SUMMARY OF THE INVENTION

EmbodimentsThe aim of the present invention is to overcome this problem and to provide an efficient retransmission protocol for data transmission between two nodes in a mobile communication system, the retransmission protocol having a possibly low average round trip time and a possibly small amount of required control signalling overhead.

This is achieved by the features of the independent claims.

Advantageous embodiments of the present invention are subject matter of the dependent claims.In one aspect, there is provided a repeat request method comprising: specifying, in a frame for communication, a plurality of subframes available for uplink data transmission from a relay node to an eNodeB; selecting a number of HARQ processes based on the specified plurality of subframes for uplink transmission, the HARQ process being a processing unit of Hybrid Automatic Repeat Request (HARQ); mapping the selected number of HARQ processes sequentially onto the specified plurality of subframes; and transmitting the frame including the plurality of subframes on which the selected number of HARQ processes are mapped, wherein the number of HARQ processes is indicated by an indicator which is transmitted from the eNodeB in a backhaul downlink subframe configuration.

In another aspect, there is provided a repeat request apparatus comprising: a specifying section configured to specify, in a frame for communication, a plurality of subframes available for uplink transmission from a relay node to an eNodeB; a selecting section configured to select a number of HARQ processes based on the specified plurality of subframes for uplink transmission, the HARQ process being a processing unit of Hybrid Automatic Repeat Request (HARQ); a mapping section configured to map the selected number of HARQ processes sequentially onto the specified plurality of subframes; and a transmitting section configured to transmit the frame including the plurality of subframes on which the selected number of HARQ processes are mapped; wherein the number of HARQ processes is indicated by an indicator which is transmitted from the eNodeB in a backhaul downlink subframe configuration.

Embodiments~~It is the particular approach~~ of the present invention ~~to~~ select the number of transmission processes for data transmission between two nodes in a mobile communication system based on the time intervals available for data transmission, and ~~to~~ map the transmission processes onto the available time intervals in a predefined order and periodically repeated fashion.

Such a configuration enables, for instance, an employment of a synchronous retransmission protocol for the uplink transmission in a relay. Due to the synchronous mapping of the transmission processes, the required control signaling overhead is kept low. Moreover, different patterns and timings of the time intervals available for transmission of data between the two nodes may be supported.

Disclosed herein is~~According to a first aspect of the present invention,~~ a method for data transmission from a first node to a second node in a mobile communication system is provided. The method comprises determining positions of time intervals available for data transmission from the first node to the second node, selecting a number of transmission processes for transmitting data from the first node to the second node based on the determined positions of the available time intervals; and deriving the position of time intervals for transmitting the data belonging to the selected number of transmission process from the first node to the second node according to the position of the available time intervals and according to a mapping of the selected number of transmission processes onto the available time intervals in a predefined order in a cyclically repeating fashion, wherein a first transmission and any

required retransmission of a single data portion are mapped to a single transmission process.

In particular, the retransmission protocol may be an uplink retransmission protocol including transmission of an uplink grant from the second node to the first node. The reception of an uplink grant triggers transmission of the uplink data from the first node to the second node. Moreover, the uplink retransmission protocol may include transmitting of feedback information such as a positive or a negative acknowledgement from the second node to the first node. The transmission of the uplink grant may be realized in the same time interval as the transmission of the feedback information. The transmission data may be either a data that is transmitted for the first time, or data that is retransmitted.

Preferably, the time intervals available for transmission of data from the first node to the second node are determined based on knowledge of the positions of the time intervals already reserved for transmission of data from the second node to the first node.

Preferably, the first node is a relay node and the second node is a (base station) network node. However, embodiments of the present invention may be used for communication between any two nodes in a mobile communication system. For instance, the retransmission protocol may be used for communication between a terminal and a network node, or between arbitrary network nodes.

Disclosed herein is ~~According to another aspect of the present invention,~~ a data receiving node communicating with a data transmitting node in a mobile communication system using a retransmission protocol for data transmission from a data transmitting node to the data receiving node is provided. The data receiving node comprises a link control unit for determining position of time intervals available for data transmission from the data transmitting node to the data receiving node; a transmission control unit for choosing a number of transmission processes for transmitting data from the data transmitting node to the data receiving node based on the position of the available time intervals determined by the link control unit. The data receiving node further comprises a receiving unit for deriving the positions of time intervals for receiving the selected number of transmission processes according to the position of the available time intervals determined by the link control unit and according to a mapping of the number of transmission processes configured by the transmission configuration unit onto the

available time intervals in a predefined and cyclically order. A first transmission and any required retransmission of a single data portion are mapped to a single transmission process.

Disclosed herein is~~According to another aspect of the present invention,~~ a data transmitting node ~~is provided~~ for communicating with a data receiving node in a mobile communication system using a transmission protocol for data transmission from the data transmitting node to a data receiving node. The data transmitting node comprises: a link control unit for determining a position of time intervals available for data transmission from the data transmitting node to the data receiving node; a receiving unit for receiving from the data receiving node an indicator indicating a number of transmission processes to be applied for the transmission of data to the receiving node; a transmission configuration unit for configuring the number of transmission processes to the value signalled within the indicator; a transmitting unit for deriving the position of time intervals for transmitting data to the data receiving node according to the position of the available time intervals and by mapping of the received number of transmission processes onto the available time intervals in a predefined order and cyclically, wherein a first transmission and any required retransmission of a single data portion are mapped to a single transmission process; and judging unit for judging whether the number of transmission processes indicated by the indicator leads to a round trip time of data transmission for a transmission process to the receiving node lower than the minimum round trip time supported by the mobile communication system, wherein the data to be transmitted are user data and signalling data and when the judging unit judges positively, no transmission of user data to the receiving node takes place in those time intervals, which cause said round trip time for a transmission process to be lower than said minimum round trip time.

Disclosed herein is~~According to yet another aspect of the present invention,~~ a data transmitting node ~~is provided~~ for communicating with a data transmitting node in a mobile communication system using a retransmission protocol for data transmission from a data transmitting node to the data receiving node. The data transmitting node comprises a link control unit capable of determining a position of time intervals available for data transmission from the data transmitting node to the data receiving node, and a retransmission control unit for

value that is designated as reserved. Such a signalling is advantageous since no separate indicator for implicit determination is required. However, embodiments of the present invention are~~is~~ not limited thereto and, in general, a separate indicator may be signalled as well. Alternatively, the implicit determination may be triggered by a particular setting of other parameters.

The positions of the available time intervals may also be signalled from the second node to the first node. Alternatively, it may be determined from another signal from the second node to the first node. For example, the second node may signal the available time intervals for transmissions from the second node to the first node. From this, the available time intervals for transmission from the first node to the second node can be determined by applying an offset, which is preferably an integer number of time intervals.

Preferably, the number of transmission processes is configured as the smallest number of transmission processes leading to the round trip time of data transmission from between the two nodes (data transmitting and data receiving) not lower than the minimum round trip time supported by the mobile communication system for data transmission between the two nodes.

The round trip time of one transmission process of the retransmission protocol is defined as the time between two consecutive transmission opportunities for the same transmission process. The minimum round trip time is a system parameter derived based on the processing time requirements of the communicating nodes.

According to still another embodiment of the present invention, the data transmitting node is a relay node and the data receiving node is a network node and the position of time intervals available for data transmission from the relay node to the network node is determined based on the timing of uplink transmission processes between communication terminal and the relay node (on relay access uplink). In particular, the relation of the relay access uplink timing to the timing of available time intervals on the relay uplink is taken into account.

Preferably, on the relay access uplink the transmission processes are identified, the receiving time interval of which overlaps with any of time intervals that can be configured as time intervals available for data transmission on the relay uplink backhaul. The process number of these identified processes is determined. As time intervals available for data transmission then the time intervals are selected, which overlap with a limited number of

Moreover, the mapping of transmission processes is performed by cyclically mapping the selected number of processes onto the available time intervals for transmission from the first node to the second node. After this mapping, the time intervals are determined, in which there is no transmission of user and/or signalling data. Thus, the mapping of processes onto available time intervals does not specially handle the time intervals in which no transmission is to take place. After the mapping, the time intervals which, for a particular transmission process, lead to a too small round trip time shall not be used for the transmission of that particular process. Other processes or time intervals for said process that observe the minimum round trip time remain unaffected.

The transmission of data from the first node to the second node may include transmitting acknowledgements for data received from the second node at the first node, transmission of the acknowledgements taking place in time intervals located a fixed number of time intervals after the transmission of said data, and the acknowledgements located in those time intervals in which no transmission takes place may be bundled or multiplexed with another acknowledgement sent in a different time interval. Bundling or multiplexing provides an efficient way to utilize one feedback opportunity to communicate feedback data related to different transmission processes. This is especially advantageous when discontinuous transmission is employed where a transmission opportunity may be lost.

Disclosed herein is~~In accordance with still another aspect of the present invention,~~ a mobile communication system ~~is provided~~, comprising the above~~a~~ network node apparatus ~~according to the present invention~~ and the above~~a~~ relay apparatus ~~according to the present invention~~. The system may further comprise one or more mobile terminals capable of communicating with the relay node apparatus. Such a system is capable of configuring an uplink retransmission protocol according to embodiments of the present invention and of transmitting data accordingly.

Disclosed herein is~~According to still another aspect of the present invention,~~ a method ~~is provided~~ for receiving data at a receiving node using a retransmission protocol for data transmission between two nodes in a communication system. First, positions of time intervals available for data transmission between the two nodes are determined. Based thereon, a number of transmission processes for transmitting data from the data transmitting node to the data

receiving node is selected. The positions of time intervals for receiving the selected number of transmission processes for data transmission from the data transmitting node are derived according to the position of the available time intervals and according to a mapping of the selected number of transmission processes onto the available time intervals in a predefined and cyclically order.

A first transmission and any required retransmission of a single data portion are mapped to a single transmission process.

Disclosed herein isAccording to yet another aspect of the present invention, a method is provided for transmitting data from a data transmitting node using a retransmission protocol for data transmission to a data receiving node in a mobile communication system. Positions of time intervals available for data transmission are determined. Accordingly, a number of transmission processes for transmitting data from the transmitting node to the receiving node is selected. The positions of time intervals for transmitting data to the network node are derived according to the position of the available time intervals and by mapping of the configured number of transmission processes onto the available time intervals in a predefined and cyclical order.

Disclosed herein isIn accordance with yet another aspect of the present invention, a computer program product is provided which comprises a computer readable medium having a computer readable program code embodied thereon, the program code being adapted to carry out any embodiment of the present invention.

The above and other aspectobjects and features of the present invention will become more apparent from the following description and preferred embodiments given in conjunction with the accompanying drawings, in which:

Figure 1 is a schematic drawing illustrating 3GPP LTE architecture;

Figure 2 is a schematic drawing illustrating 3GPP LTE architecture of the radio access network E-UTRAN;

Figure 3 is a block diagram illustrating downlink baseband processing in LTE system;

Figure 4 is an illustration of radio frame structure for LTE FDD system;

Claims

1. A method for data transmission from a first node to a second node in a mobile communication system, the method comprising the steps of:

   determining positions of time intervals available for data transmission from the first node to the second node;

   selecting a number N, wherein N is the number of HARQ processes for transmitting data from the first node to the second node based on the determined positions of the available time intervals, N being selected so as to control the value of the round trip time between the first node and the second node, round trip time being the time between two consecutive transmission opportunities for the same process; and

   deriving for the N HARQ processes the position of time intervals for transmitting the data belonging to the N HARQ process from the first node to the second node according to the position of the available time intervals and according to a mapping of the N HARQ processes onto the available time intervals in a predefined order in a cyclically repeating fashion, wherein a first transmission and any required retransmission of a single data portion are mapped to a single HARQ process.

2. The method according to claim 1, wherein the selection of the number of HARQ processes is performed by the second node, the method further comprising the step of

   transmitting from the second node to the first node an indicator indicating the selected number N of HARQ processes.

3. The method according to claim 2, wherein the indicator can take a value for indicating that the first node shall determine the number of HARQ processes based on a minimum round trip time between the first node and the second node and based on available positions of time intervals available for data transmission from the first node to the second node.

4. The method according to claim 2, wherein the mobile communication system is a 3GPP LTE system or its enhancements, the first node is a relay node, the second node is a nodeB and the indicator is transmitted within the RRC signalling related to backhaul subframe configuration.

5. The method according to claim 2 further comprising the steps of:

configuring at the first node the number of HARQ processes to the value signalled within the indicator; and

judging at the first node whether the number of HARQ processes indicated by the indicator leads to a round trip time of data transmission for a HARQ process from the first node to the second node being lower than the minimum round trip time supported by the mobile communication system for data transmission from the first node to the second node,

wherein the data to be transmitted are user data and signalling data and when the judging step judges positively, no transmission of user data from the first node to the second node takes place in those time intervals, which cause said round trip time for a HARQ process to be lower than said minimum round trip time.

6. The method according to claim 5, wherein when the judging step judges positively, no transmission of signalling data takes place in those time intervals, which cause said round trip time for a HARQ process to be lower than said minimum round trip time.

7. The method according to claim 5, wherein the transmission of data from the first node to the second node includes transmitting acknowledgements for data received from the second node at the first node, transmission of the acknowledgements taking place in time intervals located a fixed number of time intervals after the transmission of said data, and wherein the acknowledgements located in those time intervals in which no transmission takes place are bundled or multiplexed with another acknowledgement sent in a different time interval.

8. The method according to claim 1, wherein the number N of HARQ processes is selected as the smallest number of HARQ processes leading to the round trip time of data transmission from the first node to the second node not lower than the minimum round trip time supported by the mobile communication system for data transmission from the first node to the second node.

9. The method according to claim 1, wherein

the first node is a relay node;

the second node is a network node working ;

the position of time intervals available for data transmission from the relay node to the network node is determined based on timing of uplink HARQ processes between the relay node and a communication terminal.

10. The method according to claim 9, further comprising the steps of:

determining process number of uplink HARQ processes between the relay node and a communication terminal, the receiving time interval of which overlaps with time intervals that can be configured as time intervals available for data transmission from the relay node to the network node; and

selecting as time intervals available for data transmission from the relay node to the network node the time intervals which overlap with a limited number of process numbers of uplink HARQ processes between the relay node and a communication terminal in order to limit the number of the uplink HARQ processes being delayed.

11. The method according to claim 1 further comprising the step of deriving the positions of time intervals for transmitting of grants for transmission of data from the first node to the second node and/or time intervals for transmitting of feedback information based on the position of time intervals for transmitting data from the first node to the second node.

12. A data receiving node for communicating with a data transmitting node in a mobile communication system using a transmission protocol for data transmission from a data transmitting node to the data receiving node, comprising:

a link control unit for determining position of time intervals available for data transmission from the data transmitting node to the data receiving node;

a transmission configuration unit for selecting a number N, wherein N is the number of HARQ processes for transmitting data from the data transmitting node to the data receiving node based on the position of the available time intervals determined by the link control unit, wherein the transmission configuration unit is configured to select N so as to control the value of the round trip time between the data transmitting node and the data receiving node, round trip time being the time between two consecutive transmission opportunities for the same process; and

a receiving unit for deriving for the N HARQ processes the position of time intervals for receiving the N HARQ processes transmitted from the data transmitting node according to the position of the available time intervals determined by the link control unit and according to a mapping of the N HARQ processes selected by the transmission configuration unit onto the available time intervals in a predefined order and cyclically, wherein a first transmission and any required retransmission of a single data portion are mapped to a single HARQ process.

13. The node according to claim 12 further comprising

a transmitting unit for transmitting to the data transmitting node an indicator indicating the number of HARQ processes selected by the transmission configuration unit.

14. A data transmitting node for communicating with a data receiving node node in a mobile communication system using a transmission protocol for data transmission from the data transmitting node to a data receiving node, comprising:

a link control unit for determining a position of time intervals available for data transmission from the data transmitting node to the data receiving node;

a transmission configuration unit for selecting a number N, wherein N is the number of HARQ processes for transmitting data from the data transmitting node to the data receiving node based on the position of the available time intervals determined by the link control unit, wherein the transmission configuration unit is configured to select N so as to control the value of the round trip time between the data transmitting node and the data receiving node, round trip time being the time between two consecutive transmission opportunities for the same process; and

a transmitting unit for deriving for the N HARQ processes the position of time intervals for transmitting data to the data receiving node according to the position of the available time intervals and by mapping of the N HARQ processes onto the available time intervals in a predefined order and cyclically, wherein a first transmission and any required retransmission of a single data portion are mapped to a single HARQ process.

15. The node according to claim 12, wherein

the transmission configuration unit selects N as the smallest number of HARQ processes leading to the round trip time of data transmission from the data transmitting node to the data receiving node not lower than the minimum round trip time supported by the mobile communication system for data transmission from the data transmitting node to the data receiving node.

16. A data transmitting node for communicating with a data receiving node in a mobile communication system using a transmission protocol for data transmission from the data transmitting node to a data receiving node, comprising:

a link control unit for determining a position of time intervals available for data transmission from the data transmitting node to the data receiving node;

a receiving unit for receiving from the data receiving node an indicator indicating a number of HARQ processes to be applied for the transmission of data to the receiving node;

a transmission configuration unit for configuring the number of HARQ processes to the value signalled within the indicator;

a transmitting unit for deriving the position of time intervals for transmitting data to the data receiving node according to the position of the available time intervals and by mapping of the received number of HARQ processes onto the available time intervals in a predefined order and cyclically, wherein a first transmission and any required retransmission of a single data portion are mapped to a single HARQ process; and

judging unit for judging whether the number of HARQ processes indicated by the indicator leads to a round trip time of data transmission for a HARQ process to the receiving node lower than the minimum round trip time supported by the mobile communication system,

wherein the data to be transmitted are user data and signalling data and when the judging unit judges positively, no transmission of user data to the receiving node takes place in those time intervals, which cause said round trip time for a HARQ process to be lower than said minimum round trip time.

17. The node according to claim 16, wherein when the judging unit judges positively, no transmission of signalling data takes place in those time intervals, which cause said round trip time for a HARQ process to be lower than said minimum round trip time.

18. The node according to claim 16, wherein the indicator can take a value for indicating that the transmitting node shall determine the number of HARQ processes based on the desired round trip time between the transmitting node and the receiving node and based on available positions of time intervals available for data transmission from the first node to the second node.

19. The node according to claim 16, wherein the mobile communication system is a 3GPP LTE system or its enhancements, the node is a relay node, the receiving node is a nodeB and the indicator is transmitted within the RRC signalling related to backhaul subframe configuration.

20. The node according to claim 16, wherein the transmission of data to the receiving node includes transmitting acknowledgements for data received from the receiving node, transmission of the acknowledgements taking place in time intervals located a fixed number of time intervals after the transmission of said data, and wherein the acknowledgements located in those time intervals in which no transmission takes place are bundled or multiplexed with another acknowledgement sent in a different time interval.

21. The node according to claim 12, wherein

the data transmitting node is a relay node;

the data receiving node is a network node; and

the link control unit determines the position of time intervals available for data transmission from the relay node to the network node based on timing of uplink HARQ processes between the relay node and a communication terminal.

22. The node according to claim 21, further comprising:

an overlapping detector for determining process number of uplink HARQ processes between the relay node and the communication terminal, the receiving time interval of which overlaps with time intervals that can be configured as time intervals available for data transmission from the relay node to the network node,

wherein the link control unit is configured to determine as time intervals available for data transmission from the relay node to the network node the time intervals which overlap with a limited number of process numbers of uplink HARQ processes

between the relay node and the communication terminal in order to limit the number of the uplink HARQ processes being delayed.

23. The node according to claim 12, wherein the positions of time intervals for transmitting of grants for transmission of data from the data transmitting node to the data receiving node and/or the position of time intervals for transmitting of feedback information is derived based on the position of time intervals for transmitting data from the data transmitting node to the data receiving node determined by the receiving unit or transmitting unit.

CLAIMS

1. A repeat request method comprising:

specifying, in a frame for communication, a plurality of subframes available for uplink data transmission from a relay node to an eNodeB;

selecting a number of HARQ processes based on the specified plurality of subframes for uplink transmission, the HARQ process being a processing unit of Hybrid Automatic Repeat Request (HARQ);

mapping the selected number of HARQ processes sequentially onto the specified plurality of subframes; and

transmitting the frame including the plurality of subframes on which the selected number of HARQ processes are mapped,

wherein the number of HARQ processes is indicated by an indicator which is transmitted from the eNodeB in a backhaul downlink subframe configuration.

2. The repeat request method according to claim 1, wherein the selection of the number of HARQ processes is performed such that a smallest number is selected from among numbers of HARQ processes where a roundtrip time is larger than a minimum system round trip time, the roundtrip time being a transmission time interval of a same HARQ process.

3. The repeat request method according to claim 1, wherein a backhaul uplink subframe corresponding to the backhaul downlink subframe is allocated to a position which is four subframes after the backhaul downlink subframe.

4. The repeat request method according to claims 1, wherein the HARQ is an uplink repeat request from the relay node to the eNodeB.

5. A repeat request apparatus comprising:

a specifying section configured to specify, in a frame for communication, a plurality of subframes available for uplink transmission from a relay node to an eNodeB;

a selecting section configured to select a number of HARQ processes based on the specified plurality of subframes for uplink transmission, the HARQ process being a processing unit of Hybrid Automatic Repeat Request (HARQ);

a mapping section configured to map the selected number of HARQ processes sequentially onto the specified plurality of subframes; and

a transmitting section configured to transmit the frame including the plurality of subframes on which the selected number of HARQ processes are mapped;

wherein the number of HARQ processes is indicated by an indicator which is transmitted from the eNodeB in a backhaul downlink subframe configuration.

6. The repeat request apparatus according to claim 5, wherein the selecting section selects, as the number of HARQ processes, a smallest number from among numbers of HARQ processes where a roundtrip time is larger than a minimum system round trip time, the roundtrip time being a transmission time interval of a same HARQ process.

7. The repeat request apparatus according to claim 5, wherein a backhaul uplink subframe corresponding to the backhaul downlink subframe is allocated to a position which is four subframes after the backhaul downlink subframe.

8. The repeat request apparatus according to claim 5, wherein the HARQ is an uplink repeat request from the relay node to the eNodeB.