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- (54) **Title:** CONFIGURATION FOR DETECTION OF PHYSICAL HARQ INDICATOR CHANNEL

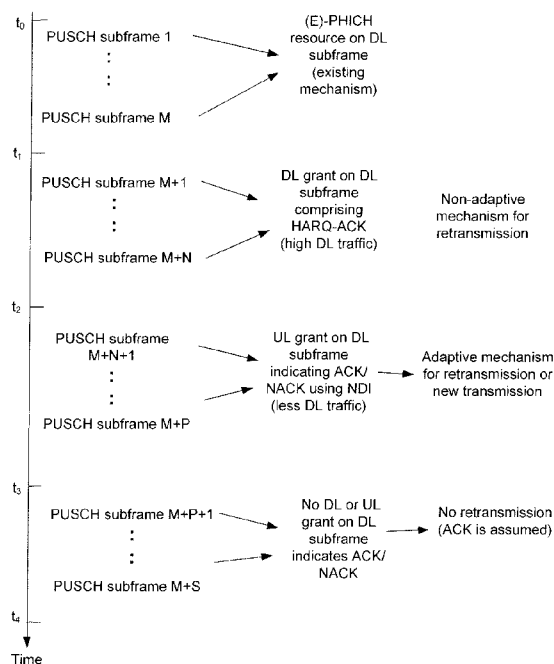


Figure 1

(57) **Abstract:** The specification and drawings present a new method, apparatus and software related product (e.g., a computer readable memory) for configuring a detection of a E-PHICH (or PHICH in general) in DL for monitoring a PUSCH to reduce resource reservation for the PHICH and correspondingly reduce an impact on detection of (E-)PD-CCH and (E-)PDSCH, e.g., in LTE-A systems. The UEs may be configured (e.g., by an eNB) to detect E-PHICH or not to detect: the configuration can be not to detect E-PHICH at all, or always to detect it, or to detect only in some subframes. The configuration may be UE specific or common to a group of UEs. If a UE is configured not to detect E-PHICH in a DL subframe #n, and if according to the defined HARQ timing the UE needs to detect a HARQ-ACK information in the same subframe, then the UE will try to detect UL and/or DL grant in the subframe #n which will provide the desired HARQ (or ACK/NACK/DTX) information.



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CONFIGURATION FOR DETECTION OF PHYSICAL HARQ INDICATOR CHANNEL

5 **Technical Field**

The exemplary and non-limiting embodiments of this invention relate generally to wireless communications and more specifically to configuring a detection of a PHICH (or E-PHICH) for monitoring a PUSCH to reduce a resource reservation for the E-PHICH, e.g., in LTE-A systems.

10

Background Art

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

15	3GPP	3 rd generation partnership project
	ACK	acknowledgement
	A/N	acknowledge/non- acknowledge
	ARQ	automatic repeat request
	CA	carrier aggregation
20	CC	component carrier
	CRC	cyclic redundancy check
	DCI	downlink control information
	DL	downlink
	DMRS	demodulation RS
25	eNB, eNodeB	evolved node B /base station in an E-UTRAN system
	E-PDCCH	evolved physical downlink control channel
	E-PDSCH	evolved physical downlink shared channel
	E-PHICH	evolved physical hybrid ARQ indicator channel
	DTX	discontinuous reception
30	HARQ	hybrid automatic repeat request
	ICIC	inter-cell interference coordination
	LTE	long term evolution
	LTE-A	long term evolution advanced

	MCS	modulation and coding schemes
	MTC	machine type communication
	MU-MIMO	multi-use multiple-input multiple-output
	NACK	negative acknowledgement
5	OFDM	orthogonal frequency division multiplexing
	PDCCH	physical downlink control channel
	PDSCH	physical downlink shared channel
	PHICH	physical hybrid ARQ indicator channel
	PRB	physical resource block
10	PUCCH	physical uplink control channel
	PUSCH	physical uplink shared channel
	RA	resource allocation
	RE	resource element
	RS	reference signal
15	RM	Reed–Muller
	RRC	radio resource control
	SNR	signal-to-noise ratio
	TBCC	tail-biting convolutional coding
	TDD	time division duplex
20	S/P	serial to parallel
	UE	user equipment
	UL	uplink
	VRB	virtual resource block

25 In LTE Release 10 of 3GPP, a downlink control channel is spanned and interleaved with a system bandwidth in order to achieve frequency diversity. This wide band feature makes it difficult to handle inter-cell interference. This limitation and the general need for an increase in control channel capacity amongst other factors, led to a working assumption supporting the introduction of an enhanced PDCCH (E-PDCCH) in Release 11 of 3GPP, see RAN1, Draft

30 Report of 3GPP TSG RAN WG1 #66bis v 0.1.0 (Zhuhai, P.R. China, 10th-14th October 2011). To support the low cost MTC with narrow bandwidth is another use case of E-PDCCH.

In legacy systems DL HARQ-ACK signalling is transmitted on a PHICH. If in the Release 11 of 3GPP a UE is configured to receive UL grants on the evolved PDCCH, e.g., due to operating in an extension carrier, due to ICIC or due to being unable to access a wide band PDCCH, a new mechanism may be required for DL HARQ-ACK signalling and the new
5 mechanism for DL HARQ-ACK is identified as E-PHICH, e.g., see R1-113682 "Views on Enhanced PHICH, Ericsson, 3GPP TSG-RAN WG1 #67, San Francisco, 14th-18th November 2011, and R1-114067 "PHICH Enhancement)", Alcatel-Lucent, 3GPP TSG-RAN WG1 #67, San Francisco, 14th-18th November 2011.

Currently the design of the E-PDCCH is not decided yet, and the E-PHICH design may
10 depends on the E-PDCCH design, e.g., whether to use precoded or non-precoded RS for demodulation, how to multiplex with E-PDCCH and E-PDSCH. However, it is clear that in order to get diversity gain, the E-PHICH is still expected to be in multiple PRBs. In such a case, the resource used by the E-PHICH may cause puncturing of the E-PDCCH/E-PDSCH which will degrade the performance; therefore, keeping the resource for the E-PHICH at a minimum
15 is desired.

As shown above, the E-PHICH is needed in case the access to normal PDCCH is not available, and reduction in the E-PHICH resource reservation is desired. In LTE Release 10 of 3GPP, the PHICH resource comprises some reserved REs in the first 3 OFDM symbols in the control region, and each PHICH resource is linked implicitly to the scheduled PUSCH resource
20 and the cyclic shift used for UL DMRS (see 3GPP TS 36.213 V10.2.0 (20101-06)). However, there may be some reservations for the PHICH resource, considering that not all PRBs will be scheduled as the start PRB of a PUSCH, not all PUSCHs will use MU-MIMO, some transmission will use adaptive HARQ which relies on a UL grant for a new transmission and retransmission rather than PHICH. In the E-PHICH design, it is desirable that such
25 over-reservation can be reduced.

The need for E-PHICH was mentioned in some 3GPP contributions (see R1-113682 "Views on Enhanced PHICH, Ericsson, 3GPP TSG-RAN WG1 #67, San Francisco, 14th-18th November 2011, and R1-114067 "PHICH Enhancement)", Alcatel-Lucent, 3GPP TSG-RAN WG1 #67, San Francisco, 14th-18th November 2011). However, there was no detail provided
30 about how the E-PHICH channel is designed or mapped to physical channels, and also there was no discussion about how to optimize the E-PHICH resource reservations.

Summary

According to a first aspect of the invention, a method comprising: receiving by a user equipment a configuration instruction from a network element not to detect a physical hybrid automatic repeat request indicator channel in at least one downlink subframe; detecting the at least one downlink subframe; and if an uplink grant or a downlink grant is detected in the at least one downlink subframe, determining if a retransmission of an uplink subframe is needed using feedback information regarding the uplink subframe, the feedback information being comprised in the received uplink or downlink grant.

According to a first aspect of the invention, a method, comprising: configuring by a network element one or more user equipments of a plurality of user equipments not to monitor a physical hybrid automatic repeat request indicator channel in at least one downlink subframe; and sending to at least one of the one or more user equipments a downlink subframe comprising a downlink grant or an uplink grant indicating whether an uplink retransmission for a received uplink subframe is needed.

According to a third aspect of the invention, an apparatus comprises: at least one processor and a memory storing a set of computer instructions, in which the processor and the memory storing the computer instructions are configured to cause the apparatus to: receive a configuration instruction from a network element not to detect a physical hybrid automatic repeat request indicator channel in at least one downlink subframe; detect the at least one downlink subframe; and if an uplink grant or a downlink grant is detected in the at least one downlink subframe, determine if a retransmission of an uplink subframe is needed using feedback information regarding the uplink subframe, the feedback information being comprised in the received uplink or downlink grant.

According to a fourth aspect of the invention, an apparatus comprising: at least one processor and a memory storing a set of computer instructions, in which the processor and the memory storing the computer instructions are configured to cause the apparatus to: configure one or more user equipments of a plurality of user equipments not to monitor a physical hybrid automatic repeat request indicator channel in at least one downlink subframe; and sending to at least one of the one or more user equipments a downlink subframe comprising a downlink grant or an uplink grant indicating whether an uplink retransmission for a received uplink subframe is needed.

According to a fifth aspect of the invention, a computer readable medium comprising a

set of instructions, which, when executed on a user equipment causes the user equipment to perform the steps of: receiving a configuration instruction from a network element not to detect a physical hybrid automatic repeat request indicator channel in at least one downlink subframe; detecting the at least one downlink subframe; and if an uplink grant or a downlink grant is
5 detected in the at least one downlink subframe, determining if a retransmission of an uplink subframe is needed using feedback information regarding the uplink subframe, the feedback information being comprised in the received uplink or downlink grant.

According to a sixth aspect of the invention, a computer readable medium comprising a set of instructions, which, when executed on a network element causes the network element to
10 perform the steps of: configuring one or more user equipments of a plurality of user equipments not to monitor a physical hybrid automatic repeat request indicator channel in at least one downlink subframe; and sending to at least one of the one or more user equipments a downlink subframe comprising a downlink grant or an uplink grant indicating whether an uplink retransmission for a received uplink subframe is needed.

Brief Description of the Drawings:

For a better understanding of the nature and objects of the present invention, reference is made to the following detailed description taken in conjunction with the following drawings, in which:

20 Figure 1 is a time diagram illustrating different mode of operation of HARQ-ACK feedback using E-PHICH, and DL and UL grants for one UE, according to embodiments of the invention;

Figures 2-3 are flow charts demonstrating implementation of exemplary embodiments of the invention; and

25 Figure 4 is a block diagram of wireless devices for practicing exemplary embodiments of the invention.

Detailed Description

A new method, apparatus, and software related product (e.g., a computer readable
30 memory) are presented for configuring a detection of a E- PHICH (or PHICH in general) in DL for monitoring a PUSCH to reduce resource reservation for the PHICH and correspondingly reduce an impact on detection of (E-)PDCCH and (E-)PDSCH, e.g., in LTE-A systems.

According to an embodiment of the invention, UEs may be configured (e.g., by an eNB) to detect E-PHICH or not to detect: the configuration can be not to detect E-PHICH at all, or always to detect it, or to detect only in some subframes. The configuration may be UE specific or common to a group of UEs.

5 For example, if a UE is configured not to detect E-PHICH in a DL subframe #n, and if according to the defined HARQ timing the UE needs to detect a HARQ-ACK information in the same subframe, then the UE will try to detect UL and/or DL grant in the subframe #n which will provide the desired HARQ (or ACK/NACK/DTX) information.

When there is no UL grant but a DL grant is detected in the subframe #n, UE should
 10 obtain the HARQ (feedback) information via the DL grant. For example, DL grant's DCI in the UE specific search space may be extended by N bits to convey the HARQ information, where N is a positive integer. In this case the retransmission may be performed according to non-adaptive mechanism using predefined UL resources and other transmission parameters. In another embodiment, some bit(s) of the DL grant's DCI may be reinterpreted/redefined to
 15 provide the desired HARQ (ACK/NACK) information for the corresponding UL transmission with no E-PHICH configured in this DL subframe #n. The reinterpreted bit(s) can be resource allocation type field, e.g., in DCI format 1, the resource allocation type can be redefined/reinterpreted as follows:

- '1': ACK and resource allocation type 1;
- 20 – '0': NACK and resource allocation type 0.

In DCI format 1A, the localized/distributed VRB assignment flag can be redefined as follows:

- '1': ACK and distributed VRB;
- '0': NACK and localized VRB.

25 In another embodiment, if no DL grant and UL grant are detected, the UE can assume that an ACK is sent by eNB, i.e., no retransmission is needed.

Moreover, if the UL grant is detected, the UE will transmit PUSCH in the following UL subframe (e.g., subframe n+4) based on the UL grant message, which may contain resource assignment, modulation and coding scheme (MCS), new data indicator (NDI), etc. The
 30 decision about retransmission or sending a new transmission in this following UL subframe n+4 can be made based on NDI. The NDI bit can implicitly indicate ACK/NACK, i.e. "new

data” implies ACK and “non-new data” implies NACK. If the UL grant is provided by the eNB, no HARQ information is appended to the DL grant.

It is further noted that by detecting the UL grant, the UE will know when and how to transmit uplink data, except in the case of non-adaptive retransmission where the UE can retransmit data according to ACK/NACK information and a predefined schedule for the non-adaptive retransmission. But even for the non-adaptive retransmission, the UL grant can be used to schedule UL retransmission with a higher priority than ACK/NACK and the cost of higher overhead.

Thus, a network element such as eNB may configure one or more UEs of a plurality of UEs served by the eNB not to monitor or detect the E-PHICH (more generally PHICH). Instead these one or more UEs would detect in a downlink subframe a downlink grant and/or an uplink grant to determine at least if an uplink retransmission needs to be performed. Then the eNB sends to each of the one or more user equipments a DL subframe comprising an ACK/NACK/DTX indication on a received UL subframe in the DL grant or in the uplink grant to determine if an uplink retransmission is needed. At the same time the eNB can further configure one or more other user equipments of the plurality of user equipments to monitor the PHICH and to process the ACK/NACK/DTX information in a normal way.

Then, each UE served by the eNB may be configured (by receiving an appropriate instruction from the eNB) not to monitor/detect the E-PHICH in at least one downlink subframe. After detecting the at least one downlink subframe, and if one or more of an uplink grant and a downlink grant are detected in the at least one downlink subframe, the UE may determine if the uplink re-transmission is needed. The uplink grant comprises at least information for sending a next uplink subframe which may a retransmission or a new transmission subframe, e.g., based on the ACK/NACK/DTX comprised in the DL grant.

Furthermore, not all UEs need to detect E-PHICH for the PUSCH transmission, and the E-PHICH resource can be reserved considering (but not being limited to) the following factors: a) how many UEs can bear with non-adaptive HARQ transmission; b) how many UEs have high DL and UL traffic. Based on this information, the network element such as eNB may assign a DL resource to the PHICH, such that the configuration of the PHICH for the UEs described herein may be based on the collected information and on the assigned resource for the PHICH as further described herein.

For the UEs with a lot of DL traffic, the E-PHICH can be embedded in a DL grant as it

is likely that the UE will have the DL grant in a large portion of the DL subframes. For UEs with less DL traffic, the UL grant can be sent in case no DL grant available in corresponding subframes or change of MCS/resource allocation is needed. It is assumed that no matter how the ACK/NACK for PUSCH is sent in E-PHICH or DL/UL grant, the same HARQ timing may
 5 be used, for example it can be 4ms HARQ delay, but for the TDD system it can be longer than 4ms.

According to a further embodiment, the configuration for the E-PHICH detection may be subframe dependent, e.g., some UEs may be configured to detect the E-PHICH only in odd subframes, while other UEs may be configured to detect the E-PHICH only in even subframes,
 10 or some UEs can be configured not to detect the E-PHICH at all as discussed herein.

It is further noted that for the UEs configured not to detect E-PHICH, if it has PUSCH in a subframe $n-4$, it will detect the DL grant in a subframe n assuming that HARQ information is embedded there which will cause a larger DCI size or reinterpretation of some field.

Since not all PUSCH PRBs will need an E-PHICH, reserving E-PHICH for each UL
 15 PRB will be a waste. Then considering this, the mapping from the PUSCH PRB to an E-PHICH resource can be a multiple-to-one mapping, i.e., multiple UL PRB index map to same E-PHICH resource. The collision can be avoided by sending HARQ information for some UEs in the DL or UL grant rather than an E-PHICH.

Figure 1 shows a time diagram illustrating different modes of operation of
 20 HARQ-ACK feedback using E-PHICH, and DL and UL grants for one UE, according to embodiments of the invention. In a time period between t_0 and t_1 with a low communication traffic for PUSCH subframes 1 through M , the UE is configured to detect E-PHICH with subsequent retransmission (if needed) using existing mechanism.

In a time period between t_1 and t_2 with a high communication traffic for PUSCH
 25 subframes $M+1$ through $M+N$, the UE is configured to not detect the E-PHICH and the eNB add HARQ-ACK feedback information in DL grant for detection by the UE with subsequent retransmission (if needed) using non-adaptive mechanism for retransmission.

In a time period between t_2 and t_3 with a less communication traffic (than in the time period between t_1 and t_2) for PUSCH subframes $M+N+1$ through $M+P$, the UE is configured to
 30 not detect the E-PHICH and the eNB add HARQ-ACK feedback information in UL grant for detection by the UE with subsequent retransmission (if needed) using adaptive mechanism for retransmission as explained herein.

In a time period between t_3 and t_4 with a high quality of transmission (low SNR) with a relatively low communication traffic for PUSCH subframes $M+P+1$ through $M+S$, the UE is configured to not detect the E-PHICH and the eNB does not add acknowledgement feedback information in UL or DL grant (or UL and/or DL grants are not sent) no retransmission is
5 assumed by the UE.

In Figure 1 M , N , P and S are integers and $S > P > N > M > 1$.

Figure 2 shows an exemplary flow chart demonstrating implementation of some embodiments of the invention by a UE. It is noted that the order of steps shown in Figure 2 is not required, so in principle the various steps may be performed out of the illustrated order.

10 Also certain steps may be skipped, different steps may be added or substituted, or selected step/steps or groups of steps may be performed separately.

In a method according to this exemplary embodiment, as shown in Figure 2, in a first step 40, the UE receives a configuration instruction from a serving eNB regarding detecting or not detecting (E)-PHICH in DL subframe(s). In a next step 42, the UE sends a PUSCH in UL
15 subframe $n-4$ to the eNB. In a next step 44, the UE receives a DL subframe n from the eNB.

In a next logical step 46, it is determined whether the UE is configured to detect the (E)-PHICH. If that is not the case, in a next step 48, the UE detects DL grant or UL grant (comprising ACK/NACK feedback information) in the DL subframe n and the process goes to step 52. However, if it is determined that the UE is configured to detect the (E)-PHICH, in a
20 next step 50, the UE detects (E)-PHICH on a configured resource. In a next step 52, the UE determines whether retransmission or new transmission needs to be sent in UL subframe $n+4$ using the UL grant if detected based on feedback information comprised in the DL or UL grant, as described herein.

Figure 3 shows an exemplary flow chart demonstrating implementation of some
25 embodiments of the invention performed by the eNB. It is noted that the order of steps shown in Figure 3 is not required, so in principle the various steps may be performed out of the illustrated order. Also certain steps may be skipped, different steps may be added or substituted, or selected step/steps or groups of steps may be performed separately.

In a method according to this exemplary embodiment, as shown in Figure 3, in a first step 60,
30 the eNB configures one or more UEs of a plurality of UEs not to detect (E)-PHICH in DL subframe(s).

In a next step **62**, the eNB configures one or more other UEs of the plurality of UEs to monitor/detect (E)-PHICH in DL subframe(s). In a next step **64**, the eNB sends to at least one of the one or more user equipments a downlink subframe comprising a DL grant or an UL grant comprising feedback information on the received UL subframe, for providing an indication
5 whether an UL retransmission for the received uplink subframe is needed based on the feedback information. In a next step **66**, the eNB sends to at least one of the one or more other UEs a DL subframe comprising (E)-PHICH for providing an indication whether an UL retransmission for the received UL subframe is needed. In a next step **68**, steps **60** and **62** under different traffic conditions and/or different UEs added are performed again, and the process
10 goes to step **64**.

Figure 4 shows an example of a block diagram demonstrating LTE devices comprised in a network **10** including an eNB **80**, and UEs **82** and **84**, according to an embodiment of the invention. Figure 4 is a simplified block diagram of various electronic devices that are suitable for practicing the exemplary embodiments of this invention, e.g., in reference to Figures 1-3,
15 and a specific manner in which components of an electronic device are configured to cause that electronic device to operate. Each of the UEs **82** and **84** may be implemented as a mobile phone, a wireless communication device, a camera phone, a portable wireless device and the like.

The eNB **80** comprises at least one transmitter **80a** at least one receiver **80b**, at least one
20 processor **80c** at least one memory **80d** and a DRX control application module **80e**. The transmitter **80a** and the receiver **80b** and corresponding antennas (not shown in Figure 4) may be configured to provide wireless communications with the UEs **82** and **84** according to the embodiment of the invention. The transmitter **80a** and the receiver **80b** may be generally means for transmitting/receiving and may be implemented as a transceiver, or a structural
25 equivalence thereof. It is further noted that the same requirements and considerations are applied to transmitters and receivers of the devices **82** and **84**.

Furthermore, the eNB **80** may further comprise communicating means such as a modem **80f**, e.g., built on an RF front end chip of the eNB **80**, which also carries the TX **80a** and RX **80b** for bidirectional wireless communications wireless links **81a** and **81b** (for
30 implementing/facilitating steps **40-50** in Figure 2 and steps **60-66** in Figure 3) with the devices **82** and **84** respectively. A similar concept is applicable to the devices **82** and **84** shown in Figure 4.

Various embodiments of the at least one memory **80d** (e.g., computer readable memory) may include any data storage technology type which is suitable to the local technical environment, including but not limited to semiconductor based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory, removable
5 memory, disc memory, flash memory, DRAM, SRAM, EEPROM and the like. Various embodiments of the processor **80c** include but are not limited to general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and multi-core processors. Similar embodiments are applicable to memories and processors in other devices **82** and **84** shown in Figure 4.

10 The PHICH configuring application module **80e** may provide various instructions for performing steps **60-68** shown in Figure 3. The module **80e** may be implemented as an application computer program stored in the memory **80d**, but in general it may be implemented as software, firmware and/or hardware module or a combination thereof. In particular, in the case of software or firmware, one embodiment may be implemented using a software related
15 product such as a computer readable memory (e.g., non-transitory computer readable memory), computer readable medium or a computer readable storage structure comprising computer readable instructions (e.g., program instructions) using a computer program code (i.e., the software or firmware) thereon to be executed by a computer processor.

Furthermore, the module **80e** may be implemented as a separate block or may be
20 combined with any other module/block of the eNB **80**, or it may be split into several blocks according to their functionality.

The devices **82** and **84** may have similar components as the eNB **80**, as shown in Figure 4, so that the above discussion about components of the LPN **80** is fully applicable to the components of the devices **82**, **84** and **86**.

25 Moreover, the retransmission scheduling application module **83** in the UEs **82** and **84** may provide/facilitate various instructions for performing steps **40-52** in Figure 2. The module **83** may be implemented as an application computer program stored in the memory **85**, but in general it may be implemented as software, firmware and/or hardware module or a combination thereof. In particular, in the case of software or firmware, one embodiment may
30 be implemented using a software related product such as a computer readable memory (e.g., non-transitory computer readable memory), computer readable medium or a computer readable storage structure comprising computer readable instructions (e.g., program

instructions) using a computer program code (i.e., the software or firmware) thereon to be executed by a computer processor. The module 83 may be implemented as a separate block or may be combined with any other module/block of the UEs 82 or 84, or it may be split into several blocks according to their functionality.

5 It is noted that various non-limiting embodiments described herein may be used separately, combined or selectively combined for specific applications.

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

 It is to be understood that the above-described arrangements are only illustrative of the application of the principles of the present invention. Numerous modifications and alternative arrangements may be devised by those skilled in the art without departing from the scope of the invention, and the appended claims are intended to cover such modifications and
15 arrangements.

WHAT IS CLAIMED IS:

1. A method, comprising:
receiving by a user equipment a configuration instruction from a network element not to detect a physical hybrid automatic repeat request indicator channel in at least one downlink subframe;
detecting the at least one downlink subframe; and
if an uplink grant or a downlink grant is detected in the at least one downlink subframe, determining if a retransmission of an uplink subframe is needed using feedback information regarding the uplink subframe, the feedback information being comprised in the received uplink or downlink grant.
2. The method of claim 1, wherein the feedback information comprised in the downlink grant is a hybrid automatic repeat request for the uplink subframe added in the downlink grant.
3. The method of claim 1, wherein the feedback information comprised in the downlink grant is provided by reinterpreting or redefining existing bits in the downlink grant without adding new bits in the downlink grant.
4. The method of claim 1, wherein if no uplink grant nor downlink grant is detected, then the retransmission is not needed.
5. The method of claim 1, wherein the network element is an eNB.
6. A method, comprising:
configuring by a network element one or more user equipments of a plurality of user equipments not to monitor a physical hybrid automatic repeat request indicator channel in at least one downlink subframe; and
sending to at least one of the one or more user equipments a downlink subframe comprising a downlink grant or an uplink grant indicating whether an uplink retransmission for a received uplink subframe is needed.

7. The method of claim 6, the downlink grant comprises a hybrid automatic repeat request for the received uplink subframe added in the downlink grant.
8. The method of claim 6, wherein the downlink grant indicates whether an uplink retransmission for the received uplink subframe is needed using reinterpreting or redefining existing bits without adding new bits in the downlink grant.
9. The method of claim 6, wherein the network element is an eNB.
10. The method of claim 6, further comprises:
further configuring one or more other user equipments of the plurality of user equipments to monitor the physical hybrid automatic repeat request indicator channel in the at least one downlink subframe.
11. The method of claim 10, wherein selected user equipments of the plurality of user equipments are configured to monitor the physical hybrid automatic repeat request indicator channel only in even subframes and further user equipments of the plurality of user equipments are configured to monitor the physical hybrid automatic repeat request indicator channel only in odd subframes.
12. The method of claim 10, wherein prior to the configuring and further configuring, the method comprises:
collecting by a network element information about the plurality of user equipments, the information comprises one or more of :
how many user equipments of the plurality of user equipments are configured to operate with a non-adaptive hybrid automatic repeat request transmission, and
how many user equipments of the plurality of user equipments have downlink traffic together with uplink transmissions above a predefined level; and
assigning a downlink resource to the physical hybrid automatic repeat request indicator channel based on said information, wherein the configuring and further configuring are based on the collected information and on the assigned resource.

13. The method of claim 10, wherein the configuring and the further configuring are subframe specific.

14. An apparatus comprising:

at least one processor and a memory storing a set of computer instructions, in which the processor and the memory storing the computer instructions are configured to cause the apparatus to:

receive a configuration instruction from a network element not to detect a physical hybrid automatic repeat request indicator channel in at least one downlink subframe;

detect the at least one downlink subframe; and

if an uplink grant or a downlink grant is detected in the at least one downlink subframe, determine if a retransmission of an uplink subframe is needed using feedback information regarding the uplink subframe, the feedback information being comprised in the received uplink or downlink grant.

15. The apparatus of claim 14, wherein the feedback information comprised in the downlink grant is a hybrid automatic repeat request for the uplink subframe added in the downlink grant, or the feedback information is provided by reinterpreting or redefining existing bits in the downlink grant without adding new bits in the downlink grant.

16. The apparatus of claim 14, wherein if no uplink grant nor downlink grant is not detected, then the retransmission is not needed.

17. The apparatus of claim 14, wherein the network element is an eNB.

18. An apparatus comprising:

at least one processor and a memory storing a set of computer instructions, in which the processor and the memory storing the computer instructions are configured to cause the apparatus to:

configure one or more user equipments of a plurality of user equipments not to monitor a physical hybrid automatic repeat request indicator channel in at least one downlink subframe;

and

sending to at least one of the one or more user equipments a downlink subframe comprising a downlink grant or an uplink grant indicating whether an uplink retransmission for a received uplink subframe is needed.

19. The apparatus of claim 18, the downlink grant comprises a hybrid automatic repeat request for the received uplink subframe added in the downlink grant, or the downlink grant indicates whether an uplink retransmission for the received uplink subframe is needed using reinterpreting or redefining existing bits without adding new bits in the downlink grant.

20. The apparatus of claim 18, wherein the network element is an eNB.

21. The apparatus of claim 18, wherein the computer instructions are configured to cause the apparatus to:

further configure one or more other user equipments of the plurality of user equipments to monitor the physical hybrid automatic repeat request indicator channel in the at least one downlink subframe.

22. The apparatus of claim 21, wherein selected user equipments of the plurality of user equipments are configured to monitor the physical hybrid automatic repeat request indicator channel only in even subframes and further user equipments of the plurality of user equipments are configured to monitor the physical hybrid automatic repeat request indicator channel only in odd subframes.

23. The apparatus of claim 21, wherein prior to the configuring and further configuring, the computer instructions are configured to cause the apparatus to:

collect information about the plurality of user equipments, the information comprises one or more of :

how many user equipments of the plurality of user equipments are configured to operate with a non-adaptive hybrid automatic repeat request transmission, and

how many user equipments of the plurality of user equipments have downlink traffic together with uplink transmissions above a predefined level; and

assign a downlink resource to the physical hybrid automatic repeat request indicator channel based on said information, wherein the configuring and further configuring are based on the collected information and on the assigned resource.

24. The apparatus of claim 21, wherein the configuring and the further configuring are subframe specific.

25. A computer readable medium comprising a set of instructions, which, when executed on a user equipment causes the user equipment to perform the steps of:

receiving a configuration instruction from a network element not to detect a physical hybrid automatic repeat request indicator channel in at least one downlink subframe;

detecting the at least one downlink subframe; and

if an uplink grant or a downlink grant is detected in the at least one downlink subframe, determining if a retransmission of an uplink subframe is needed using feedback information regarding the uplink subframe, the feedback information being comprised in the received uplink or downlink grant.

26. The computer readable medium of claim 25, wherein the feedback information comprised in the downlink grant is a hybrid automatic repeat request for the uplink subframe added in the downlink grant, or the feedback information is provided by reinterpreting or redefining existing bits in the downlink grant without adding new bits in the downlink grant.

27. The computer readable medium of claim 25, wherein if no uplink grant nor downlink grant is detected, then the retransmission is not needed.

28. A computer readable medium comprising a set of instructions, which, when executed on a network element causes the network element to perform the steps of:

configuring one or more user equipments of a plurality of user equipments not to monitor a physical hybrid automatic repeat request indicator channel in at least one downlink subframe; and

sending to at least one of the one or more user equipments a downlink subframe comprising a downlink grant or an uplink grant indicating whether an uplink retransmission for

a received uplink subframe is needed.

29. The computer readable medium of claim 26, the downlink grant comprises a hybrid automatic repeat request for the received uplink subframe added in the downlink grant, or the downlink grant indicates whether an uplink retransmission for the received uplink subframe is needed using reinterpreting or redefining existing bits grant without adding new bits in the downlink grant.

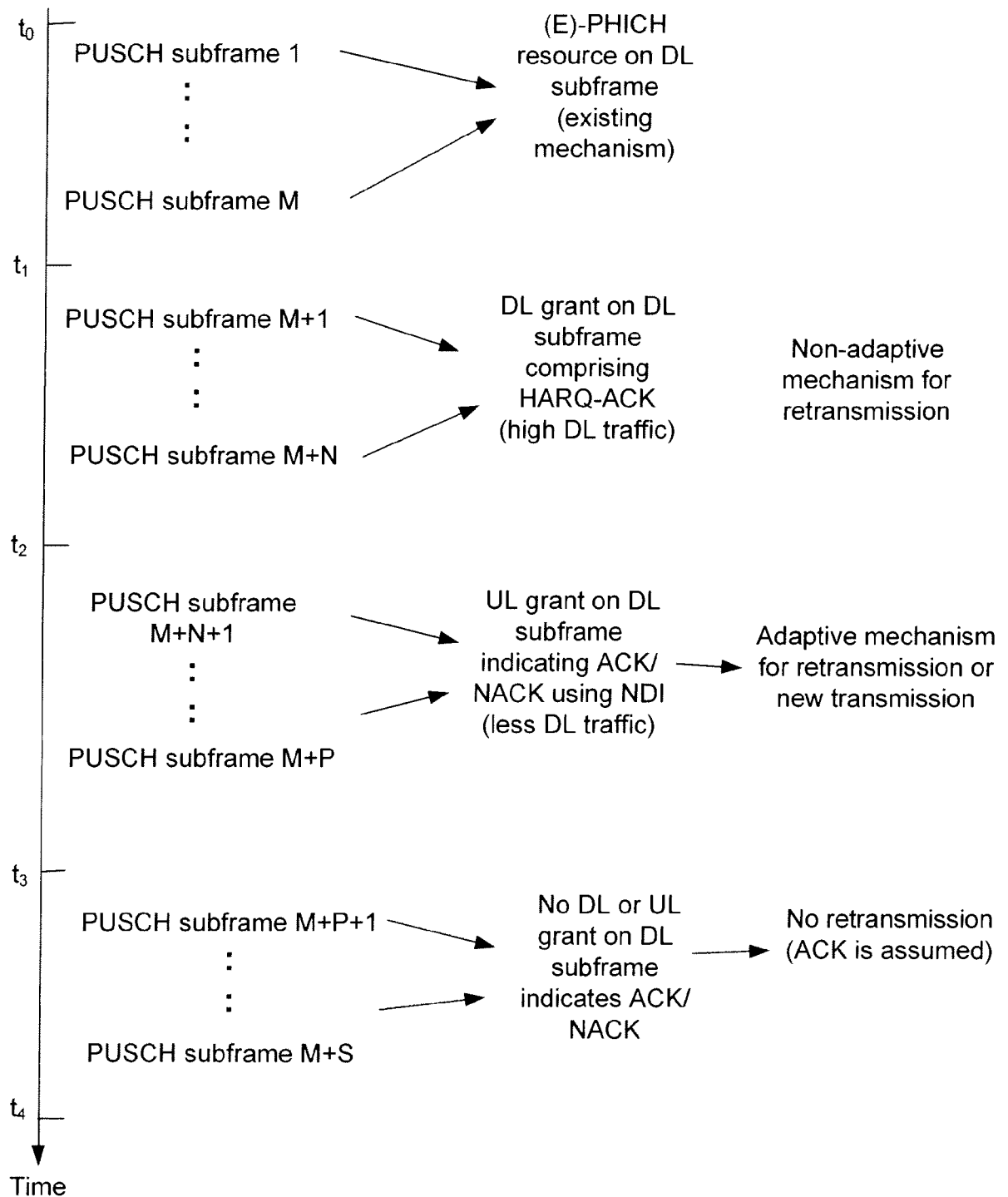


Figure 1

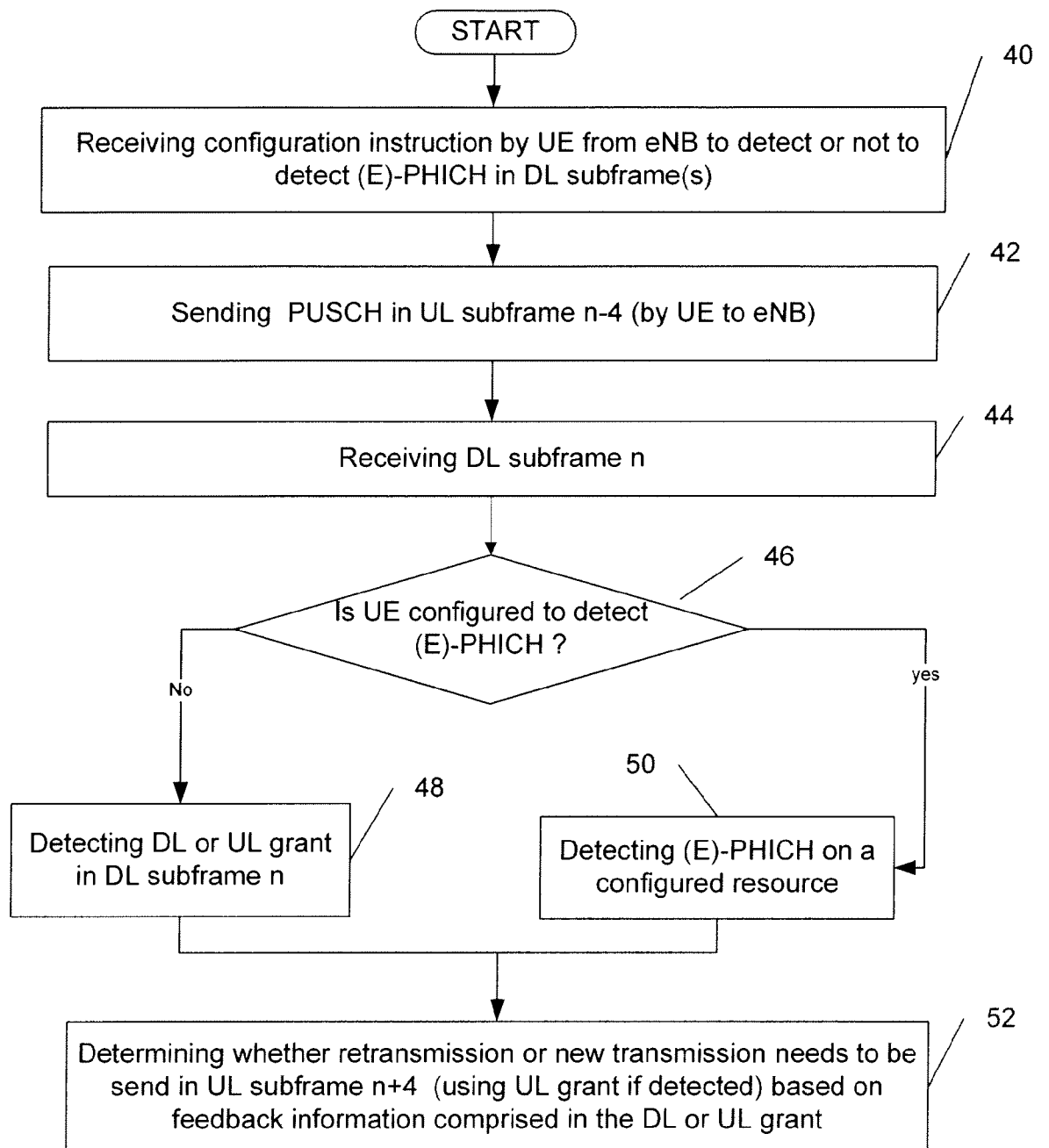
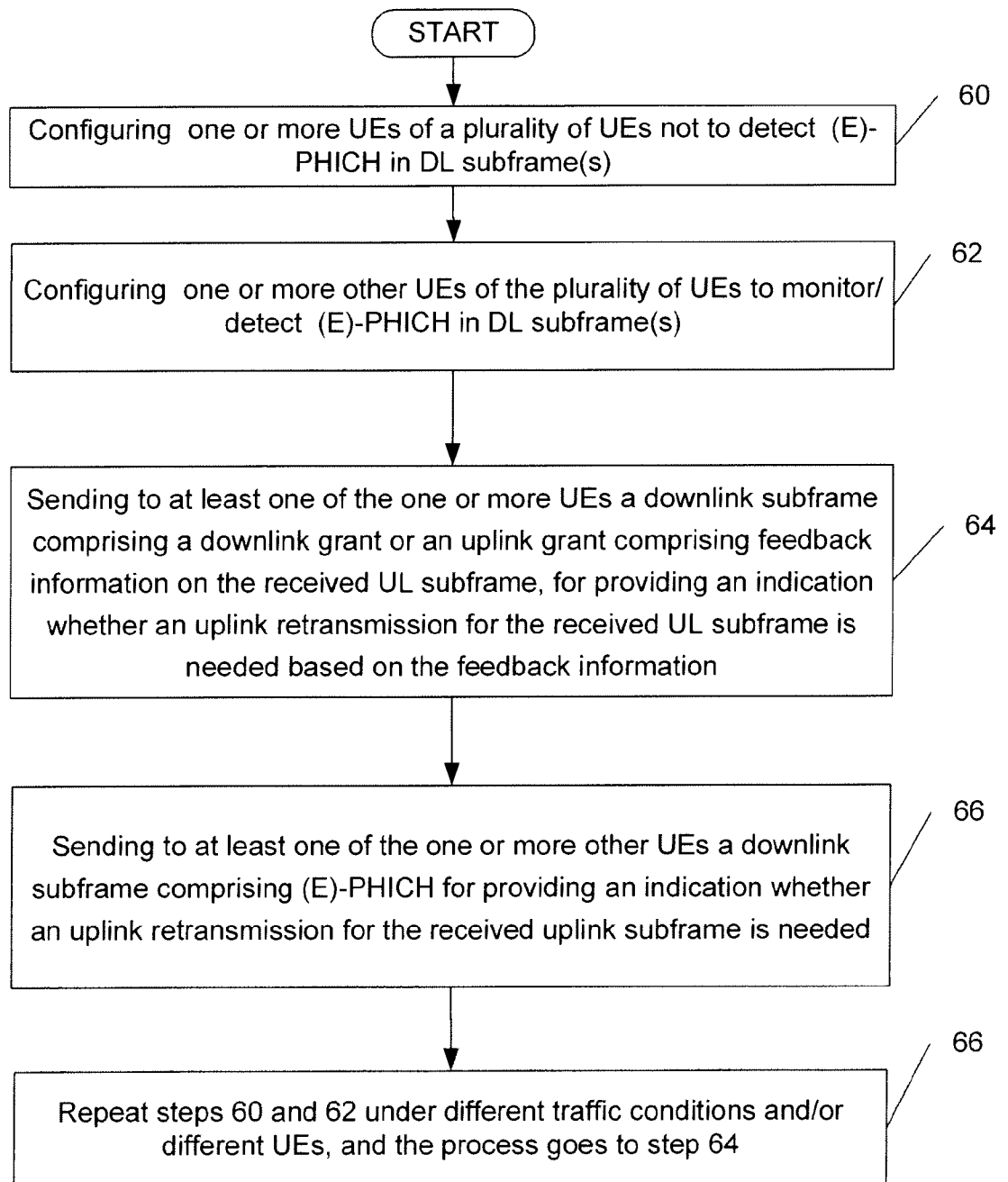
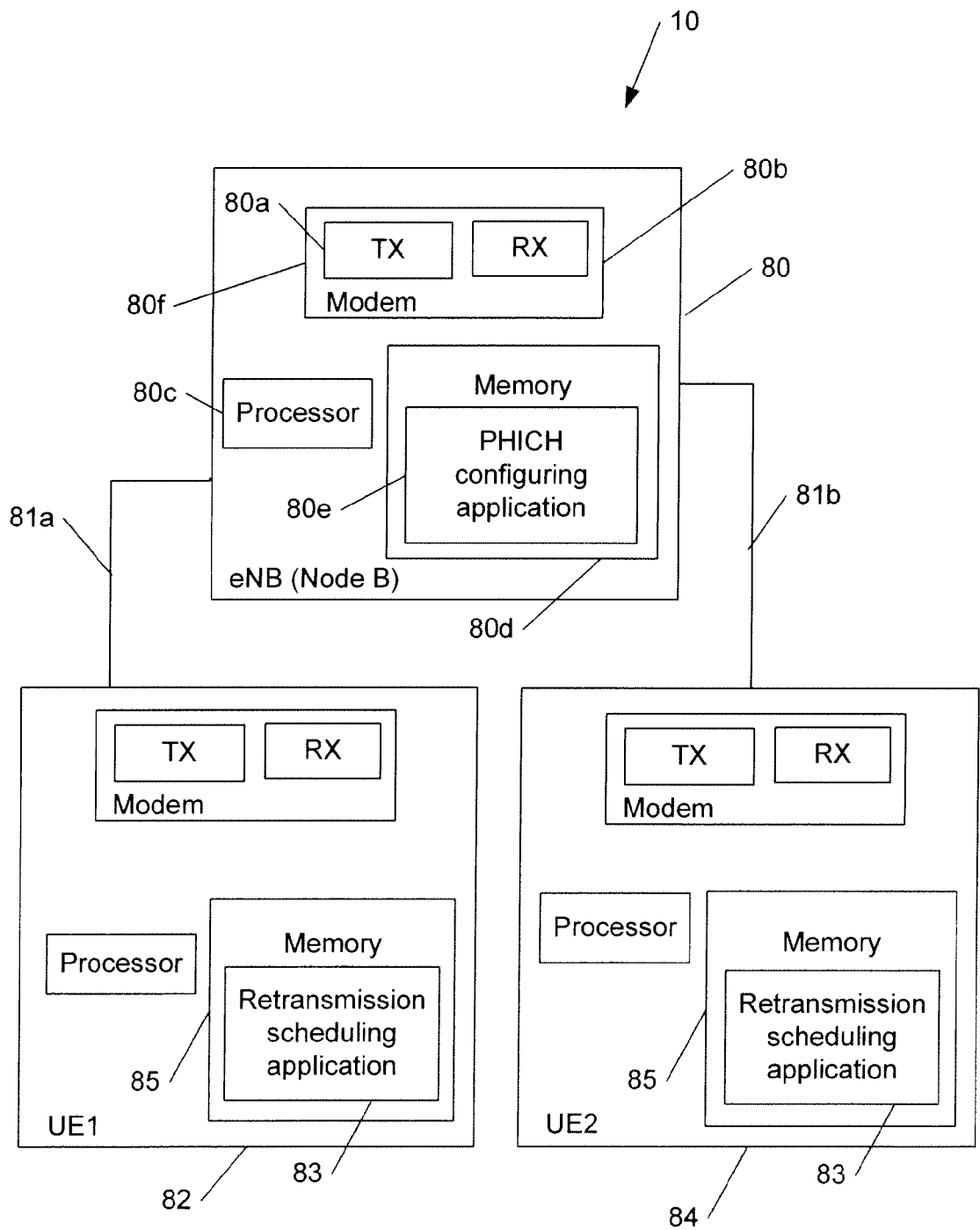


Figure 2

**Figure 3**

**Figure 4**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/070803

A. CLASSIFICATION OF SUBJECT MATTER

H04L 1/18 (2006.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:H04B H04L H04Q 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)

EPODOC,WPI,CNABS,CNXT:physical hybrid automatic repeat request indicator channel control PHICH PDCCH uplink downlink
UL DL grant retransm+ feedback acknowledge ACK HARQ subframe detect**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US2008192674A1(WANG, Haiming ET AL.)14 Aug.2008(14.08.2008) Paragraphs 0025,0035-0049 in description	1-11,13-22,24-29
A	WO2009155826A1(HUAWEI TECHNOLOGIES CO., LTD.)30 Dec.2009(30.12.2009) The whole document	1-29
A	US2008253326A1(QUALCOMM INCORPORATED)16 Oct.2008(16.10.2008) The whole document	1-29
A	US2011235586A1(SAMSUNG ELECTRONICS CO., LTD.)29 Sep.2011(29.09.2011) The whole document	1-29

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
“A” document defining the general state of the art which is not considered to be of particular relevance	“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
“E” earlier application or patent but published on or after the international filing date	“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
“L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	“&”document member of the same patent family
“O” document referring to an oral disclosure, use, exhibition or other means	
“P” document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 16 Oct. 2012(16.10.2012)	Date of mailing of the international search report 15 Nov. 2012 (15.11.2012)
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2012/070803

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