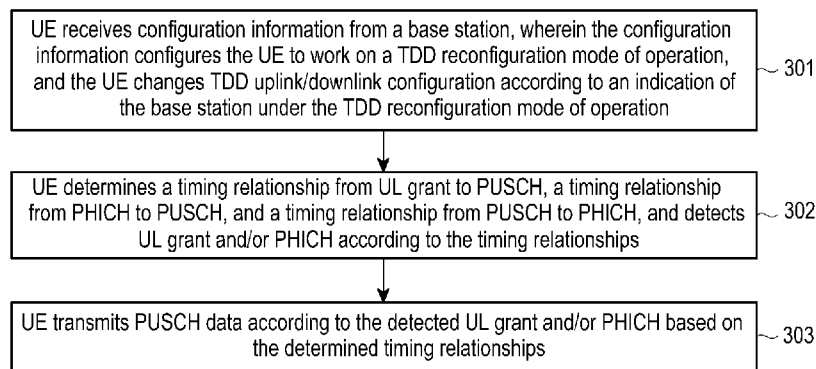


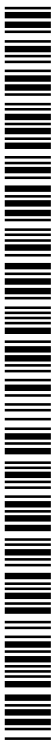


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 - (71) **Applicants:** **SAMSUNG ELECTRONICS CO., LTD.** [KR/KR]; 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do 443-742 (KR). **BEIJING SAMSUNG TELECOM R&D CENTER** [CN/CN]; 1503, 15Floor, Building No.12, Taiyanggong Middle Road, Chaoyang district, Beijing 100125 (CN).
 - (72) **Inventors:** **FU, Jingxing**; 1503, 15Floor, Building No.12, Taiyanggong Middle Road, Chaoyang district, Beijing 100125 (CN). **LI, Yingyang**; 1503, 15Floor, Building No.12, Taiyanggong Middle Road, Chaoyang district, Beijing 100125 (CN). **SUN, Chengjun**; 1503, 15Floor, Building No.12, Taiyanggong Middle Road, Chaoyang district, Beijing 100125 (CN).
 - (74) **Agents:** **LEE, Keon-Joo** et al.; Mihwa Bldg., 16 Dae-hak-ro 9-gil, Chongro-gu, Seoul 110-524 (KR).
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(54) **Title:** TRANSMISSION METHOD ON PHYSICAL UPLINK SHARED CHANNEL AND USER EQUIPMENT



(57) **Abstract:** The present application discloses a PUSCH transmission method. In the method, a UE receives configuration information from a base station, wherein the configuration information configures the UE to operate in a TDD reconfiguration mode of operation. Under the TDD reconfiguration mode of operation, the UE changes TDD uplink/downlink configuration according to an indication of the base station. The UE determines a timing relationship from UL Grant to PUSCH, a timing relationship from PHICH to PUSCH, and a timing relationship from PUSCH to PHICH, and detects the UL grant and/or PHICH according to the determined timing relationships. The UE sends PUSCH data based on the determined timing relationships according to the detected UL grant and/or PHICH. The present application also discloses a user equipment. By using this application, the UE can perform transmission on the PUSCH normally under the TDD reconfiguration mode of operation, transmit as much data as possible on the PUSCH of uplink subframes in case that the TDD uplink/downlink configuration changes frequently, and continue as many synchronization HARQ processes of the uplink subframes as possible before and after the change of the TDD uplink/downlink configuration.



Description

Title of Invention: TRANSMISSION METHOD ON PHYSICAL UPLINK SHARED CHANNEL AND USER EQUIPMENT

Technical Field

- [1] The present application relates to a field of mobile communication technology, and specifically, to a transmission method on a physical uplink shared channel (PUSCH).

Background Art

- [2] Long term evolution (LTE) technology supports two duplex manners, namely, frequency division duplexing (FDD) and time division duplexing (TDD). FIG. 1 is a schematic diagram of a frame structure of a TDD system of LTE. The length of each radio frame is 10ms. The radio frame is equally divided into two half frames, and the length of each half frame is 5ms. Each half frame includes eight time slots of 0.5ms each, and three special fields. The total length of the three special fields is 1ms, and these three special fields are a downlink pilot time slot (DwPTS), a guard period (GP), and an uplink pilot time slot (UpPTS), respectively. Each subframe includes two consecutive time slots.
- [3] Transmission in the TDD system includes: a transmission from a base station to a user equipment (UE) which is referred to as downlink, and a transmission from a UE to a base station (referred to as uplink). Based on the frame structure shown in FIG. 1, 10 subframes are totally used by the uplink and downlink within every 10ms. Each subframe may be configured to either the uplink or downlink. A subframe configured to the uplink can be referred to as an uplink subframe, and a subframe configured to the downlink can be referred to as a downlink subframe. It can support 7 TDD uplink/downlink configurations in the TDD system. As shown in Table 1, D represents a downlink subframe, U represents an uplink subframe, and S represents a special subframe including 3 special fields.
- [4] <Table 1 TDD uplink/downlink configuration table>

[5]

index of configuration	Switching point period	number of subframe									
		0	1	2	3	4	5	6	7	8	9
0	5ms	D	S	U	U	U	D	S	U	U	U
1	5ms	D	S	U	U	D	D	S	U	U	D
2	5ms	D	S	U	D	D	D	S	U	D	D
3	10ms	D	S	U	U	U	D	D	D	D	D
4	10ms	D	S	U	U	D	D	D	D	D	D
5	10ms	D	S	U	D	D	D	D	D	D	D
6	10ms	D	S	U	U	U	D	S	U	U	D

[6]

The TDD system of LTE supports the HARQ mechanism, which has the following basic principles including: a base station allocates uplink resources for UEs; a UE sends uplink data to the base station using the uplink resources; the base station receives the uplink data and sends HARQ indication information to the UE, and the UE retransmits the uplink data according to the indication information. Specifically, the UE carries the uplink data by PUSCH, the base station carries scheduling and control information of PUSCH by a physical downlink control channel (PDCCH), i.e., uplink grant (UL Grant), and the base station carries the HARQ indication information by a physical hybrid retransmission indication channel (PHICH). In the above process, the timing position of one transmission of PUSCH and the timing position of subsequent retransmission may be determined based on preconfigured timing relationships, including a timing relationship from UL Grant to PUSCH, a timing relationship from PHICH to PUSCH, and a timing relationship from PUSCH to PHICH. The above three timing relationships may be collectively referred to hereinafter as a HARQ timing for PUSCH synchronization.

[7]

Firstly, the timing relationship from UL Grant or PHICH to PUSCH in LTE and LTE-A is introduced.

[8]

For the timing relationship from UL Grant to PUSCH, it is assumed that a UE receives a UL Grant in a downlink subframe n (n is the number of the subframe, which has the same meaning below), then the UL Grant is used for scheduling the PUSCH within an uplink subframe $n+k$. Here, the value of k is defined in Table 2. Specifically, for the TDD uplink/downlink configurations (or simply referred to as uplink/downlink configuration) 1~6, the number of uplink subframes is less than or equal to the number of downlink subframes (S frame can be used as a downlink subframe). For any downlink subframe n , it can configure a unique synchronization HARQ timing for PUSCH by a unique value of k , which is reflected in Table 2, it cannot schedule PUSCH within one downlink subframe or can only schedule PUSCH within one uplink

subframe; while for the TDD uplink/downlink configuration 0, the number of uplink subframe is greater than that of the downlink subframe, PDCCH of each downlink subframe needs to schedule PUSCH in two uplink subframes, for this, the value of k is not unique, it needs to use the uplink index (UL index) techniques in PDCCH to support the schedule of PUSCH in two downlink subframes, for PUSCH different in index, using different values of k. For example, when UE receives PDCCH in downlink subframe 0, the PUSCH within uplink subframe 4 and/or uplink subframe 7 is scheduled; when UE receives PDCCH in downlink subframe 1, the PUSCH within uplink subframe 7 and/or uplink subframe 8 is scheduled.

- [9] For the timing relationship from PHICH to PUSCH, in LTE and LTE-A, allocating the PHICH resource set for PUSCH within each uplink subframe independently, assumed that UE receives PHICH in downlink subframe n, then the PHICH is used for controlling the PUSCH within uplink subframe. Here the value of j is defined in table 2. Specifically, for the TDD uplink/downlink configurations 1~6, the number of the uplink subframe is less than or equal to the number of the downlink subframe, for any downlink subframe n, it can configure a unique timing relationship of PUSCH synchronization HARQ by a unique value of j, which is reflected in table 2, it can not configure the PHICH resource set within one downlink subframe or can only configure the PHICH resource set of one uplink subframe; for the TDD uplink/downlink configuration 0, the number of uplink subframe is greater than that of the downlink subframe, the value of j is not unique, but two PHICH resource set are configured respectively in downlink subframe 0 and 5, i.e. PHICH resource 0 and PHICH resource 1, for different PHICH resources, using different values of j. For example, when UE receives PDCCH in downlink subframe 0, it can trigger PUSCH within uplink subframe 4 and/or uplink subframe 7.

- [10] <Table 2 Timing relationship table of UL-Grant/PHICH to PUSCH>

[11]

Index of configuration	Number of subframe									
	0	1	2	3	4	5	6	7	8	9
0	4,7	6,7				4,7	6,7			
1		6			4		6			4
2				4					4	
3	4								4	4
4									4	4
5									4	
6	7	7				7	7			5

- [12] Secondly, the timing relationship of PUSCH to PHICH in LTE and LTE-A is introduced.

[13] For TDD uplink/downlink configurations 1~6, when UE receives PHICH within a downlink subframe n, the PHICH indicates the HARQ-ACK information of PUSCH within the uplink subframe n-h, the value of h as shown in table 3.

[14] For TDD uplink/downlink configuration 0, as two PHICH resources are configured, when UE receives PHICH on a PHICH resource 0 within a downlink subframe n, the PHICH indicates the HARQ-ACK information of PUSCH within uplink subframe n-h; and when UE receives PHICH on PHICH resource 1 of downlink subframe 0 or downlink subframe 5, then the PHICH indicates the HARQ-ACK information of PUSCH within uplink subframe n-6.

[15] <Table 3 Timing relationship table of PUSCH to PHICH>

[16]

Index of configuration	Number of subframe									
	0	1	2	3	4	5	6	7	8	9
0	7	4				7	4			
1		4			6		4			6
2				6						6
3	6								6	6
4									6	6
5									6	
6	6	4				7	4			6

[17] According to the above tables for three timing relationships (Table 2 and Table 3), the synchronization HARQ timing relationship of PUSCH while a cell employs some particular TDD uplink/downlink configurations can be determined, thereby achieving the synchronization transmission on the PUSCH according to the HARQ timing relationship of PUSCH.

[18] As user requirement for data transmission rate increases, the LTE augmented (LTE-A) techniques have also been proposed. In LTE-A, by TDD reconfiguration techniques, i.e. configuring the TDD uplink/downlink configuration by signaling, the ratio of current uplink subframe and downlink subframe can be used which more in line with the ratio of current uplink traffic and downlink traffic, it can help to improve the uplink/downlink peak rate of user and improve the throughput of the system, e.g., using the physical layer signaling, broadcast signaling or higher layer signaling to indicate TDD uplink/downlink configuration.

[19] For a system employs the TDD reconfiguration techniques (hereinafter referred to as TDD reconfiguration system), the TDD uplink/downlink configuration of cell are changed dynamically with the uplink/downlink traffics in the current cell. While according to the protocol provisions of the existing LTE and LTE-A, the UE obtains the TDD uplink/downlink configuration of the cell by the system information

broadcast in the cell, then regards the TDD uplink/downlink configuration as index, obtains the corresponding timing relationship according to Table 2 and Table 3.

However, in TDD reconfiguration scene, it is required to achieve the fast switching of the TDD uplink/downlink configuration.

- [20] For TDD reconfiguration system, since TDD uplink/downlink configuration changes relatively frequently, the timing relationship of PUSCH synchronization HARQ cannot be determined with the existing method before and after switching the point. Therefore, it is necessary to propose the effective technical solution to solve the transmission problems of PUSCH in TDD reconfiguration system.

Disclosure of Invention

Technical Problem

- [21] The present application aims to solve at least one of the technical drawbacks described above, and provides a PUSCH transmission method in a TDD reconfiguration system and a user equipment, so that the UE can normally transmit data on the PUSCH under a TDD reconfiguration mode of operation.

Solution to Problem

- [22] The present application discloses a transmission method on a physical uplink shared channel (PUSCH), including:
- [23] a user equipment (UE) receiving configuration information from a base station, wherein the configuration information configures the UE to operate in a TDD reconfiguration mode of operation, and under the TDD reconfiguration mode of operation, the UE changing TDD uplink/downlink configuration according to an indication of the base station;
- [24] the UE determining a timing relationship from UL Grant to PUSCH, a timing relationship from PHICH to PUSCH, and a timing relationship from PUSCH to PHICH, and detecting the UL grant and/or PHICH according to the determined timing relationships; and
- [25] the UE sending PUSCH data based on the determined timing relationships according to the detected UL grant and/or PHICH.
- [26] Preferably, the UE changing the TDD uplink/downlink configuration according to the indication of the base station includes:
- [27] uplink subframes included in a radio frame before the UE changes the TDD uplink/downlink configuration is a subset of uplink subframes included in the radio frame after the UE changes the TDD uplink/downlink configuration;
- [28] the UE regarding the timing relationship from UL Grant to PUSCH, the timing relationship from PHICH to PUSCH, and the timing relationship from PUSCH to PHICH of the TDD uplink/downlink configuration after the change as the determined timing

relationships in accordance with Table 4;

[29] wherein Table 4 includes:

[30]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0	0	0	0	0	0	0	0
	1		1	1		1	1	
	2			2			2	
	3				3	3	3	
	4					4	4	
	5						5	
	6		6	6	6	6	6	6

[31] .

[32] Preferably, the UE sending the PUSCH data based on the determined timing relationships according to the detected UL grant and/or PHICH includes:

[33] according to the determined timing relationships, finding corresponding retransmission PUSCH subframe positions within the radio frame after the change of the TDD uplink/downlink configuration for synchronization HARQ processes within the radio frame before the change of the TDD uplink/downlink configuration, respectively; and

[34] performing the synchronization HARQ process on the corresponding retransmission PUSCH subframe position.

[35] Preferably, the UE changing the TDD uplink/downlink configuration according to the indication of the base station includes:

[36] uplink subframes included in a radio frame after the UE changes the TDD uplink/downlink configuration is a subset of uplink subframes included in the radio frame before the UE changes the TDD uplink/downlink configuration; and

[37] the UE regarding the timing relationship from UL Grant to PUSCH, the timing relationship from PHICH to PUSCH, and the timing relationship from PUSCH to PHICH of the TDD uplink/downlink configuration before the change as the determined timing relationships in accordance with Table5-1;

[38] wherein Table 5-1 includes:

[39]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0							
	1	0						6
	2	0	1					6
	3	0						6
	4	0	1		3			6
	5	0	1	2	3	4		6
	6	0						

[40] ; or

[41] the UE determining the timing relationship from UL Grant to PUSCH, the timing relationship from PHICH to PUSCH, and the timing relationship from PUSCH to PHICH in accordance with Table 5-2;

[42] wherein Table 5-2 includes:

[43]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0							
	1	6						6
	2	1	1					1
	3	6						6
	4	6	1		3			1
	5	1	1	2	3	4		1
	6	6						

[44] .

[45] Preferably, the UE changing the TDD uplink/downlink configuration according to the indication of the base station includes:

[46] uplink subframes included in a radio frame before the UE changes the TDD uplink/downlink configuration is not a subset of uplink subframes included in the radio frame after the UE changes the TDD uplink/downlink configuration, and uplink subframes included in the radio frame after the UE changes the TDD uplink/downlink configuration is not a subset of uplink subframes included in the radio frame before the UE changes the TDD uplink/downlink configuration; and

[47] the UE determining the timing relationship from UL Grant to PUSCH, the timing relationship from PHICH to PUSCH, and the timing relationship from PUSCH to PHICH in accordance with Table 6 or 7;

[48] wherein Table 6 includes:

[49]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0							
	1				6			
	2				6	1		
	3		6	6				
	4			1				
	5							
	6							

[50] ; and

[51] Table 7 includes:

[52]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0							
	1				6			
	2				1	1		
	3		6	3				
	4			4				
	5							
	6							

[53] .

[54] Preferably, the UE determines the timing relationship from UL Grant to PUSCH, the timing relationship from PHICH to PUSCH, and the timing relationship from PUSCH to PHICH in accordance with Table 8, 9 or 10;

[55] wherein Table 8 includes:

[56]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0	0	0	0	0	0	0	0
	1	0	1	1	6	1	1	6
	2	0	1	2	6	1	2	6
	3	0	6	6	3	3	3	6
	4	0	1	1	3	4	4	6
	5	0	1	2	3	4	5	6
	6	0	6	6	6	6	6	6

[57]

;

[58]

Table 9 includes:

[59]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0	0	0	0	0	0	0	0
	1	0	1	1	6	1	1	6
	2	0	1	2	1	1	2	6
	3	0	6	3	3	3	3	6
	4	0	1	4	3	4	4	6
	5	0	1	2	3	4	5	6
	6	0	6	6	6	6	6	6

[60]

;

[61]

Table 10 includes:

[62]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0	0	0	0	0	0	0	0
	1	6	1	1	6	1	1	6
	2	1	1	2	1	1	2	1
	3	6	6	3	3	3	3	6
	4	6	1	4	3	4	4	1
	5	1	1	2	3	4	5	1
	6	6	6	6	6	6	6	6

[63]

.

[64]

Preferably, the UE sending the PUSCH data based on the determined timing relationships according to the detected UL grant and/or PHICH includes:

- [65] according to the determined timing relationships, finding corresponding retransmission PUSCH subframe positions in the radio frame after the change of the TDD uplink/downlink configuration for synchronization HARQ processes within the radio frame before the change of the TDD uplink/downlink configuration, respectively;
- [66] if the retransmission PUSCH subframe position is an uplink subframe within the radio frame after the change, performing the corresponding synchronization HARQ process on the retransmission PUSCH subframe position;
- [67] if the retransmission PUSCH subframe position is a downlink subframe, terminating the corresponding synchronization HARQ process; and
- [68] if the retransmission PUSCH subframe position is within a next radio frame of the changed radio frame, terminating the corresponding synchronization HARQ process.
- [69] Preferably, if the determined timing relationship is a timing relationship corresponding to the TDD uplink/downlink configuration 1, 2, 3, 4 or 6, the UE skipping the detection of the UL grant and PHICH transmitted on the PUSCH of a subframe scheduled in accordance with the determined timing relationship for the subframe, wherein the subframe is an uplink subframe in the TDD uplink/downlink configuration corresponding to the determined timing relationship and is a downlink subframe in the radio frame after the change; and
- [70] if the determined timing relationship is a timing relationship corresponding to the TDD uplink/downlink configuration 0, for a subframe which is an uplink subframe in the TDD uplink/downlink configuration corresponding to the determined timing relationship and is a downlink subframe in the radio frame after the change, the UE detecting the UL grant transmitted on the PUSCH of the subframe scheduled in accordance with the determined timing relationship and ignoring the detected UL grant which schedules the PUSCH of the subframe, and the UE skipping the detection of the PHICH Group transmitted on the PUSCH of the subframe scheduled in accordance with the determined timing relationship.
- [71] Preferably, for a subframe which is an uplink subframe in the TDD uplink/downlink configuration corresponding to the determined timing relationship, and is a downlink subframe in the radio frame after the change, the UE skipping the detection of the UL grant and PHICH which schedule the PUSCH transmission of the subframe in accordance with the determined timing relationship.
- [72] Preferably, according to the determined timing relationships, finding corresponding retransmission PUSCH subframe positions in the radio frame after the change of the TDD uplink/downlink configuration for synchronization HARQ processes within the radio frame before the change of the TDD uplink/downlink configuration, respectively;
- [73] if the retransmission PUSCH subframe position is an uplink subframe within the radio frame after the change, performing the corresponding synchronization HARQ

- process on the retransmission PUSCH subframe position;
- [74] if the retransmission PUSCH subframe position is a downlink subframe, suspending the corresponding synchronization HARQ process; and
- [75] if the retransmission PUSCH subframe position is within a next radio frame after the changed radio frame, suspending the corresponding synchronization HARQ process.
- [76] Preferably, the method further includes: recovering the suspended synchronization HARQ process;
- [77] wherein the recovery includes: when the number of uplink subframes in the radio frame after the change is more than that in the radio frame before the change, for each uplink subframe in the radio frame after the change, finding the timing position of the last PUSCH data transmission of the corresponding synchronization HARQ process in accordance with the determined timing relationships, and if the timing position is a downlink subframe, recovering the suspended synchronization HARQ process.
- [78] The present application discloses a user equipment (UE), including: a configuration module, a timing relationship processing module, and a transmission module;
- [79] wherein the configuration module is used to receive configuration information from a base station, wherein the configuration information configures the UE to operate in a TDD reconfiguration mode of operation, and under the TDD reconfiguration mode of operation, the UE changes TDD uplink/downlink configuration according to an indication of the base station;
- [80] the timing relationship processing module is used to determine a timing relationship from UL grant to PUSCH, a timing relationship from PHICH to PUSCH, and a timing relationship from PUSCH to PHICH, and detect the UL grant and/or PHICH according to the determined timing relationships; and
- [81] the transmission module is used to send PUSCH data based on the determined timing relationships according to the detected UL grant and/or PHICH.
- [82] As can be seen from the above technical solutions, the transmission method on the PUSCH and the user equipment provided by the present application enable the UE to perform normal PUSCH transmission under the TDD reconfiguration mode of operation, and transmit as much data as possible on the PUSCH of uplink subframes when the TDD uplink/downlink configuration changes frequently, and continue as many synchronization HARQ processes of the uplink subframes as possible before and after the change of the TDD uplink/downlink configuration.

Brief Description of Drawings

- [83] FIG. 1 is a schematic diagram of a frame structure of a TDD system of LTE;
- [84] FIG. 2 is a schematic diagram of a TDD reconfiguration technique;
- [85] FIG. 3 is a flow diagram of a PUSCH transmission method in a TDD reconfiguration

system of the present application;

[86] FIG. 4 is a schematic diagram of the transfer of PUSCH synchronization HARQ processes of Example one of the present application;

[87] FIG. 5 is a schematic diagram of the transfer of PUSCH synchronization HARQ processes of Example two of the present application;

[88] FIG. 6 is a schematic diagram of the transfer of PUSCH synchronization HARQ processes of Example three of the present application;

[89] FIG. 7 is a schematic diagram of the transfer of PUSCH synchronization HARQ processes of Example four of the present application;

[90] FIG. 8 is a schematic diagram illustrating a method of processing the continuity of a synchronization HARQ process in accordance with Example five of the present application;

[91] FIG. 9 is a schematic diagram of the structure of a preferred user equipment of the present application.

Mode for the Invention

[92] To make the purposes, technical solutions and advantages of the present application more apparent, with reference to the accompanying figures and embodiments set forth below, further detailed description to the present application is made.

[93] The present application mainly focuses on the TDD reconfiguration (TDD reconfiguration) scene. In this scene, with the dynamic changes of the uplink/downlink traffic within the current cell, the uplink/downlink configuration of cell can be dynamically configured by signaling. TDD reconfiguration technique is refers to: a certain cell employs a TDD uplink/downlink configuration before changes the boundary of the uplink/downlink configuration, and employs another TDD uplink/downlink configuration after changes the boundary of the uplink/downlink configuration, generally divided the boundary in a unit of radio frame. As shown in FIG. 2, employs TDD uplink/downlink configuration 0 before changes the boundary, employs TDD uplink/downlink configuration 2 after changes the boundary.

[94] To achieve the purposes of the present application, a PUSCH transmission method in a TDD reconfiguration system is proposed, which is as shown in FIG. 3. The method includes the following steps.

[95] Step 301: A UE receives the configuration information from a base station, the configuration information configures UE to operate in a TDD reconfiguration mode of operation.

[96] Step 302: The UE determines the timing relationship of UL Grant to PUSCH, PHICH to PUSCH and PUSCH to PHICH, and detects UL grant and/or PHICH according to the determined timing relationship.

- [97] In this application, UE receives the TDD uplink/downlink configuration information by signaling, the TDD uplink/downlink configuration information can be sent by the physical layer signaling, broadcast signaling, radio resource control (RRC) signaling or media access control (MAC) signalling, this enables UE can quickly adapt the demand of uplink/downlink traffic changes.
- [98] The timing relationship determined by the present step is used for determining the timing position associated with PUSCH in two radio frames before and after change the boundary, specifically:
- [99] If a certain subframe in the radio frame after the change is scheduled to transmit PUSCH, then detects the UL Grant and/or PHICH which schedules the subframe in the radio frame before or after the change in accordance with the determined timing relationship of UL Grant to PUSCH and PHICH to PUSCH;
- [100] If a certain subframe in the radio frame before the change is scheduled to transmit PUSCH, then detects the PHICH of the subframe in the radio frame before and after the change in accordance with the determined timing relationship of PUSCH to PHICH.
- [101] Step 303: The UE sends the PUSCH data in accordance with the timing relationship determined by step 302 according to the detected UL grant and/or PHICH.
- [102] In the above step 302, the method for determining the timing relationship of UL Grant to PUSCH, the timing relationship PHICH to PUSCH and the timing relationship PUSCH to PHICH is that: determined by a combination relationship of TDD uplink/downlink configuration before the change and TDD uplink/downlink configuration after the change. Or, it can define a particular TDD uplink/downlink configuration, UE which operates in a dynamic TDD mode of operation follows the timing relationship of UL Grant to PUSCH, the timing relationship of PHICH to PUSCH and the timing relationship of PUSCH to PHICH of this particular TDD uplink/downlink configuration, the particular TDD uplink/downlink configuration may be indicated to UE by the system information indication or RRC signaling, or directly given by the 3GPP protocol.
- [103] Or, for UE which operates in a dynamic TDD mode of operation, if the TDD uplink/downlink configuration of the radio frame n and the radio frame n+1 are same, UE follows the timing relationship of UL Grant to PUSCH, the timing relationship of PHICH to PUSCH and the timing relationship of PUSCH to PHICH of TDD uplink/downlink configuration of radio frame n or radio frame n+1; if the TDD uplink/downlink configuration of the radio frame n and the radio frame n+1 are not same, UE follows the timing relationship of UL Grant to PUSCH, PHICH to PUSCH and PUSCH to PHICH of the particular TDD uplink/downlink configuration, the particular TDD uplink/downlink configuration may be indicated to UE by system information in-

dication or RRC signaling, or directly given by the 3GPP protocol, such as follows the timing relationship of UL Grant to PUSCH, the timing relationship of PHICH to PUSCH and the timing relationship of PUSCH to PHICH of TDD uplink/downlink configuration 0.

[104] The following three cases illustrate how to determine the timing relationship of UL Grant to PUSCH, the timing relationship of PHICH to PUSCH and the timing relationship of PUSCH to PHICH by UE under the TDD reconfiguration mode of operation, and how to connection the PUSCH synchronization HARQ process of the uplink subframe within the radio frame before the change of the TDD uplink/downlink configuration and the PUSCH synchronization HARQ process of the radio frame after the change.

[105] Case 1: the uplink subframe included in the radio frame before the change of the TDD uplink/downlink configuration is the subset of uplink subframe included in the radio frame after the change of the TDD uplink/downlink configuration.

[106] In this case, UE employs the timing relationship of PUSCH synchronization HARQ of TDD uplink//downlink configuration after the change, specifically as shown in table 4. For example, assumed that the TDD uplink//downlink configuration before the change is TDD uplink/downlink configuration 1, the TDD uplink/downlink configuration after the change is TDD uplink/downlink configuration 0, due to the uplink subframe contained by TDD uplink/downlink configuration 1 is the subset of the uplink subframe contained by TDD uplink/downlink configuration 0, UE employs the timing relationship of PUSCH synchronization HARQ of TDD uplink/downlink configuration 0 according to table 4.

[107] <Table 4>

[108]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0	0	0	0	0	0	0	0
	1		1	1		1	1	
	2			2			2	
	3				3	3	3	
	4					4	4	
	5						5	
	6		6	6	6	6	6	6

[109] The connection method of PUSCH synchronization HARQ process:

[110] According to the determined timing relationship, for the various synchronization HARQ processes within radio frame before the change of the TDD uplink/downlink configuration finds the corresponding retransmission PUSCH subframe position in the

radio frame after the change of the TDD uplink/downlink configuration respectively, and performs the corresponding synchronization HARQ process on the retransmission PUSCH subframe position. In other words, according to the above determined timing relationship, for the various synchronization HARQ processes within radio frame before the change of the TDD uplink/downlink configuration finds the corresponding retransmission PUSCH subframe position in the radio frame after the change of the TDD uplink/downlink configuration respectively, and performs the corresponding synchronization HARQ process on the retransmission PUSCH subframe position, the uplink subframes are involved here all refers to the uplink subframes within the radio frame before the change of the TDD uplink/downlink configuration. Due to the uplink subframe included in the radio frame before the change of the TDD uplink/downlink configuration is the subset of uplink subframe included in the radio frame after the change of the TDD uplink/downlink configuration, such that able to find the corresponding retransmission PUSCH subframe position for the uplink subframe within radio frame before the change within the radio frame after the change according to the timing relationship of PUSCH synchronization HARQ of TDD uplink and downlink configurations after the change, therefore, the PUSCH synchronization HARQ process of the uplink subframe included in radio frame before the change can be transferred to the corresponding position within the radio frame after the change for performing.

[111] Different synchronization HARQ processes are unique identified by "process index number". In the system without employs TDD reconfiguration techniques, the uplink/downlink configuration of UE does not change, therefore, the various synchronization HARQ processes of UE are performed on the corresponding subframe position in accordance with the given timing relationship. In the system employs TDD reconfiguration techniques, the uplink/downlink configuration of UE will dynamically change, thus, the various synchronization HARQ processes of UE may be performed on the different subframe positions in accordance with the timing relationship determined by step 302. The method described by the previous paragraph is used for determining the various synchronization HARQ processes of UE can be performed on which subframe position in the radio frame after the change.

[112] The retransmission PUSCH subframe position of a certain uplink subframe refers to: a position of the synchronization HARQ process of the uplink subframe performed on the next radio frame determined in accordance with the timing relationship of the uplink subframe in the radio frame, the synchronization HARQ process may perform the retransmission of the uplink subframe or retransmit the PUSCH data.

[113] The specific embodiments of case 1 are illustrated below by one example.

[114] Example 1:

[115] It is assumed that the UE operates in a TDD reconfiguration mode of operation, it is

the TDD uplink/downlink configuration 2 before the change of the boundary, it is the TDD uplink/downlink configuration 1 after the change of the boundary, UE follows the timing relationship of UL Grant to PUSCH, the timing relationship of PHICH to PUSCH and the timing relationship of PUSCH to PHICH of TDD uplink/downlink configuration 1.

[116] According to the timing relationship of TDD uplink/downlink configuration 1, the re-transmission PUSCH subframe position of UE in the uplink subframe 2 of radio frame n is in the uplink subframe 2 of radio frame n+1, the PUSCH synchronization HARQ process is transferred to the uplink subframe 2 of radio frame n+1 for performing, as shown in FIG. 4.

[117] With this present method, before and after the change of the TDD uplink/downlink configuration, all of the synchronization HARQ processes of uplink subframe are continued.

[118] Case 2: the uplink subframe included in the radio frame after the change of the TDD uplink/downlink configuration is the subset of uplink subframe included in the radio frame before the change of the TDD uplink/downlink configuration.

[119] In this case, UE can employ the timing relationship of PUSCH synchronization HARQ of TDD uplink/downlink configuration before the change, the uplink subframe included in the radio frame after the change can be scheduled, specifically as shown in Table 5-1. For example, assumed that the TDD uplink/downlink configuration after the change is uplink/downlink configuration 1, the TDD uplink/downlink configuration before the change is uplink/downlink configuration 0, due to the uplink subframe included in TDD uplink/downlink configuration 1 is the subset of the uplink subframe included in TDD uplink/downlink configuration 0, UE employs the timing relationship of PUSCH synchronization HARQ of TDD uplink/downlink configuration 0 according to table 5-1.

[120] <Table 5-1>

[121]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0							
	1	0						6
	2	0	1					6
	3	0						6
	4	0	1		3			6
	5	0	1	2	3	4		6
	6	0						

[122] In the case of above case 2, it can also employ the timing relationship as shown in

table 5-2.

[123] <Table 5-2>

[124]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0							
	1	6						6
	2	1	1					1
	3	6						6
	4	6	1		3			1
	5	1	1	2	3	4		1
	6	6						

[125] The connection method of PUSCH synchronization HARQ process:

[126] Firstly, according to the above determined timing relationship, for the various synchronization HARQ processes within radio frame before the change of the TDD uplink/downlink configuration finds the corresponding retransmission PUSCH subframe position in the radio frame after the change of the TDD uplink/downlink configuration respectively;

[127] If the retransmission PUSCH subframe position is the uplink subframe within the radio frame after the change, then performs the corresponding synchronization HARQ process on the retransmission PUSCH subframe position; Otherwise, if it is the downlink subframe, then terminates the corresponding synchronization HARQ process; If the retransmission PUSCH subframe position is within a next radio frame after the change, then terminates the corresponding synchronization HARQ process. For example: assumed that the TDD uplink/downlink configuration before the change is TDD uplink/downlink configuration 0, the subframe position of retransmission PUSCH of subframe 9 within the radio frame before the change is the subframe 2 of the next radio subframe of radio subframe after the change, therefore, terminates the synchronization HARQ process of subframe 9. But there is an exception to this: assumed that the TDD uplink/downlink configuration of the radio frame n and the radio frame n+1 are the same, and the TDD uplink/downlink configuration of the radio frame n+1 and the radio frame n+2 are not the same, if the subframe position of retransmission PUSCH of uplink subframe of radio frame n is within the radio frame n+2, and the subframe position of retransmission PUSCH within the radio frame n+2 is the uplink subframe, then the synchronization HARQ process of uplink subframe in radio frame n is not terminated, but performed on the corresponding subframe position of retransmission PUSCH within the radio frame n+2.

[128] As described above, in case 2, UE employs the PUSCH synchronization HARQ

timing relationship of TDD uplink/downlink configuration before the change, due to the uplink subframe included in the radio frame after the change of the TDD uplink/downlink configuration is the subset of uplink subframe included in the radio frame before the change of the TDD uplink/downlink configuration under the case 2, that is to say the uplink subframe included in the radio frame after the change of the TDD uplink/downlink configuration more than that of the radio frame before the change of the TDD uplink/downlink configuration, therefore, there are some subframes, which are the uplink subframe in the TDD uplink/downlink configuration before the change, while are the downlink subframe in the TDD uplink/downlink configuration after the change. For such a number of subframes, it may detect its corresponding UL grant and PHICH, if in accordance with the timing relationship of the TDD uplink/downlink configuration before the change, but such detection is obviously unnecessary, to this end, the application employs the following ways to process.

- [129] If the determined timing relationship is the timing relationship corresponding to the TDD uplink/downlink configurations 1, 2, 3, 4 or 6, according to table 2, due to the UL-Grant or PHICH within one subframe can only schedule PUSCH of one “uplink subframe” under the above TDD uplink/downlink configuration, thus, for a subframe which is the uplink subframe in the TDD uplink/downlink configuration corresponding to the determined timing relationship, and is the downlink subframe in the radio frame after the change (that is, if a certain subframe is the uplink subframe in the TDD uplink/downlink configuration corresponding to the determined timing relationship, and it is the downlink subframe in the radio frame after the change), UE does not detect the UL grant and PHICH which schedules the PUSCH transmission of the subframe in accordance with the determined timing relationship.
- [130] If the determined timing relationship is corresponding to the timing relationship of TDD uplink/downlink configuration 0, UL-Grant within one subframe can schedule PUSCH of two “uplink subframe” according to table 2, thus, for a subframe which is the uplink subframe in the TDD uplink/downlink configuration corresponding to the determined timing relationship, and is the downlink subframe in the radio frame after the change, on one hand, UE detects the UL grant which schedule the PUSCH transmission of the subframe according to the determined timing relationship, and ignores the detected UL grant which schedule the PUSCH of the subframe, on the other hand, UE does not detect the PHICH Group which schedule the PUSCH transmission of the subframe in accordance with the determined timing relationship.
- [131] The specific embodiments of case 2 are illustrated by the following examples 2 and 3.
- [132] Example 2:
- [133] It is assumed that the UE operates in a TDD reconfiguration mode of operation, it is

the TDD uplink/downlink configuration 0 before the change of the boundary, and it is the TDD uplink/downlink configuration 2 after the change of the boundary, UE follows the timing relationship of UL Grant to PUSCH, PHICH to PUSCH and PUSCH to PHICH of TDD uplink/downlink configuration 0 in accordance with table 5-1.

- [134] With reference to FIG. 5, according to the timing relationship of UL Grant to PUSCH of the TDD uplink/downlink configuration 0, the uplink index (UL index) of the UL grant is 01, which is detected by UE in the subframe 0 of the radio frame n+1, and the PUSCH of the subframe 4 of the radio frame n+1 is scheduled by UE, but the subframe 4 of the radio frame n+1 is a downlink subframe, thus, UE ignores the UL grant of the uplink index being equal to 01 which is detected in the subframe 0 of the radio frame n+1. According to the timing relationship of PHICH to PUSCH and the timing relationship of PUSCH to PHICH for the TDD uplink/downlink configuration 0, the decision of the PHICH of IPHICH=0 on the subframe 0 of the radio frame n+1 is the retransmission of the PUSCH of the subframe 4, but the subframe 4 of the radio frame n+1 is a downlink subframe, and thus the UE will not perform the PHICH detection on the PHICH resource of IPHICH=0 on the subframe 0 of the radio frame n+1.
- [135] In the case of the TDD uplink/downlink configuration changes frequently, using this method can achieve that as many synchronization PUSCH processes of the uplink subframe as possible are continued, and the change of the protocol has a small workload.
- [136] Example 3:
- [137] It is assumed that the UE operates in the TDD reconfiguration mode of operation, it is the TDD uplink/downlink configuration 0 before changes the boundary, and it is the TDD uplink/downlink configuration 1 after changes the boundary, the UE follows the timing relationship of UL Grant to PUSCH, the timing relationship of PHICH to PUSCH and the timing relationship of PUSCH to PHICH for the TDD uplink/downlink configuration 0 in accordance with Table 5-1.
- [138] According to the timing relationship of the TDD uplink/downlink configuration 0, the retransmission PUSCH subframe position of the UE in the uplink subframe 2 of the radio frame n is in the subframe 3 of the radio frame n+1, and in the TDD uplink/downlink configuration 1, the subframe 3 of the radio frame n+1 is the uplink subframe, and thus, the PUSCH synchronization HARQ process of the uplink subframe 2 of the radio frame n is transferred to the uplink subframe 3 of the radio frame n+1 uplink subframe for performing, as shown in FIG. 6.
- [139] According to the timing relationship of the TDD uplink/downlink configuration 0, the retransmission PUSCH subframe position of the UE in the uplink subframe 3 of the

radio frame n is in the subframe 4 of the radio frame n+1, and in the TDD uplink/downlink configuration 1, the subframe 4 of the radio frame n+1 is the downlink subframe, and thus, the PUSCH synchronization HARQ process of the uplink subframe 3 of the radio frame n is terminated, as shown in FIG. 6.

[140] According to the timing relationship of the TDD uplink/downlink configuration 0, the retransmission PUSCH subframe position of the UE in the uplink subframe 9 of the radio frame n is in the subframe 2 of the radio frame n+2, and the PUSCH synchronization HARQ process of the uplink subframe 9 of the radio frame n is terminated, as shown in FIG. 6.

[141] In the case of the TDD uplink/downlink configuration changes frequently, using this method will make the changes of the specification smaller.

[142] Case 3: the uplink subframe included in the radio frame after the change of the TDD uplink/downlink configuration is not the subset of the uplink subframe included in the radio frame before the change, and the uplink subframe included in the radio frame before the change is not the subset of the uplink subframe included in the radio frame after the change.

[143] In this case, the present application provides two preferred ways for determining the corresponding timing relationship.

[144] The first way is that: the corresponding timing relationship is determined in accordance with the following steps:

[145] a) UE calculates the collection of both the uplink subframe in the radio frame before the change and the uplink subframe in the radio frame after the change.

[146] b) the collection containing the uplink subframe is searched in the existing LTE frame structure 2(FS2), and the TDD uplink/downlink configuration, which has the fewest number of the uplink subframes, in accordance with the timing relationship of the TDD uplink/downlink configuration, and the details as shown in Table 6.

[147] For example, it is assumed that the TDD uplink/downlink configuration before the change is the TDD uplink/downlink configuration 3, and the TDD uplink/downlink configuration after the change is the TDD uplink/downlink configuration 1, reference to the timing relationship, the PUSCH reference is the TDD uplink/downlink configuration 6.

[148] <Table 6>

[149]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0							
	1				6			
	2				6	1		
	3		6	6				
	4			1				
	5							
	6							

[150] The second way is that: the timing relationship of the TDD uplink/downlink configuration can be used, which can ensure that the PUSCH of the uplink subframe within the radio frame before the change can be transmitted, and the details as shown in Table 7.

[151] <Table 7>

[152]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0							
	1				6			
	2				1	1		
	3		6	3				
	4			4				
	5							
	6							

[153] The connection method of the PUSCH synchronization HARQ process is that:

[154] Firstly, according to the determined timing relationship described above, for the various synchronization HARQ processes within the radio frame before the change of the TDD uplink/downlink configuration, finds the corresponding retransmission PUSCH subframe position in the radio frame after the change respectively;

[155] If a certain retransmission PUSCH subframe position within the radio frame after the change is the uplink subframe, the corresponding synchronization HARQ process will be performed in this position; otherwise if it is the downlink subframe, then terminates the corresponding synchronization HARQ process; if a certain retransmission PUSCH subframe position is within the next radio frame of the radio frame after the change, then terminates the corresponding synchronization HARQ process; but there is an exception to this: if the TDD uplink/downlink configuration of the radio frame n and

the radio frame $n+1$ are the same, and the TDD uplink/downlink configuration of the radio frame $n+1$ and the radio frame $n+2$ are not the same, and if the retransmission PUSCH subframe position of a certain uplink subframe of the radio frame n is within a radio frame $n+2$, and the retransmission PUSCH subframe position within the radio frame $n+2$ is the uplink subframe, then, the synchronization HARQ process in the radio frame n will be not terminated, and it will be performed in the corresponding retransmission PUSCH subframe position within the radio frame $n+2$.

- [156] Similar to the case 2, it is desired to take into account whether it is necessary to detect the certain UL grants and PHICHs, specifically: for the subframe which is the uplink subframe in the TDD uplink/downlink configuration corresponding to the determined timing relationship, and is the downlink subframe in the radio frame after the change, UE does not detect the UL grant and PHICH which schedules the PUSCH transmission of the subframe in accordance with the determined timing relationship.
- [157] The specific embodiments of case 3 are illustrated below by one example.
- [158] Example 4:
- [159] It is assumed that the UE operates in the TDD reconfiguration mode of operation, it is the TDD uplink/downlink configuration 1 before changes the boundary, and it is the TDD uplink/downlink configuration 3 after changes the boundary, UE follows the timing relationship of UL Grant to PUSCH, the timing relationship of PHICH to PUSCH and the timing relationship of PUSCH to PHICH of the TDD uplink/downlink configuration 6 in accordance with Table 6.
- [160] According to the timing relationship of the TDD uplink/downlink configuration 6, the retransmission PUSCH subframe position of the UE in the uplink subframe 2 of the radio frame n is in the subframe 3 of the radio frame $n+1$, and in the TDD uplink/downlink configuration 6, the subframe 3 of the radio frame $n+1$ is the uplink subframe, and in this way, the PUSCH synchronization HARQ process of the uplink subframe 2 of the radio frame n is transferred to the uplink subframe 3 of the radio frame $n+1$ upstream subframe for performing, as shown in figure 7.
- [161] According to the timing relationship of the TDD uplink/downlink configuration 6, the retransmission PUSCH subframe position of the UE in the uplink subframe 7 of the radio frame n is in the subframe 8 of the radio frame $n+1$, and in the TDD uplink/downlink configuration 6, the subframe 8 of the radio frame $n+1$ is the downlink subframe, and in this way, the PUSCH synchronization HARQ process of the uplink subframe 7 of the radio frame n is terminated, as shown in figure 7.
- [162] According to the timing relationship of the TDD uplink/downlink configuration 6, the retransmission PUSCH subframe position of the UE in the uplink subframe 8 of the radio frame n is in the subframe 2 of the radio frame $n+2$, and the PUSCH synchronization HARQ process of the uplink subframe 8 of the radio frame n is terminated, as

shown in figure 7.

[163] In the case of the TDD uplink/downlink configuration changes frequently, using this method will make the change of the protocol smaller.

[164] Synthesizing the above case 1, case 2 and case 3, under the TDD reconfiguration mode of operation, the timing relationship which is determined by UE according to the TDD uplink/downlink configuration before the change and the TDD uplink/downlink configuration after the change is illustrated in table 8-10. Wherein: Table 8 is a combination of the Table 4, Table 5-1 and Table 6, and Table 9 is a combination of the Table 4, Table 5-1 and Table 7, and Table 10 is a combination of the Table 4, Table 5-2 and Table 7.

[165] <Table 8>

[166]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0	0	0	0	0	0	0	0
	1	0	1	1	6	1	1	6
	2	0	1	2	6	1	2	6
	3	0	6	6	3	3	3	6
	4	0	1	1	3	4	4	6
	5	0	1	2	3	4	5	6
	6	0	6	6	6	6	6	6

[167] <Table 9>

[168]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0	0	0	0	0	0	0	0
	1	0	1	1	6	1	1	6
	2	0	1	2	1	1	2	6
	3	0	6	3	3	3	3	6
	4	0	1	4	3	4	4	6
	5	0	1	2	3	4	5	6
	6	0	6	6	6	6	6	6

[169] <Table 10>

[170]

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0	0	0	0	0	0	0	0
	1	6	1	1	6	1	1	6
	2	1	1	2	1	1	2	1
	3	6	6	3	3	3	3	6
	4	6	1	4	3	4	4	1
	5	1	1	2	3	4	5	1
	6	6	6	6	6	6	6	6

[171] As previously described, within the two radio frames with which the change of the TDD uplink/downlink configuration is involved, if the continuity of a certain HARQ process within the previous radio frame cannot be maintained, the HARQ process will terminate, and if the transmission of the uplink data corresponding to the HARQ process is not successful, it will be discarded, namely, it needs to ensure its transmission depending on the retransmission of high layer. With respect to the problem, the present application further proposed an improved method, the main idea is that: as far as possible to maintain the continuity of the HARQ process, for the HARQ process incapable of being continuous, for example, if the downlink subframe is on the retransmission PUSCH subframe position, the HARQ process will be suspended, and it will be recovered at an appropriate moment, and thus the transmission of the uplink data suspended previously will be continued; for the HARQ process capable of being continuous, the transmission of the HARQ will be performed without interruption.

[172] Table 11 is the total amount of the uplink synchronization HARQ process of various TDD uplink/downlink configurations. In the improved method of the present application, according to the TDD uplink/downlink configuration look-up table 11 with which the TDD uplink/downlink reconfiguration process is involved, the obtained maximum of the total amount of the uplink synchronization HARQ processes serves as the maximum amount of HARQ processes, the base station and the UE process the PUSCH transmission in TDD reconfiguration process according to the maximum amount of the HARQ process.

[173] The maximum amount of HARQ processes can use the high layer signaling, for example, the RRC signaling or broadcast signaling.

[174] The UE may determine the maximum amount of the HARQ process by the following ways:

[175] 1) according to the TDD uplink/downlink configuration look-up table 11 with which

the TDD uplink/downlink reconfiguration process is involved, the obtained maximum of the total amount of the uplink synchronization HARQ process serves as the maximum amount of the HARQ process;

[176] 2) the semi-static configuration of the maximum amount of the HARQ process is performed by receiving a high layer signaling, for example, the RRC signaling or broadcast signaling;

[177] 3) the maximum amount of the HARQ process may be obtained by receiving the information of other higher layer configuration, for example, the higher layer semi-static indicates one TDD uplink/downlink configuration, the maximum amount of the HARQ process may be obtained in accordance with table 11, according to the TDD uplink/downlink configuration;

[178] 4) The maximum amount of the HARQ process may be pre-defined in the standard, for example it is equal to 7.

[179] <Table 11: the amount of uplink synchronization HARQ processes of the TDD uplink/downlink configuration>

[180]

TDD uplink/downlink configuration	total amount of uplink synchronization HARQ processes
0	7
1	4
2	2
3	3
4	2
5	1
6	6

[181] For example, if the reconfiguration of the base station may be performed in all of seven kinds of the TDD uplink/downlink configurations, then the maximum amount of the HARQ process can be 7, this is because the maximum amount of the synchronization HARQ process which the TDD uplink/downlink configuration 0 needs is 7. Also, for example, if the reconfiguration of the base station may be performed in the TDD uplink/downlink configurations 3, 4 and 5, then the maximum amount of the HARQ process can be 3, this is because the maximum amount of the synchronization HARQ process which the TDD uplink/downlink configuration 3 needs is 3.

[182] Next, the determined timing relationship (in the following, the TDD uplink/downlink configuration corresponding to the timing relationship is referred to as "reference uplink/downlink configuration ") according to step 302, the UE determines whether it is able to send the new data or retransmit the data to a synchronization HARQ process. For a uplink subframe A, according to the timing relationship of the synchronization

HARQ transmission of the reference uplink/downlink configuration, determining the timing position of the previous uplink data transmission corresponding to the uplink subframe A in the same synchronization HARQ process, if a uplink subframe B actually exists in the timing position, then the data transmission within the uplink subframe A is the new data or data retransmission of the synchronization HARQ process of the uplink subframe B. In contrast, if a downlink subframe is actually in the timing position, then the synchronization HARQ process corresponding to the data transmission within the uplink subframe A will be not directly obtained, in this way, the synchronization HARQ process corresponding to the data transmission within the uplink subframe A can be determined according to the uplink subframe corresponding to the synchronization HARQ process which may be directly obtained, and the continuity of the HARQ process number can be guaranteed.

[183] It is described below how to implement the improved process of this application in conjunction with the embodiments.

[184] Example 5:

[185] Firstly, a method for determining a reference uplink/downlink configuration is described, namely: the reference uplink/downlink configuration is determined according to the actual uplink/downlink configuration of the radio frame n and $n+1$, and the reference uplink/downlink configuration is applied to all the uplink subframes within the radio frame $n+1$. On one hand, according to the reference uplink/downlink configuration, it is determined that the PUSCH transmission of the uplink subframe of the radio frame n is the transmission or the retransmission of the new data to which synchronization HARQ process. On the other hand, according to the reference uplink/downlink configuration, the timing relationship of UL Grant or PHICH to PUSCH which schedules the PUSCH transmission of the uplink subframe of the radio frame n is determined.

[186] Table 12 shows a possible method for determining a reference uplink/downlink configuration. The principles of construction of Table 12 is to ensure to be capable of scheduling all the uplink subframes; in the case of all the actual uplink/downlink configurations of the radio frame n and $n+1$ are 10ms HARQ RTT, try to avoid the use of the reference uplink/downlink configuration which is not 10ms HARQ RTT. According to this principle, the table which can be obtained, may not be unique, in which the Table 12 is only an example.

[187] <Table 12>

[188]

		TDD uplink/downlink configuration for radio frame n						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration for radio frame n+1	0	0	0	0	0	0	0	0
	1	0	1	1	1	1	1	6
	2	0	1	2	1	1	1	6
	3	0	6	3	3	3	3	6
	4	0	1	1	1	4	1	6
	5	0	1	1	1	1	5	6
	6	0	6	6	6	6	6	6

[189] In the following, the method of the present embodiment for processing the continuity of the synchronization HARQ process is described in conjunction with the reference uplink/downlink configuration of Table 12, but the method of the present embodiment for processing the continuity of the synchronization HARQ process is not limited to the use of the reference uplink/downlink configuration of Table 12.

[190] As shown in FIG.8, if the actual uplink/downlink configurations of the radio frames x01 and x02 are 0; the TDD uplink/downlink configurations change at the boundary of the radio frames x02 and x03 and the actual uplink/downlink configurations of the radio frames x03 and x04 are 1; then the TDD uplink/downlink configurations change again at the boundary of the radio frames x04 and x05, and the TDD uplink/downlink configurations of the radio frames x05 and x06 are turned to configuration 0 again; if the reference uplink/downlink configuration of the radio frame x01 is the configuration 0, and according to table 9, the reference uplink/downlink configurations of the radio frames x02~x06 are, in order, 0, 0, 1, 0 and 0.

[191] In this way, since the actual uplink/downlink configurations of the radio frames x03 and x04 are the configuration 1, and it contains a small number of uplink subframes, only the synchronization HARQ process whose sequence numbers are 7, 1, 3 and 4 can keep the continuity, and the synchronization HARQ process whose sequence numbers are 2, 5 and 6 will be temporarily suspended. Specifically, for the subframe x13, although its uplink/downlink configuration is the configuration 1, its reference uplink/downlink configuration is still the configuration 0, the previous data transmission timing of the synchronization HARQ process corresponding to the subframe x13, is found according the reference uplink/downlink configuration 0, namely, subframe x12, the HARQ process number corresponding to the subframe x13 is 3; for the subframe x14, its reference uplink/downlink configuration is the configuration 1, and thus the previous data transmission timing of the synchronization HARQ process corresponding to the subframe x14, is found according the reference configuration 1,

namely, subframe x13, and thus the HARQ process number corresponding to the subframe x14 is 3; for the subframe x22, the HARQ process number corresponding to the subframe x22 is 2, the uplink subframe corresponding to the synchronization HARQ process of the subframe x22 cannot be found in the radio frames x03 and x04, and thus this synchronization HARQ process will be suspended.

[192] Next, in the radio frames x05 and x06, since the number of uplink subframes is recovered into a larger number, the HARQ processes 7, 1, 3 and 4 still maintain the continuity, and the HARQ processes 2, 5 and 6 which are suspended previously are recovered. Specifically, as shown in FIG.8, for the subframe x15, its reference uplink/downlink configuration is the configuration 0, and thus the previous data transmission timing of the synchronization HARQ process corresponding to the subframe x15, is found according the reference uplink/downlink configuration 0, namely, subframe x14, and thus the HARQ process number corresponding to the subframe x15 is 3; for the subframe x16, its reference uplink/downlink configuration is the configuration 0, and thus the previous data transmission timing of the synchronization HARQ process corresponding to the subframe x16, is found according the reference uplink/downlink configuration 0, namely, subframe x15, the HARQ process number corresponding to the subframe x16 is 3; for the subframe x23, its reference uplink/downlink configuration is still the configuration 0, and thus the previous data transmission timing of the HARQ process corresponding to the subframe x23, is found according the reference configuration 0, namely, subframe x33, but the subframe x33 is a downlink subframe, and the HARQ process number corresponding to the subframe x23 cannot be directly determined, since the subframe x15 corresponding to the HARQ process number 3, in order to keep the continuity of the process number, it is deduced that the subframe x23 corresponding to the HARQ process number 2, and in this way, the new data transmission or data retransmission of HARQ process number 2 suspended previously is recovered in the subframe x23.

[193] Corresponding to the above method, the present application also discloses a user equipment. As shown in FIG. 9, the user equipment includes: a configuration module, a timing relationship processing module and a transmission module, wherein:

[194] the configuration module is used for receiving configuration information from a base station, the configuration information configures UE to operate in a TDD reconfiguration mode of operation, under the TDD reconfiguration mode of operation, UE changes the TDD uplink/downlink configuration according to the indication of a base station.

[195] The timing relationship processing module is used for determining the timing relationship of UL Grant to PUSCH, the timing relationship of PHICH to PUSCH and the timing relationship of PUSCH to PHICH, and detects the UL grant and/or PHICH

according to the determined timing relationship.

[196] The transmission module is used for sending the PUSCH data in accordance with the determined timing relationship according to the detected UL grant and/or PHICH.

[197] The present application presents a method of transmitting PUSCH and user equipment under the TDD reconfiguration mode of operation, so that enable the UE can normal transmit PUSCH under the TDD reconfiguration mode of operation, and can transmit as much PUSCH of uplink subframe as possible in the case of TDD uplink/downlink configuration changes frequently, before and after the change of the TDD uplink/downlink configuration, as many synchronization HARQ processes of uplink subframe as possible are continued.

[198] The foregoing is only the preferred embodiments of the present application, and is not intended to limit the present application, any modification, equivalent substitution and improvement made within the spirit and principle of the present application are intended to be included within the protection scope of the present application.

Claims

[Claim 1]

A transmission method on a physical uplink shared channel (PUSCH), characterized in that, comprising:
 a user equipment (UE) receiving configuration information from a base station, wherein the configuration information configures the UE to operate in a TDD reconfiguration mode of operation, and under the TDD reconfiguration mode of operation, the UE changing TDD uplink/downlink configuration according to an indication of the base station;
 the UE determining a timing relationship from UL Grant to PUSCH, a timing relationship from PHICH to PUSCH, and a timing relationship from PUSCH to PHICH, and detecting the UL grant and/or PHICH according to the determined timing relationships; and
 the UE sending PUSCH data based on the determined timing relationships according to the detected UL grant and/or PHICH.

[Claim 2]

The method of claim 1, characterized in that, the UE changing the TDD uplink/downlink configuration according to the indication of the base station comprises:

uplink subframes included in a radio frame before the UE changes the TDD uplink/downlink configuration is a subset of uplink subframes included in the radio frame after the UE changes the TDD uplink/downlink configuration;

the UE regarding the timing relationship from UL Grant to PUSCH, the timing relationship from PHICH to PUSCH, and the timing relationship from PUSCH to PHICH of the TDD uplink/downlink configuration after the change as the determined timing relationships in accordance with Table 4;

wherein Table 4 includes:

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0	0	0	0	0	0	0	0
	1		1	1		1	1	
	2			2			2	
	3				3	3	3	
	4					4	4	
	5						5	
	6		6	6	6	6	6	6

[Claim 3]

The method of claim 2, characterized in that, the UE sending the PUSCH data based on the determined timing relationships according to the detected UL grant and/or PHICH comprises:
 according to the determined timing relationships, finding corresponding retransmission PUSCH subframe positions within the radio frame after the change of the TDD uplink/downlink configuration for synchronization HARQ processes within the radio frame before the change of the TDD uplink/downlink configuration, respectively; and
 performing the synchronization HARQ process on the corresponding retransmission PUSCH subframe position.

[Claim 4]

The method of claim 1, characterized in that, the UE changing the TDD uplink/downlink configuration according to the indication of the base station comprises:
 uplink subframes included in a radio frame after the UE changes the TDD uplink/downlink configuration is a subset of uplink subframes included in the radio frame before the UE changes the TDD uplink/downlink configuration; and
 the UE regarding the timing relationship from UL Grant to PUSCH, the timing relationship from PHICH to PUSCH, and the timing relationship from PUSCH to PHICH of the TDD uplink/downlink configuration before the change as the determined timing relationships in accordance with Table5-1;
 wherein Table 5-1 includes:

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0							
	1	0						6
	2	0	1					6
	3	0						6
	4	0	1		3			6
	5	0	1	2	3	4		6
	6	0						

; or

the UE determining the timing relationship from UL Grant to PUSCH, the timing relationship from PHICH to PUSCH, and the timing relationship from PUSCH to PHICH in accordance with Table 5-2;

wherein Table 5-2 includes:

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0							
	1	6						6
	2	1	1					1
	3	6						6
	4	6	1		3			1
	5	1	1	2	3	4		1
	6	6						

[Claim 5]

The method of claim 1, characterized in that, the UE changing the TDD uplink/downlink configuration according to the indication of the base station comprises:

uplink subframes included in a radio frame before the UE changes the TDD uplink/downlink configuration is not a subset of uplink subframes included in the radio frame after the UE changes the TDD uplink/downlink configuration, and uplink subframes included in the radio frame after the UE changes the TDD uplink/downlink configuration is not a subset of uplink subframes included in the radio frame before the UE changes the TDD uplink/downlink configuration; and
the UE determining the timing relationship from UL Grant to PUSCH, the timing relationship from PHICH to PUSCH, and the timing relationship from PUSCH to PHICH in accordance with Table 6 or 7;
wherein Table 6 includes:

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0							
	1				6			
	2				6	1		
	3		6	6				
	4			1				
	5							
	6							

; and

Table 7 includes:

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0							
	1				6			
	2				1	1		
	3		6	3				
	4			4				
	5							
	6							

[Claim 6]

The method of claim 1, characterized in that, the UE determining the timing relationship from UL Grant to PUSCH, the timing relationship from PHICH to PUSCH, and the timing relationship from PUSCH to PHICH in accordance with Table 8, 9 or 10;

wherein Table 8 includes:

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0	0	0	0	0	0	0	0
	1	0	1	1	6	1	1	6
	2	0	1	2	6	1	2	6
	3	0	6	6	3	3	3	6
	4	0	1	1	3	4	4	6
	5	0	1	2	3	4	5	6
	6	0	6	6	6	6	6	6

;

Table 9 includes:

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0	0	0	0	0	0	0	0
	1	0	1	1	6	1	1	6
	2	0	1	2	1	1	2	6
	3	0	6	3	3	3	3	6
	4	0	1	4	3	4	4	6
	5	0	1	2	3	4	5	6
	6	0	6	6	6	6	6	6

;

Table 10 includes:

		TDD uplink/downlink configuration before the change						
		0	1	2	3	4	5	6
TDD uplink/downlink configuration after the change	0	0	0	0	0	0	0	0
	1	6	1	1	6	1	1	6
	2	1	1	2	1	1	2	1
	3	6	6	3	3	3	3	6
	4	6	1	4	3	4	4	1
	5	1	1	2	3	4	5	1
	6	6	6	6	6	6	6	6

.

[Claim 7]

The method of any of claims 4 to 6, characterized in that, the UE sending the PUSCH data based on the determined timing relationships according to the detected UL grant and/or PHICH comprises: according to the determined timing relationships, finding corresponding retransmission PUSCH subframe positions in the radio frame after the change of the TDD uplink/downlink configuration for synchronization HARQ processes within the radio frame before the change of the TDD uplink/downlink configuration, respectively;

if the retransmission PUSCH subframe position is a uplink subframe within the radio frame after the change, performing the corresponding synchronization HARQ process on the retransmission PUSCH subframe position;

if the retransmission PUSCH subframe position is a downlink subframe, terminating the corresponding synchronization HARQ

process; and

if the retransmission PUSCH subframe position is within a next radio frame of the changed radio frame, terminating the corresponding synchronization HARQ process.

[Claim 8]

The method of claim 4, characterized in that,

if the determined timing relationship is a timing relationship corresponding to the TDD uplink/downlink configuration 1, 2, 3, 4 or 6, the UE skipping the detection of the UL grant and PHICH transmitted on the PUSCH of a subframe scheduled in accordance with the determined timing relationship for the subframe, wherein the subframe is an uplink subframe in the TDD uplink/downlink configuration corresponding to the determined timing relationship and is a downlink subframe in the radio frame after the change; and

if the determined timing relationship is a timing relationship corresponding to the TDD uplink/downlink configuration 0, for a subframe which is an uplink subframe in the TDD uplink/downlink configuration corresponding to the determined timing relationship and is a downlink subframe in the radio frame after the change, the UE detecting the UL grant transmitted on the PUSCH of the subframe scheduled in accordance with the determined timing relationship and ignoring the detected UL grant which schedules the PUSCH of the subframe, and the UE skipping the detection of the PHICH Group transmitted on the PUSCH of the subframe scheduled in accordance with the determined timing relationship.

[Claim 9]

The method of claim 5, characterized in that,

for a subframe which is an uplink subframe in the TDD uplink/downlink configuration corresponding to the determined timing relationship, and is a downlink subframe in the radio frame after the change, the UE skipping the detection of the UL grant and PHICH which schedule the PUSCH transmission of the subframe in accordance with the determined timing relationship.

[Claim 10]

The method of any of claims 4, 5, 6, 8 and 9, characterized in that, according to the determined timing relationships, finding corresponding retransmission PUSCH subframe positions in the radio frame after the change of the TDD uplink/downlink configuration for synchronization HARQ processes within the radio frame before the change of the TDD uplink/downlink configuration, respectively; if the retransmission PUSCH subframe position is an uplink subframe

within the radio frame after the change, performing the corresponding synchronization HARQ process on the retransmission PUSCH subframe position;
if the retransmission PUSCH subframe position is a downlink subframe, suspending the corresponding synchronization HARQ process; and
if the retransmission PUSCH subframe position is within a next radio frame after the changed radio frame, suspending the corresponding synchronization HARQ process.

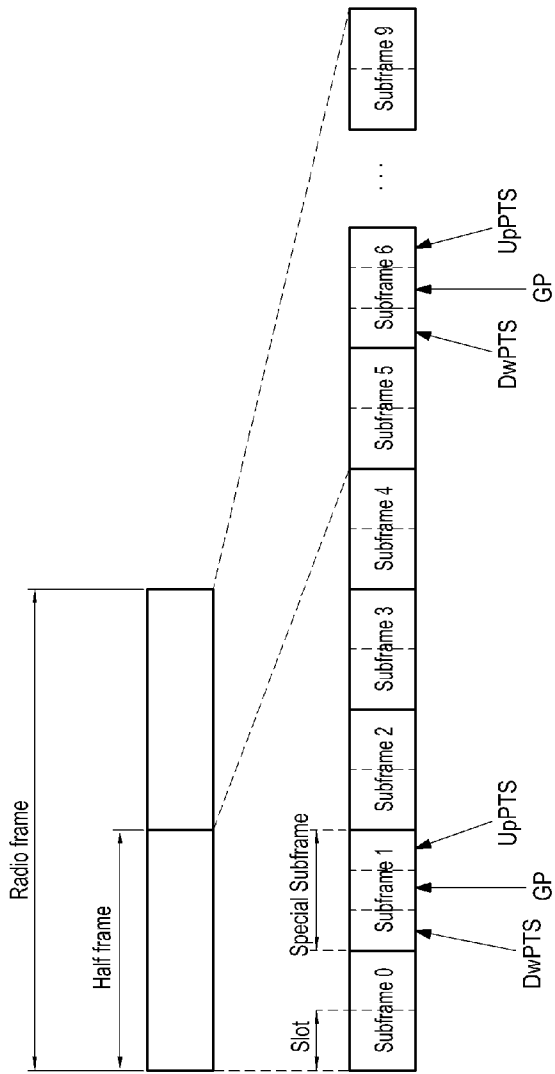
[Claim 11]

The method of claim 10, characterized in that, further comprising: recovering the suspended synchronization HARQ process;
wherein the recovery comprises: when the number of uplink subframes in the radio frame after the change is more than that in the radio frame before the change, for each uplink subframe in the radio frame after the change, finding the timing position of the last PUSCH data transmission of the corresponding synchronization HARQ process in accordance with the determined timing relationships, and if the timing position is a downlink subframe, recovering the suspended synchronization HARQ process.

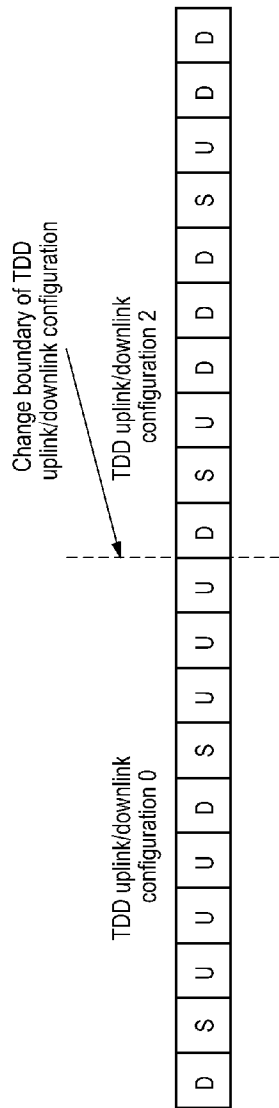
[Claim 12]

A user equipment (UE), characterized in that, comprising: a configuration module, a timing relationship processing module, and a transmission module;
wherein the configuration module is used to receive configuration information from a base station, wherein the configuration information configures the UE to operate in a TDD reconfiguration mode of operation, and under the TDD reconfiguration mode of operation, the UE changes TDD uplink/downlink configuration according to an indication of the base station;
the timing relationship processing module is used to determine a timing relationship from UL grant to PUSCH, a timing relationship from PHICH to PUSCH, and a timing relationship from PUSCH to PHICH, and detect the UL grant and/or PHICH according to the determined timing relationships; and
the transmission module is used to send PUSCH data based on the determined timing relationships according to the detected UL grant and/or PHICH.

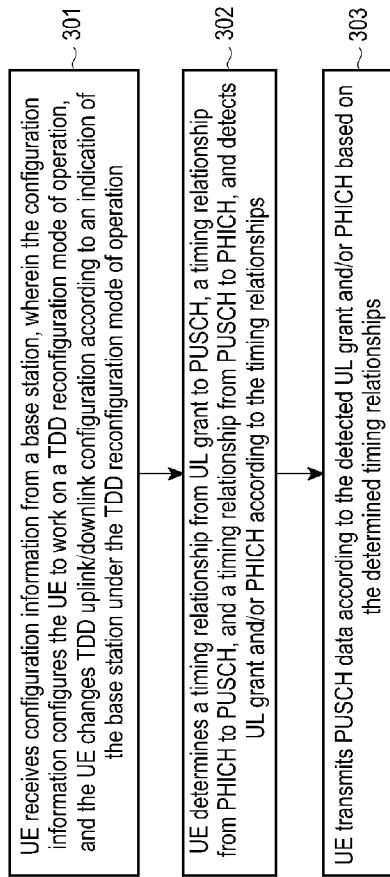
[Fig. 1]



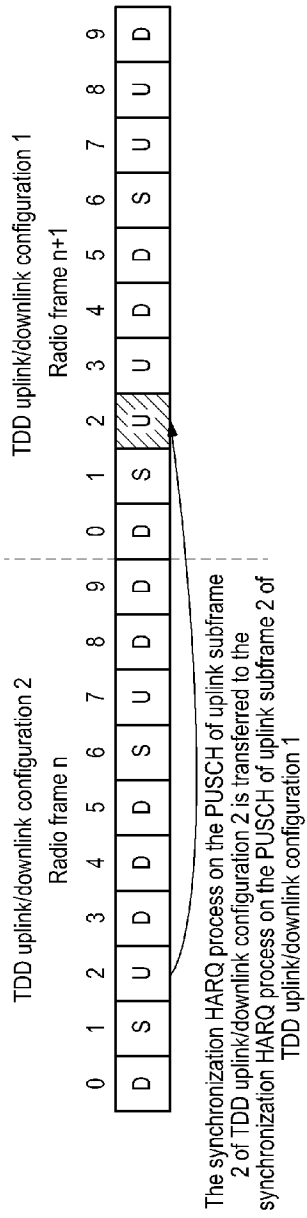
[Fig. 2]



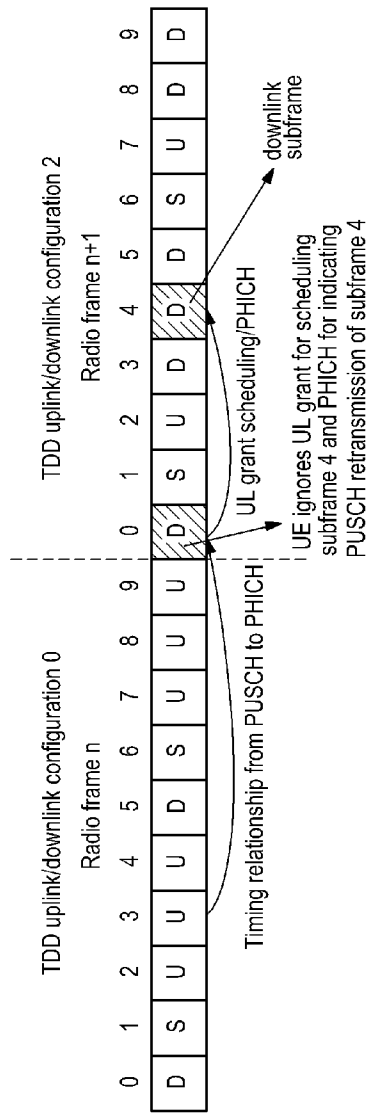
[Fig. 3]



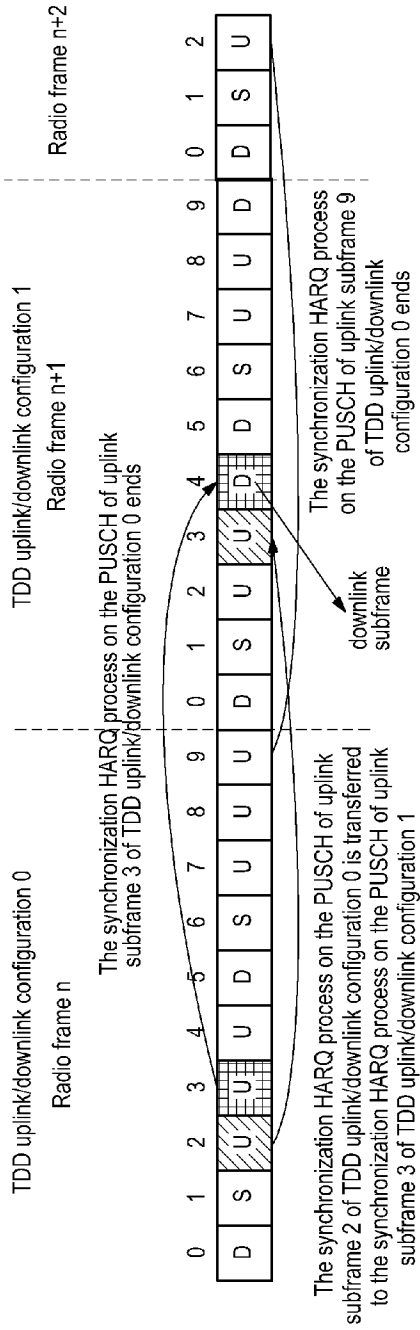
[Fig. 4]



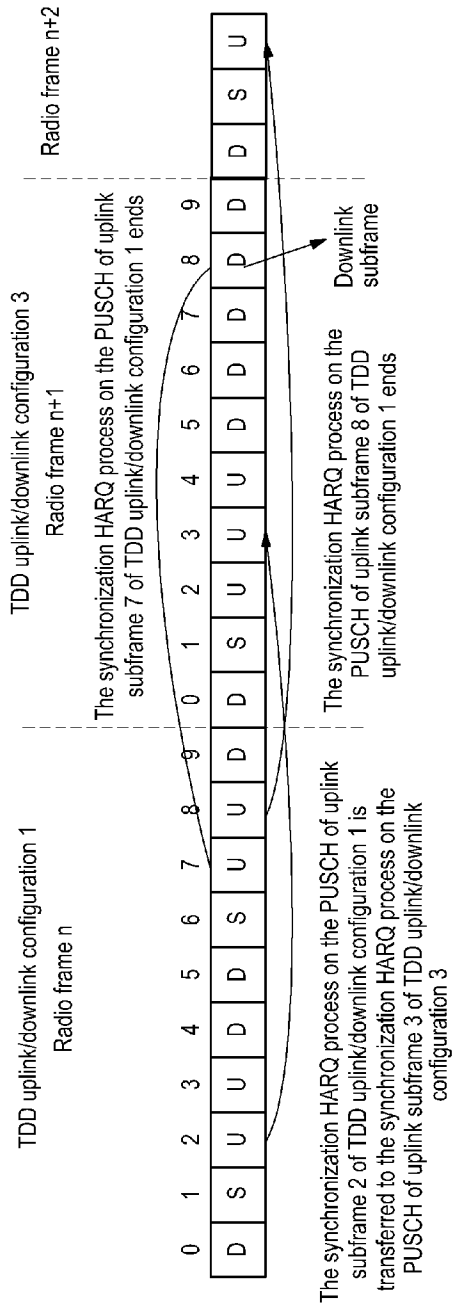
[Fig. 5]



[Fig. 6]



[Fig. 7]



A. CLASSIFICATION OF SUBJECT MATTER**H04W 72/14(2009.01)i, H04J 4/00(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)

H04W 72/14; H04B 7/26; H04J 11/00; H04L 1/18; H04W 72/04; H04W 36/00; H04L 27/26; H04J 4/00

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: PUSCH, PHICH, TDD, reconfiguration, indication, time relationship

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2012-0327821 A1 (SHIANG-JIUN LIN et al.) 27 December 2012 See paragraphs [0038], [0054], [0080]; claim 11; and figure 8	1-12
A	WO 2012-128598 A2 (LG ELECTRONICS INC.) 27 September 2012 See paragraphs [0082], [0083], [0099]; and figure 4.	1-12
A	WO 2012-165782 A2 (SAMSUNG ELECTRONICS CO., LTD.) 06 December 2012 See paragraphs [0031], [0032], [0034]; and figure 1.	1-12
A	US 2011-0211503 A1 (XIANG GUANG CHE et al.) 01 September 2011 See paragraphs [0045], [0065]; claims 36, 51 and figure 5.	1-12
A	ALCATEL-LUCENT SHANGHAI BELL et al., 'Discussion on HARQ and UL-grant timing with dynamic TDD UL-DL configuration', R1-121260, 3GPP TSG RAN WG1 Meeting #68bis, Jeju, Korea, 26-30 March 2012 (http://www.3gpp.org/ftp/tsg_ran/wg1_r11/TSGR1_68b/Docs/) See pages 3, 4.	1-12

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

* Special categories of cited documents:

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"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

23 June 2014 (23.06.2014)

Date of mailing of the international search report

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Name and mailing address of the ISA/KR

International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701,
Republic of Korea

Facsimile No. +82-42-472-7140

Authorized officer

YANG, Jeong Rok

Telephone No. +82-42-481-5709



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2014/002649

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