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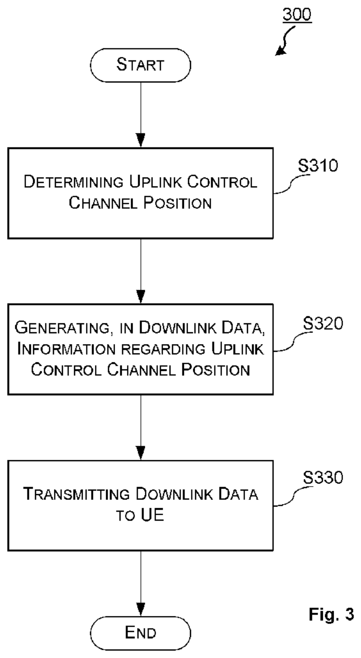

Fig. 3

(57) Abstract: The present disclosure relates to a method used in a BS for SPS scheduling a UE, and an associated BS. The method includes: determining an uplink control channel position available for the UE transmitting HARQ feedback of downlink data from the BS; generating, in the downlink data, information regarding the determined uplink control channel position; and transmitting the downlink data to the UE. The present disclosure also relates to a method used in a SPS scheduled UE for transmitting HARQ feedback of downlink data from a BS, and an associated UE.

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METHOD AND BS FOR SPS SCHEDULING UE, AND METHOD AND UE FOR TRANSMITTING HARQ

TECHNICAL FIELD

The technology presented in this disclosure generally relates to radio communication networks. More particularly, the present disclosure relates to a method used in a Base Station (BS) for Semi-Persistent Scheduling (SPS) scheduling a User Equipment (UE) and an associated BS, and to a method used in a SPS scheduled UE for transmitting Hybrid Automatic Repeat Request (HARQ) feedback of downlink data from a BS and an associated UE.

BACKGROUND

This section is intended to provide a background to the various embodiments of the technology described in this disclosure. The description in this section may include concepts that could be pursued, but are not necessarily ones that have been previously conceived or pursued. Therefore, unless otherwise indicated herein, what is described in this section is not prior art to the description and/or claims of this disclosure and is not admitted to be prior art by the mere inclusion in this section.

Usually, there are two kinds of scheduling, dynamical scheduling and Semi-Persistent Scheduling (SPS). A HARQ feedback (ACK/NACK) position for dynamical scheduling is derived according to Control Channel Element (CCE) index. For SPS, due to no Downlink Control Information (DCI) indication, HARQ feedback position of DownLink (DL) periodical data can't be derived from its CCE index like the dynamic scheduling does. So, the 3GPP specifies that the eNB needs to statically allocate up to 4 candidate positions in a Radio Resource Control (RRC) message, from which a specific position may be chosen for the UE to carry the HARQ feedback position of DL periodical data and may be notified to UE through 2 bits Transmit Power Control (TPC) field in DL DCI at (re)activation. That is, SPS has statically allocated HARQ index for HARQ feedback position of DL periodical data.

To increase Physical Uplink Control Channel (PUCCH) resource usage efficiency, the HARQ feedback position for SPS is usually multiplexed with that for dynamic scheduling on the same PUCCH1a/1b area. Unlike SPS's static configuration, the dynamic scheduling derives its HARQ feedback position based on the corresponding CCE index. In many cases, the CCE index corresponding to the HARQ feedback position in dynamical scheduling and the HARQ index for HARQ feedback position in SPS might be multiplexed in the same Physical Uplink Control Channel (PUCCH) area, thereby resulting in potential collision between SPS and dynamic scheduling, as shown in Fig. 1.

One existing solution is to schedule another DCI masked by Radio Network Temporary Identity (RNTI)-SPS for indicating a new HARQ index for SPS when the collision really occurs.

As shown in Fig. 2, in an existing implementation, once the collision occurs unexpectedly, the eNB needs to find another idle position from the 4 reserved candidate positions and to notify it to the UE in another DCI masked by SPS-RNTI. Upon being aware of the new position, the UE starts to use it to return the HARQ feedback of DL SPS data transmission.

However, the existing solution has the following problems.

1. The existing solution needs to occupy the valuable PDCCH resources, thereby wasting PDCCH resource.

To resolve the collision, the eNB needs to schedule another DCI indicating the new PUCCH index even only two bits are used within the whole DCI, which wastes the valuable PDCCH resources. As a scarce resource, PDCCH space is the main factor impacting UE number scheduled per sub-frame. Introduction of an extra DCI for SPS HARQ position adjustment will further deteriorate PDCCH scarcity, especially at heavy cell load and high CCE aggregation level. To be worse, it may still result in the “avalanche” side-effect, since the new added SPS-DCI may also result in more collision with other SPS's HARQ position, which then need further introduce more SPS-DCIs until no collision occurs again.

2. The existing solution can't handle the collision at Block Error Ratio (BLER) case.

Once the new added SPS-DCI is missed by the UE, the UE will still feedback Negative ACKnowledgment (NACK) on its original HARQ position which however has already been occupied by other UE for dynamic scheduling, then collision between SPS and dynamic scheduling still inevitably occurs.

3. The existing solution also increases complexity of CCE allocation algorithm as well as its execution time.

Once detecting the collision of dynamically scheduled UE's HARQ feedback position with that of SPS UE's static HARQ reservation, the eNB needs to automatically insert another DCI indicating a new SPS HARQ position into the scheduling list for CCE allocation. This not only complicates CCE allocation algorithm, but also prolongs its execution time, thereby greatly impacting time-critical 1ms scheduling.

4. The existing solution may only adjust PUCCH index within the 4 reserved candidate positions.

Due to the 2bits constraint in SPS-DCI, it only allows for the adjustment within the maximum 4 reserved candidate positions. Once the 4 candidate positions are all unavailable, the collision resolution will have to fail and the dynamic scheduling has to be cancelled.

SUMMARY

It is in view of the above considerations and others that the various embodiments of the present technology have been made. To be specific, aiming to at least some of the above defects, the present disclosure proposes a more robust and efficient approach to support flexible HARQ position adjustment, thereby resolving or mitigating the HARQ position collision between SPS and dynamic scheduling.

According to a first aspect of the present disclosure, there is proposed a method used in a BS for SPS scheduling a UE. The method includes: determining an uplink control channel position available for the UE transmitting HARQ feedback of downlink data from the BS; generating, in the downlink data, information regarding the determined uplink control channel position; and transmitting the downlink data to the UE.

According to a second aspect of the present disclosure, there is proposed a method used in a SPS scheduled UE for transmitting HARQ feedback of downlink data from a BS. The method includes: receiving the downlink data from the BS, the downlink data comprising information regarding an uplink control channel position available for the UE transmitting the HAQR feedback; determining the uplink control channel position based on the received downlink data; and transmitting the HARQ feedback based on the determined uplink control channel position.

According to a third aspect of the present disclosure, there is proposed a BS for SPS scheduling a UE. The BS includes: a determining unit configured to determine an uplink control channel position available for the UE transmitting HARQ feedback of downlink data from the BS; a generating unit configured to generate, in the downlink data, information regarding the determined uplink control channel position; and a transmitting unit configured to transmit the downlink data to the UE.

According to a fourth aspect of the present disclosure, there is proposed a SPS scheduled UE for transmitting HARQ feedback of downlink data from a BS. The UE includes: a receiving unit configured to receive the downlink data from the BS, the downlink data comprising information regarding an uplink control channel position available for the UE transmitting the HAQR feedback; a determining unit configured to determine the uplink control channel position based on the received downlink data; and a transmitting unit configured to transmit the HARQ feedback based on the determined uplink control channel position.

According to a fifth aspect of the present disclosure, there is proposed a computer program product storing instructions that when executed, cause one or more computing devices to perform the method according to any of the first to the fourth aspects of the present disclosure.

Preferably, according to any of the above embodiments, the determined uplink control channel position is a PUCCH position, the downlink data is Physical Downlink Sharing Channel (PDSCH) data, and the information regarding the determined uplink control channel position is indicated by a Media Access Control (MAC) control element (MCE) of PDSCH.

Preferably, according to any of the above embodiments, the MCE is a Time Alignment (TA) MCE, and the determined uplink control channel position is one of candidate PUCCH positions statically allocated by the BS other than currently used PUCCH position.

Preferably, according to any of the above embodiments, the MCE indicates a HARQ position offset defining an offset relative to currently used PUCCH position.

By transmitting, in the downlink data, information regarding the uplink control channel position for the UE transmitting HARQ feedback in SPS, for example transmitting a PUCCH position in PDSCH data instead of in DCI, the present disclosure can save PDCCH resources. Moreover, this may alleviate collision between SPS and dynamic scheduling, so that the CCE allocation algorithm for the dynamical scheduling remains unchanged.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features of this disclosure will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only several embodiments in accordance with the disclosure and are, therefore, not to be considered limiting of its scope, the disclosure will be described with additional specificity and detail through use of the accompanying drawings.

Fig. 1 illustrates how SPS's HARQ feedback position conflicts with that of dynamic scheduling.

Fig. 2 illustrates how SPS's HARQ feedback is moved to a new position through another DCI to avoid collision.

Fig. 3 shows a flowchart of a method 300 used in a BS for SPS scheduling a UE according to a first embodiment of the present disclosure.

Fig. 4 is a schematic diagram illustrating a format of a Time Alignment (TA) MCE for carrying the information regarding the determined uplink control channel position.

Fig. 5 is a schematic diagram illustrating a format of a new MCE for carrying the information regarding the determined uplink control channel position;

Fig. 6 shows a flowchart of a method 600 in a SPS scheduled UE for transmitting HARQ feedback of downlink data from a BS according to a second embodiment of the present disclosure.

Fig. 7 is a schematic block diagram of a BS 700 for SPS scheduling a UE according to a third embodiment of the present disclosure.

Fig. 8 is a schematic block diagram of a SPS scheduled UE 800 for transmitting HARQ feedback of downlink data from a BS according to a fourth embodiment of the present disclosure.

Fig. 9 schematically shows an embodiment of an arrangement 900 which may be used in the BS 700 or the UE 800.

DETAILED DESCRIPTION OF EMBODIMENTS

In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative examples or embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other examples or embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here. It will be readily understood that aspects of this disclosure, as generally described herein, and illustrated in the figures, can be arranged, substituted, combined, and designed in a wide variety of different configurations, all of which are explicitly contemplated and make part of this disclosure.

As used hereinafter, it should be appreciated the term UE may be referred to as a mobile terminal, a terminal, a user terminal (UT), a wireless terminal, a wireless communication device, a wireless transmit/receive unit (WTRU), a mobile phone, a cell phone, a PDA, a portal computer etc. Yet further, the term UE includes MTC (Machine Type Communication) devices, which do not necessarily involve human interaction. Also, the term “BS” as used herein may be referred to as a radio base station, a NodeB or an evolved NodeB (eNB), access point, relay node, etcetera.

For SPS, as mentioned above, it is specified in the 3GPP that at an initial phase or at (re)activation, up to 4 candidate HARQ feedback positions are statically allocated in a RRC message, and one of them is chosen and notified to the UE through 2 bits TPC field in DL DCI for the UE carrying HARQ feedback of DL data.

The present disclosure proposes a solution applied in a case where the HARQ feedback position for SPS conflicts with that for dynamical scheduling. To be specific, the present disclosure proposes to transmit, in DL data, information regarding a new HARQ feedback position for replacing the currently used one.

Fig. 3 shows a flowchart of a method 300 used in a BS for SPS scheduling a UE according to a first embodiment of the present disclosure.

At step S310, the BS determines an uplink control channel position available for the UE transmitting HARQ feedback of downlink data from the BS. For example, the uplink control channel position may be chosen from several candidate positions reserved for the UE transmitting the HARQ feedback, other than the currently used position.

At step S320, the BS generates, in the downlink data, information regarding the determined uplink control channel position. For example, the information may be HARQ index for the determined uplink control channel position.

At step S330, the BS transmits the downlink data to the UE.

Preferably, the uplink control channel position determined at step S310 is a PUCCH position, and the downlink data is PDSCH data. In this case, the information regarding the determined uplink control channel position may be indicated by a MCE of PDSCH. Of course, the present disclosure is not limited thereto, but may be applied to appropriate channels in other communication standards, such as High-Speed Downlink Packet Access (HSDPA).

In an implementation, the MCE is a TA MCE. Then, the determined uplink control channel position is one of candidate PUCCH positions statically allocated by the BS other than the currently used PUCCH position.

A feasible manner to implement step S320 is to generate, in a header of the TA

MCE, an indication indicating whether the higher 2 bits of the TA field are used to carry the information regarding the determined uplink control channel position or not. For example, one bit in the header of the TA MCE may be used here. When the bit is 0, it indicates that the higher 2 bits of the TA field are not used to carry the information regarding the determined uplink control channel position, i.e., the higher 2 bits of the TA field still indicates the original TA format. When the bit is 1, it indicates that the higher 2 bits of the TA field are used to carry the information regarding the determined uplink control channel position.

In another implementation, the MCE indicates a HARQ position offset defining an offset relative to currently used PUCCH position.

Fig. 4 is a schematic diagram illustrating a format of a TA MCE for carrying the information regarding the determined uplink control channel position.

As shown in Fig. 4, for a TA MCE (LCID=11101, as shown in the following Table 1), only 6 bits are used to indicate 0~63 value range. The higher 2bits are reserved, which is then used to carry the 2bits HARQ index. The 2bits HARQ index indicates a new HARQ feedback position for SPS, which is one of candidate PUCCH positions statically allocated by the BS other than currently used PUCCH position, when collision with dynamic scheduling occurs.

The “E” bit in the MAC header may be used to indicate such a new TA format. For example, when “E” bit is 0, LCID (11101) indicates the original TA format, that is the higher 2 bits are still reserved. When “E” bit is 1, LCID (11101) indicates the new TA format and the 2 higher bits are used to carry the HARQ index.

By employing the higher 2 bits of the TA MCE for carrying the information regarding the determined uplink control channel position, instead of using DCI, the present disclosure may save PDCCH resource without complicating CCE allocation algorithm.

Fig. 5 is a schematic diagram illustrating a format of a new MCE for carrying the information regarding the determined uplink control channel position.

As shown in Fig. 5, a new type of MCE, “HARQ index offset”, is defined to carry the information regarding the determined uplink control channel position. To be specific, the MCE indicates a HARQ position offset defining an offset relative to currently used PUCCH position. For example, HARQ index of the determined uplink control channel position may be equal to HARQ index of the currently used HARQ position plus the HARQ index offset.

The new MCE has 8bits, indicating a [-128, 127] offset range based on current HARQ index. That is, the new MCE may indicate at most 256 new HARQ positions, thereby resolving the maximum 4 HARQ positions constraint. Of course, only part of the new MCE, such as 3bits, 4 bits, etc, may be used, depending on actual practices.

Table 1 illustrates values of LCID for DL-SCH. From the reserved LCID range in Table 1, 11011 is allocated to indicate the new MCE, "HARQ index offset". Of course, it would be appreciated that 11011 is just an example for illustration, and any other reserved MCE may be applicable to the present disclosure.

Table 1: Values of LCID for DL-SCH

Index	LCID values
00000	CCCH
00001-01010	Identity of the logical channel
01011-11011	Reserved
11100	UE Contention Resolution Identity
11101	Timing Advance Command
11110	DRX Command
11111	Padding

By defining such a new type of MCE, as long as the eNB can find another idle HARQ position within such a wide range, the eNB can always notify the UE to use it for HARQ feedback through the new MCE in SPS. With the same size as TA, the new MCE can also reuse the buffer room for TA in periodic SPS data. So, such an optional improvement can resolve maximum 4 HARQ slots constraint without introducing any extra cost.

Fig. 6 shows a flowchart of a method 600 in a SPS scheduled UE for transmitting HARQ feedback of downlink data from a BS according to a second embodiment of the present disclosure.

At step S610, the UE receives the downlink data from the BS. The downlink data includes information regarding an uplink control channel position available for the UE transmitting the HAQR feedback. For example, the information may be HARQ index for the uplink control channel position.

At step S620, the UE determines the uplink control channel position based on the received downlink data.

At step S630, the UE transmits the HARQ feedback based on the determined uplink control channel position.

Preferably, the uplink control channel position determined at step S620 is a PUCCH position, and the downlink data is PDSCH data. In this case, the information regarding the determined uplink control channel position may be indicated by a MCE of PDSCH. Of course, the present disclosure is not limited thereto, but may be applied to appropriate channels in other communication standards, such as HSDPA.

In an implementation, the MCE is a TA MCE. Then, the determined uplink control channel position is one of candidate PUCCH positions statically allocated by the BS other than the currently used PUCCH position. The TA MCE as shown in Fig. 4 may be applied in this implementation.

A feasible manner to implement step S620 is to determine, from a header of the TA MCE, an indication indicating whether the higher 2 bits of the TA MCE are used to carry the information regarding the determined uplink control channel position. For example, the indication may be carried in the “E” bit as shown in Fig. 4.

In another implementation, the MCE indicates a HARQ position offset defining an offset relative to currently used PUCCH position. The MCE is a new type of MCE other than the TA MCE. For example, the MCE as shown in Fig. 5 may be applied here.

In yet another implementation, the HARQ feedback includes ACKnowledgement (ACK) or Discontinuous Transmission (DTX). DTX is used to replace NACK.

Normally, there are three values for HARQ feedback, i.e., ACK, NACK and DTX. NACK means that the UE has correctly detected DCI, but fails to decode data. DTX refers to failure of decoding DCI itself. However, for SPS, NACK and DTX actually refer to the same meaning that UE fails to decode SPS data from the eNB perspective. So, NACK is replaced here with DTX to indicate SPS data decoding failure.

In view of this, a new rule for the UE to transmit HARQ feedback is described as follows.

If the UE successfully decodes DL SPS data, then the UE must find the new HARQ index embedded in the DL SPS data, on which ACK is replied to the eNB.

If the UE fails to decode DL SPS data, the UE then returns DTX instead of NACK to the eNB on the original HARQ position.

On one hand, DTX is actually just NO power, which means nothing is sent on the original HAQR position. So, even if the original HARQ position has been occupied by other UE for dynamic scheduling, it won’t cause any collision.

On the other hand, when the UE has no idea of the new HARQ position, the eNB must also receive DTX from the new position, based on which the eNB detects failure of reception of the DL SPS data at the UE side, then retransmission is scheduled.

Therefore, by using only ACK and DTX during SPS, the collision issue is resolved even at DL data transmission BLER case.

Fig. 7 is a schematic block diagram of a BS 700 for SPS scheduling a UE according to a third embodiment of the present disclosure.

The part of BS 700 which is most affected by the adaptation to the herein described method, e.g., the method 300, is illustrated as an arrangement 701, surrounded by a dashed line. The BS 700 could be e.g. an eNB, or a NodeB, depending on in which type of communication system it is operable, e.g., Long Term Evolution (LTE)-type systems or Wideband Code Division Multiple Access

(WCDMA)-type systems. The BS 700 and arrangement 701 may be further configured to communicate with other entities via a communication unit 702 which may be regarded as part of the arrangement 701. The communication unit 702 comprises means for wireless communication, and may comprise means for, e.g., wired communication. The arrangement 701 or BS 700 may further comprise other functional units 704, such as functional units providing regular BS functions, and may further comprise one or more storage units (memories) 703.

The arrangement 701 may be implemented, e.g., by one or more of: a processor or a micro processor and adequate software and memory for storing of the software, a Programmable Logic Device (PLD) or other electronic component(s) or processing circuitry configured to perform the actions described above, and illustrated, e.g., in Fig. 3. The arrangement part of the BS 700 may be implemented and/or described as follows.

Referring to Fig. 7, BS 700 includes a determining unit 710, a generating unit 720, and a transmitting unit 730.

The determining unit 710 is configured to determine an uplink control channel position available for the UE transmitting HARQ feedback of downlink data from the BS.

The generating unit 720 is configured to generate, in the downlink data, information regarding the determined uplink control channel position.

The transmitting unit 730 is configured to transmit the downlink data to the UE.

Preferably, the determined uplink control channel position is a PUCCH position, the downlink data is PDSCH data, and the information regarding the determined uplink control channel position is indicated by a MCE of PDSCH.

In an implementation, the MCE is a TA MCE, and the determined uplink control channel position is one of candidate PUCCH positions statically allocated by the BS other than currently used PUCCH position. As an example of this implementation, the generating unit 720 may be further configured to generate, in a header of the TA MCE, an indication indicating whether the higher 2 bits of the

TA field are used to carry the information regarding the determined uplink control channel position or not.

In another implementation, the MCE indicates a HARQ position offset defining an offset relative to currently used PUCCH position.

It should be noted that two or more different units in this disclosure may be logically or physically combined. For example, the determining unit 710 and the generating unit 720 may be combined as one single unit.

Fig. 8 is a schematic block diagram of a SPS scheduled UE 800 for transmitting HARQ feedback of downlink data from a BS according to a fourth embodiment of the present disclosure.

The part of UE800 which is most affected by the adaptation to the herein described method, e.g., the method 600, is illustrated as an arrangement 801, surrounded by a dashed line. The UE 800 could be, e.g., a mobile terminal, depending on in which type of communication system it is operable, e.g., LTE-type systems or WCDMA-type systems. The UE 800 and arrangement 801 may be further configured to communicate with other entities via a communication unit 802 which may be regarded as part of the arrangement 801. The communication unit 802 comprises means for wireless communication. The arrangement 801 or UE 800 may further comprise other functional units 804, such as functional units providing regular UE functions, and may further comprise one or more storage units (memories) 803.

The arrangement 801 could be implemented, e.g., by one or more of: a processor or a micro processor and adequate software and memory for storing of the software, a Programmable Logic Device (PLD) or other electronic component(s) or processing circuitry configured to perform the actions described above, and illustrated, e.g., in Fig. 6. The arrangement part of the UE 800 may be implemented and/or described as follows.

Referring to Fig. 8, UE 800 includes a receiving unit 810, a determining unit 820, and a transmitting unit 830.

The receiving unit 810 is configured to receive the downlink data from the BS. The downlink data includes information regarding an uplink control channel position available for the UE transmitting the HAQR feedback.

The determining unit 820 is configured to determine the uplink control channel position based on the received downlink data.

The transmitting unit 830 is configured to transmit the HARQ feedback based on the determined uplink control channel position.

Preferably, the determined uplink control channel position is a PUCCH position, the downlink data is PDSCH data, and the information regarding the uplink control channel position is indicated by a MCE of PDSCH.

In an implementation, the MCE is a TA MCE, and the determined uplink control channel position is one of candidate PUCCH positions statically allocated by the BS other than currently used PUCCH position. For example, the higher 2 bits of the TA MCE may be used to carry the information regarding the determined uplink control channel position.

As an example of this implementation, the determining unit 820 may be further configured to determine, from a header of the TA MCE, an indication indicating whether the higher 2 bits of the TA MCE are used to carry the information regarding the determined uplink control channel position or not.

In another implementation, the MCE indicates a HARQ position offset indicating an offset relative to currently used PUCCH position. That is, the MCE is a newly defined MCE and indicates a HARQ position offset defining an offset relative to currently used PUCCH position. The MCE has 8 bits and can indicate a [-128, 127] offset range. For example, HARQ index of the determined uplink control channel position may be equal to HARQ index of the currently used HARQ position plus the HARQ index offset.

In yet another implementation, the HARQ feedback includes ACK or DTX, and DTX is used to replace NACK.

It should be noted that two or more different units in this disclosure may be logically or physically combined. For example, the receiving unit 810 and the transmitting unit 830 may be combined as one single unit.

Fig. 9 schematically shows an embodiment of an arrangement 900 which may be used in the BS 700 or the UE 800. Comprised in the arrangement 900 are here a processing unit 906, e.g., with a Digital Signal Processor (DSP). The processing unit 906 may be a single unit or a plurality of units to perform different actions of procedures described herein. The arrangement 900 may also comprise an input unit 902 for receiving signals from other entities, and an output unit 904 for providing signal(s) to other entities. The input unit and the output unit may be arranged as an integrated entity or as illustrated in the example of Fig. 7 or Fig. 8.

Furthermore, the arrangement 900 may comprise at least one computer program product 908 in the form of a non-volatile or volatile memory, e.g., an Electrically Erasable Programmable Read-Only Memory (EEPROM), a flash memory and a hard drive. The computer program product 908 comprises a computer program 910, which comprises code/computer readable instructions, which when executed by the processing unit 906 in the arrangement 900 causes the arrangement 900 and/or the BS or the UE in which it is comprised to perform the actions, e.g., of the procedure described earlier in conjunction with Fig. 3 or Fig. 6.

The computer program 910 may be configured as a computer program code structured in computer program modules 910A – 910D or 910E – 910H.

Hence, in an exemplifying embodiment when the arrangement 900 is used in the BS 700, the code in the computer program of the arrangement 900 includes a determining module 910A, for determining an uplink control channel position available for the UE transmitting HARQ feedback of downlink data from the BS. The code in the computer program 910 further includes a generating module 910B, for generating, in the downlink data, information regarding the determined uplink control channel position. The code in the computer program 910 further includes a transmitting module 910C, for transmitting the downlink data to the UE. The code in the computer program 910 may comprise further modules, illustrated as module 910D, e.g. for controlling and performing other related procedures associated with BS's operations.

In another exemplifying embodiment when the arrangement 900 is used in the UE 800, the code in the computer program of the arrangement 900 includes a receiving module 910E, for receiving the downlink data from the BS, the downlink data comprising information regarding an uplink control channel position available for the UE transmitting the HAQR feedback. The code in the computer program further includes a determining module 910F, for determining the uplink control channel position based on the received downlink data. The code in the computer program further includes a transmitting module 910G, for transmitting the HARQ feedback based on the determined uplink control channel position. The code in the computer program 910 may comprise further modules, illustrated as module 910H, e.g. for controlling and performing other related procedures associated with UE's operations.

The computer program modules could essentially perform the actions of the flow illustrated in Fig. 3, to emulate the arrangement 701 in the BS 700, or the actions of the flow illustrated in Fig. 6, to emulate the arrangement 801 in the UE 800. In other words, when the different computer program modules are executed in the processing unit 906, they may correspond, e.g., to the units 710 – 730 of Fig. 7 or to the units 810-830 of Fig. 8.

Although the code means in the embodiments disclosed above in conjunction with Fig. 9 are implemented as computer program modules which when executed in the processing unit causes the device to perform the actions described above in conjunction with the figures mentioned above, at least one of the code means may in alternative embodiments be implemented at least partly as hardware circuits.

The processor may be a single CPU (Central processing unit), but could also comprise two or more processing units. For example, the processor may include general purpose microprocessors; instruction set processors and/or related chips sets and/or special purpose microprocessors such as Application Specific Integrated Circuit (ASICs). The processor may also comprise board memory for caching purposes. The computer program may be carried by a computer program product connected to the processor. The computer program product may comprise a computer readable medium on which the computer program is stored. For example, the computer program product may be a flash memory, a

Random-access memory (RAM), a Read-Only Memory (ROM), or an EEPROM, and the computer program modules described above could in alternative embodiments be distributed on different computer program products in the form of memories within the UE.

The present disclosure is described above with reference to the embodiments thereof. However, those embodiments are provided just for illustrative purpose, rather than limiting the present disclosure. The scope of the disclosure is defined by the attached claims as well as equivalents thereof. Those skilled in the art can make various alternations and modifications without departing from the scope of the disclosure, which all fall into the scope of the disclosure.

WHAT IS CLAIMED IS:

1. A method (300) used in a Base Station (BS) for Semi-Persistent Scheduling (SPS) scheduling a User Equipment (UE), the method (300) comprising:

determining (S310) an uplink control channel position available for the UE transmitting Hybrid Automatic Repeat Request (HARQ) feedback of downlink data from the BS;

generating (S320), in the downlink data, information regarding the determined uplink control channel position; and

transmitting (S330) the downlink data to the UE.

2. The method (300) according to claim 1, wherein the determined uplink control channel position is a Physical Uplink Control Channel (PUCCH) position, the downlink data is Physical Downlink Sharing Channel (PDSCH) data, and the information regarding the determined uplink control channel position is indicated by a Media Access Control (MAC) control element (MCE) of PDSCH.

3. The method (300) according to claim 2, wherein the MCE is a Time Alignment (TA) MCE, and wherein the determined uplink control channel position is one of candidate PUCCH positions statically allocated by the BS other than currently used PUCCH position.

4. The method (300) according to claim 2, wherein the MCE indicates a HARQ position offset defining an offset relative to currently used PUCCH position.

5. A method (600) used in a Semi-Persistent Scheduling (SPS) scheduled User Equipment (UE) for transmitting Hybrid Automatic Repeat Request (HARQ) feedback of downlink data from a Base Station (BS), the method comprising:

receiving (S610) the downlink data from the BS, the downlink data comprising information regarding an uplink control channel position available for the UE transmitting the HAQR feedback;

determining (S620) the uplink control channel position based on the received downlink data; and

transmitting (S630) the HARQ feedback based on the determined uplink control channel position.

6. The method (600) according to claim 5, wherein the determined uplink control channel position is a Physical Uplink Control Channel (PUCCH) position, the downlink data is Physical Downlink Sharing Channel (PDSCH) data, and the information regarding the uplink control channel position is indicated by a Media Access Control (MAC) control element (MCE) of PDSCH.

7. The method (600) according to claim 6, wherein the MCE is a Time Alignment (TA) MCE, and wherein the determined uplink control channel position is one of candidate PUCCH positions statically allocated by the BS other than currently used PUCCH position.

8. The method (600) according to claim 6, wherein the MCE indicates a HARQ position offset defining an offset relative to currently used PUCCH position.

9. The method (600) according to any of claims 5 to 8, wherein the HARQ feedback includes ACKnowledgement (ACK) or Discontinuous Transmission (DTX), and DTX is used to replace Negative ACKnowledgment (NACK).

10. A Base Station (BS) (700) for Semi-Persistent Scheduling (SPS) scheduling a User Equipment (UE), the BS (700) comprising:

a determining unit (710) configured to determine an uplink control channel position available for the UE transmitting Hybrid Automatic Repeat Request (HARQ) feedback of downlink data from the BS;

a generating unit (720) configured to generate, in the downlink data, information regarding the determined uplink control channel position; and

a transmitting unit (730) configured to transmit the downlink data to the UE.

11. The BS (700) according to claim 10, wherein the determined uplink control channel position is a Physical Uplink Control Channel (PUCCH) position, the downlink data is Physical Downlink Sharing Channel (PDSCH) data, and the information regarding the determined uplink control channel position is indicated by a Media Access Control (MAC) control element (MCE) of PDSCH.

12. The BS (700) according to claim 11, wherein the MCE is a Time Alignment (TA) MCE, and wherein the determined uplink control channel position

is one of candidate PUCCH positions statically allocated by the BS other than currently used PUCCH position.

13. The BS (700) according to claim 11, wherein the MCE indicates a HARQ position offset defining an offset relative to currently used PUCCH position.

14. A Semi-Persistent Scheduling (SPS) scheduled User Equipment (UE) (800) for transmitting Hybrid Automatic Repeat Request (HARQ) feedback of downlink data from a Base Station (BS), the UE (800) comprising:

a receiving unit (810) configured to receive the downlink data from the BS, the downlink data comprising information regarding an uplink control channel position available for the UE transmitting the HAQR feedback;

a determining unit (820) configured to determine the uplink control channel position based on the received downlink data; and

a transmitting unit (830) configured to transmit the HARQ feedback based on the determined uplink control channel position.

15. The UE (800) according to claim 14, wherein the determined uplink control channel position is a Physical Uplink Control Channel (PUCCH) position, the downlink data is Physical Downlink Sharing Channel (PDSCH) data, and the information regarding the uplink control channel position is indicated by a Media Access Control (MAC) control element (MCE) of PDSCH.

16. The UE (800) according to claim 15, wherein the MCE is a Time Alignment (TA) MCE, and wherein the determined uplink control channel position is one of candidate PUCCH positions statically allocated by the BS other than currently used PUCCH position.

17. The UE (800) according to claim 15, wherein the MCE indicates a HARQ position offset indicating an offset relative to currently used PUCCH position.

18. The UE (800) according to any of claims 14 to 17, wherein the HARQ feedback includes ACKnowledgement (ACK) or Discontinuous Transmission (DTX), and DTX is used to replace Negative ACKnowledgment (NACK).

19. A computer program product (908) storing instructions (910) that when executed, cause one or more computing devices to perform the method of any of claims 1 –9.

Fig. 1

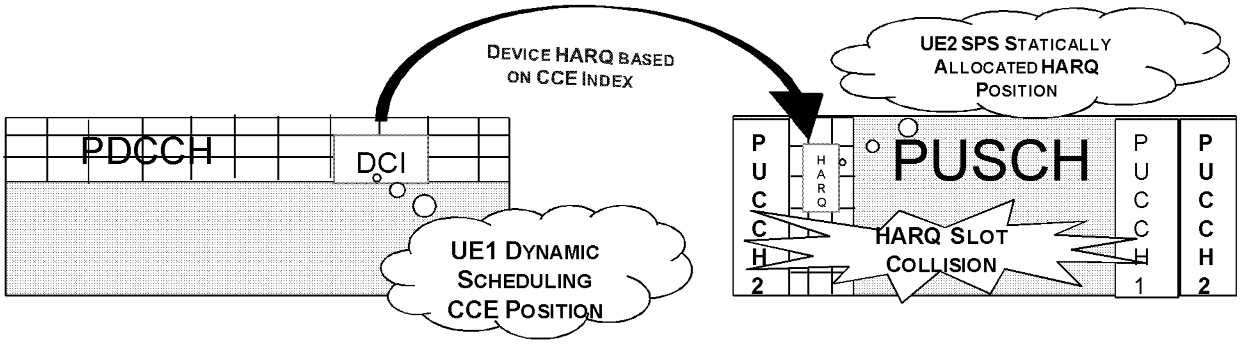

DEVICE HARQ BASED ON CCE INDEX
UE2 SPS STATICALLY ALLOCATED HARQ POSITION
PDCCH
DCI
UE1 DYNAMIC SCHEDULING CCE POSITION
PUCCH2
HARQ
PUSCH
HARQ SLOT COLLISION
PUCCH1
PUCCH2

Fig. 2

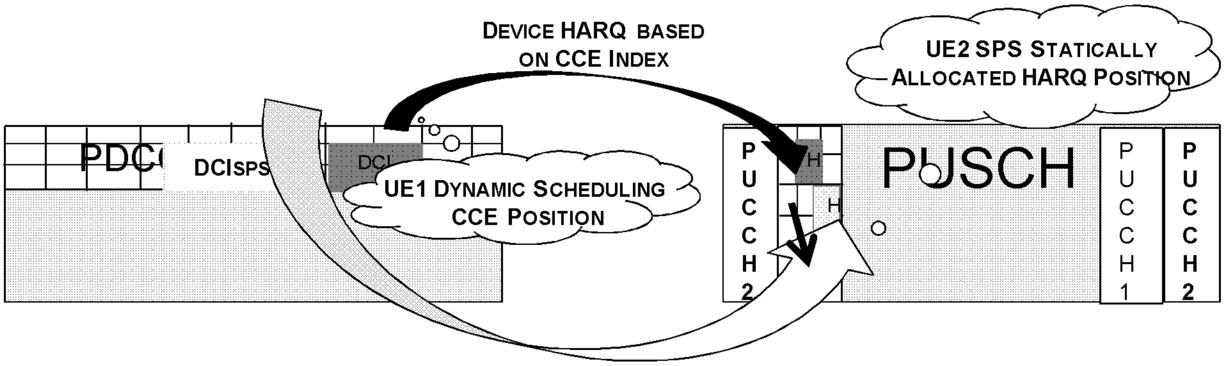

DEVICE HARQ BASED ON CCE INDEX
UE2 SPS STATICALLY ALLOCATED HARQ POSITION
DCISPS
DCI
UE1 DYNAMIC SCHEDULING CCE POSITION
PUCCH2
PUSCH
PUCCH1
PUCCH2
ANOTHER DCI WITH 2BITS TPC INDICATES NEW HARQ POSITION FOR SPS UE

Fig. 3

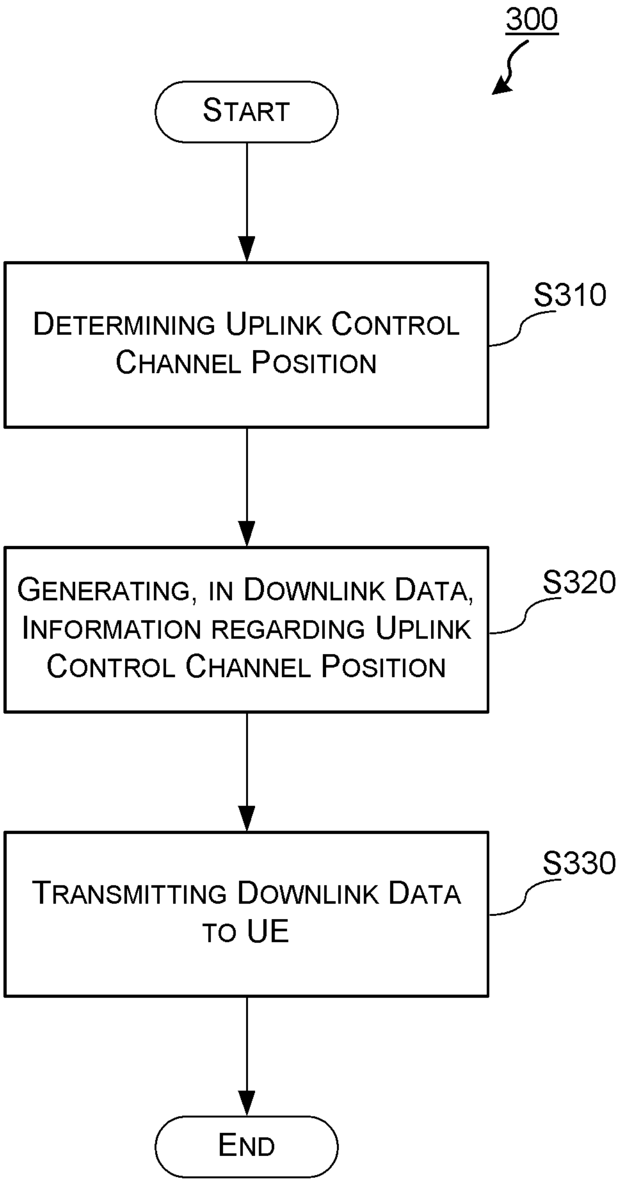
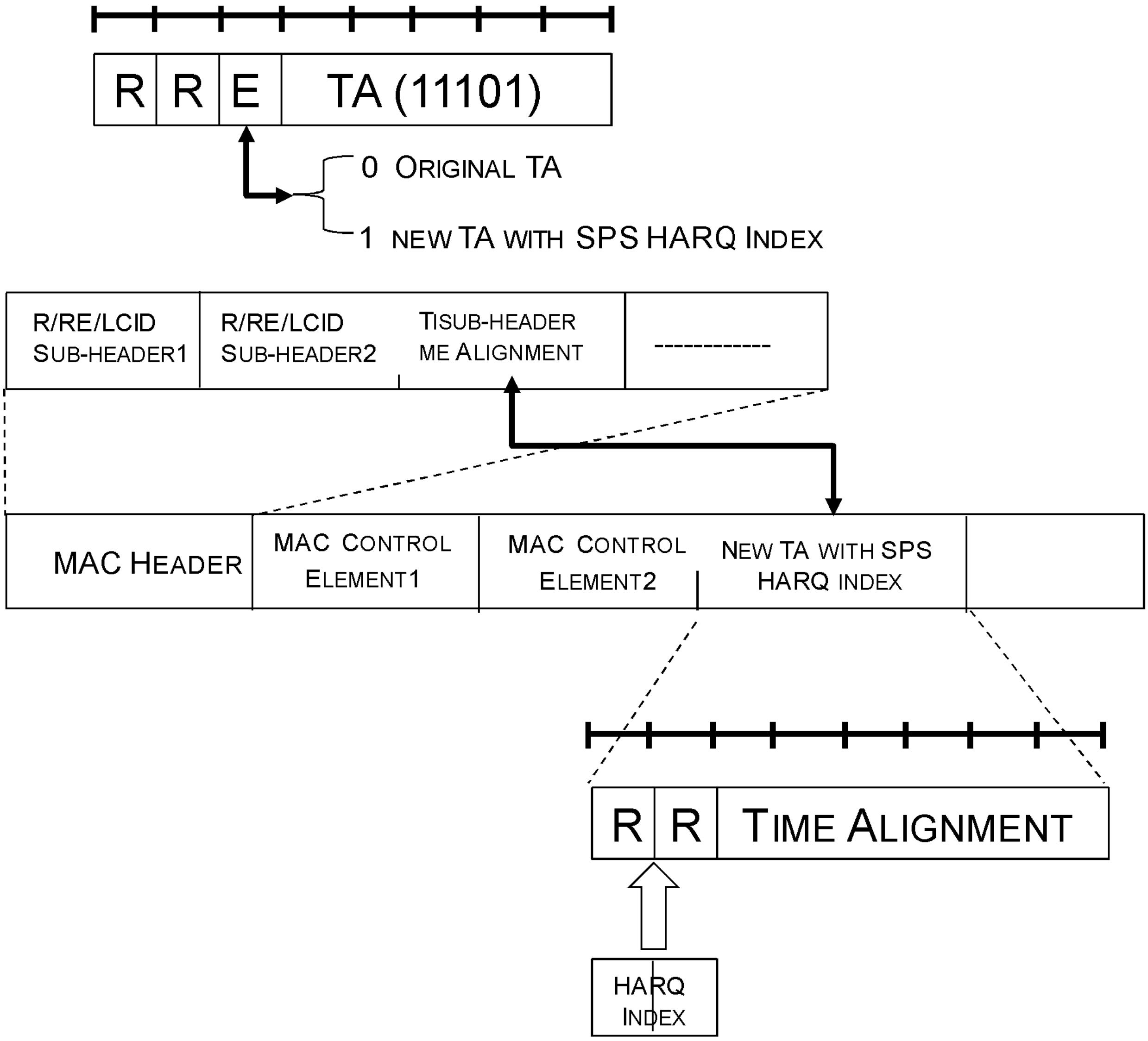
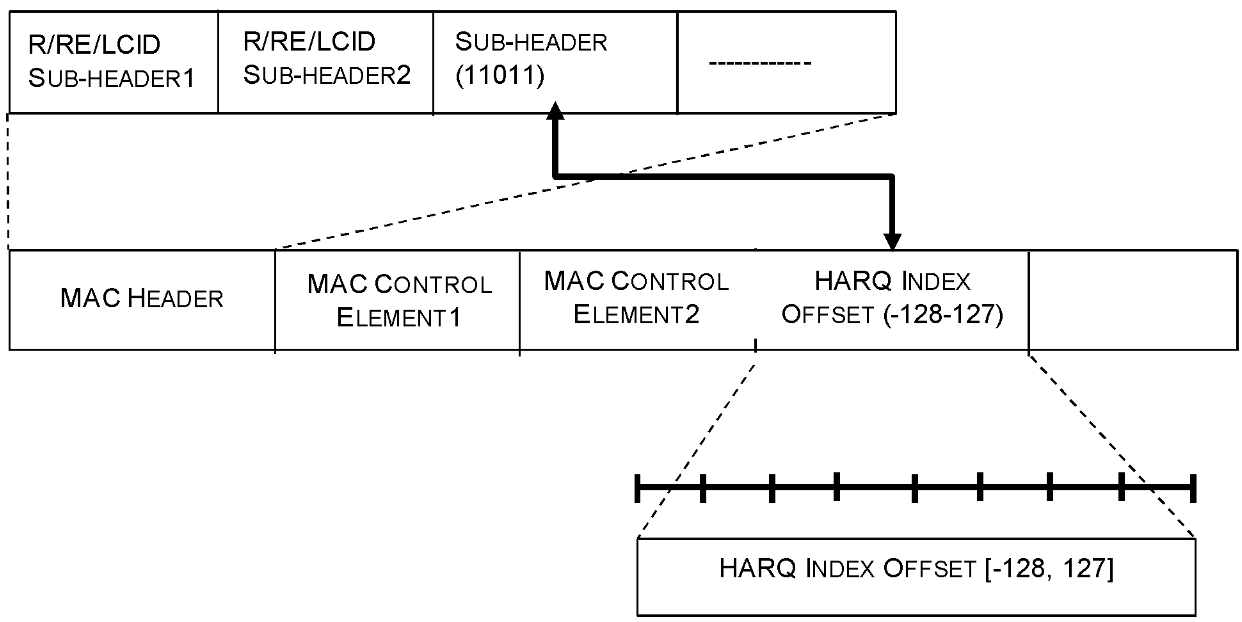

300
START
DETERMINING UPLINK CONTROL CHANNEL POSITION
S310
GENERATING, IN DOWNLINK DATA, INFORMATION REGARDING UPLINK CONTROL CHANNEL POSITION
S320
TRANSMITTING DOWNLINK DATA TO UE
S330
END

Fig. 4


R
R
E
TA (11101)
0 ORIGINAL TA
1 NEW TA WITH SPS HARQ INDEX
R/RE/LCID SUB-HEADER1
R/RE/LCID SUB-HEADER2
TISUB-HEADER ME ALIGNMENT

MAC HEADER
MAC CONTROL ELEMENT1
MAC CONTROL ELEMENT2
NEW TA WITH SPS HARQ INDEX
R
R
TIME ALIGNMENT
HARQ INDEX

Fig. 5


R/RE/LCID SUB-HEADER1
R/RE/LCID SUB-HEADER2
SUB-HEADER (11011)

MAC HEADER
MAC CONTROL ELEMENT1
MAC CONTROL ELEMENT2
HARQ INDEX OFFSET (-128-127)
HARQ INDEX OFFSET [-128, 127]

Fig. 6

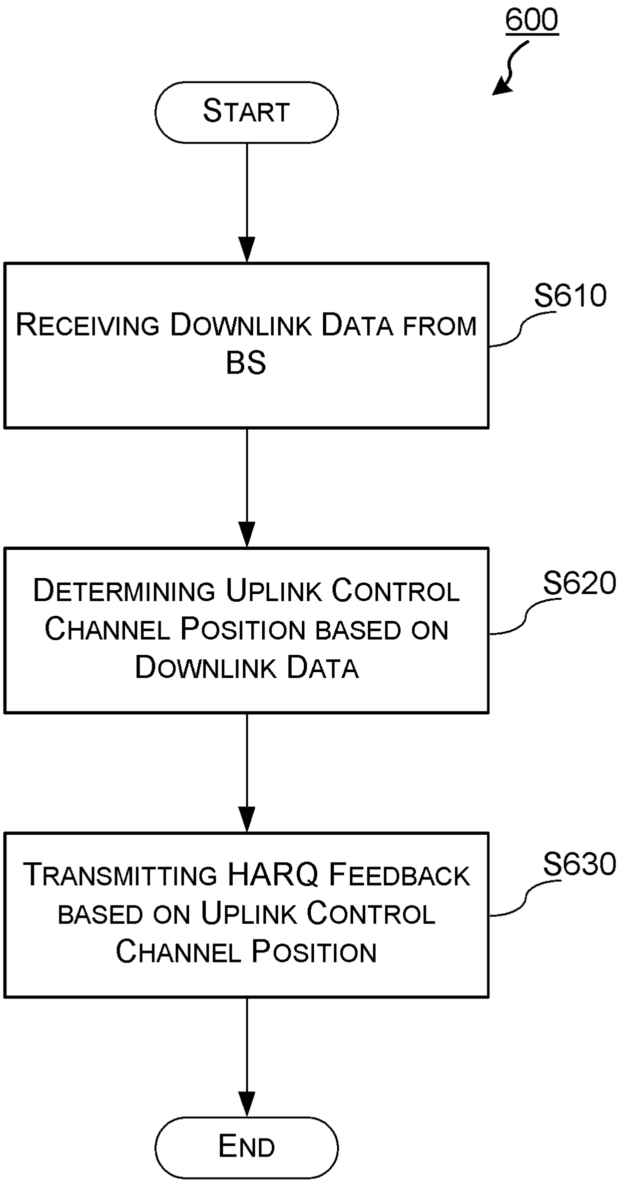

600
START
RECEIVING DOWNLINK DATA FROM BS
S610
DETERMINING UPLINK CONTROL CHANNEL POSITION BASED ON DOWNLINK DATA
S620
TRANSMITTING HARQ FEEDBACK BASED ON UPLINK CONTROL CHANNEL POSITION
S630
END

Fig. 7

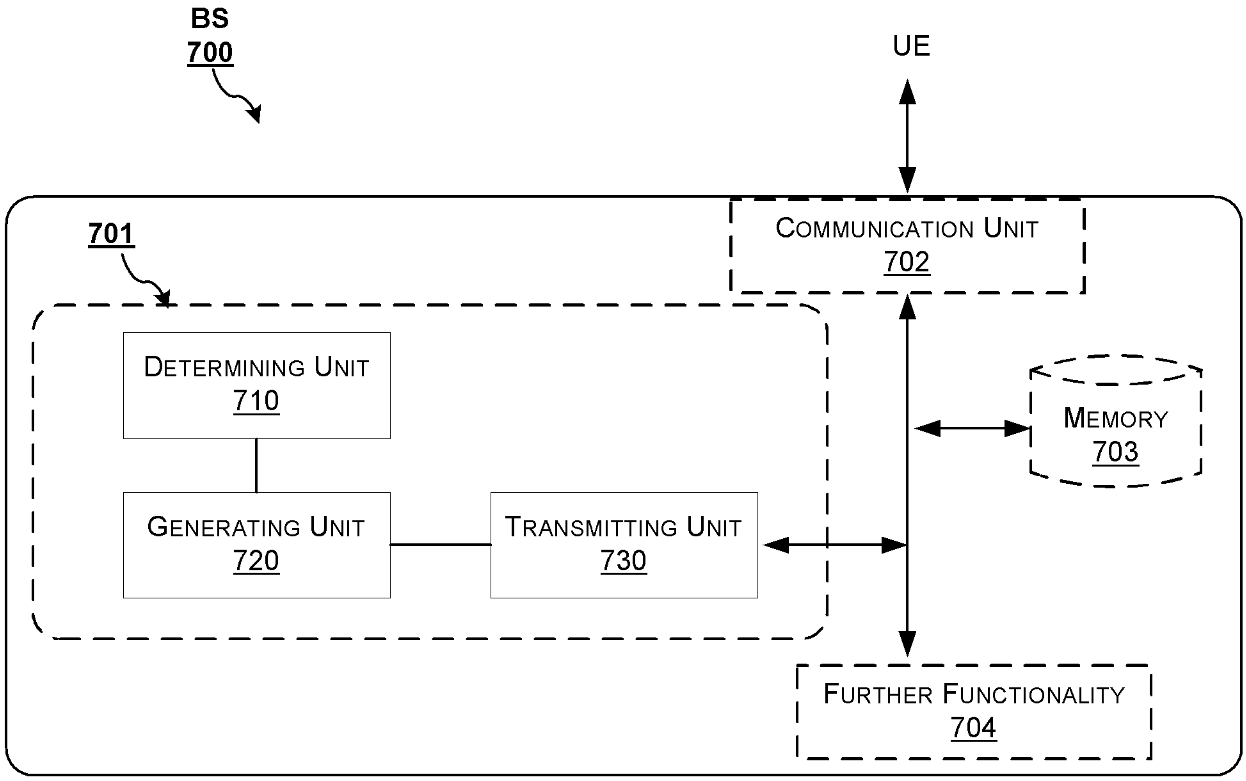

BS
700
UE
701
COMMUNICATION UNIT
702
DETERMINING UNIT
710
MEMORY
703
GENERATING UNIT
720
TRANSMITTING UNIT
730
FURTHER FUNCTIONALITY
704

Fig. 8

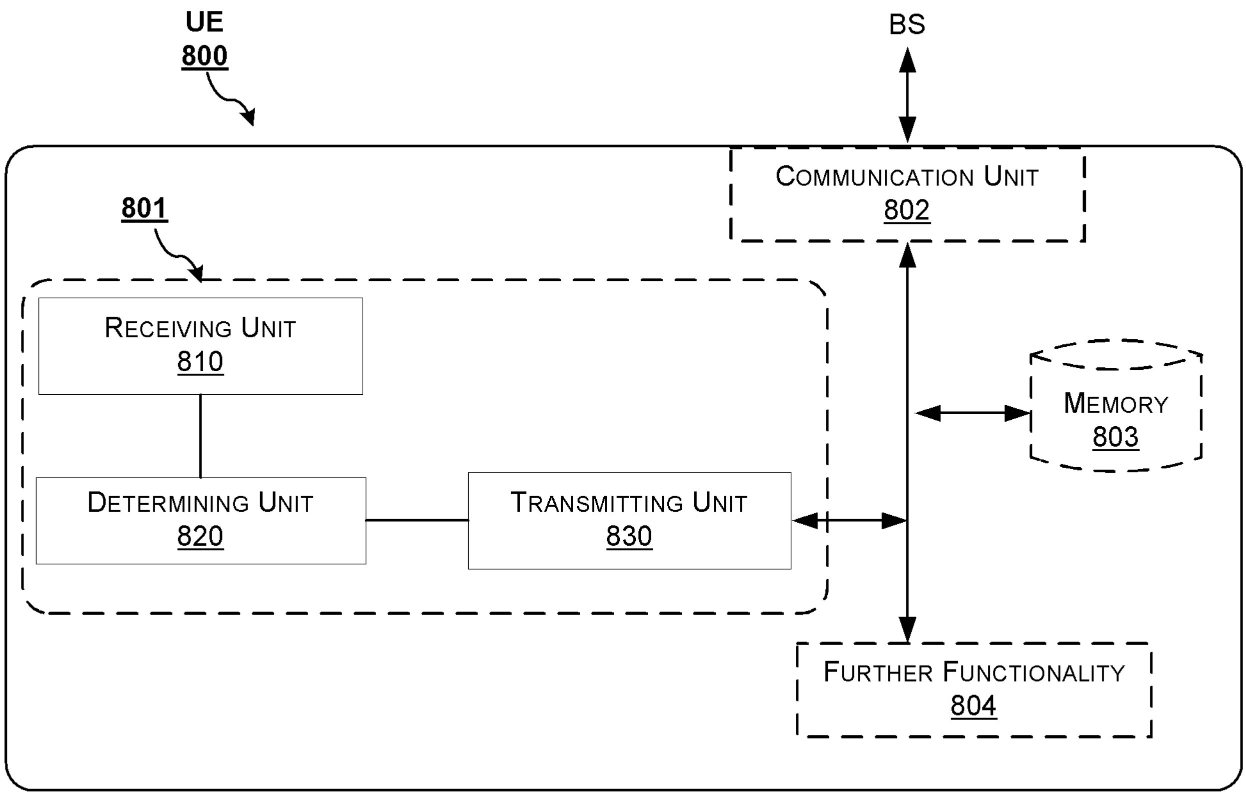
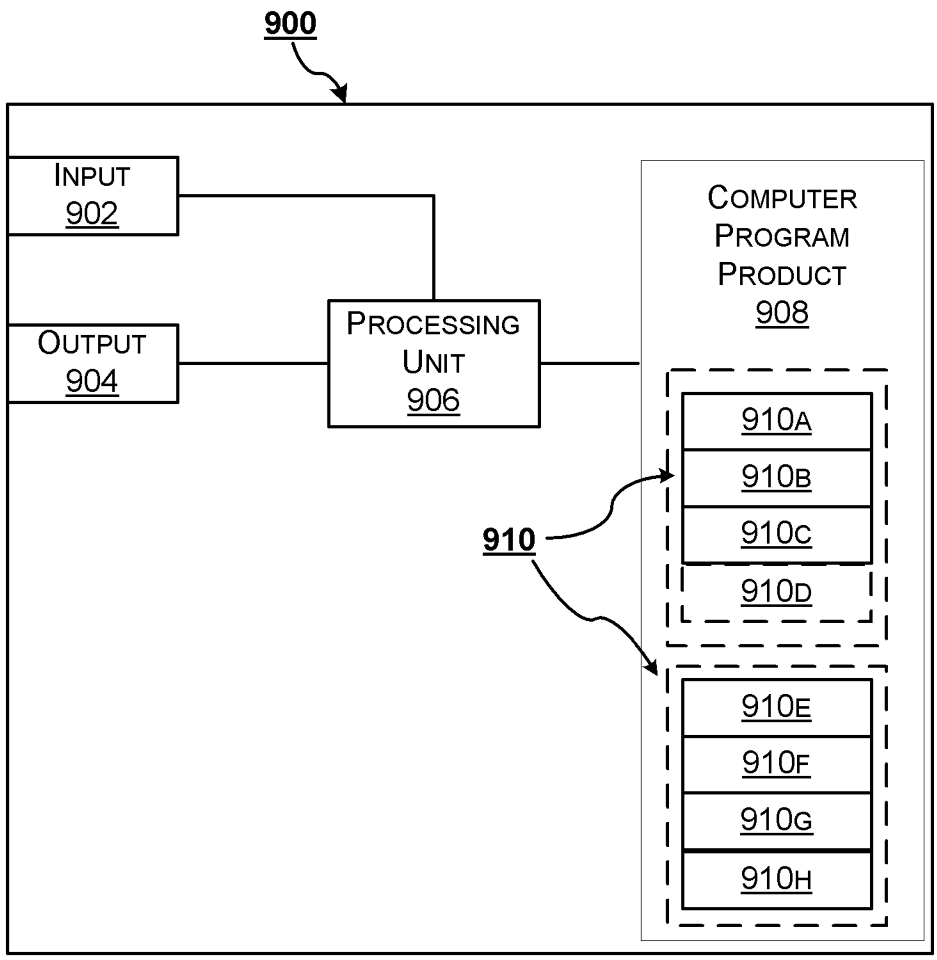

UE
800
BS
COMMUNICATION UNIT
802
801
RECEIVING UNIT
810
MEMORY
803
DETERMINING UNIT
820
TRANSMITTING UNIT
830
FURTHER FUNCTIONALITY
804

Fig. 9


900
INPUT
902
OUTPUT
904
PROCESSING
UNIT
906
COMPUTER
PROGRAM
PRODUCT
908
910
910A
910B
910C
910D
910E
910F
910G
910H

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/081375

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)

H04L; H04W; H04Q

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)

CNPAT,CNKI,WPI,EPODOC: Semi, persistent, schedule, SPS, hybrid, antomatic, repeat, request, HARQ, ACK, NACK, PUCCH, MAC, control, element, MCE, DCI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2014051508 A1 (TELEFONAKTIEBOLAGET L M ERICSSON PUBL) 03 April 2014 (2014-04-03) description, pages 15, 22-23 and 25, figures 18 and 19	1-19
X	CN 103229447 A (LG ELECTRONICS INC.) 31 July 2013 (2013-07-31) description, paragraphs [0051], [0155]-[0174] and [0196]	1, 5, 9-10, 14, 18-19
X	CN 101465720 A (ZTE CORPORATION) 24 June 2009 (2009-06-24) description, page 7 line 2 to page 8 line 4, figure 3	1, 5, 9-10, 14, 18-19
X	CN 103580827 A (BEIJING SAMSUNG COMMUNICATION TECHNOLOGY ET AL.) 12 February 2014 (2014-02-12) description, paragraphs [0042]-[0050], [0065]-[0066], [0140] and [0154]-[0158], figures 2 and 3	1, 5, 9-10, 14, 18-19
A	US 2010195629 A1 (QUALCOMM INCORPORATED) 05 August 2010 (2010-08-05) the whole document	1-19

☐ 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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 March 2015	**30 March 2015**

Name and mailing address of the ISA/CN	Authorized officer
STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA(ISA/CN) **6,Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China**	**LIU,Xinlei**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)84813841**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2014/081375

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2014051508	A1	03 April 2014		Non	e	
CN	103229447	A	31 July 2013	EP	2661006	A2	06 November 2013
				KR	20130064118	A	17 June 2013
				WO	2012091490	A2	05 July 2012
				US	2015049655	A1	19 February 2015
				US	2013223300	A1	29 August 2013
CN	101465720	A	24 June 2009		Non	e	
CN	103580827	A	12 February 2014		Non	e	
US	2010195629	A1	05 August 2010	TW	201108663	A	01 March 2011
				WO	2010091289	A2	12 August 2010