX power level is to be used, which is derived in step S350, for a calculation of a current SG value (also referred to as an alternative SG value). The former DPCCH RX power level is for example the last DPCCH RX power level before the CS, or a correspondingly calculated value using several previous DPCCH RX power levels.

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In step S360, a current SG value is determined. The current SG value is calculated such that a predicted total received power P does not exceed the power budget (target power level P_{target}) allocated for UE 10 which is determined and provided in step S370. Furthermore, the total received power level is predicted on the basis of the set DPCCH RX power level (currently measured DPCCH RX power level of step S320, or former DPCCH RX power level of step S340, depending on step S310), i.e. P_{DPCCH} . Thus, the current SG value which is determined by considering a relation between the predicted total received power P (as a function of the set received DPCCH power P_{DPCCH}) and the target power level P_{target} is calculated to be provided to the UE in step S360.

After the current SG value is determined in step S360, the NodeB 20 sends (updates) the current SG value to the UE 10 by a suitable communication channel, such as E-AGCH and E-RGCH, in step S380.

A still further example of embodiments of the invention is described in connection with Fig. 8. Similar to Fig. 7, Fig. 8 shows an example of an operation conducted in the NodeB 20 for controlling the UL communication from the UE 10 when HSUPA is used, wherein a carrier switching for load balancing is conducted. In particular, a procedure for determining and providing the current serving or scheduling grant (SG) for the power-based scheduling is described.

According to the present examples of embodiments of the invention, the scheduling algorithm is modified in such a manner that the former measured reference channel power level, such as a former DPCCH RX power value measured in at least one scheduling procedure before the CS, is only used for a predetermined time interval after the CS for calculating a SG value to be used as a current SG value in case it is greater than the currently measured DPCCH RX power value. In other words, for conducting a scheduling procedure within a predetermined time interval after the CS, the maximum of the former DPCCH RX power level (measured before a CS) and the currently measured DPCCH RX power level (measured after the CS) is to be used.

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Examples of embodiments of the invention according to Fig. 8 are a further development of the examples of embodiments of the invention according to Fig. 7. Here, in the time interval determined by T0, the scheduling algorithm is modified in such a manner that the former DPCCH RX power level (before the CS) is used instead of the currently measured DPCCH RX power level if the time T0 after the CS has not yet elapsed and the currently measured DPCCH RX power level is below the former DPPCH RX power level. In other words, the present examples of embodiments of the invention allow to increase the DPCCH RX power level taken as an input to the scheduling procedure, but do not allow to decrease it, until the predetermined time after the CS is elapsed (i.e. the system operation has converged).

For example, the former DPCCH RX power value is the last DPCCH RX power value measured by the NodeB 20 before the CS event. According to some further examples of embodiments of the invention, the former DPCCH RX power value is derived from a value being calculated by using a predefined algorithm with plural previous DPCCH RX power values, e.g. by a weighted averaging process of DPCCH RX power levels being measured in several intervals before the CS.

That is, according to Fig. 8, in step S410, it is determined whether a time measured since the CS event is below or above a predetermined threshold T0. That is, it is determined in S410 whether a time T0 has elapsed since the CS. The time T0 is, for example, a time which is determined by experiences or calculated by corresponding algorithms and which is required for allowing the system to be stabilized after the CS, e.g. that the DPCCH level has converged towards a target level in a sufficient manner. The parameter indicating the time T0 is, according to some examples of embodiments of the invention, a preset parameter or, according to some further examples of embodiments of the invention, a parameter calculated on the network side (e.g. in the NodeB 20).

In case the decision in step S410 is positive, i.e. the time T0 has been elapsed, step S440 follows. Here, it is determined that a currently measured

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DPCCH RX power level, which is measured in step S430, is to be used for a calculation of a current SG value.

5 Otherwise, in case the decision in step S410 is negative, i.e. the time T0 has not been elapsed, step S420 follows. Here, it is determined whether the currently measured DPCCH RX power level determined in step S430 is below a former DPCCH RX power level. The former DPCCH RX power level is derived in step S450 and is for example the last DPCCH RX power level before the CS, or a correspondingly calculated value using several previous
10 DPCCH RX power levels.

If the decision in step S420 is positive, i.e. the currently measured DPCCH RX power level of step S430 is below the former DPCCH RX power level of step S450, the processing jumps to step S440 where the currently
15 measured DPCCH RX power level is determined to be used for the further process.

Otherwise, in case the decision in step S420 is negative, step S460 follows where it is determined that that the former DPCCH RX power level, which is
20 determined in step S450, is to be used for a calculation of a current SG value.

In step S470, a current SG value is determined. The current SG value is calculated such that a predicted total received power P does not exceed the
25 power budget (target power level P_{target}) allocated for UE 10 which is determined and provided in step S480. Furthermore, the total received power level is predicted on the basis of the set DPCCH RX power level (currently measured DPCCH RX power level of step S440, or former DPCCH RX power level of step S460, depending on steps S410 and S420), i.e.
30 P_{DPCCH} . Thus, the current SG value which is determined by considering a relation between the predicted total received power P (as a function of the set received DPCCH power P_{DPCCH}) and the target power level P_{target} is calculated to be provided to the UE in step S470.

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After the current SG value is determined in step S470, the NodeB 20 sends (updates) the current SG value to the UE 10 by a suitable communication channel, such as E-AGCH and E-RGCH, in step S490.

5 By means of the examples of embodiments of the invention described in connection with Figs. 3 and 5 to 8, a scheduler algorithm is provided which solves the problem described in connection with Fig. 9. That is, it is possible to avoid sudden SG jumps after a CS, in particular when the current carrier has a lower total power gain of the radio channel than the previous carrier.

10 The achieved SG stabilization in turn minimizes the probability of data loss after a CS and eliminates the interference surge caused by the sudden TX power increase after a CS, so that a higher stability of the whole system is achieved.

15 These effects are illustrated in the diagrams of Fig. 10. Similar to Fig. 9, Fig. 10 shows time-domain diagrams illustrating a system behavior after a carrier switch when the current carrier (i.e. the carrier used after the switch) has a lower total power gain of the radio channel than the previous carrier (i.e. the carrier used before the switch). As also noted with regard

20 to Fig. 9, Fig. 10 shows only a theoretical example of a system behavior which is to be understood only as a support for the reader to understand effects of communication control schemes according to some examples of embodiments of the invention. Fig. 10 is not to be understood as a real implementation example of a communication control procedure according to

25 examples of embodiments of the invention (even though a real implementation example may lead to a similar result). Furthermore, also the units used for indicating the respective results shown in Fig. 10 are only for illustrative purpose and do not limit an implementation of the system or a measurement of system properties to corresponding units, when

30 implementing a communication control procedure according to some examples of embodiments of the invention.

Specifically, the upper diagram in Fig. 10 shows with a curve A.1 a target total RX E_c/N_0 and with a curve A.2 an actual total RX E_c/N_0 (in dB), and

35 with a curve B a DPCCH RX E_c/N_0 (in dB), i.e. a respective received chip energy-to-noise level over the time, while the lower diagram in Fig. 10

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shows with a curve D the SG value (in dB) over the time. Indicated by a dashed line at time instance 14ms, a carrier switch event is indicated, so that the system behavior before and after the carrier switching is illustrated. Reference sign C indicates a virtual DPCCH RX power level for scheduling.

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Unlike in the example in Fig. 9, Fig. 10 shows a case where it is assumed that a scheduler modification is applied so as to compensate for the adverse impacts described in connection with Fig. 9. As can be seen from Fig. 10 (compared to Fig. 9), it is assumed that the modification of the scheduler allows avoiding of SG and RX Ec/No surges after the CS, even if the carrier switching leads to a discontinuous drop of the DPCCH RX power level from the UE 10 undergoing the carrier switching

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Fig. 11 shows a flowchart illustrating a processing executed in a communication element like the UE 10 of Fig. 1 according to some examples of embodiments of the invention.

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In step S700, it is determined whether a carrier switching for switching a communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier is executed. According to some examples of embodiments of the invention, the communication is a high speed packet access based communication, wherein the carrier switching is conducted for switching the communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier in a same cell or in a different cell of a communication network on the basis of a command received from a communication network control element, or on the basis of a processing result of an internal determination processing in the UE for determining whether the carrier switching is to be conducted.

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In step S710, a time beginning from a switching time where the carrier switching is executed is measured.

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In step S720, it is determined determining whether a retransmission of data is required. The requirement for the retransmission of data is determined when at least one of the following is valid:

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- an acknowledgement for a successful transmission in a preceding transmission cycle in one hybrid automatic repeat request process is not determined to be received,
- an incorrect transmission or decoding of a transport block in a preceding transmission cycle is detected.

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In step S730, it is determined whether the measured time is below a predetermined threshold. The value of the predetermined time threshold is a preset time value being stored in the UE, or a time value signaled by a communication network control element (the NodeB 20), for example in the form of policy information. The predetermined time threshold is based on a time where a power level of a reference control channel (e.g. DPCCH) is sufficiently converged to a target level.

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In case the decision in step S730 is positive, the retransmission of the data is disabled (step S740), for example by stopping a hybrid automatic repeat request process. Otherwise, in case the decision in step S730 is negative, the retransmission is allowed (step S750). In this case, the retransmission of the data is conducted by using a preceding scheduling grant valid for a communication before the switching of the at least one frequency carrier.

20

According to some examples of embodiments, the procedure comprises also further measures, such as a determination of a current scheduling grant for a current uplink communication, which is used in reaction to step S740 or in case no retransmission is required, for sending new data.

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Furthermore, according to some examples of embodiments of the invention, a further decision is made e.g. between steps S730 and S740 where it is determined whether to cancel disabling the retransmission. For example, a condition on a frequency carrier to which the communication is switched is detected and compared with a condition on a frequency carrier from which the communication is switched. The condition comprises, for example, a total power gain parameter of the respective carrier, or the like. Based on the comparison of the conditions on the respective carriers, it is decided to cancel the disabling of the retransmission is cancelled (i.e. the retransmission is yet allowed even if the timing is still within the

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predetermined time period) in case it is detected that a total power gain on the frequency carrier to which the communication is switched is lower than a total power gain on the frequency carrier from which the communication is switched.

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Fig. 12 shows a flowchart illustrating a processing executed in a communication network control element like the NodeB 20 of Fig. 1 according to some examples of embodiments of the invention.

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In step S800, it is detected that a carrier switching for switching a communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier is executed.

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According to some examples of embodiments of the invention, the communication is e.g. a high speed packet access based communication, wherein the carrier switching is conducted for switching the communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier in a same cell or in a different cell of a communication network.

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In step S810, a time is measured beginning from a switching time where the carrier switching is executed.

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In step S820, a scheduling grant procedure is executed after the carrier switching is detected.

30

According to some examples of embodiments of the invention, the scheduling grant procedure includes a determination of a current scheduling grant value for an uplink communication, wherein the current scheduling grant value is determined on the basis of whether or not the time measured by the time measuring function is below a predetermined time threshold.

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For example, according to some examples of embodiments of the invention, in the scheduling grant procedure, in case the time being measured is equal to or greater than the predetermined time threshold, a new scheduling grant value is calculated on the basis of a target power level allowed for the

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communication and a currently measured power level of a reference control channel (e.g. DPCCH), wherein the thus calculated new scheduling grant value is set as the current scheduling grant value. Otherwise, in case the measured time is below the predetermined time threshold, a former scheduling grant value is obtained on the basis of a scheduling grant value determined in at least one previous scheduling grant procedure being conducted before the carrier switching is executed, wherein the obtained former scheduling grant value is set as the current scheduling grant value.

Alternatively, according to some further examples of embodiments of the invention, in the scheduling grant procedure, a new scheduling grant value is calculated on the basis of a target power level allowed for the communication and a currently measured power level of a reference control channel. Furthermore, a former scheduling grant value is obtained on the basis of a scheduling grant value determined in a previous scheduling grant procedure being conducted before the carrier switching is executed. Then the former scheduling grant value is set as the current scheduling grant value, in case the measured time is below the predetermined time threshold and the new scheduling grant value is equal to or greater than the former scheduling grant value. Otherwise, the new scheduling grant value is set as the current scheduling grant value, in case the measured time is equal to or greater than the predetermined time threshold or in case the new scheduling grant value is lower than the former scheduling grant value.

It is to be noted that according to examples of embodiments of the invention, the former scheduling grant value is obtained by retrieving a last scheduling grant value determined immediately before the detection of the carrier switching and setting the last scheduling grant value as the former scheduling grant value, or by conducting an arithmetic processing (e.g. an averaging operation) on plural scheduling grant values determined before the detection of the carrier switching and setting the result of the arithmetic processing as the former scheduling grant value.

Furthermore, according to some examples of embodiments of the invention, in the scheduling grant procedure, in case the measured time is equal to or greater than the predetermined time threshold, a new scheduling grant

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value is calculated on the basis of a target power level allowed for the communication and a currently measured power level of a reference control channel (e.g. DPCCH), wherein the new scheduling grant value is set as the current scheduling grant value. Otherwise, in case the measured time is below the predetermined time threshold, an alternative scheduling grant value is calculated on the basis of a target power level allowed for the communication and a former power value of the reference control channel detected in at least one previous scheduling grant procedure being conducted before the carrier switching is executed, wherein the alternative scheduling grant value is set as the current scheduling grant value.

Alternatively, according to some examples of embodiments of the invention, in the scheduling grant procedure, a currently measured power level of a reference control channel and a former power value of the reference control channel detected in at least one previous scheduling grant procedure being conducted before the carrier switching is executed are obtained. Then, a new scheduling grant value is calculated on the basis of a target power level allowed for the communication and the former power level of the reference control channel, in case the measured time is below the predetermined time threshold and the currently measured power level of the reference control channel is equal to or below the former power level of the reference control channel, or a new scheduling grant value is calculated on the basis of a target power level allowed for the communication and the currently measured power level of the reference control channel, in case the measured time is equal to or greater than the predetermined time threshold or the currently measured power level of the reference control channel is greater than the former power level of the reference control channel. The correspondingly calculated the new scheduling grant value is set as the current scheduling grant value.

It is to be noted that according to examples of embodiments of the invention, the former power level of the reference control channel is obtained by retrieving a last power level of the reference control channel detected in the scheduling grant procedure being conducted immediately before the detection of the carrier switching and setting the last power level of the reference control channel as the former power level of the reference

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control channel, or by conducting an arithmetic processing on plural power levels of the reference control channel determined before the detection of the carrier switching and setting the result of the arithmetic processing as the former scheduling grant value.

5

According to some examples of embodiments of the invention, the predetermined time threshold is based on a time where a power level of a reference control channel is converged to a target level.

10

Then, in step S830, an update message indicating the current scheduling grant value is sent to the UE 10.

15

In Fig. 13, a block circuit diagram illustrating a configuration of a communication element, such as of UE 10, is shown, which is configured to implement the control procedure for the UL communication as described in connection with some examples of embodiments of the invention. It is to be noted that the communication element or UE 10 shown in Fig. 13 may comprise several further elements or functions besides those described herein below, which are omitted herein for the sake of simplicity as they are not essential for understanding the invention. Furthermore, even though reference is made to a UE (or terminal device), the communication element 10 may be also another device having a similar function, such as a chipset, a chip, a module etc., which can also be part of a UE or attached as a separate element to a UE, or the like.

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The communication element or UE 10 may comprise a processing function or processor 11, such as a CPU or the like, which executes instructions given by programs or the like related to the control procedure for the UL communication. The processor 11 may comprise one or more processing portions dedicated to specific processing as described below, or the processing may be run in a single processor. Portions for executing such specific processing may be also provided as discrete elements or within one or more further processors or processing portions, such as in one physical processor like a CPU or in several physical entities, for example. Reference sign 12 denotes transceiver or input/output (I/O) units (interfaces)

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connected to the processor 11. The I/O units 12 are used for communicating with one or more communication network control elements like the NodeB 20. The I/O units 12 may be a combined unit comprising communication equipment towards several network elements, or may
5 comprise a distributed structure with a plurality of different interfaces for different network elements. Reference sign 13 denotes a memory usable, for example, for storing data and programs to be executed by the processor 11 and/or as a working storage of the processor 11.

10 The processor 11 is configured to execute processing related to the above described control procedure for the UL communication. In particular, the processor 11 comprises a sub-portion 111 as a processing portion which is usable for conducting a carrier switching. Furthermore, the processor 11
15 comprises a sub-portion 112 usable as a portion for determining the switching of the carrier. The portion 112 may be configured to perform processing according to step S700 of Fig. 11, for example. Furthermore, the processor 11 comprises a sub-portion 113 usable as a portion for determining whether a retransmission is required and allowed. The portion 113 may be configured to perform a processing according to steps S720
20 and 730 to 750 of Fig. 11, for example. Moreover, the processor 11 comprises a sub-portion 114 usable as a portion for measuring a time since the carrier switching. The portion 114 may be configured to perform a processing according to step S710 of Fig. 11, for example. In addition, the processor 11 comprises a sub-portion 115 usable as a portion for
25 determining a current SG.

In Fig. 14, a block circuit diagram illustrating a configuration of a communication network control element, such as of the eNB 20, is shown, which is configured to implement the procedure for resource requesting as
30 described in connection with some of the examples of embodiments of the invention. It is to be noted that the communication network control element like the NodeB 20 shown in Fig. 14 may comprise several further elements or functions besides those described herein below, which are omitted herein for the sake of simplicity as they are not essential for understanding the
35 invention. Furthermore, even though reference is made to a NodeB, the

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communication network control element may be also another device having a similar function, such as a chipset, a chip, a module etc., which can also be part of a communication network control element or attached as a separate element to a communication network control element, or the like.

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The communication network control element shown in Fig. 14 may comprise a processing function or processor 21, such as a CPU or the like, which executes instructions given by programs or the like related to control procedure of the UL communication. The processor 21 may comprise one or more processing portions dedicated to specific processing as described below, or the processing may be run in a single processor. Portions for executing such specific processing may be also provided as discrete elements or within one or more further processors or processing portions, such as in one physical processor like a CPU or in several physical entities, for example. Reference signs 22 denote transceiver or input/output (I/O) units (interfaces) connected to the processor 21. The I/O units 22 may be used for communicating with one or more communication elements like UEs. The I/O units 22 may be a combined unit comprising communication equipment towards several network elements, or may comprise a distributed structure with a plurality of different interfaces for different network elements. Reference sign 23 denotes a memory usable, for example, for storing data and programs to be executed by the processor 21 and/or as a working storage of the processor 21.

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The processor 21 is configured to execute processing related to the above described control procedure of the UL communication. In particular, the processor 21 comprises a sub-portion 211 as a processing portion which is usable for detecting a carrier switching. The portion 211 may be configured to perform processing according to step S800 of Fig. 12, for example. Furthermore, the processor 21 comprises a sub-portion 212 usable as a portion for measuring a time since the carrier switching. The portion 212 may be configured to perform processing according to step S810 of Fig. 12, for example. Furthermore, the processor 21 comprises a sub-portion 213 usable as a portion for conducting a scheduling grant processing. The

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portion 213 may be configured to perform processing according to steps S820 and S830 of Fig. 12, for example.

5 It is to be noted that the above described examples of embodiments of the invention can be also used in a combined manner. For example, the SG value determined in any of the examples of embodiments of the invention described in Figs. 5 to 8 can be used as a SG value considered in the processing of examples of embodiments of the invention according to Fig. 3.

10 Furthermore, even though it is described that according to examples of embodiments of the invention a case is considered where multiple UL carriers are provided from a system for communications from the UE to the network, wherein it is assumed that one UE is capable to use one carrier frequency at a time, examples of embodiments of the invention are also
15 applicable in case where multiple UL carriers are provided from a system for communications from the UE to the network, wherein an UE is capable to use more than one carrier frequency at a time.

20 According to some further examples of embodiments of the invention, there is provided an apparatus comprising carrier switching means for conducting a carrier switching for switching a communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier, switching determining means for determining whether a carrier switching is executed, retransmission determining means for determining whether a
25 retransmission of data is required, and time measuring means for measuring a time beginning from a switching time where the carrier switching is executed, wherein the retransmission determining means are further configured to disable the retransmission of the data in case the time measured by the time measuring function is below a predetermined time
30 threshold.

In addition, according to some further examples of embodiments of the invention, there is provided an apparatus comprising carrier switching
35 detecting means for detecting that a carrier switching for switching a communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier is executed, time measuring means for

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measuring a time beginning from a switching time where the carrier switching is executed, and scheduling grant processing means for conducting a scheduling grant procedure after the carrier switching is detected, wherein the scheduling grant procedure includes: determining a
5 current scheduling grant value for an uplink communication, wherein the current scheduling grant value is determined on the basis of whether or not the time measured by the time measuring function is below a predetermined time threshold, and causing a transmission of an update message indicating the current scheduling grant value.

10 For the purpose of the present invention as described herein above, it should be noted that

- an access technology via which signaling is transferred to and from a network element may be any technology by means of which a network
15 element or sensor node can access another network element or node (e.g. via a base station or generally an access node). Any present or future technology, such as WLAN (Wireless Local Access Network), WiMAX (Worldwide Interoperability for Microwave Access), LTE, LTE-A, Bluetooth, Infrared, and the like may be used; although the above technologies are
20 mostly wireless access technologies, e.g. in different radio spectra, access technology in the sense of the present invention implies also wired technologies, e.g. IP based access technologies like cable networks or fixed lines but also circuit switched access technologies; access technologies may be distinguishable in at least two categories or access domains such as
25 packet switched and circuit switched, but the existence of more than two access domains does not impede the invention being applied thereto,

- usable communication networks, stations and transmission nodes may be or comprise any device, apparatus, unit or means by which a station, entity
30 or other user equipment may connect to and/or utilize services offered by the access network; such services include, among others, data and/or (audio-) visual communication, data download etc.;

- a user equipment or communication network element (station) may be any device, apparatus, unit or means by which a system user or subscriber
35 may experience services from an access network, such as a mobile phone or smart phone, a personal digital assistant PDA, or computer, or a device having a corresponding functionality, such as a modem chipset, a chip, a

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module etc., which can also be part of a UE or attached as a separate element to a UE, or the like;

- method steps likely to be implemented as software code portions and being run using a processor at a network element or terminal (as examples of devices, apparatuses and/or modules thereof, or as examples of entities including apparatuses and/or modules for it), are software code independent and can be specified using any known or future developed programming language as long as the functionality defined by the method steps is preserved;

- generally, any method step is suitable to be implemented as software or by hardware without changing the idea of the invention in terms of the functionality implemented;

- method steps and/or devices, apparatuses, units or means likely to be implemented as hardware components at a terminal or network element, or any module(s) thereof, are hardware independent and can be implemented using any known or future developed hardware technology or any hybrids of these, such as a microprocessor or CPU (Central Processing Unit), 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; in addition, any method steps and/or devices, units or means likely to be implemented as software components may for example be based on any security architecture capable e.g. of authentication, authorization, keying and/or traffic protection;

- devices, apparatuses, units or means can be implemented as individual devices, apparatuses, units or means, but this does not exclude that they are implemented in a distributed fashion throughout the system, as long as the functionality of the device, apparatus, unit or means is preserved; for example, for executing operations and functions according to examples of embodiments of the invention, one or more processors may be used or shared in the processing, or one or more processing sections or processing portions may be used and shared in the processing, wherein one physical processor or more than one physical processor may be used for

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implementing one or more processing portions dedicated to specific processing as described,

- an apparatus may be represented by a semiconductor chip, a chipset, or a (hardware) module comprising such chip or chipset; this, however, does not
5 exclude the possibility that a functionality of an 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;

10 - a device may be regarded as an apparatus or as an assembly of more than one apparatus, whether functionally in cooperation with each other or functionally independently of each other but in a same device housing, for example.

15 As described above, there is provided a mechanism for controlling a communication in UL direction where a load balancing mechanism such as carrier switching is conducted. When a carrier switching for switching a communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier is executed, it is determined whether a
20 retransmission of data is required. In case a time being measured beginning from a switching time where the carrier switching is executed is below a threshold, the retransmission of the data is disabled.

25 Although the present invention has been described herein before with reference to particular embodiments thereof, the present invention is not limited thereto and various modifications can be made thereto.

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CLAIMS

1. An apparatus comprising

5 at least one processor,
 at least one interface to at least one other network element, and
 at least one memory for storing instructions to be executed by the
processor, wherein

10 the at least one memory and the instructions are configured to, with
the at least one processor, cause the apparatus at least to perform:

 a carrier switching function configured to conduct a carrier switching
for switching a communication from at least one first uplink frequency
carrier to at least one second uplink frequency carrier,

15 a switching determining function configured to determine whether a
carrier switching is executed,

 a retransmission determining function configured to determine
whether a retransmission of data is required, and

 a time measuring function configured to measure a time beginning
from a switching time where the carrier switching is executed,

20 wherein the retransmission determining function is further configured
to disable the retransmission of the data in case the time measured by the
time measuring function is below a predetermined time threshold.

25 2. The apparatus according to claim 1, wherein the at least one memory
and the instructions are configured to, with the at least one processor,
cause the apparatus at least to further perform:

 a scheduling grant determining function configured to determine a
current scheduling grant for a current uplink communication, and

30 a data transmission function configured to cause a transmission of
new data by using the current scheduling grant when a retransmission of
data is not required,

 wherein the retransmission determining function is further configured
to cause a transmission of new data by using the current scheduling grant
when the retransmission is disabled.

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3. The apparatus according to any of claims 1 and 2, wherein

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the retransmission determining function is further configured to determine that the retransmission of data is required when at least one of the following is valid:

5 an acknowledgement for a successful transmission in a preceding transmission cycle in one hybrid automatic repeat request process is not determined to be received, and

an incorrect transmission or decoding of a transport block in a preceding transmission cycle is detected,

10 wherein the retransmission determining function is further configured to stop the hybrid automatic repeat request process for disabling the retransmission.

4. The apparatus according to any of claims 1 to 3, wherein

15 the retransmission determining function is further configured to cause, when it is determined that the retransmission is not to be disabled, the retransmission of the data by using a preceding scheduling grant valid for a communication before the switching of the at least one frequency carrier.

20 5. The apparatus according to any of claims 1 to 4, wherein

a value of the predetermined time threshold is one of

a preset time value stored in the memory of the apparatus,
and

25 a time value signaled by a communication network control element as policy information,

wherein the predetermined time threshold is based on a time where a power level of a reference control channel is converged to a target level.

30 6. The apparatus according to any of claims 1 to 5, wherein the at least one memory and the instructions are configured to, with the at least one processor, cause the apparatus at least to further perform:

35 a carrier condition detection function configured to detect a condition on a frequency carrier to which the communication is switched in comparison to a condition on a frequency carrier from which the communication is switched,

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wherein the retransmission determining function is further configured to cancel the disabling of the retransmission in case the carrier condition detection function detects that a total power gain on the frequency carrier to which the communication is switched is lower than a total power gain on the frequency carrier from which the communication is switched.

5

7. The apparatus according to any of claims 1 to 6, wherein the communication is a high speed packet access based communication, wherein the carrier switching function is configured to conduct a carrier switching for switching the communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier in a same cell or in a different cell of a communication network on the basis of one of a command received from a communication network control element, and a processing result of an internal determination processing for determining whether the carrier switching is to be conducted.

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8. The apparatus according to any of claims 1 to 7, wherein the apparatus is comprised in a communication element comprising at least one of a terminal device or user equipment communicating with a communication network control element, wherein the communication is conducted with the communication network control element which comprises at least one of a base station or an access node of a cellular communication network.

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9. A method comprising
determining whether a carrier switching for switching a communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier is executed,
measuring a time beginning from a switching time where the carrier switching is executed,
determining whether a retransmission of data is required, and
disabling the retransmission of the data in case the time being measured is below a predetermined time threshold.

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10. The method according to claim 9, further comprising:

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determining a current scheduling grant for a current uplink communication, and

causing transmission of new data by using the current scheduling grant when a retransmission of data is not required, or

5 causing transmission of new data by using the current scheduling grant when the retransmission is disabled.

11. The method according to any of claims 9 and 10, wherein

10 the retransmission of data is determined to be required when at least one of the following is valid:

an acknowledgement for a successful transmission in a preceding transmission cycle in one hybrid automatic repeat request process is not determined to be received, and

15 an incorrect transmission or decoding of a transport block in a preceding transmission cycle is detected,

wherein the disabling of the retransmission is achieved by stopping the hybrid automatic repeat request process.

12. The method according to any of claims 9 to 11, further comprising

20 causing, when it is determined that the retransmission is not to be disabled, the retransmission of the data by using a preceding scheduling grant valid for a communication before the switching of the at least one frequency carrier.

13. The method according to any of claims 9 to 12, wherein

a value of the predetermined time threshold is one of

a preset time value being stored, and

a time value signaled by a communication network control element as policy information,

30 wherein the predetermined time threshold is based on a time where a power level of a reference control channel is converged to a target level.

14. The method according to any of claims 9 to 13, further comprising

35 detecting a condition on a frequency carrier to which the communication is switched in comparison to a condition on a frequency carrier from which the communication is switched, and

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canceling the disabling of the retransmission in case it is detected that a total power gain on the frequency carrier to which the communication is switched is lower than a total power gain on the frequency carrier from which the communication is switched.

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15. The method according to any of claims 9 to 14, wherein the communication is a high speed packet access based communication, wherein the carrier switching is conducted for switching the communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier in a same cell or in a different cell of a communication network on the basis of one of

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a command received from a communication network control element, and

a processing result of an internal determination processing for determining whether the carrier switching is to be conducted.

15

16. The method according to any of claims 9 to 15, wherein the method is implemented in a communication element comprising at least one of a terminal device or user equipment communicating with a communication network control element, wherein the communication is conducted with the communication network control element which comprises at least one of a base station or an access node of a cellular communication network.

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17. An apparatus comprising

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at least one processor,

at least one interface to at least one other network element, and

at least one memory for storing instructions to be executed by the processor, wherein

the at least one memory and the instructions are configured to, with the at least one processor, cause the apparatus at least to perform:

30

a carrier switching detecting function configured to detect that a carrier switching for switching a communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier is executed,

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a time measuring function configured to measure a time beginning from a switching time where the carrier switching is executed, and

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a scheduling grant processing function configured to conduct a scheduling grant procedure after the carrier switching is detected, wherein the scheduling grant procedure includes:

determining a current scheduling grant value for an uplink communication, wherein the current scheduling grant value is determined on the basis of whether or not the time measured by the time measuring function is below a predetermined time threshold, and

causing a transmission of an update message indicating the current scheduling grant value.

18. The apparatus according to claim 17, wherein the scheduling grant procedure further includes:

in case the time measured by the time measuring function is equal to or greater than the predetermined time threshold, calculating a new scheduling grant value on the basis of a target power level allowed for the communication and a currently measured power level of a reference control channel, and setting the new scheduling grant value as the current scheduling grant value; and

in case the time measured by the time measuring function is below the predetermined time threshold, obtaining a former scheduling grant value on the basis of a scheduling grant value determined in at least one previous scheduling grant procedure being conducted before the carrier switching is executed, and setting the former scheduling grant value as the current scheduling grant value.

19. The apparatus according to claim 17, wherein the scheduling grant procedure further includes:

calculating a new scheduling grant value on the basis of a target power level allowed for the communication and a currently measured power level of a reference control channel,

obtaining a former scheduling grant value on the basis of a scheduling grant value determined in a previous scheduling grant procedure being conducted before the carrier switching is executed,

setting the former scheduling grant value as the current scheduling grant value, in case the time measured by the time measuring function is

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below the predetermined time threshold and the new scheduling grant value is equal to or greater than the former scheduling grant value, and

5 setting the new scheduling grant value as the current scheduling grant value, in case the time measured by the time measuring function is equal to or greater than the predetermined time threshold or in case the new scheduling grant value is lower than the former scheduling grant value.

20. The apparatus according to claim 18 or 19, wherein the scheduling grant procedure further includes:

10 obtaining the former scheduling grant value by one of
 retrieving a last scheduling grant value determined immediately before the detection of the carrier switching and setting the last scheduling grant value as the former scheduling grant value, and
 conducting an arithmetic processing on plural scheduling grant
15 values determined before the detection of the carrier switching and setting the result of the arithmetic processing as the former scheduling grant value.

21. The apparatus according to claim 17, wherein the scheduling grant procedure further includes:

20 in case the time measured by the time measuring function is equal to or greater than the predetermined time threshold, calculating a new scheduling grant value on the basis of a target power level allowed for the communication and a currently measured power level of a reference control channel, and setting the new scheduling grant value as the current
25 scheduling grant value; and

 in case the time measured by the time measuring function is below the predetermined time threshold, calculating an alternative scheduling grant value on the basis of a target power level allowed for the communication and a former power value of the reference control channel
30 detected in at least one previous scheduling grant procedure being conducted before the carrier switching is executed, and setting the alternative scheduling grant value as the current scheduling grant value.

22. The apparatus according to claim 17, wherein the scheduling grant
35 procedure further includes:

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obtaining a currently measured power level of a reference control channel and a former power value of the reference control channel detected in at least one previous scheduling grant procedure being conducted before the carrier switching is executed,

5 calculating a new scheduling grant value on the basis of a target power level allowed for the communication and the former power level of the reference control channel, in case the time measured by the time measuring function is below the predetermined time threshold and the currently measured power level of the reference control channel is equal to
10 or below the former power level of the reference control channel, or

 calculating a new scheduling grant value on the basis of a target power level allowed for the communication and the currently measured power level of the reference control channel, in case the time measured by the time measuring function is equal to or greater than the predetermined
15 time threshold or the currently measured power level of the reference control channel is greater than the former power level of the reference control channel, and

 setting the new scheduling grant value as the current scheduling grant value.

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23. The apparatus according to claim 21 or 22, wherein the scheduling grant procedure further includes:

 obtaining the former power level of the reference control channel by one of

25 retrieving a last power level of the reference control channel detected in the scheduling grant procedure being conducted immediately before the detection of the carrier switching and setting the last power level of the reference control channel as the former power level of the reference control channel, and

30 conducting an arithmetic processing on plural power levels of the reference control channel determined before the detection of the carrier switching and setting the result of the arithmetic processing as the former scheduling grant value.

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24. The apparatus according to any of claims 18 to 23, wherein the power level of the reference control channel is a power level of a dedicated physical control channel.

5 25. The apparatus according to any of claims 17 to 24, wherein
 the predetermined time threshold is based on a time where a power
 level of a reference control channel is converged to a target level.

10 26. The apparatus according to any of claims 17 to 25, wherein the
 communication is a high speed packet access based communication,
 wherein the carrier switching is conducted for switching the communication
 from at least one first uplink frequency carrier to at least one second uplink
 frequency carrier in a same cell or in a different cell of a communication
 network.

15 27. The apparatus according to any of claims 17 to 26, wherein the
 apparatus is comprised in a communication network control element
 comprising at least one of a base station or an access node of a cellular
 communication network, wherein the communication is conducted with a
20 communication element comprising at least one of a terminal device or user
 equipment communicating with the communication network control
 element.

25 28. A method comprising
 detecting that a carrier switching for switching a communication from
 at least one first uplink frequency carrier to at least one second uplink
 frequency carrier is executed,
 measuring a time beginning from a switching time where the carrier
 switching is executed, and
30 conducting a scheduling grant procedure after the carrier switching is
 detected, wherein the scheduling grant procedure includes:
 determining a current scheduling grant value for an uplink
 communication, wherein the current scheduling grant value is determined
 on the basis of whether or not the time measured by the time measuring
35 function is below a predetermined time threshold, and

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causing a transmission of an update message indicating the current scheduling grant value.

29. The method according to claim 28, wherein the scheduling grant procedure further includes:

5 in case the time being measured is equal to or greater than the predetermined time threshold, calculating a new scheduling grant value on the basis of a target power level allowed for the communication and a currently measured power level of a reference control channel, and setting
10 the new scheduling grant value as the current scheduling grant value; and

 in case the measured time is below the predetermined time threshold, obtaining a former scheduling grant value on the basis of a scheduling grant value determined in at least one previous scheduling grant procedure being conducted before the carrier switching is executed, and
15 setting the former scheduling grant value as the current scheduling grant value.

30. The method according to claim 28, wherein the scheduling grant procedure further includes:

20 calculating a new scheduling grant value on the basis of a target power level allowed for the communication and a currently measured power level of a reference control channel,

 obtaining a former scheduling grant value on the basis of a scheduling grant value determined in a previous scheduling grant procedure being conducted before the carrier switching is executed,
25

 setting the former scheduling grant value as the current scheduling grant value, in case the measured time is below the predetermined time threshold and the new scheduling grant value is equal to or greater than the former scheduling grant value, and

30 setting the new scheduling grant value as the current scheduling grant value, in case the measured time is equal to or greater than the predetermined time threshold or in case the new scheduling grant value is lower than the former scheduling grant value.

31. The method according to claim 29 or 30, wherein the scheduling grant procedure further includes:

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obtaining the former scheduling grant value by one of
retrieving a last scheduling grant value determined
immediately before the detection of the carrier switching and setting the
last scheduling grant value as the former scheduling grant value, and
5 conducting an arithmetic processing on plural scheduling grant
values determined before the detection of the carrier switching and setting
the result of the arithmetic processing as the former scheduling grant value.

10 32. The method according to claim 28, wherein the scheduling grant
procedure further includes:

in case the measured time is equal to or greater than the
predetermined time threshold, calculating a new scheduling grant value on
the basis of a target power level allowed for the communication and a
currently measured power level of a reference control channel, and setting
15 the new scheduling grant value as the current scheduling grant value; and

in case the measured time is below the predetermined time
threshold, calculating an alternative scheduling grant value on the basis of a
target power level allowed for the communication and a former power value
of the reference control channel detected in at least one previous scheduling
20 grant procedure being conducted before the carrier switching is executed,
and setting the alternative scheduling grant value as the current scheduling
grant value.

25 33. The method according to claim 287, wherein the scheduling grant
procedure further includes:

obtaining a currently measured power level of a reference control
channel and a former power value of the reference control channel detected
in at least one previous scheduling grant procedure being conducted before
the carrier switching is executed,

30 calculating a new scheduling grant value on the basis of a target
power level allowed for the communication and the former power level of
the reference control channel, in case the measured time is below the
predetermined time threshold and the currently measured power level of
the reference control channel is equal to or below the former power level of
35 the reference control channel, or

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calculating a new scheduling grant value on the basis of a target power level allowed for the communication and the currently measured power level of the reference control channel, in case the measured time is equal to or greater than the predetermined time threshold or the currently measured power level of the reference control channel is greater than the former power level of the reference control channel, and

setting the new scheduling grant value as the current scheduling grant value.

34. The method according to claim 32 or 33, wherein the scheduling grant procedure further includes:

obtaining the former power level of the reference control channel by one of

retrieving a last power level of the reference control channel detected in the scheduling grant procedure being conducted immediately before the detection of the carrier switching and setting the last power level of the reference control channel as the former power level of the reference control channel, and

conducting an arithmetic processing on plural power levels of the reference control channel determined before the detection of the carrier switching and setting the result of the arithmetic processing as the former scheduling grant value.

35. The method according to any of claims 29 to 34, wherein the power level of the reference control channel is a power level of a dedicated physical control channel.

36. The method according to any of claims 28 to 35, wherein

the predetermined time threshold is based on a time where a power level of a reference control channel is converged to a target level.

37. The method according to any of claims 28 to 36, wherein the communication is a high speed packet access based communication, wherein the carrier switching is conducted for switching the communication from at least one first uplink frequency carrier to at least one second uplink

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frequency carrier in a same cell or in a different cell of a communication network.

38. The method according to any of claims 28 to 37, wherein the method is implemented in a communication network control element comprising at least one of a base station or an access node of a cellular communication network, wherein the communication is conducted with a communication element comprising at least one of a terminal device or user equipment communicating with the communication network control element.

39. A communication system comprising

communication element comprising at least one a terminal device or user equipment communicating in an uplink direction and being capable of conducting a carrier switching for switching a communication from at least one first uplink frequency carrier to at least one second uplink frequency carrier, wherein the communication element comprises an apparatus according to any of claims 1 to 8, and

a communication network control element comprising at least one of a base station or an access node, wherein the communication network control element comprises an apparatus according to any of claims 17 to 27,

wherein the communication is conducted between the communication element and the communication network control element.

40. A computer program product for a computer, comprising software code portions for performing the steps of any of claims 9 to 16 or any of claims 28 to 38 when said product is run on the computer.

41. The computer program product according to claim 40, wherein

the computer program product comprises a computer-readable medium on which said software code portions are stored, and/or

the computer program product is directly loadable into the internal memory of the computer and/or transmittable via a network by means of at least one of upload, download and push procedures.

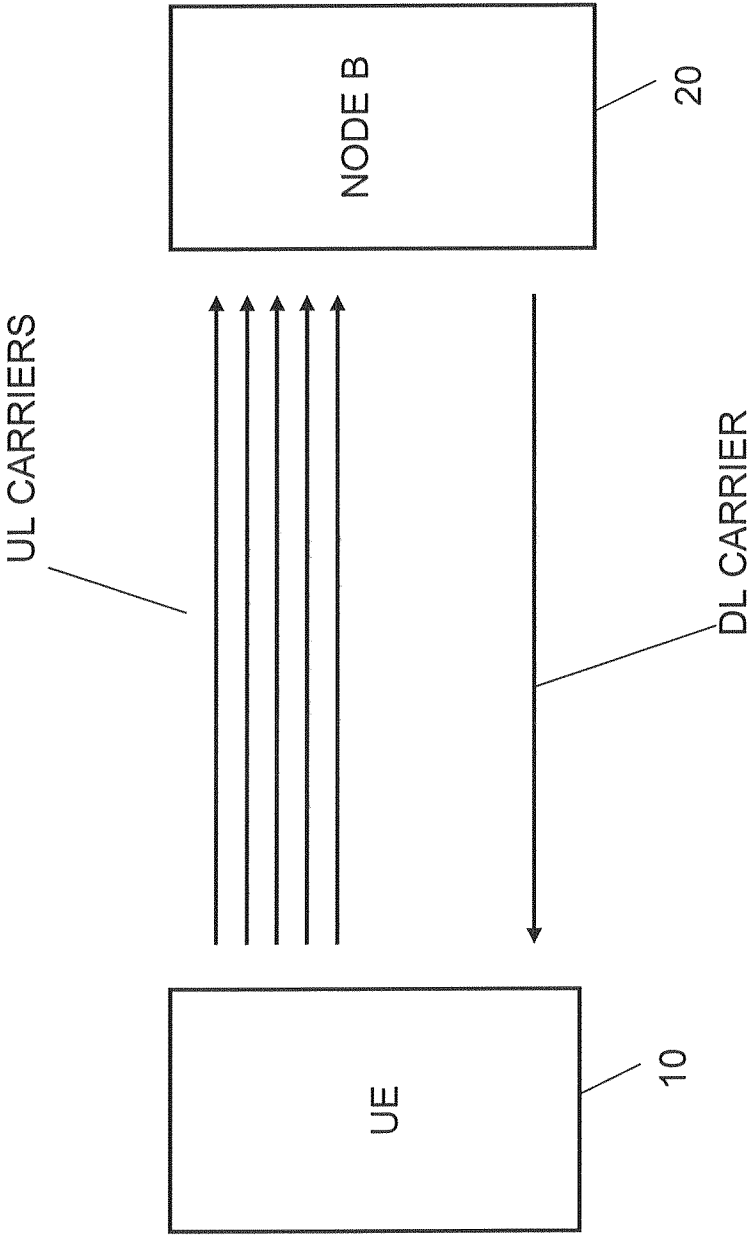


Fig. 1

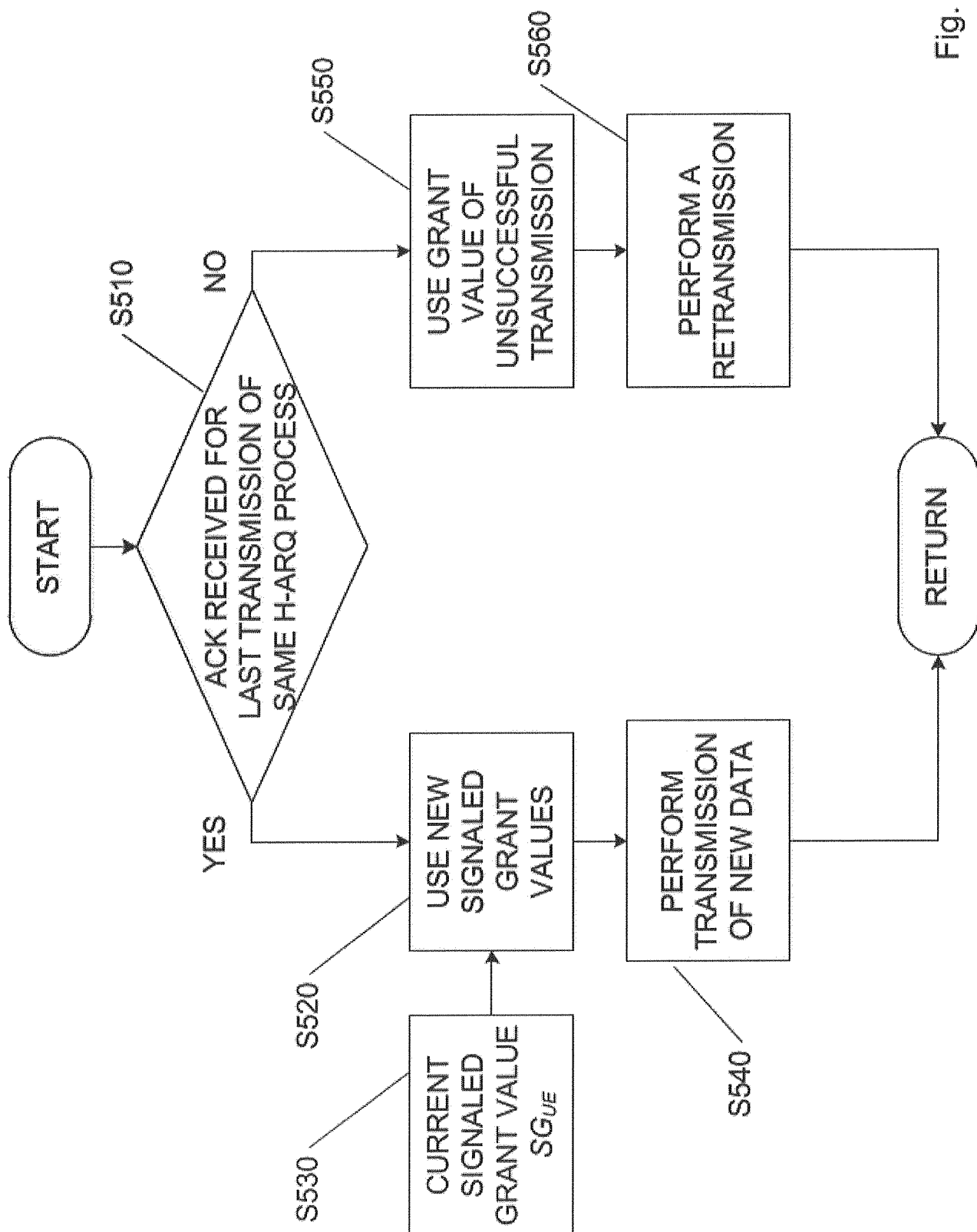


Fig. 2

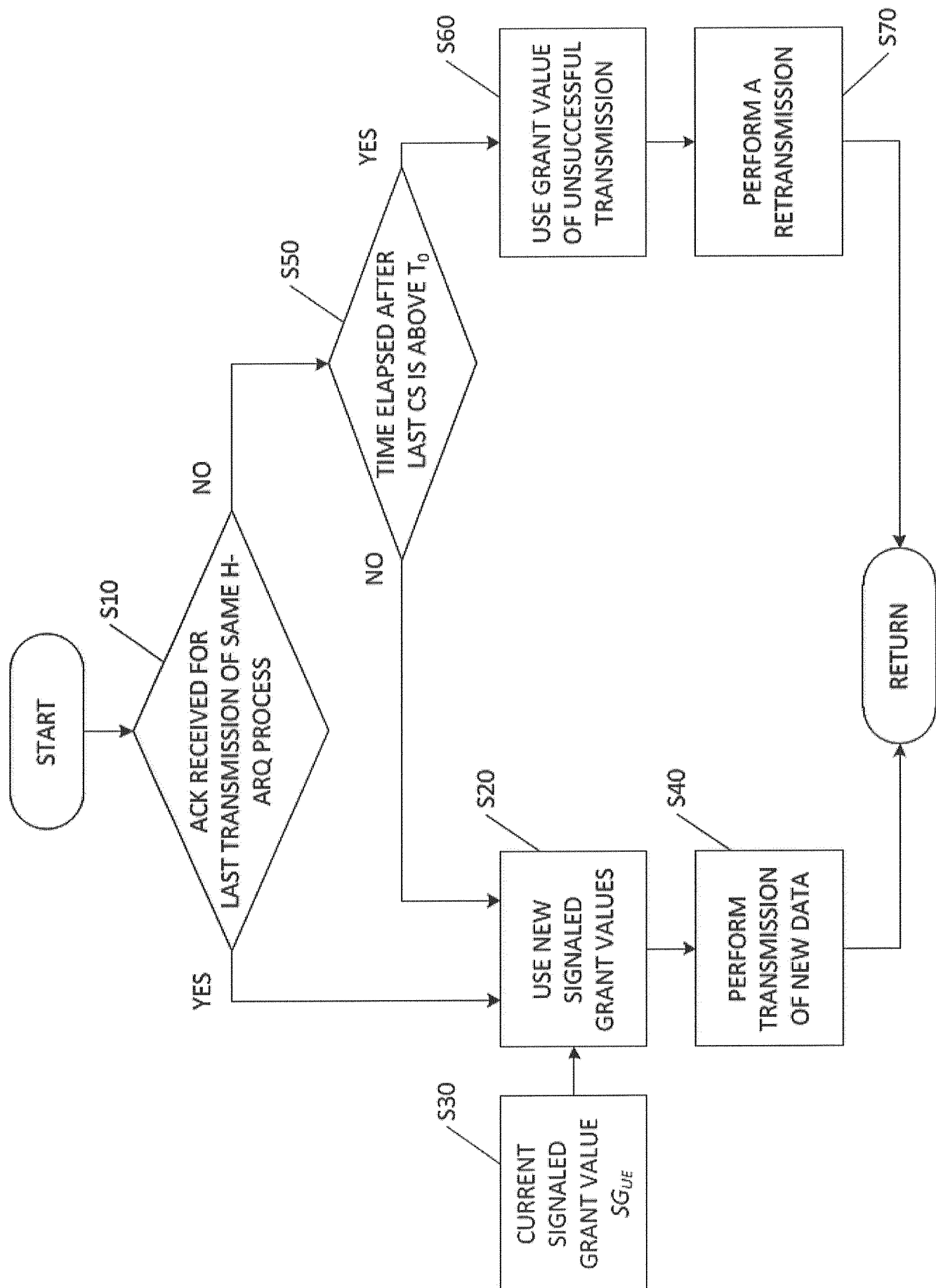


Fig. 3

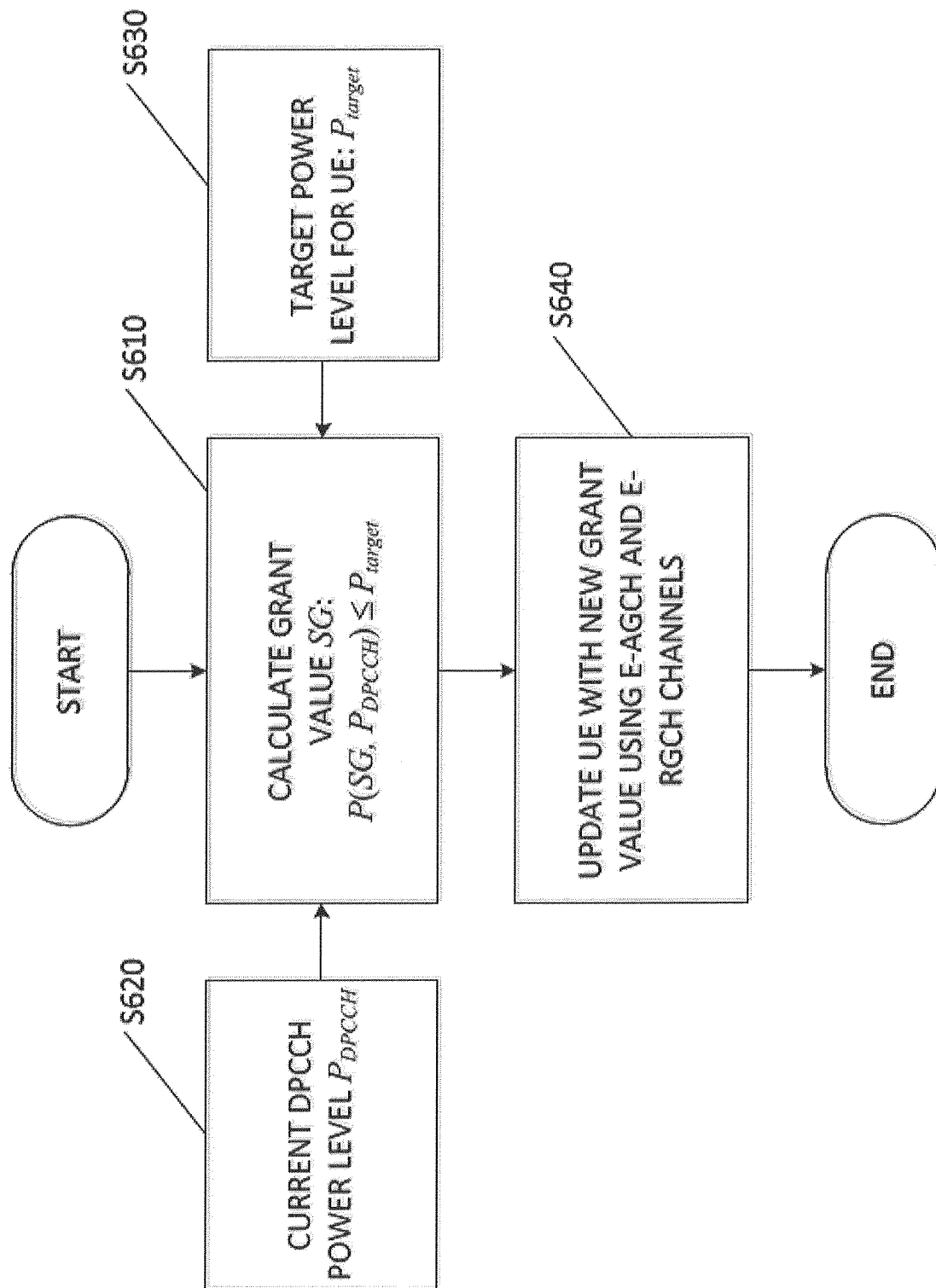


Fig. 4

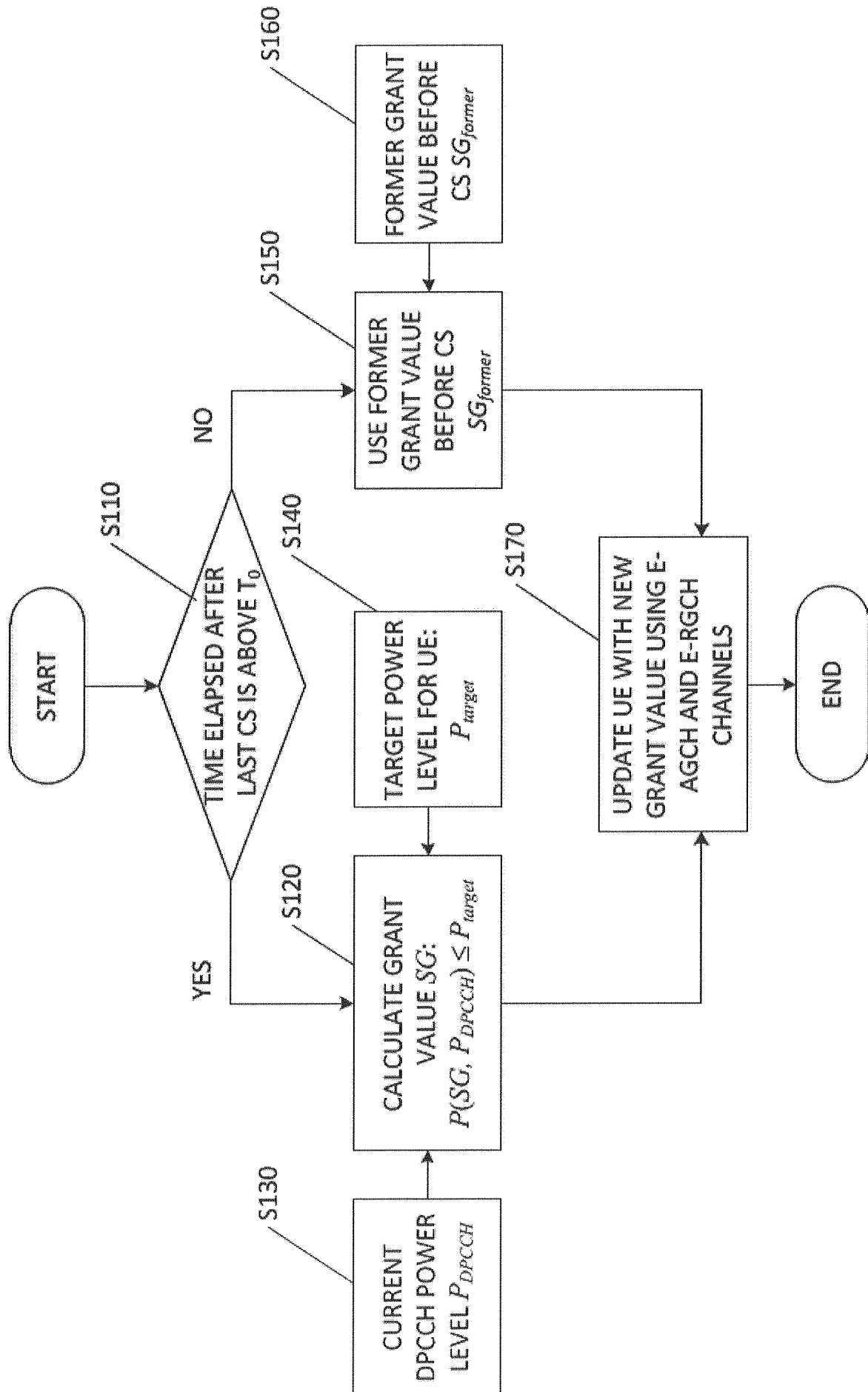


Fig. 5

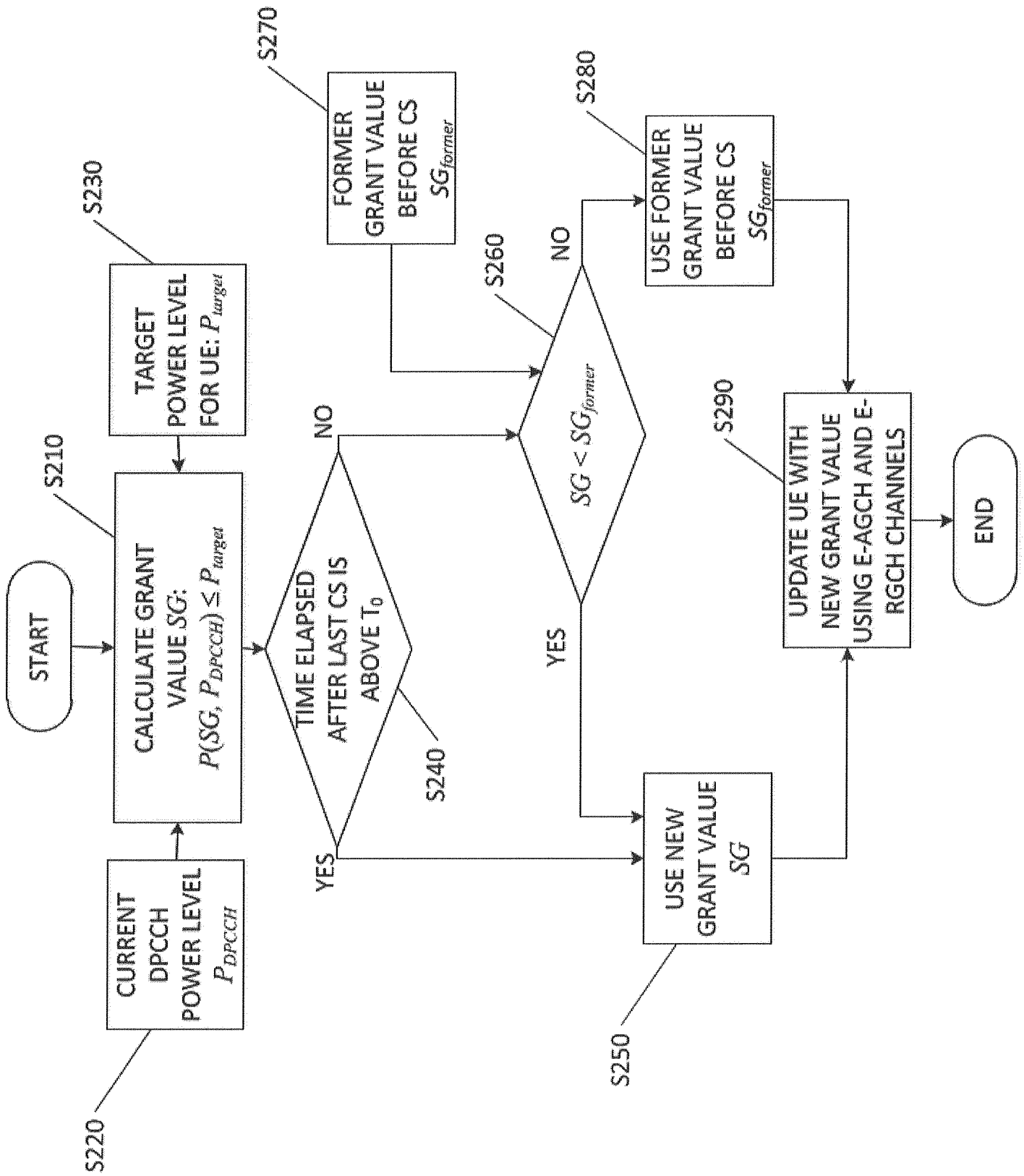


Fig. 6

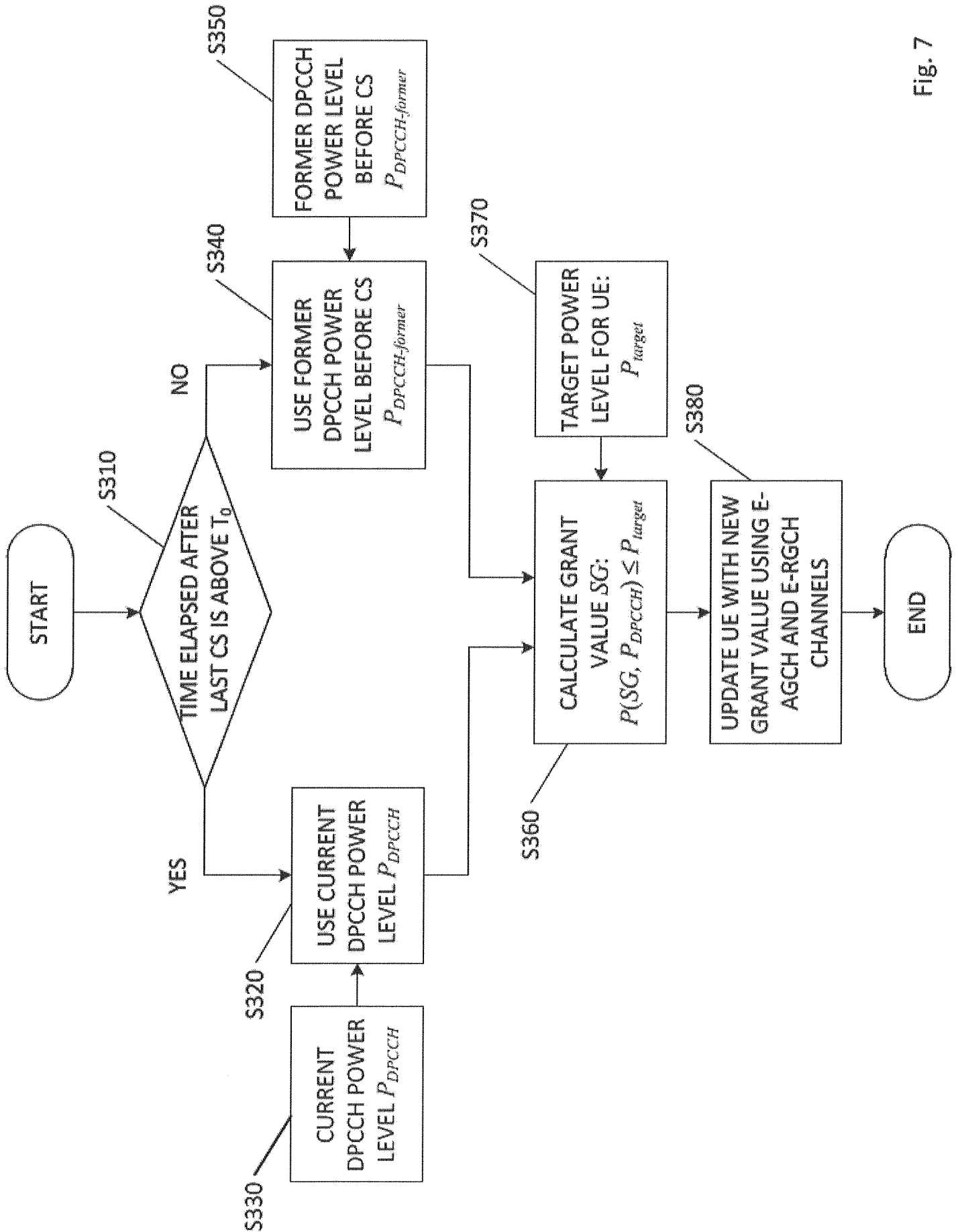


Fig. 7

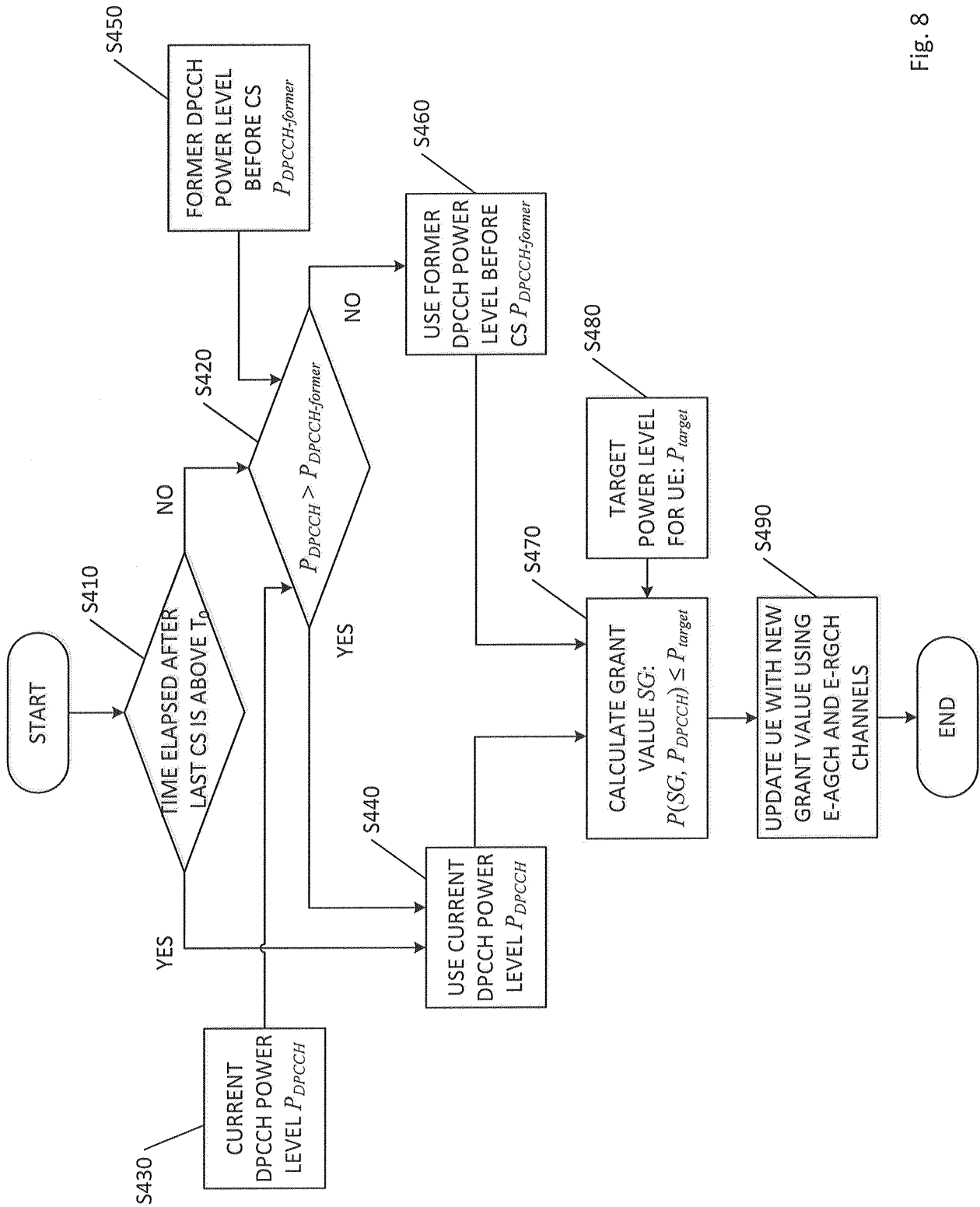
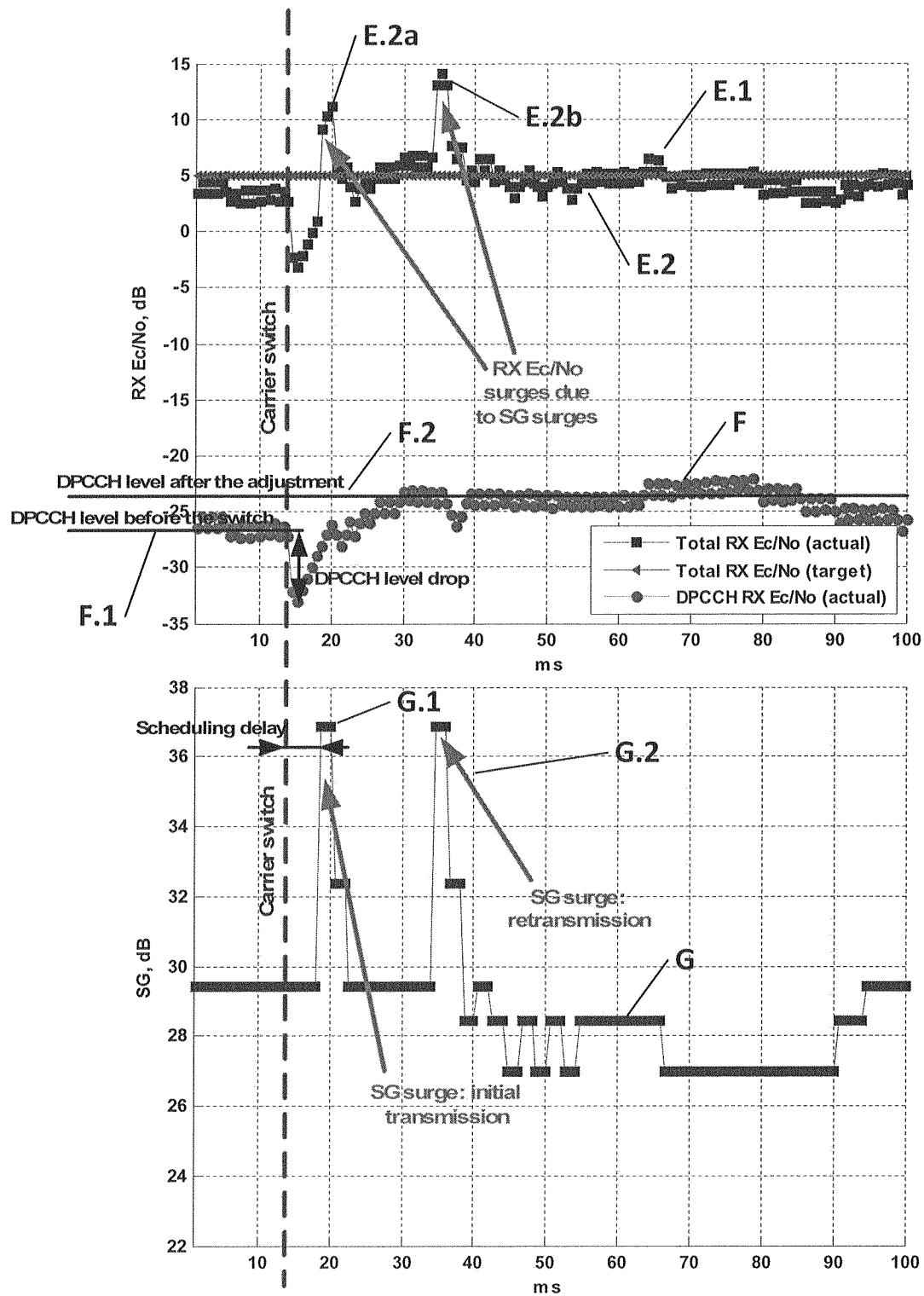


Fig. 8



G.1

Fig. 9

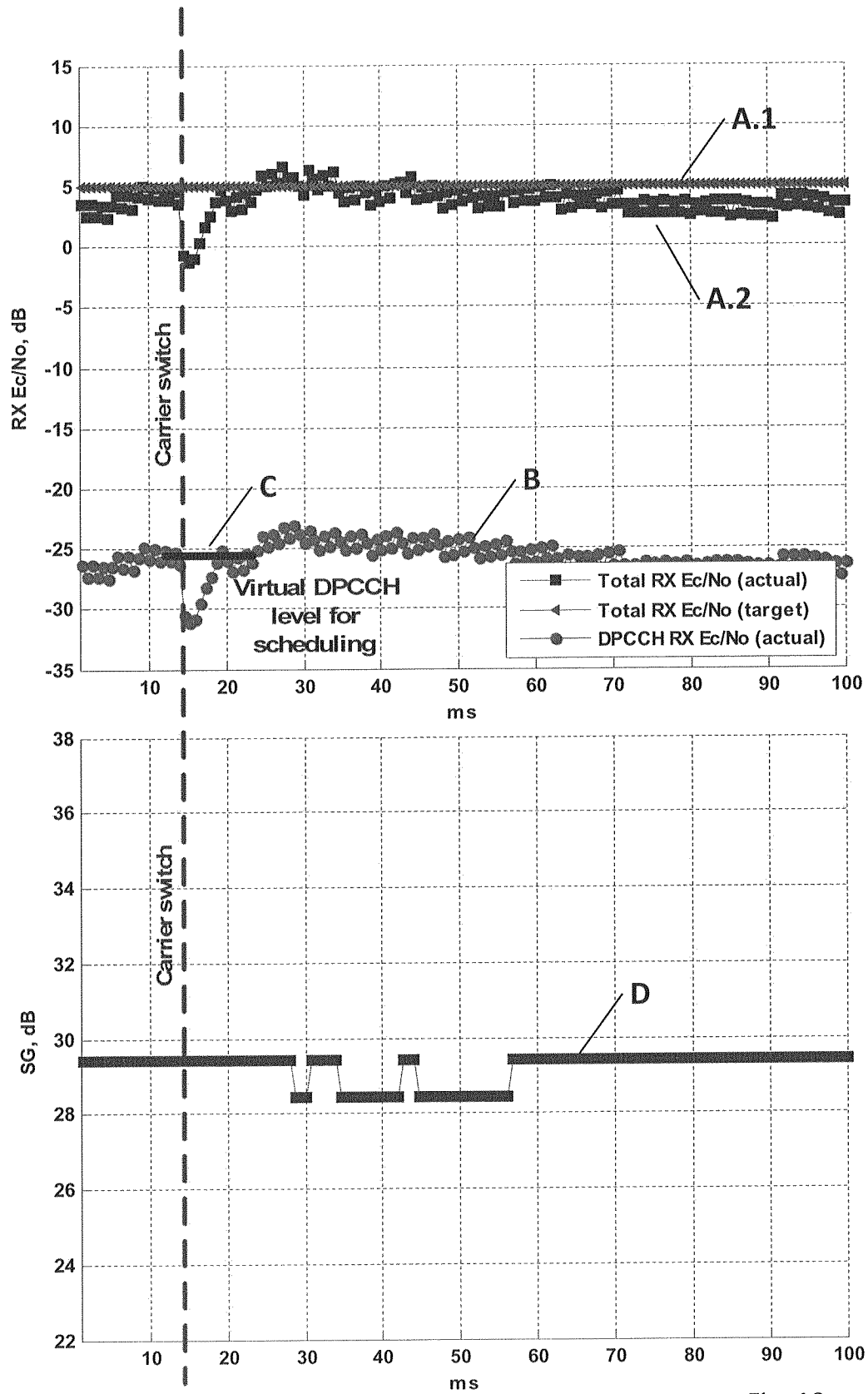


Fig. 10

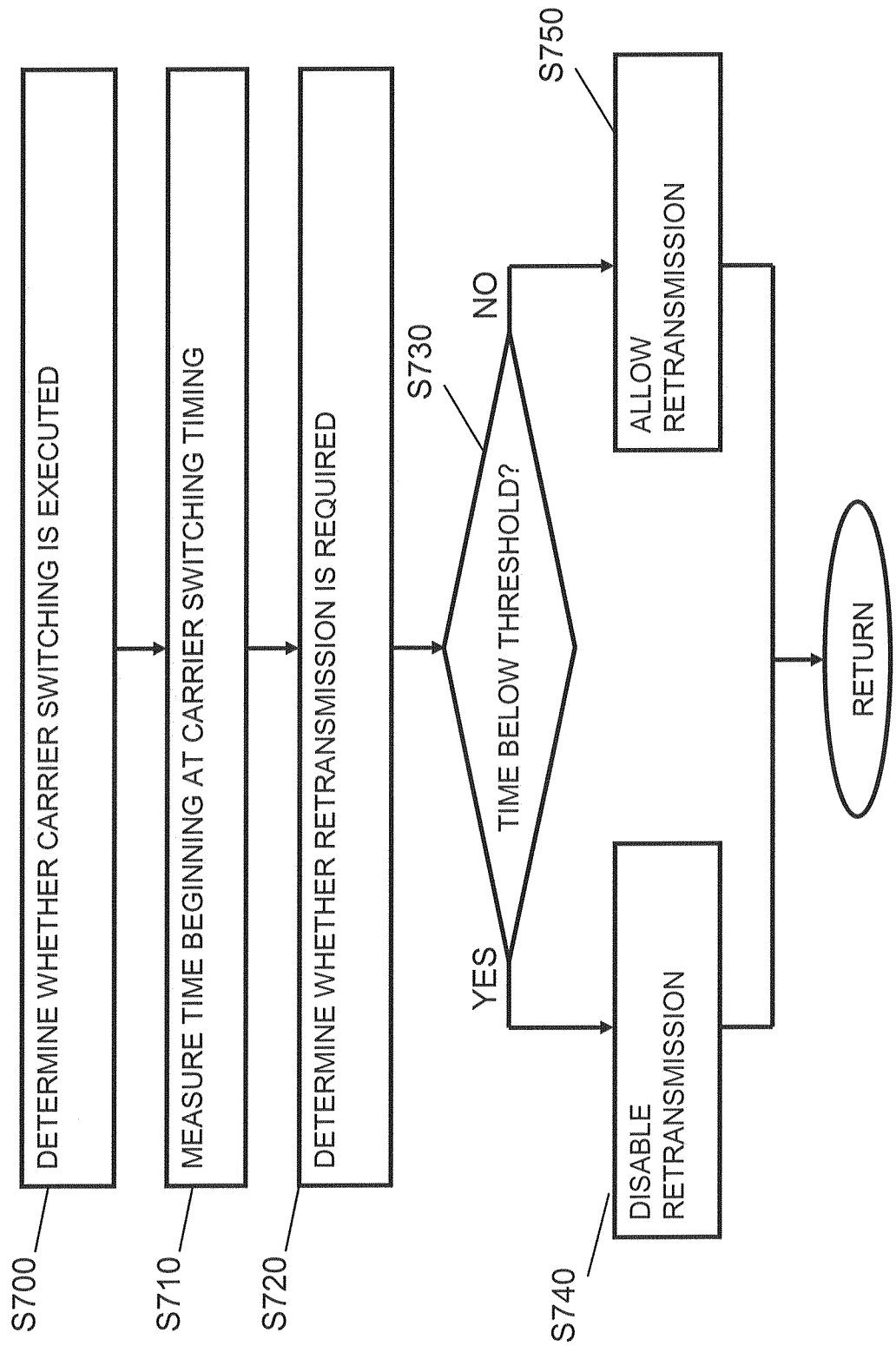


Fig. 11

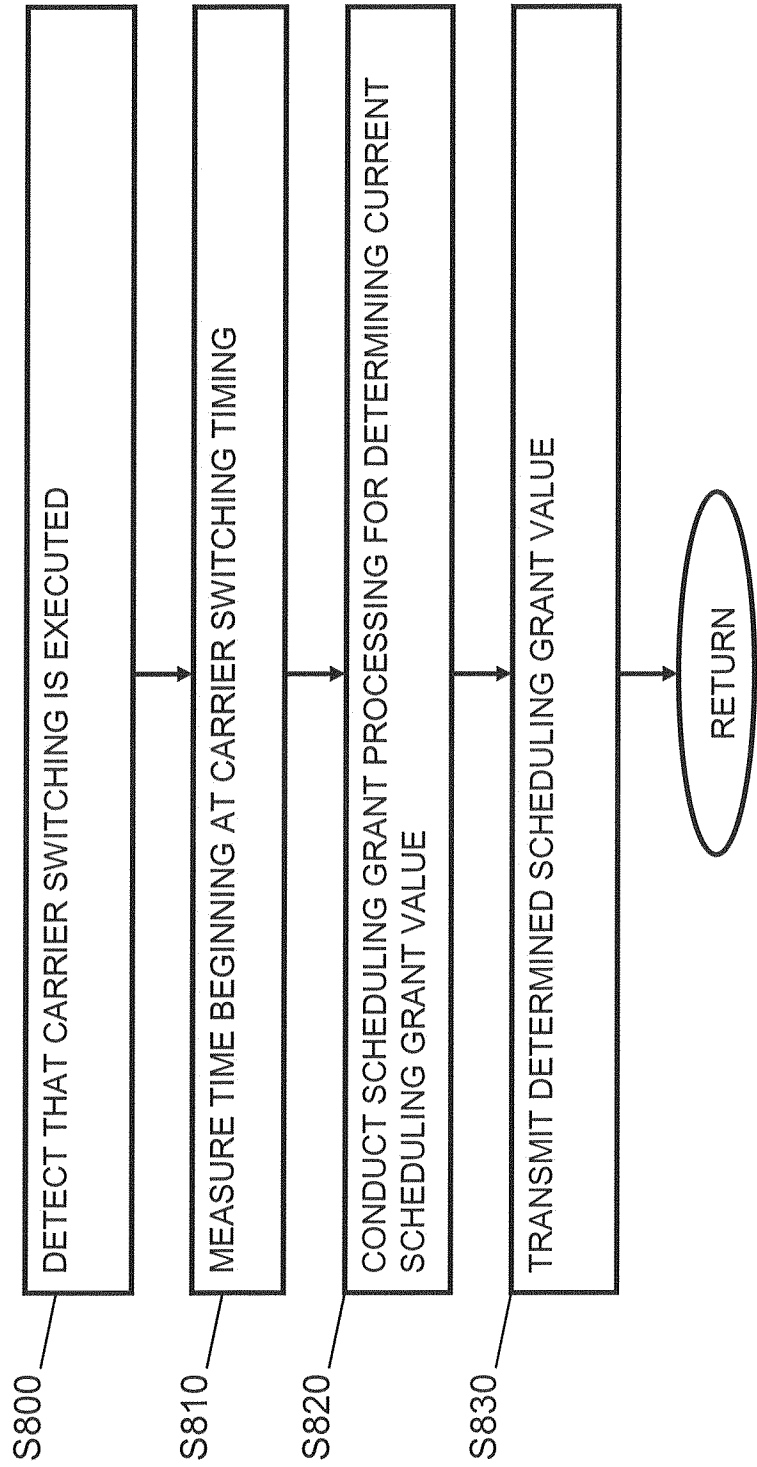


Fig. 12

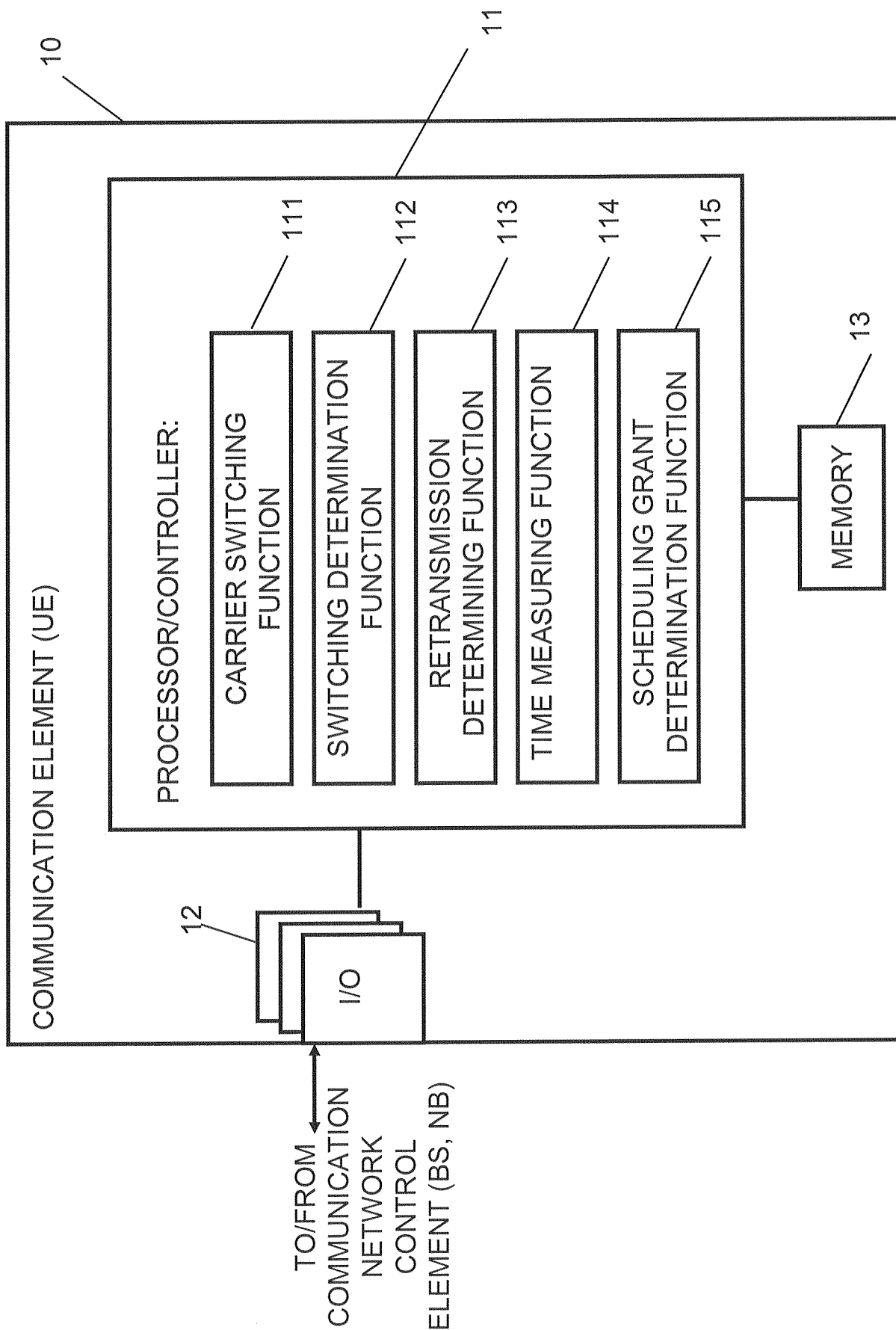


Fig. 13

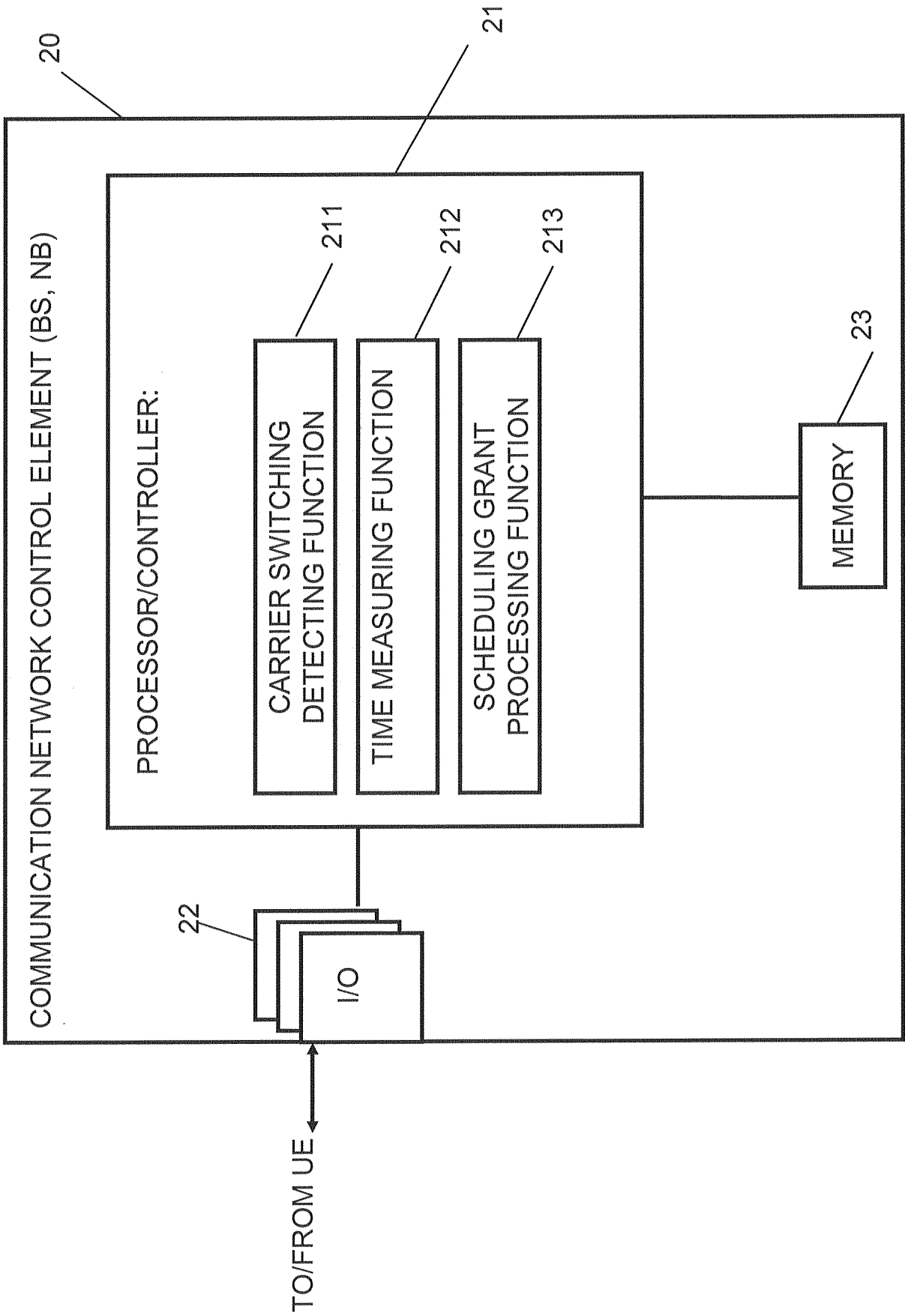


Fig. 14

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2013/050956

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W52/38

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2007/042798 A1 (CHEN WANSHI [US] ET AL) 22 February 2007 (2007-02-22) abstract paragraph [0002] - paragraph [0007] paragraph [0011] paragraph [0023] - paragraph [0025] paragraph [0027] paragraph [0034] - paragraph [0035] paragraph [0037] - paragraph [0038] paragraph [0042] - paragraph [0043] ----- -/--	1-41



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

2 April 2014

Date of mailing of the international search report

09/04/2014

Name and mailing address of the ISA/

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Martinozzi, A

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2013/050956

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2007/217397 A1 (CUI DONGZHE [US] ET AL) 20 September 2007 (2007-09-20) paragraph [0004] - paragraph [0007] paragraph [0009] - paragraph [0011] paragraph [0018] paragraph [0020] - paragraph [0023] paragraph [0025] - paragraph [0026] paragraph [0032] - paragraph [0033] paragraph [0038] -----	1-41
A	QUALCOMM EUROPE: "Intra-System Mobility", 3GPP DRAFT; R2-060013 INTRA-SYSTEM MOBILITY, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG2, no. Sophia Antipolis, France; 20060113, 13 January 2006 (2006-01-13), XP050130182, [retrieved on 2006-01-13] paragraph [03.1] -----	1-41

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Information on patent family members

International application No

PCT/EP2013/050956

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			CA 2618853 A1 22-02-2007
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			JP 5394740 B2 22-01-2014
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