

DATA TRANSMISSION METHOD BASED ON CROSS-CARRIER SCHEDULING, USER EQUIPMENT, AND BASE STATION

TECHNICAL FIELD

[0001] Embodiments of the present invention relate to the field of communications technologies, and in particular, to a data transmission method based on cross-carrier scheduling, a user equipment, and a base station.

BACKGROUND

[0002] In an LTE (Long Term Evolution, ~~Long Term Evolution~~) system, the smallest time interval for a base station to schedule a user equipment is a subframe. Data transmission in an uplink direction is based on a policy of a synchronous (hybrid automatic repeat request, Hybrid Automatic Repeat reQuest) HARQ. Specifically, the base station sends uplink scheduling grant (Uplink_grant, UL_grant) information in a downlink subframe to schedule a physical uplink shared channel (Physical Uplink Shared Channel, PUSCH) in a certain subsequent uplink subframe; the user equipment (User Equipment, UE) sends the PUSCH according to the UL_grant; the base station receives the PUSCH, and sends feedback information (ACK or NACK) of the PUSCH, that is, physical HARQ indicator channel (Physical HARQ Indicator Channel, PHICH) information, at fixed timing, and negative PHICH information (that is, NACK) triggers PUSCH retransmission in a subsequent uplink subframe. Herein, after the base station schedules a PUSCH, timing of retransmitting a PHICH corresponding to the PUSCH and the PUSCH is fixed.

[0003] In LTE release 10, a carrier aggregation (Carrier Aggregation, CA) technology is introduced, so as to increase a peak rate of a system by supporting data sending on multiple carriers simultaneously. Two methods for scheduling uplink data, that is, non-cross-carrier scheduling and cross-carrier scheduling, are introduced in the LTE release 10. Because in the release 10, it is supposed that a primary cell (Pcell) and a secondary cell (Scell) adopting the CA technology adopt the same time division duplexing (Time Division Duplexing, TDD) uplink and downlink configuration, in the two scheduling policies, the primary cell and the secondary cell may work according to a timing relationship of an HARQ in an uplink and downlink configuration defined in an LTE release 8. For the non-cross-carrier scheduling, the UL_grant and the PHICH used to schedule a PUSCH of the Scell are sent by the Scell; and for the cross-carrier scheduling, the

UL_grant and the PHICH used to schedule a PUSCH of the SCell are sent by the Pcell.

[0004] In LTE release 11, for a TDD system, it is necessary to study a ~~processing method for a circumstance that~~how to process different uplink and downlink configurations of multiple cells adopting the CA technology are different. For example, the PCell adopts an uplink and downlink configuration 1, and the SCell adopts an uplink and downlink configuration 2. For some subframes, a duplexing direction of the PCell and a duplexing direction of the SCell are consistent, for example, subframes 0 of the two cells are downlink subframes, and subframes 2 of the two cells are uplink subframes; however, for some special subframes, for example, a subframe 3 and a subframe 8, duplexing directions of the two cells are different.

[0005] For the foregoing circumstance that the uplink and downlink configurations of the two cells adopting the CA technology are different, if the non-cross-carrier scheduling is adopted, scheduling of PUSCH transmission of the SCell may still be performed according to timing of an uplink HARQ of the SCell. However, in the case of cross-carrier scheduling, because the UL_grant and the PHICH need to be sent by the Pcell, and a subframe of the Pcell used for~~of~~ the timing for scheduling the PUSCH may be an uplink subframe, where and~~and~~ the timing is obtained according to a certain timing policy, ~~may be an~~The uplink subframe, which is incapable of supporting the cross-carrier scheduling of the PUSCH of the SCell, thereby failing to effectively implement the cross-carrier scheduling.

SUMMARY

[0006] Embodiments of the present invention provide a data transmission method based on cross-carrier scheduling, a user equipment, and a base station, capable of effectively implementing cross-carrier scheduling under a circumstance that uplink and downlink configurations of two cells adopting carrier aggregation are different.

[0007] According to one aspect, a data transmission method based on cross-carrier scheduling is provided, which includes: determining a first downlink subframe according to a timing relationship of an uplink hybrid automatic repeat request HARQ of a reference uplink and downlink configuration, where the first downlink subframe is used to indicate timing of sending uplink scheduling grant information of a first uplink subframe of a scheduled cell; transmitting the uplink scheduling grant information in a subframe of a scheduling cell corresponding to the first downlink subframe, under a circumstance that the subframe of the scheduling cell corresponding to the first downlink subframe is a downlink subframe, where an uplink and downlink configuration of the scheduling cell and an uplink and downlink configuration of the scheduled cell are different; and transmitting uplink data in the first uplink subframe.

[0008] According to another aspect, a base station is provided, which includes: a processor,

embodiments or the prior art. Apparently, the accompanying drawings in the following description show merely some embodiments of the present invention, and a person of ordinary skill in the art may still derive other drawings from these accompanying drawings without creative efforts.

[0013] FIG. 1 is a schematic flowchart of a data transmission method based on cross-carrier scheduling according to Embodiment 1 of the present invention;

[0014] FIG. 2 is a schematic flowchart of a data transmission procedure based on cross-carrier scheduling according to Embodiment 2 of the present invention;

[0015] FIG. 3 is a schematic flowchart of a data transmission procedure based on cross-carrier scheduling according to Embodiment 3 of the present invention;

[0016] FIG. 4 is a schematic structural diagram of a base station according to an embodiment of the present invention; and

[0017] FIG. 5 is a schematic structural diagram of a user equipment according to an embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0018] The following clearly and completely describes the technical solutions in the embodiments of the present invention with reference to the accompanying drawings in the embodiments of the present invention. Apparently, the described embodiments are merely a part rather than all of the embodiments of the present invention. All other embodiments obtained by a person of ordinary skill in the art based on the embodiments of the present invention without creative efforts shall fall within the protection scope of the present invention.

[0019] It should be understood that, technical solutions of the present invention may be applied to various communications systems, such as: Global System of Mobile Communication (GSM, Global System of Mobile Communication) system, a Code Division Multiple Access (CDMA, Code Division Multiple Access) system, Wideband Code Division Multiple Access (WCDMA, Wideband Code Division Multiple Access) system, a general packet radio service (GPRS, General Packet Radio Service), Long Term Evolution (LTE, Long Term Evolution) system, Advanced Long Term Evolution (LTE-A, Advanced Long Term Evolution) system, Universal Mobile Telecommunications System (UMTS, Universal Mobile Telecommunications System), and the like, which is not limited in embodiments of the present invention. However, for ease of description, the embodiments of the present invention are described by using an LTE network as an example.

[0020] The embodiments of the present invention may be applied to wireless networks with different standards. In different systems, a radio access network may include different network elements. For example, network elements of a radio access network in the LTE (Long Term

Evolution, Long Term Evolution) and the LTE-A (Advanced long term evolution, Advanced Long Term Evolution) include an eNB (eNodeB, evolved base station), network elements of a radio access network in the WCDMA (Wideband Code Division Multiple Access, Wideband Code Division Multiple Access) include an RNC (Radio Network Controller, radio network controller) and a NodeB; similarly, other wireless networks, such as WiMAX (Worldwide Interoperability for Microwave Access, Worldwide Interoperability for Microwave Access), may also use a solution similar to the embodiments of the present invention, but related modules in a base station system may be different, which is not limited in the embodiments of the present invention. However, for ease of description, the embodiments in the following are described by using the eNodeB as an example.

[0021] It should be further understood that, in the embodiments of the present invention, a user equipment (UE, User Equipment) includes, but is not limited to, a mobile station (MS, Mobile Station), a mobile terminal (Mobile Terminal), a mobile telephone (Mobile Telephone), a handset (handset), portable equipment (portable equipment), and the like. The user equipment may communicate with one or more core networks through a radio access network (RAN, Radio Access Network), for example, the user equipment may be a mobile phone (or called a "cellular" phone), a computer having a radio communications function, and the like, and the user equipment may further be a portable, pocket, hand-held, computer built-in, or vehicle-mounted mobile apparatus.

[0022] According to the embodiments of the present invention, concepts of a scheduling cell and a scheduled cell are introduced. A cell sending UL_grant information and a PHICH is referred to as the scheduling cell, and a cell sending a PUSCH is referred to as the scheduled cell. According to the embodiments of the present invention, a method of the present invention is described by using one scheduling cell and one scheduled cell as an example. It should be understood that, the embodiments of the present invention may be directly extended to the case of one scheduling cell and multiple scheduled cells. For a system that has only two cells and adopts a CA technology, the scheduling cell corresponds to a primary cell adopting the of-CA technology, and the scheduled cell corresponds to a secondary cell adopting the CA technology. However, for a system that has more than two cells and adopts the CA technology, the scheduling cell may correspond to the primary cell, or correspond to the secondary cell, the scheduled cell corresponds to the secondary cell, and there may be multiple scheduling cells and scheduled cells.

Embodiment 1

[0023] FIG. 1 is a schematic flowchart of a data transmission method based on cross-carrier scheduling according to Embodiment 1 of the present invention. The method of FIG. 1 may be

downlink configuration 0 and the reference uplink and downlink configuration is the uplink and downlink configuration of the scheduled cell, PHICHs (such as, a PHICH 0 and a PHICH 1) in the synchronous HARQ procedure of the two uplink subframes are respectively defined in the subframe 0 or 5 of the uplink and downlink configuration 0. If the PHICH is also defined in the subframe 0 (or 5) of the scheduling cell, the PHICH of the subframe 0 (or 5) of the scheduling cell is used according to the synchronous HARQ procedure using the PHICH 0 or PHICH 1; or the PHICH of the subframe 0 (or 5) of the scheduling cell is used for both two synchronous HARQ procedures.

[0049] In 120, under a circumstance that the subframe of the scheduling cell corresponding to the second downlink subframe is the downlink subframe and the PHICH is defined, the uplink scheduling grant information is transmitted in the subframe of the scheduling cell corresponding to the first downlink subframe.

[0050] For example, if it is limited that the available PHICH channel defined in the LTE release 8 needs to exist in the scheduling cell, for the uplink subframe of one scheduled cell, timing of sending the PHICH is determined according to the uplink timing relationship of the reference uplink and downlink configuration. If what in the timing of the scheduling cell is a downlink subframe and the available PHICH defined in the LTE release 8 exists, the cross-carrier scheduling may be performed on the uplink subframe of the scheduled cell.

[0051] Optionally, as a supplement or an exception, the method in FIG. 1 further includes: determining a second uplink subframe according to the timing relationship of the uplink HARQ of the reference uplink and downlink configuration, where the second uplink subframe is used to indicate timing of retransmitting the PUSCH; retransmitting the PHICH in a subframe of the scheduled cell corresponding to the second downlink subframe, under a circumstance that the subframe of the scheduled cell corresponding to the second uplink subframe is an uplink subframe, where in 120, the uplink scheduling grant information is transmitted in the subframe of the scheduling cell corresponding to the first downlink subframe, under the circumstance that the subframe of the scheduled cell corresponding to the second uplink subframe is the uplink subframe.

[0052] For example, for the PUSCH of the uplink subframe of the scheduled cell, it is ensured that what in the subframe timing used when the PUSCH is retransmitted in the synchronous HARQ procedure is also an uplink subframe, thereby ensuring performance of the synchronous HARQ. Otherwise, if the downlink subframe is in one or more retransmitting locations, under a circumstance of such a combination of the configuration of the scheduling cell and the configuration of the scheduled cell, more time needs to be taken to wait before the PUSCH is retransmitted again. If the wait time is excessively long and exceeds a service tolerance range, it is actually equivalent to that the HARQ technology cannot be used to enhance transmission

according to the uplink and downlink configuration of the scheduling cell, to use timing of an uplink HARQ of which reference uplink and downlink configuration to process the PUSCH transmission of the scheduled cell, which, however, is irrelevant to the uplink and downlink configuration adopted by the scheduled cell. If the method of notifying by using the signaling is adopted to configure the reference uplink and downlink configuration, as long as the scheduling cell (corresponding to the Pcell) remains unchanged, new signaling is not needed to notify the reference uplink and downlink configuration. Alternatively, signaling for configuring the reference uplink and downlink configuration is sent together with signaling for configuring the Pcell. If the method of notifying by using the signaling is not used, the reference uplink and downlink configuration corresponding to each kind of the uplink and downlink configuration of the scheduled cell may be determined according to the following method.

[0059] For example, when the scheduling cell adopts a certain configuration in uplink and downlink configurations 1 to 5, the uplink and downlink configuration of the scheduling cell serves as the reference uplink and downlink configuration, that is, the cross-carrier scheduling of the uplink subframe of the scheduled cell is supported according to the timing of the uplink HARQ of the scheduling cell. Specifically, for timing of the subframes that are uplink subframes in the scheduling cell and the scheduled cell, and for the uplink subframe of the scheduled cell, UL_grant information and PHICH information are sent according to the timing of the uplink HARQ of the scheduling cell; however, under a circumstance that what in the scheduled cell is the uplink subframe, and what in the scheduling cell in the same subframe timing is a downlink subframe, the cross-carrier scheduling is not supported for the uplink subframe in such a scheduled cell.

[0060] For example, when the scheduling cell adopts an uplink and downlink configuration 0 or 6, the uplink and downlink configuration 1 is always adopted to serve as the reference uplink and downlink configuration, that is, the cross-carrier scheduling is ~~transmitted~~ performed on the uplink subframe of the scheduled cell according to the timing of the uplink HARQ of the uplink and downlink configuration 1. Because the PHICHs defined in the release 8 exist in all the subframes of the uplink and downlink configuration 0 or 6, there is no problem of failing to find an available PHICH. Specifically, for the uplink subframe of one scheduled cell, when timing of sending the UL_grant and the PHICH information is determined according to an uplink timing relationship of the uplink and downlink configuration 1, if what in the two pieces of timing of the scheduling cell are downlink subframes, the cross-carrier scheduling may be performed on the uplink subframe of the scheduled cell; otherwise, the cross-carrier scheduling is not supported.

[0061] 210: Determine whether a downlink subframe corresponding to a first downlink subframe exists in the scheduling cell.

the uplink subframe of the scheduled cell according to timing of an uplink HARQ of the scheduled cell. Specifically, for a circumstance that the scheduled cell adopts configurations 1 to 5, for an uplink subframe of the scheduled cell, timing of sending UL_grant and PHICH information is determined according to an uplink timing relationship of the scheduled cell, if what in timing of the scheduling cell is a downlink subframe, the cross-carrier scheduling may be performed on the uplink subframe of the scheduled cell; otherwise, the cross-carrier scheduling is not supported. Because the cycle of the configurations 1 to 5 is 10ms, when PUSCH is retransmitted in a synchronous HARQ procedure according to the timing of the uplink HARQ of the configurations 1 to 5, an available uplink subframe definitely exist in retransmission timing. For a circumstance that the scheduled cell adopts the configuration 0 or 6, the downlink subframes of the configuration 0 or 6 are subsets of the downlink subframes of the scheduling cell, therefore, the downlink subframe sending the UL_grant and the PHICH information needs to exist in the scheduling cell according to the timing of the uplink HARQ of the scheduled cell, that is, the cross-carrier scheduling may be performed on all the uplink subframes of the scheduled cells, which ensures that the available uplink subframe definitely exist in the retransmission timing when the synchronous HARQ retransmission is processed according to the timing of the uplink HARQ of the configuration 0 or 6.

[0078] In particular, in the LTE release 8, an LTE release 9, and an LTE release 10, for a circumstance that the scheduled cell adopts the uplink and downlink configuration 0, a UL_index field needs to be set in the UL_grant. For a circumstance that the scheduled cell adopts another uplink and downlink configuration, a UL_DAI field is set in the UL_grant. In the LTE release 8, the LTE release 9, and the LTE release 10, two PHICHs (such as, PHICH 0, PHICH 1) respectively exist in a subframe 0 or 5 of the uplink and downlink configuration 0, and are used for different synchronous HARQ procedures. In this case, under a circumstance that different ratios are adopted, when the scheduled cell adopts the uplink and downlink configuration 0, if the PHICH exists in the subframe 0 or 5 of the scheduling cell, the PHICH existing in the subframe 0 or 5 of the scheduling cell may serve as the PHICH 0, that is, the PHICH existing in the subframe 0 or 5 may only be used for the synchronous HARQ procedure using the PHICH 0 according to the LTE release 8; or the PHICH existing in the subframe 0 or 5 may also be used for two synchronous HARQ procedures.

[0079] When the scheduling cell adopts uplink and downlink configuration 0, 1, or 6, the uplink and downlink configuration 1 is always adopted to serve as the reference uplink and downlink configuration, that is, the cross-carrier scheduling is ~~transmitted-performed~~ on the uplink subframe of the scheduled cell according to the timing of the uplink HARQ of the uplink and downlink configuration 1. Specifically, for an uplink subframe of the scheduled cell, the timing of sending the UL_grant and the PHICH information is determined according to the uplink timing relationship of

CLAIMS

1. A data transmission method based on cross-carrier scheduling, comprising:

determining a first downlink subframe according to a timing relationship of an uplink hybrid automatic repeat request HARQ of a reference uplink and downlink configuration, wherein the first
5 downlink subframe is used to indicate timing of sending uplink scheduling grant information of a first uplink subframe of a scheduled cell;

transmitting the uplink scheduling grant information in a subframe of a scheduling cell
corresponding to the first downlink subframe, under a circumstance that the subframe of the
scheduling cell corresponding to the first downlink subframe is a downlink subframe, wherein an
10 uplink and downlink configuration of the scheduling cell and an uplink and downlink configuration
of the scheduled cell are different; and

transmitting uplink data in the first uplink subframe.

2. The method according to claim 1, wherein the reference uplink and downlink configuration
allows performing the cross-carrier scheduling on at least one uplink subframe of the scheduled cell
15 according to the timing relationship of the uplink HARQ of the reference uplink and downlink
configuration.

3. The method according to claim 2, wherein that the reference uplink and downlink
configuration allows performing the cross-carrier scheduling on at least one uplink subframe of the
scheduled cell according to the timing relationship of the uplink HARQ of the reference uplink and
20 downlink configuration comprises that:

the reference uplink and downlink configuration allows performing the cross-carrier
scheduling on the at least one uplink subframe of the scheduled cell, under a circumstance that a
subframe of the scheduling cell corresponding to a downlink subframe that is used to send uplink
scheduling grant information of the at least one uplink subframe and determined according to the
25 timing relationship of the uplink HARQ is a downlink subframe, a subframe of the scheduling cell
corresponding to a downlink subframe that is used to send physical hybrid automatic repeat request
indicator channel PHICH information and determined according to the timing relationship of the
uplink HARQ is a downlink subframe, and a subframe of the scheduled cell corresponding to an
uplink-downlink subframe that is used to retransmit uplink data of the at least one uplink subframe
30 and determined according to the timing relationship of the uplink HARQ is an uplink subframe.

4. The method according to any one of claims 1 to 3, wherein the scheduling cell adopts one of
uplink and downlink configurations 2 to 5 defined in a Long Term Evolution LTE release 8, and the
uplink and downlink configuration of the scheduled cell serves as the reference uplink and

comprises: transmitting the uplink scheduling grant information in the subframe of the scheduling cell corresponding to the first downlink subframe, under a circumstance that the subframe of the scheduling cell corresponding to the second downlink subframe is the downlink subframe and a PHICH is defined.

5 9. The method according to any one of claims 1 to 8, further comprising:

 determining a second uplink subframe according to the timing relationship of the uplink HARQ of the reference uplink and downlink configuration, wherein the second uplink subframe is used to indicate timing of retransmitting the uplink data; and

10 retransmitting the uplink data in a subframe of the scheduled cell corresponding to the second uplink subframe, under a circumstance that the subframe of the scheduled cell corresponding to the second uplink subframe is an uplink subframe,

 wherein the transmitting the uplink scheduling grant information in a subframe of a scheduling cell corresponding to the first downlink subframe comprises:

15 transmitting the uplink scheduling grant information in the subframe of the scheduling cell corresponding to the first downlink subframe, under the circumstance that the subframe of the scheduled cell corresponding to the second uplink subframe is the uplink subframe.

~~10. The method according to any one of claims 1 to 9, wherein the reference uplink and downlink configuration is notified by using high-layer signaling, or the reference uplink and downlink configuration is preconfigured.~~

20 ~~11~~10. A base station, comprising:

 a processor, configured to determine a first downlink subframe according to a timing relationship of an uplink hybrid automatic repeat request HARQ of a reference uplink and downlink configuration, wherein the first downlink subframe is used to indicate timing of sending uplink scheduling grant information of a first uplink subframe of a scheduled cell;

25 a sender, configured to send the uplink scheduling grant information in a subframe of a scheduling cell corresponding to the first downlink subframe, under a circumstance that the subframe of the scheduling cell corresponding to the first downlink subframe is a downlink subframe, wherein an uplink and downlink configuration of the scheduling cell and an uplink and downlink configuration of the scheduled cell are different; and

30 a receiver, configured to receive uplink data sent in the first uplink subframe by a user equipment.

~~12~~11. The base station according to claim ~~11~~10, wherein the reference uplink and downlink configuration allows performing cross-carrier scheduling on at least one uplink subframe of the scheduled cell according to the timing relationship of the uplink HARQ of the reference uplink and

downlink configuration.

1312. The base station according to claim 1211, wherein the reference uplink and downlink configuration allows performing the cross-carrier scheduling on the at least one uplink subframe of the scheduled cell, under a circumstance that a subframe of the scheduling cell corresponding to a downlink subframe that is used to send uplink scheduling grant information of the at least one uplink subframe and determined according to the timing relationship of the uplink HARQ is a downlink subframe, a subframe of the scheduling cell corresponding to a downlink subframe that is used to send physical hybrid automatic repeat request indicator channel PHICH information and determined according to the timing relationship of the uplink HARQ is a downlink subframe, and a subframe of the scheduled cell corresponding to a downlink subframe that is used to retransmit uplink data of the at least one uplink subframe and determined according to the timing relationship of the uplink HARQ is an uplink subframe.

1413. The base station according to claim 110, wherein the processor is further configured to determine a second downlink subframe according to the timing relationship of the uplink HARQ of the reference uplink and downlink configuration, wherein the second downlink subframe is used to indicate timing of sending physical hybrid automatic repeat request indicator channel PHICH information of the uplink data, and the sender is further configured to send the PHICH information in a subframe of the scheduling cell corresponding to the second downlink subframe, under a circumstance that the subframe of the scheduling cell corresponding to the second downlink subframe is a downlink subframe, wherein the sender is further configured to send the uplink scheduling grant information in the subframe of the scheduling cell corresponding to the first downlink subframe, under the circumstance that the subframe of the scheduling cell corresponding to the second downlink subframe is the downlink subframe.

~~15. The base station according to claim 14, wherein the sender is further configured to send the uplink scheduling grant information in the subframe of the scheduling cell corresponding to the first downlink subframe, under a circumstance that the subframe of the scheduling cell corresponding to the second downlink subframe is the downlink subframe and a PHICH is defined.~~

~~16. The base station according to any one of claims 11 to 15, wherein the processor is further configured to determine a second uplink subframe according to the timing relationship of the uplink HARQ of the reference uplink and downlink configuration, wherein the second uplink subframe is used to indicate timing of retransmitting the uplink data, and the receiver is further configured to receive, in a subframe of the scheduled cell corresponding to the second uplink subframe, the uplink data retransmitted by a user equipment, under a circumstance that the subframe of the scheduled cell corresponding to the second uplink subframe is an uplink subframe, wherein the sender is~~

further configured to send the uplink scheduling grant information in the subframe of the scheduling cell corresponding to the first downlink subframe, under the circumstance that the subframe of the scheduled cell corresponding to the second uplink subframe is the uplink subframe.

17. The base station according to any one of claims 11 to 15, wherein the reference uplink and downlink configuration is preconfigured, and the sender is further configured to notify the user equipment of the reference uplink and downlink configuration.

18. The base station according to any one of claims 11 to 13, wherein the scheduling cell adopts one of uplink and downlink configuration 2 to 5 defined in a Long Term Evolution LTE release 8, and the uplink and downlink configuration of the scheduled cell serves as the reference uplink and downlink configuration;

or

the scheduling cell adopts an uplink and downlink configuration 0, an uplink and downlink configuration 1, or an uplink and downlink configuration 6 defined in an LTE release 8, and the uplink and downlink configuration 1 defined in the LTE release 8 serves as the reference uplink and downlink configuration.

19. A user equipment, comprising:

a processor, configured to determine a first downlink subframe according to a timing relationship of an uplink hybrid automatic repeat request HARQ of a reference uplink and downlink configuration, wherein the first downlink subframe is used to indicate timing of sending uplink scheduling grant information of a first uplink subframe of a scheduled cell;

a receiver, configured to receive the uplink scheduling grant information in a subframe of a scheduling cell corresponding to the first downlink subframe, under a circumstance that the subframe of the scheduling cell corresponding to the first downlink subframe is a downlink subframe, wherein an uplink and downlink configuration of the scheduling cell and an uplink and downlink configuration of the scheduled cell are different; and

a sender, configured to send uplink data in the first uplink subframe according to the uplink scheduling grant information.

20. The user equipment according to claim 19, wherein the reference uplink and downlink configuration allows performing cross-carrier scheduling on at least one uplink subframe of the scheduled cell according to the timing relationship of the uplink HARQ of the reference uplink and downlink configuration.

21. The user equipment according to claim 20, wherein the reference uplink and downlink configuration allows performing the cross-carrier scheduling in the at least one uplink subframe of the scheduled cell, under a circumstance that a subframe of the scheduling cell corresponding to a

downlink subframe that is used to send uplink scheduling grant information of the at least one uplink subframe and determined according to the timing relationship of the uplink HARQ is a downlink subframe, a subframe of the scheduling cell corresponding to a downlink subframe that is used to send physical hybrid automatic repeat request indicator channel PHICH information and determined according to the timing relationship of the uplink HARQ is a downlink subframe, and a subframe of the scheduled cell corresponding to a downlink subframe that is used to retransmit uplink data of the at least one uplink subframe and determined according to the timing relationship of the uplink HARQ is an uplink subframe.

2217. The user equipment according to claim 1914, wherein the processor is further configured to determine a second downlink subframe according to the timing relationship of the uplink HARQ of the reference uplink and downlink configuration, wherein the second downlink subframe is used to indicate timing of receiving physical hybrid automatic repeat request indicator channel PHICH information of the uplink data, and the receiver is further configured to receive the PHICH information in a subframe of the scheduling cell corresponding to the second downlink subframe, under a circumstance that the subframe of the scheduling cell corresponding to the second downlink subframe is a downlink subframe, wherein the receiver is further configured to receive the uplink scheduling grant information in the subframe of the scheduling cell corresponding to the first downlink subframe, under the circumstance that the subframe of the scheduling cell corresponding to the second downlink subframe is the downlink subframe.

2318. The user equipment according to claim 2217, wherein the receiver is further configured to receive the uplink scheduling grant information in the subframe of the scheduling cell corresponding to the first downlink subframe, under a circumstance that the subframe of the scheduling cell corresponding to the second downlink subframe is the downlink subframe and a PHICH is defined.

2419. The user equipment according to any one of claims 19-14 to 2318, wherein the processor is further configured to determine a second uplink subframe according to the timing relationship of the uplink HARQ of the reference uplink and downlink configuration, wherein the second uplink subframe is used to indicate timing of retransmitting the uplink data, and the sender is further configured to retransmit the uplink data in a subframe of the scheduled cell corresponding to the second uplink subframe, under a circumstance that the subframe of the scheduled cell corresponding to the second uplink subframe is an uplink subframe, wherein the receiver is further configured to receive the uplink scheduling grant information in the subframe of the scheduling cell corresponding to the first downlink subframe, under the circumstance that the subframe of the scheduled cell corresponding to the second uplink subframe is the uplink subframe.

~~25. The user equipment according to any one of claims 19 to 23, wherein the receiver is further configured to receive the reference uplink and downlink configuration from a base station, or the reference uplink and downlink configuration is preconfigured.~~

~~26~~20. The user equipment according to any one of claims ~~19~~14 to ~~21~~16, wherein

the scheduling cell adopts one of uplink and downlink configuration 2 to 5 defined in a Long Term Evolution LTE release 8, and the uplink and downlink configuration of the scheduled cell serves as the reference uplink and downlink configuration;

or

the scheduling cell adopts an uplink and downlink configuration 0, an uplink and downlink configuration 1, or an uplink and downlink configuration 6 defined in an LTE release 8, and the uplink and downlink configuration 1 defined in the LTE release 8 serves as the reference uplink and downlink configuration.

~~27. A communications system, comprising:~~

~~the base station according to any one of claims 11 to 18; and~~

~~the user equipment according to any one of claims 19 to 26.~~

~~28. A readable medium, comprising: computer readable instructions that are executed to perform the following operations, wherein the operation comprises:~~

~~determining a first downlink subframe according to a timing relationship of an uplink hybrid automatic repeat request HARQ of a reference uplink and downlink configuration, wherein the first downlink subframe is used to indicate timing of sending uplink scheduling grant information of a first uplink subframe of a scheduled cell;~~

~~transmitting the uplink scheduling grant information in a subframe of a scheduling cell corresponding to the first downlink subframe, under a circumstance that the subframe of the scheduling cell corresponding to the first downlink subframe is a downlink subframe, wherein an uplink and downlink configuration of the scheduling cell and an uplink and downlink configuration of the scheduled cell are different; and~~

~~transmitting uplink data in the first uplink subframe.~~

~~29. The readable medium according to claim 28, wherein the reference uplink and downlink configuration allows performing cross-carrier scheduling on at least one uplink subframe of the scheduled cell according to the timing relationship of the uplink HARQ of the reference uplink and downlink configuration.~~

~~30. The readable medium according to claim 29, wherein~~

~~that the reference uplink and downlink configuration allows performing the cross-carrier scheduling on at least one uplink subframe of the scheduled cell according to the timing relationship~~

of the uplink HARQ of the reference uplink and downlink configuration comprises that:

the reference uplink and downlink configuration allows performing the cross-carrier scheduling on the at least one uplink subframe of the scheduled cell, under a circumstance that a subframe of the scheduling cell corresponding to a downlink subframe that is used to send uplink scheduling grant information of the at least one uplink subframe and determined according to the timing relationship of the uplink HARQ is a downlink subframe, a subframe of the scheduling cell corresponding to a downlink subframe that is used to send physical hybrid automatic repeat request indicator channel PHICH information and determined according to the timing relationship of the uplink HARQ is a downlink subframe, and a subframe of the scheduled cell corresponding to an uplink subframe that is used to retransmit uplink data of the at least one uplink subframe and determined according to the timing relationship of the uplink HARQ is an uplink subframe.

31. The readable medium according to any one of claims 28 to 30, wherein the scheduling cell adopts one of uplink and downlink configuration 2 to 5 defined in a Long Term Evolution LTE release 8, and the uplink and downlink configuration of the scheduled cell serves as the reference uplink and downlink configuration;

or

the scheduling cell adopts an uplink and downlink configuration 0, an uplink and downlink configuration 1, or an uplink and downlink configuration 6 defined in an LTE release 8, and the uplink and downlink configuration 1 defined in the LTE release 8 serves as the reference uplink and downlink configuration.

32. The readable medium according to any one of claims 28 to 30, wherein the scheduling cell adopts one of an uplink and downlink configuration 1 to an uplink and downlink configuration 5 defined in an LTE release 8, and the uplink and downlink configuration of the scheduling cell serves as the reference uplink and downlink configuration;

or

the scheduling cell adopts an uplink and downlink configuration 0 or an uplink and downlink configuration 6 defined in an LTE release 8, and the uplink and downlink configuration 1 defined in the LTE release 8 serves as the reference uplink and downlink configuration.

33. The readable medium according to any one of claims 28 to 32, wherein

the operation further comprises:

determining a second downlink subframe according to the timing relationship of the uplink HARQ of the reference uplink and downlink configuration, wherein the second downlink subframe is used to indicate timing of transmitting physical hybrid automatic repeat request indicator channel PHICH information of the uplink data; and

transmitting the PHICH information in a subframe of the scheduling cell corresponding to the second downlink subframe, under a circumstance that the subframe of the scheduling cell corresponding to the second downlink subframe is a downlink subframe,

wherein the transmitting the uplink scheduling grant information in a subframe of a scheduling cell corresponding to the first downlink subframe comprises:

transmitting the uplink scheduling grant information in the subframe of the scheduling cell corresponding to the first downlink subframe, under the circumstance that the subframe of the scheduling cell corresponding to the second downlink subframe is the downlink subframe.

34. The readable medium according to claim 33, wherein

if a PHICH used for multiple uplink subframes is defined in the second downlink subframe of the reference uplink and downlink configuration, and a PHICH is also defined in the subframe of the scheduling cell corresponding to the second downlink subframe, one of the multiple uplink subframes uses the PHICH defined in the subframe of the scheduling cell, or the multiple uplink subframes use the PHICH defined in the subframe of the scheduling cell.

35. The readable medium according to claim 33, wherein the transmitting the uplink scheduling grant information in a subframe of a scheduling cell corresponding to the first downlink subframe comprises: transmitting the uplink scheduling grant information in the subframe of the scheduling cell corresponding to the first downlink subframe, under a circumstance that the subframe of the scheduling cell corresponding to the second downlink subframe is the downlink subframe and a PHICH is defined.

36. The readable medium according to any one of claims 28 to 35, further comprising:

determining a second uplink subframe according to the timing relationship of the uplink HARQ of the reference uplink and downlink configuration, wherein the second uplink subframe is used to indicate timing of retransmitting the uplink data; and

retransmitting the uplink data in a subframe of the scheduled cell corresponding to the second uplink subframe, under a circumstance that the subframe of the scheduled cell corresponding to the second uplink subframe is an uplink subframe,

wherein the transmitting the uplink scheduling grant information in a subframe of a scheduling cell corresponding to the first downlink subframe comprises:

transmitting the uplink scheduling grant information in the subframe of the scheduling cell corresponding to the first downlink subframe, under the circumstance that the subframe of the scheduled cell corresponding to the second uplink subframe is the uplink subframe.

37. The readable medium according to any one of claims 28 to 36, wherein the reference uplink and downlink configuration is notified by using high-layer signaling, or the reference uplink

| and downlink configuration is preconfigured.