

[0001] METHOD AND SYSTEM FOR SUPPORTING
MULTIPLE HYBRID AUTOMATIC REPEAT REQUEST
PROCESSES PER TRANSMISSION TIME INTERVAL

[0002] FIELD OF INVENTION

[0003] The present invention is related to wireless communication systems. More particularly, the present invention is related to a method and system for supporting multiple hybrid automatic repeat request (H-ARQ) processes per transmission time interval (TTI).

[0004] BACKGROUND

[0005] The third generation partnership project (3GPP) is currently considering a long term evolution (LTE) of the 3GPP to provide a new radio access network for a high-data-rate, low-latency, packet-optimized, improved system with high capacity and better coverage. The LTE is an evolution of the radio interface, (i.e., evolved universal terrestrial radio access (UTRA)), and the radio network architecture, (i.e., evolved universal terrestrial radio access network (UTRAN)). Currently, orthogonal frequency division multiple access (OFDMA) and single carrier frequency division multiple access (SC-FDMA) are proposed as air interface technologies to be used in the downlink and uplink transmissions respectively.

[0006] Meanwhile, 3GPP high speed packet access evolution (HSPA+) is also being proposed to improve the 3GPP radio access network capacity and coverage. In HSPA+, an evolution of the radio interface and the radio network architecture is being considered. In HSPA+, the air interface technology will still be based on code division multiple access (CDMA), but with a more efficient physical layer architecture including independent channelization codes, (distinguished with respect to channel quality), and multiple-input multiple-output (MIMO).

[0007] H-ARQ has been adopted by several wireless communication standards including 3GPP and 3GPP2. Besides the radio link control (RLC)

layer's automatic repeat request (ARQ) function, H-ARQ provides improved throughput and performance with respect to link adaptation errors and rate control. Asynchronous H-ARQ is used in high speed downlink packet access (HSDPA) and synchronous H-ARQ is used in high speed uplink packet access (HSUPA).

[0008] The conventional H-ARQ scheme is a single H-ARQ scheme in which a transmitter transmits only one transport block (TB) per TTI via one H-ARQ process. With the introduction of physical resource dependent link adaptation mechanism in LTE or HSPA+, the conventional H-ARQ signaling mechanism, (i.e., signaling mechanism for single H-ARQ), is not sufficient for transmitting multiple TBs per TTI via multiple H-ARQ processes.

[0009] Therefore, it would be desirable to provide a method and system for supporting multiple H-ARQ processes for transmitting multiple TBs simultaneously per TTI.

[0010] SUMMARY

[0011] The present invention is related to a method and system for supporting multiple H-ARQ processes per TTI. A transmitter and a receiver include a plurality of H-ARQ processes. Each H-ARQ process transmits and receives one TB per TTI. The transmitter generates a plurality of TBs and assigns each TB to a particular H-ARQ process. The transmitter sends control information for the assigned H-ARQ processes and associated TBs to the receiver. The transmitter sends the TBs using the assigned H-ARQ processes simultaneously per TTI. After receiving the TBs, the receiver sends feedback for each of the H-ARQ processes and associated TBs indicating successful or unsuccessful receipt of each of the TBs to the transmitter. The feedback for multiple TBs may be combined for the simultaneously transmitted H-ARQ processes, (i.e., TBs). The control information and the feedback may be sent via a layer 1 control part or layer 2 or layer 3 signaling. When MIMO is implemented, one H-ARQ process may be assigned for one MIMO stream, or

codeword. The feedback may include a channel quality indicator (CQI) per MIMO stream or codeword.

[0012] **BRIEF DESCRIPTION OF THE DRAWINGS**

[0013] A more detailed understanding of the invention may be had from the following description, given by way of example and to be understood in conjunction with the accompanying drawings wherein:

[0014] Figure 1 is a block diagram of a system supporting multiple H-ARQ processes per TTI in accordance with the present invention;

[0015] Figure 2 shows transmission of associated control information for supporting simultaneous multiple H-ARQ processes and transmission of multiple TBs per TTI in accordance with the present invention;

[0016] Figure 3 shows an LTE downlink physical layer frame structure of data and associated control information; and

[0017] Figure 4 shows an LTE uplink physical layer frame structure for data and associated control information.

[0018] **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

[0019] The present invention is applicable to any wireless communication system including, but not limited to, LTE and HSPA+ of the 3GPP standard.

[0020] Figure 1 is a block diagram of a system 100 in accordance with the present invention. The system 100 includes a transmitter 110 and a receiver 120. The transmitter 110 and the receiver 120 may be a wireless transmit/receive unit (WTRU) and a Node-B, or vice versa. The terminology "WTRU" includes but is not limited to a user equipment (UE), a mobile station, a fixed or mobile subscriber unit, a pager, a cellular telephone, a personal digital assistant (PDA), a computer, or any other type of user device capable of operating in a wireless environment. The terminology "base station" includes but is not limited to a Node-B, a site controller, an access

point (AP), or any other type of interfacing device capable of operating in a wireless environment.

[0021] The transmitter 110 includes a plurality of TB processors 112, a plurality of H-ARQ processes 114 and a control information processor 116. Each TB processor 112 receives at least one data flow, (for example, at least one flow of medium access control (MAC) or RLC packet data units (PDUs)), and generates at least one TB. Multiple MAC or RLC PDUs may be multiplexed into one TB. In accordance with the present invention, multiple TBs may be transmitted simultaneously per TTI using multiple H-ARQ processes. The TB processor 112 selects a proper transport format combination (TFC), (i.e., TB size, TB set size, TTI, modulation and coding scheme (MCS), subcarriers, antenna beams, precoding matrix indication (PMI), cyclic redundancy check (CRC) size, redundancy version (RV), data block to radio resource mapping, or the like), for each of the TBs based on the link condition between the transmitter 110 and the receiver 120. Preferably, a separate CRC is attached to each TB. Multiple TBs are then transmitted simultaneously via multiple H-ARQ processes 114 per TTI.

[0022] The transmitter 110 assigns each of the TBs to a particular H-ARQ process and transmits multiple TBs via the assigned H-ARQ processes simultaneously per TTI. For example, when several independent spatial data streams, (i.e., several TBs), are transmitted simultaneously using MIMO, one H-ARQ process may be assigned to each spatial data stream, (i.e., one TB), and the multiple spatial data streams may be transmitted simultaneously via multiple H-ARQ processes.

[0023] The control information processor 116 is configured to send control information regarding the TBs and the H-ARQ processes associated with the TBs to the receiver 120 each TTI. The control information includes, but is not limited to, a transport format and resource indicators (TFRIs) and H-ARQ-related information. The TFRIs include, but is not limited to, information about the dynamic part of the TFC, (including TB set size and modulation and coding scheme) and physical channel information, (i.e.,

channelization codes, subcarriers and antenna beams onto which the TBs are mapped in the corresponding TTI). The H-ARQ information includes, but is not limited to, an H-ARQ process ID, an H-ARQ function ID and a redundancy version. The control information may include rate matching parameters for each TB. Rate matching parameters for each TB may be derived from the TFRI.

[0024] The receiver 120 includes a plurality of TB processors 122, a plurality of H-ARQ processes 124 and a control information processor 126. The control information processor 126 processes control information received from the transmitter 110. Each H-ARQ process 124 processes one TB per TTI so that multiple TBs may be processed simultaneously per TTI based on the control information received from the transmitter 110. The H-ARQ process 124, (or the control information processor 126), sends feedback to the transmitter 110 indicating successful or unsuccessful receipt of each of the TBs, so that the transmitter 110 may retransmit failed TBs based on the feedback. The TB processors 122 process successfully received TBs based on the control information.

[0025] The feedback for multiple TBs may be combined for the simultaneous transmission of H-ARQ processes, (i.e., TBs). The control information and the feedback may be sent via a layer 1 control part or layer 2 or layer 3 signaling. When MIMO is implemented, the feedback may include a CQI per MIMO stream, or codeword.

[0026] Figure 2 shows transmission of associated control information for supporting simultaneous multiple H-ARQ processes and transmission of multiple TBs per TTI in accordance with the present invention. The transmitter 110 sends a set of control information 202a-202n for the set of TBs transmitted in a common TTI to the receiver 120. The control information 202a-202n for the simultaneous H-ARQ transmissions may be concatenated into a single packet.

[0027] The control information 202a-202n includes information associating each control information 202a-202n with a corresponding TB. In a

conventional wireless communication system, (i.e., HSDPA and HSUPA), control information for only one TB is transmitted through a separate control channel per TTI, (i.e., a high speed shared control channel (HS-SCCH) in HSDPA and an enhanced dedicated physical control channel (E-DPCCH) in HSUPA), and since only one TB is transmitted per TTI, there is an implicit association between the transmitted TB and the related control information. However, in accordance with the present invention, since multiple TBs are transmitted simultaneously in one TTI through multiple H-ARQ processes, the control information 202a-202n should include association information relating each control information 202a-202n to its associated TB. With the association information, the receiver 220 unambiguously knows which control information 202a-202n is for which TB so that the receiver 220 can use the right control information 202a-202n for processing of each TB.

[0028] The control information may be transmitted via a layer 1 control part of one TTI or layer 2 or layer 3 signaling. Figure 3 shows an LTE downlink physical layer subframe 300 for data and associated control information. The subframe 300 includes a data part, (denoted as "D"), and a control part, (denoted as "C"). The control information may be included in the control part of the subframe 300. The downlink layer 1 frame structure for HSPA+ will be based on CDMA technology which may include independent channelization-codes (distinguished with regard to channel quality) and MIMO. With variable TTI, the control part may contain control information for data block mapped onto several subframes. When MIMO is used, the control information may also contain the allocation of spatial streams or codewords of different data blocks mapped to different H-ARQ functions per TTI.

[0029] Upon reception of the TBs, the receiver 120 sends separate feedback, (i.e., a positive acknowledgement (ACK) or a negative acknowledgement (NACK)), for each of the TBs. Figure 2 also shows transmission of feedback 204a-204n for supporting multiple H-ARQ processes per TTI in accordance with the present invention. Since multiple feedback

transmission 204a-204n is done for different H-ARQ processes from the receiver 120 to the transmitter 110, the transmitter 110 will know which feedback is for which H-ARQ process, (i.e., TB). For this association, an H-ARQ process ID, (or any other association information), may be included in each feedback 204a-204n to indicate the corresponding H-ARQ process.

[0030] Alternatively, if a pre-defined pattern or sequence of TBs associated with H-ARQ processes can be maintained and guaranteed by the transmitter 110 and the receiver 120, the feedback 204a-204n may be sent according to the pre-defined pattern or sequence so that the transmitter 110 knows which feedback corresponds to which H-ARQ process. For example, the feedback may be arranged in either ascending or descending order with respect to H-ARQ IDs associated with the feedback. This may be determined during the call setup. Alternatively, if a TB is successfully received by the receiver 120, the position for that TB's feedback may be filled with a dummy packet with a known pattern so that the transmitter 110 may recognize the successful receipt of the TB when the transmitter 110 decodes the feedback packet.

[0031] The feedback 204a-204n may be concatenated into a single packet for multiple H-ARQ processes, (i.e., multiple TBs). The number of feedback, (i.e., the number of ACKs and NACKs), concatenated into a single feedback packet is dependent on the number of H-ARQ processes used for transmission of the TBs. When the number of feedback increases, a more robust MCS, subcarriers, antenna beams, codewords, or higher transmission power may be used for transmission of the concatenated feedback packet. Due to the importance of this feedback packet, a CRC may be attached to the concatenated feedback packet to improve the error detection at the transmitter 110.

[0032] The feedback may be included in the control part of the physical layer frame. Figure 4 shows an LTE uplink physical layer subframe 400 structure. The subframe 400 includes a pilot part 402 and a control and data

part 404. The feedback may be included in the control and data part 404 of the subframe 400.

[0033] Embodiments.

[0034] 1. A method for sending multiple TBs simultaneously in a TTI using multiple H-ARQ processes in a wireless communication system including a transmitter and a receiver, both the transmitter and the receiver including a plurality of H-ARQ processes for processing multiple TBs per TTI.

[0035] 2. The method of embodiment 1 comprising the step of the transmitter generating a plurality of TBs.

[0036] 3. The method of embodiment 2 comprising the step of the transmitter assigning each TB to a particular H-ARQ process.

[0037] 4. The method as in any of the embodiments 2-3 comprising the step of the transmitter sending control information for the TBs and the H-ARQ processes associated with the TBs to the receiver.

[0038] 5. The method as in any of the embodiments 3-4 comprising the step of the transmitter sending the TBs using the H-ARQ processes assigned for the TBs simultaneously per TTI.

[0039] 6. The method as in any of the embodiments 4-5, wherein the control information includes a TFRI for each TB.

[0040] 7. The method of embodiment 6, wherein rate matching parameters for each TB are derived from the TFRI.

[0041] 8. The method as in any of the embodiments 6-7, wherein the control information further includes rate matching parameters for each TB.

[0042] 9. The method as in any of the embodiments 4-8, wherein the control information includes an H-ARQ process ID assigned to each of the TBs.

[0043] 10. The method as in any of the embodiments 4-9, wherein the transmitter sends the control information via a layer 1 control part.

- [0044] 11. The method as in any of the embodiments 4-9, wherein the transmitter sends the control information via one of a layer 2 signaling and a layer 3 signaling.
- [0045] 12. The method as in any of the embodiments 4-11, wherein the control information for the TBs is concatenated.
- [0046] 13. The method as in any of the embodiments 2-12, further comprising the step of attaching a separate CRC to each of the TBs.
- [0047] 14. The method of embodiment 13, further comprising the step of the receiver sending H-ARQ feedback in response to the TBs indicating successful or unsuccessful receipt of each of the TBs to the transmitter.
- [0048] 15. The method of embodiment 14, wherein the receiver sends a CQI for each MIMO stream or codeword.
- [0049] 16. The method as in any of the embodiments 14-15, wherein the receiver concatenates the feedback for multiple TBs into a single feedback packet.
- [0050] 17. The method as in any of the embodiments 14-16, wherein the receiver attaches a CRC to the feedback packet.
- [0051] 18. The method as in any of the embodiments 16-17, wherein a more robust link adaptation scheme is used for the feedback packet as the number of feedback concatenated in to the feedback packet increases.
- [0052] 19. The method as in any of the embodiments 14-18, wherein the feedback is transmitted via a layer 1 control part.
- [0053] 20. The method as in any of the embodiments 14-18, wherein the feedback is transmitted via one of a layer 2 signaling and a layer 3 signaling.
- [0054] 21. The method as in any of the embodiments 14-20, wherein each feedback includes an H-ARQ process identity via which a corresponding TB is transmitted.
- [0055] 22. The method as in any of the embodiments 14-21, wherein the transmitter and the receiver implements a synchronous H-ARQ scheme,

whereby the transmitter recognizes which feedback is for which H-ARQ process based on a predetermined timing.

[0056] 23. The method as in any of the embodiments 14-22, wherein the transmitter and the receiver maintain a predetermined sequence of TBs and the receiver sends feedback to the TBs according to the predetermined sequence.

[0057] 24. The method of embodiment 23, wherein the receiver inserts a dummy sequence for a successfully received TB into the concatenated feedback packet.

[0058] 25. The method as in any of the embodiments 5-24, wherein the transmitter and the receiver include a plurality of transmit antennas and receiver antennas, respectively, to implement MIMO, whereby the TBs are transmitted via one of multiple antenna beams and multiple codewords.

[0059] 26. The method of embodiment 25, wherein the transmitter assigns one H-ARQ for each one of MIMO stream and codeword.

[0060] 27. The method as in any of the embodiments 1-26, wherein the wireless communication system is a 3G LTE system.

[0061] 28. The method as in any of the embodiments 1-26, wherein the wireless communication system is HSPA+ in a 3GPP.

[0062] 29. A wireless communication system for sending multiple TBs simultaneously per TTI using multiple H-ARQ processes.

[0063] 30. The system of embodiment 29 comprising a transmitter comprising a plurality of H-ARQ processes to transmit multiple TBs simultaneously per TTI.

[0064] 31. The system of embodiment 30 wherein the transmitter comprises a control information processor configured to send control information regarding the TBs and H-ARQ processes associated with the TBs.

[0065] 32. The system of embodiment 31, comprising a receiver comprising a plurality of H-ARQ processes to process multiple TBs simultaneously based on the control information and send feedback in

response to the TBs indicating successful or unsuccessful receipt of each of the TBs to the transmitter.

[0066] 33. The system as in any of the embodiments 31-32, wherein the control information includes a TFRI for each TB.

[0067] 34. The system of embodiment 33, wherein rate matching parameters for each TB are derived from the TFRI.

[0068] 35. The system as in any of the embodiments 31-34, wherein the control information further includes rate matching parameters for each TB.

[0069] 36. The system as in any of the embodiments 31-35, wherein the control information includes an H-ARQ process ID assigned to each of the TBs.

[0070] 37. The system as in any of the embodiments 31-36, wherein the control information is sent via a layer 1 control part.

[0071] 38. The system as in any of the embodiments 31-36, wherein the control information is sent via one of a layer 2 signaling and a layer 3 signaling.

[0072] 39. The system as in any of the embodiments 31-38, wherein the control information for the TBs is concatenated.

[0073] 40. The system as in any of the embodiments 30-39, wherein a separate CRC is attached to each of the TBs.

[0074] 41. The system as in any of the embodiments 32-40 wherein the receiver concatenates the feedback for multiple TBs into a single feedback packet.

[0075] 42. The system of embodiment 41, wherein the receiver attaches a CRC to the feedback packet.

[0076] 43. The system as in any of the embodiments 41-42, wherein the receiver uses a more robust link adaptation scheme for the feedback packet as the number of feedback concatenated into the feedback packet increases.

- [0077] 44. The system as in any of the embodiments 32-43, wherein the feedback is transmitted via a layer 1 control part.
- [0078] 45. The system as in any of the embodiments 32-43, wherein the feedback is transmitted via one of a layer 2 signaling and a layer 3 signaling.
- [0079] 46. The system as in any of the embodiments 32-45, wherein each feedback includes an H-ARQ process identity via which a corresponding TB is transmitted.
- [0080] 47. The system as in any of the embodiments 32-46, wherein the transmitter and the receiver implement a synchronous H-ARQ scheme, whereby the transmitter recognizes which feedback is for which H-ARQ process based on a predetermined timing.
- [0081] 48. The system as in any of the embodiments 32-47, wherein the transmitter transmits the TBs in a predetermined sequence and the receiver sends the feedback to the TBs according to the predetermined sequence.
- [0082] 49. The system of embodiment 48, wherein the receiver inserts a dummy sequence for a successfully received TB into the concatenated feedback packet.
- [0083] 50. The system as in any of the embodiments 32-49, wherein the transmitter and the receiver include a plurality of transmit antennas and receive antennas, respectively, to implement MIMO, whereby the TBs are transmitted via one of multiple antenna beams and codewords.
- [0084] 51. The system of embodiment 50, wherein the transmitter assigns one H-ARQ for each one of MIMO stream and codeword.
- [0085] 52. The system as in any of the embodiments 50-51, wherein the receiver sends a CQI for each one of MIMO stream and codeword.
- [0086] 53. The system as in any of the embodiments 29-52, wherein the wireless communication system is a 3G LTE system.
- [0087] 54. The system as in any of the embodiments 29-52, wherein the wireless communication system is 3GPP HSPA+ system.

- [0088] 55. An apparatus for sending multiple TBs per TTI simultaneously using multiple H-ARQ processes.
- [0089] 56. The apparatus of embodiment 55 comprising a plurality of TB processors, each TB processor being configured to generate at least one TB for transmission and process a received TB.
- [0090] 57. The apparatus of embodiment 56 comprising a plurality of H-ARQ processes to transmit and receive multiple TBs per TTI simultaneously, and send feedback in response to the received TBs indicating successful or unsuccessful receipt of each of the received TBs.
- [0091] 58. The apparatus of embodiment 57 further comprising a control information processor configured to send and receive control information regarding the TBs and H-ARQ processes associated with the TBs.
- [0092] 59. The apparatus of embodiment 58, wherein the control information includes a TFRI for each TB.
- [0093] 60. The apparatus of embodiment 59, wherein rate matching parameters for each TB are derived from the TFRI.
- [0094] 61. The apparatus as in any of the embodiments 58-60, wherein the control information further includes rate matching parameters for each TB.
- [0095] 62. The apparatus as in any of the embodiments 58-61, wherein the control information includes an H-ARQ process ID assigned to each of the TBs.
- [0096] 63. The apparatus as in any of the embodiments 58-62, wherein the control information is sent via a layer 1 control part.
- [0097] 64. The apparatus as in any of the embodiments 58-62, wherein the control information is sent via one of a layer 2 signaling and a layer 3 signaling.
- [0098] 65. The apparatus as in any of the embodiments 58-64, wherein the control information for the TBs is concatenated.
- [0099] 66. The apparatus as in any of the embodiments 56-65, wherein a separate CRC is attached to each of the TBs.

[00100] 67. The apparatus as in any of the embodiments 57-66, wherein the feedback is concatenated into a single feedback packet.

[00101] 68. The apparatus of embodiment 67, wherein a CRC is attached to the feedback packet.

[00102] 69. The apparatus as in any of the embodiments 67-68, wherein a more robust link adaptation scheme is used for the feedback packet as the number of feedback concatenated in to the feedback packet increases.

[00103] 70. The apparatus as in any of the embodiments 57-69, wherein the feedback is transmitted via a layer 1 control part.

[00104] 71. The apparatus as in any of the embodiments 57-69, wherein the feedback is transmitted via one of a layer 2 signaling and a layer 3 signaling.

[00105] 72. The apparatus as in any of the embodiments 57-71, wherein each feedback includes an H-ARQ process identity via which a corresponding TB is transmitted.

[00106] Although the features and elements of the present invention are described in the preferred embodiments in particular combinations, each feature or element can be used alone without the other features and elements of the preferred embodiments or in various combinations with or without other features and elements of the present invention. The methods or flow charts provided in the present invention may be implemented in a computer program, software, or firmware tangibly embodied in a computer-readable storage medium for execution by a general purpose computer or a processor. Examples of computer-readable storage mediums include a read only memory (ROM), a random access memory (RAM), a register, cache memory, semiconductor memory devices, magnetic media such as internal hard disks and removable disks, magneto-optical media, and optical media such as CD-ROM disks, and digital versatile disks (DVDs).

[00107] Suitable processors include, by way of example, a general purpose processor, a special purpose processor, a conventional processor, a digital signal processor (DSP), a plurality of microprocessors, one or more

microprocessors in association with a DSP core, a controller, a microcontroller, Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs) circuits, any other type of integrated circuit (IC), and/or a state machine.

[00108] A processor in association with software may be used to implement a radio frequency transceiver for use in a wireless transmit receive unit (WTRU), user equipment (UE), terminal, base station, radio network controller (RNC), or any host computer. The WTRU may be used in conjunction with modules, implemented in hardware and/or software, such as a camera, a video camera module, a videophone, a speakerphone, a vibration device, a speaker, a microphone, a television transceiver, a hands free headset, a keyboard, a Bluetooth® module, a frequency modulated (FM) radio unit, a liquid crystal display (LCD) display unit, an organic light-emitting diode (OLED) display unit, a digital music player, a media player, a video game player module, an Internet browser, and/or any wireless local area network (WLAN) module.

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CLAIMS

What is claimed is:

1. In a wireless communication system including a transmitter and a receiver, both the transmitter and the receiver including a plurality of hybrid automatic repeat request (H-ARQ) processes for processing multiple transport blocks (TBs) per transmission time interval (TTI), a method for sending multiple TBs simultaneously in a TTI using multiple H-ARQ processes, the method comprising:
 - the transmitter generating a plurality of TBs;
 - the transmitter assigning each TB to a particular H-ARQ process;
 - the transmitter sending control information for the TBs and the H-ARQ processes associated with the TBs to the receiver; and
 - the transmitter sending the TBs using the H-ARQ processes assigned for the TBs simultaneously per TTI.
2. The method of claim 1 wherein the control information includes a transport format and resource indicator (TFRI) for each TB.
3. The method of claim 2 wherein rate matching parameters for each TB are derived from the TFRI.
4. The method of claim 2 wherein the control information further includes rate matching parameters for each TB.
5. The method of claim 1 wherein the control information includes an H-ARQ process identity (ID) assigned to each of the TBs.
6. The method of claim 1 wherein the transmitter sends the control information via a layer 1 control part.

7. The method of claim 1 wherein the transmitter sends the control information via one of a layer 2 signaling and a layer 3 signaling.

8. The method of claim 1 wherein the control information for the TBs is concatenated.

9. The method of claim 1 further comprising:
attaching a separate cyclic redundancy check (CRC) to each of the TBs.

10. The method of claim 1 further comprising:
the receiver sending H-ARQ feedback in response to the TBs indicating successful or unsuccessful receipt of each of the TBs to the transmitter.

11. The method of claim 10 wherein the receiver sends a channel quality indicator (CQI) for each multiple-input multiple-output (MIMO) stream.

12. The method of claim 10 wherein the receiver concatenates the feedback for multiple TBs into a single feedback packet.

13. The method of claim 12 wherein the receiver attaches a cyclic redundancy check (CRC) to the feedback packet.

14. The method of claim 12 wherein a more robust link adaptation scheme is used for the feedback packet as the number of feedback concatenated in to the feedback packet increases.

15. The method of claim 10 wherein the feedback is transmitted via a layer 1 control part.

16. The method of claim 10 wherein the feedback is transmitted via one of a layer 2 signaling and a layer 3 signaling.

17. The method of claim 10 wherein each feedback includes an H-ARQ process identity via which a corresponding TB is transmitted.

18. The method of claim 10 wherein the transmitter and the receiver implement a synchronous H-ARQ scheme, whereby the transmitter recognizes which feedback is for which H-ARQ process based on a predetermined timing.

19. The method of claim 10 wherein the transmitter and the receiver maintain a predetermined sequence of TBs and the receiver sends feedback to the TBs according to the predetermined sequence.

20. The method of claim 19 wherein the receiver inserts a dummy sequence for a successfully received TB into the concatenated feedback packet.

21. The method of claim 1 wherein the transmitter and the receiver include a plurality of transmit antennas and receiver antennas, respectively, to implement multiple-input multiple-output (MIMO), whereby the TBs are transmitted via one of multiple antenna beams and multiple codewords.

22. The method of claim 21 wherein the transmitter assigns one H-ARQ for each one of MIMO stream and codeword.

23. The method of claim 1 wherein the wireless communication system is a long term evolution (LTE) of a third generation (3G) system.

24. The method of claim 1 wherein the wireless communication system is high speed packet access+ (HSPA+) in a third generation partnership project (3GPP).

25. A wireless communication system for sending multiple transport blocks (TBs) simultaneously per transmission time interval (TTI) using multiple hybrid automatic repeat request (H-ARQ) processes, the system comprising:

a transmitter comprising:

a plurality of H-ARQ processes to transmit multiple TBs simultaneously per TTI; and

a control information processor configured to send control information regarding the TBs and H-ARQ processes associated with the TBs; and

a receiver comprising:

a plurality of H-ARQ processes to process multiple TBs simultaneously based on the control information and send feedback in response to the TBs indicating successful or unsuccessful receipt of each of the TBs to the transmitter.

26. The system of claim 25 wherein the control information includes a transport format and resource indicator (TFRI) for each TB.

27. The system of claim 26 wherein rate matching parameters for each TB are derived from the TFRI.

28. The system of claim 26 wherein the control information further includes rate matching parameters for each TB.

29. The system of claim 25 wherein the control information includes an H-ARQ process identity (ID) assigned to each of the TBs.

30. The system of claim 25 wherein the control information is sent via a layer 1 control part.

31. The system of claim 25 wherein the control information is sent via one of a layer 2 signaling and a layer 3 signaling.
32. The system of claim 25 wherein the control information for the TBs is concatenated.
33. The system of claim 25 wherein a separate cyclic redundancy check (CRC) is attached to each of the TBs.
34. The system of claim 25 wherein the receiver concatenates the feedback for multiple TBs into a single feedback packet.
35. The system of claim 34 wherein the receiver attaches a cyclic redundancy check (CRC) to the feedback packet.
36. The system of claim 34 wherein the receiver uses a more robust link adaptation scheme for the feedback packet as the number of feedback concatenated into the feedback packet increases.
37. The system of claim 25 wherein the feedback is transmitted via a layer 1 control part.
38. The system of claim 25 wherein the feedback is transmitted via one of a layer 2 signaling and a layer 3 signaling.
39. The system of claim 25 wherein each feedback includes an H-ARQ process identity via which a corresponding TB is transmitted.
40. The system of claim 25 wherein the transmitter and the receiver implement a synchronous H-ARQ scheme, whereby the transmitter recognizes which feedback is for which H-ARQ process based on a predetermined timing.

41. The system of claim 25 wherein the transmitter transmits the TBs in a predetermined sequence and the receiver sends the feedback to the TBs according to the predetermined sequence.

42. The system of claim 41 wherein the receiver inserts a dummy sequence for a successfully received TB into the concatenated feedback packet.

43. The system of claim 25 wherein the transmitter and the receiver include a plurality of transmit antennas and receive antennas, respectively, to implement multiple-input multiple-output (MIMO), whereby the TBs are transmitted via one of multiple antenna beams and codewords.

44. The system of claim 43 wherein the transmitter assigns one H-ARQ for each one of MIMO stream and codeword.

45. The system of claim 43 wherein the receiver sends a channel quality indicator (CQI) for each one of MIMO stream and codeword.

46. The system of claim 25 wherein the wireless communication system is a long term evolution (LTE) of a third generation (3G) system.

47. The system of claim 25 wherein the wireless communication system is high speed packet access+ (HSPA+) in a third generation partnership project (3GPP).

48. An apparatus for sending multiple transport blocks (TBs) per transmission time interval (TTI) simultaneously using multiple hybrid automatic repeat request (H-ARQ) processes, the apparatus comprising:

a plurality of TB processors, each TB processor being configured to generate at least one TB for transmission and process a received TB; and

a plurality of H-ARQ processes to transmit and receive multiple TBs per TTI simultaneously, and send feedback in response to the received TBs indicating successful or unsuccessful receipt of each of the received TBs.

49. The apparatus of claim 48 further comprising:

a control information processor configured to send and receive control information regarding the TBs and H-ARQ processes associated with the TBs.

50. The apparatus of claim 49 wherein the control information includes a transport format and resource indicator (TFRI) for each TB.

51. The apparatus of claim 50 wherein rate matching parameters for each TB are derived from the TFRI.

52. The apparatus of claim 50 wherein the control information further includes rate matching parameters for each TB.

53. The apparatus of claim 49 wherein the control information includes an H-ARQ process identity (ID) assigned to each of the TBs.

54. The apparatus of claim 49 wherein the control information is sent via a layer 1 control part.

55. The apparatus of claim 49 wherein the control information is sent via one of a layer 2 signaling and a layer 3 signaling.

56. The apparatus of claim 49 wherein the control information for the TBs is concatenated.

57. The apparatus of claim 49 wherein a separate cyclic redundancy check (CRC) is attached to each of the TBs.

58. The apparatus of claim 48 wherein the feedback is concatenated into a single feedback packet.

59. The apparatus of claim 58 wherein a cyclic redundancy check (CRC) is attached to the feedback packet.

60. The apparatus of claim 58 wherein a more robust link adaptation scheme is used for the feedback packet as the number of feedback concatenated in to the feedback packet increases.

61. The apparatus of claim 48 wherein the feedback is transmitted via a layer 1 control part.

62. The apparatus of claim 48 wherein the feedback is transmitted via one of a layer 2 signaling and a layer 3 signaling.

63. The apparatus of claim 48 wherein each feedback includes an H-ARQ process identity via which a corresponding TB is transmitted.