

SCell becomes greater than the maximum number of DL HARQ processes defined in the UL-DL configuration set in SCell. Thus, problems similar to those described above exist also when PCell is neither DL heavy nor UL heavy.

[0075] As described above, when SCell references PDSCH-PUCCH timings defined in a UL-DL configuration which is DL heavier than the UL-DL configuration set in SCell, there is a case where the IR buffer is not allocated to some DL HARQ processes and it is not possible to obtain any coding gain through HARQ retransmission.

[0076] Embodiments of the present invention provide a terminal apparatus and a buffer dividing method capable of obtaining a coding gain by HARQ for all DL HARQ processes even when a UL-DL configuration differs among a plurality of component carriers.

Solution to Problem

[0076a] According to a first aspect of the present invention, there is provided a terminal apparatus comprising: a receiver which, in operation, receives first and second downlink data in first and second component carriers, respectively, wherein a first configuration pattern of UL (uplink) and DL (downlink) subframes is set for the first component carrier and a second configuration pattern of UL and DL subframes is set for the second component carrier; and a memory which, in operation, stores retransmission data of the first and second downlink data in a soft buffer, wherein the soft buffer for the second downlink data is sized according to a maximum number of downlink HARQ (hybrid automatic repeat request) retransmission processes executable in a reference configuration pattern of UL and DL subframes, the maximum number of downlink HARQ retransmission processes is determined according to the reference configuration pattern, and the reference configuration pattern is determined according to the first and second configuration patterns.

[0076b] According to a second aspect of the present invention, there is provided a method implemented in a terminal apparatus configured to communicate with a base station apparatus, the method comprising steps of: receiving first and second downlink data in first and second component carriers, respectively, wherein a first configuration pattern of UL (uplink) and DL (downlink) subframes is set for the first component carrier and a second configuration pattern of UL and DL subframes is set for the second component carrier; and storing retransmission data of the first and second downlink data in a soft buffer, wherein the soft buffer for the second downlink data is sized according to a maximum number of downlink HARQ (hybrid automatic repeat request) retransmission processes executable in a reference configuration pattern of UL and DL

subframes, the maximum number of downlink HARQ retransmission processes is determined according to the reference configuration pattern, and the reference configuration pattern is determined according to the first and second configuration patterns.

[0077] Disclosed herein is a terminal apparatus which communicates with a base station

5 apparatus using a plurality of component carriers and for which a configuration pattern of subframes included in one frame is set for each of the plurality of component carriers, the configuration pattern including a downlink communication subframe used for downlink communication and an uplink communication subframe used for uplink communication, the terminal apparatus including: a decoding section that stores, in a retransmission buffer, downlink
10 data transmitted in each of the plurality of component carriers and decodes the downlink data; a generating section that generates a response signal using a result of error detection of the downlink data; and a transmitting section that transmits, using a first component carrier of the plurality of component carriers, a response signal for first downlink data received using the first component carrier and a response signal for second downlink data received using a second component carrier
15 of the plurality of component carriers,

in which: the buffer includes a first buffer that stores the first downlink data and a second buffer that stores the second downlink data; and the second buffer is divided into regions respectively corresponding to retransmission processes based on a specific value determined by a combination of a first configuration pattern that is set in the first component carrier and a second configuration pattern that is set in the second component carrier.

[0078] Disclosed herein is a buffer dividing method for a terminal apparatus which communicates with a base station apparatus, using a plurality of component carriers and in which a configuration pattern of subframes included in one frame is set for each of the plurality of component carriers, the configuration pattern including a downlink communication subframe used for downlink communication and an uplink communication subframe used for uplink communication, the method including: storing, in a retransmission buffer, downlink data transmitted in each of the plurality of component carriers; decoding the downlink data; generating a response signal using a result of error detection of the downlink data; and transmitting, using a first component carrier of the plurality of component carriers, a response signal for first downlink data received in the first component carrier and a response signal for second downlink data received in a second component carrier of the plurality of component carriers, in which: the buffer includes a first buffer that stores the first downlink data and a second buffer that stores the second downlink data; and the second buffer is divided into regions respectively corresponding to retransmission processes based on a specific value determined by a combination of a first configuration pattern that is set in the first component carrier and a second configuration pattern that is set in the second component carrier.

Advantageous Effects of Invention

[0079] According to embodiments of the present invention, it is possible to obtain a coding gain by HARQ for all DL HARQ processes even when a UL-DL configuration differs among a plurality of component carriers.

CLAIMS:

1. A terminal apparatus comprising:
 - a receiver which, in operation, receives first and second downlink data in first and second component carriers, respectively, wherein a first configuration pattern of UL (uplink) and DL (downlink) subframes is set for the first component carrier and a second configuration pattern of UL and DL subframes is set for the second component carrier; and
 - a memory which, in operation, stores retransmission data of the first and second downlink data in a soft buffer, wherein the soft buffer for the second downlink data is sized according to a maximum number of downlink HARQ (hybrid automatic repeat request) retransmission processes executable in a reference configuration pattern of UL and DL subframes, the maximum number of downlink HARQ retransmission processes is determined according to the reference configuration pattern, and the reference configuration pattern is determined according to the first and second configuration patterns.
2. The terminal apparatus according to claim 1, further comprising:
 - a controller which, in operation, performs error detection of the first and second downlink data; and
 - a transmitter which, in operation, transmits in the first component carrier ACK/NACK (acknowledgement/negative acknowledgement) corresponding to a result of the error detection of the first and the second downlink data.
3. The terminal apparatus according to claim 2, wherein the transmitter transmits the ACK/NACK at a timing of an UL subframe of the reference configuration pattern.
4. The terminal apparatus according to claim 2, wherein, when the first configuration pattern and the second configuration pattern are different, the transmitter transmits the ACK/NACK at a timing of an UL subframe of the reference configuration pattern.
5. The terminal apparatus according to claim 1, wherein the first component carrier is a primary cell (PCell) and the second component carrier is a secondary cell (SCell).

6. The terminal apparatus according to claim 5, wherein when a set of DL subframes of PCell included in one frame includes a set of DL subframes of SCell, the reference configuration pattern is the same as the first configuration pattern.
7. The terminal apparatus according to claim 5, wherein when a set of DL subframes of SCell included in one frame includes a set of DL subframes of PCell, the reference configuration pattern is the same as the second configuration pattern.
8. The terminal apparatus according to claim 5, wherein when a set of DL subframes of SCell is not included in a set of DL subframes of PCell included in one frame and the set of DL subframes of PCell is not included in the set of DL subframes of SCell, the reference configuration pattern is a UL-DL configuration pattern which is DL heavy with respect to both PCell and SCell.
9. The terminal apparatus according to claim 1, wherein the memory further stores:
 - a first table which defines multiple reference configuration patterns respectively corresponding to multiple combinations of the first and second configuration patterns, wherein each of the first and second configuration patterns is selected from a set of configuration patterns, and
 - a second table which defines multiple maximum numbers of downlink HARQ retransmission processes respectively corresponding to the multiple reference configuration patterns.
10. The terminal apparatus according to claim 1, wherein the soft buffer stores an LLR (Log Likelihood Ratio) of the second downlink data when error is detected, to be combined with an LLR of the second downlink data that is retransmitted.
11. A method implemented in a terminal apparatus configured to communicate with a base station apparatus, the method comprising steps of:
 - receiving first and second downlink data in first and second component carriers, respectively, wherein a first configuration pattern of UL (uplink) and DL (downlink) subframes is set for the first component carrier and a second configuration pattern of UL and DL subframes is set for the second component carrier; and

storing retransmission data of the first and second downlink data in a soft buffer, wherein the soft buffer for the second downlink data is sized according to a maximum number of downlink HARQ (hybrid automatic repeat request) retransmission processes executable in a reference configuration pattern of UL and DL subframes, the maximum number of downlink HARQ retransmission processes is determined according to the reference configuration pattern, and the reference configuration pattern is determined according to the first and second configuration patterns.

12. The method according to claim 11, further comprising:
performing error detection of the first and second downlink data; and
transmitting in the first component carrier ACK/NACK (acknowledgement/negative acknowledgement) corresponding to a result of the error detection of the first and the second downlink data.
13. The method according to claim 12, wherein the transmitting step includes transmitting the ACK/NACK at a timing of an UL subframe of the reference configuration pattern.
14. The method according to claim 12, wherein, when the first configuration pattern and the second configuration pattern are different, the transmitting step includes transmitting the ACK/NACK at a timing of an UL subframe of the reference configuration pattern.
15. The method according to claim 11, wherein the first component carrier is a primary cell (PCell) and the second component carrier is a secondary cell (SCell).
16. The method according to claim 15, wherein when a set of DL subframes of PCell included in one frame includes a set of DL subframes of SCell, the reference configuration pattern is the same as the first configuration pattern.
17. The method according to claim 15, wherein when a set of DL subframes of SCell included in one frame includes a set of DL subframes of PCell, the reference configuration pattern is the same as the second configuration pattern.
18. The method according to claim 15, wherein when a set of DL subframes of SCell is not included in a set of DL subframes of PCell included in one frame and the set of DL subframes of

Pcell is not included in the set of DL subframes of SCell, the reference configuration pattern is a UL-DL configuration pattern which is DL heavy with respect to both PCell and SCell.

19. The method according to claim 11, further comprising:

storing a first table which defines multiple reference configuration patterns respectively corresponding to multiple combinations of the first and second configuration patterns, wherein each of the first and second configuration patterns is selected from a set of configuration patterns, and

storing a second table which defines multiple maximum numbers of downlink HARQ retransmission processes respectively corresponding to the multiple reference configuration patterns.

20. The method according to claim 11, further comprising:

storing in the soft buffer an LLR (Log Likelihood Ratio) of the second downlink data when error is detected, to be combined with an LLR of the second downlink data that is retransmitted.