[0001] METHOD AND APPARATUS FOR INDICATING A TEMPORARY BLOCK FLOW TO WHICH A PIGGYBACKED ACKNOWLEDGEMENT/NON-ACKNOWLEDGEMENT FIELD IS ADDRESSED

[0002] FIELD OF INVENTION

[0003] The present invention is related to a wireless communication system.

[0004] BACKGROUND

[0005] Latency reduction is one of the considerations in a GSM/EDGE radio access network (GERAN). Two techniques have been proposed for the latency reduction: reduced transmission time interval (RTTI) and fast acknowledgement/non-acknowledgement (ACK/NACK) reporting (FANR).

[0006] Conventionally, an ACK/NACK report is sent in an explicit message, also referred to as a radio link control/medium access control (RLC/MAC) control block. The ACK/NACK report is addressed to a particular radio resource, called a Temporary Block Flow (TBF).

[0007] A TBF is a temporal connection between a mobile station and a network to support a uni-directional transfer of data. A TBF is temporary and is maintained only for the duration of the data transfer. Each TBF is assigned a temporary flow identity (TFI) by the network. The TFI is unique among concurrent TBFs in each direction and is used instead of mobile station identity in the RLC/MAC layer. The same TFI is included in every RLC header belonging to a particular TBF.

[0008] It has been proposed to send the ACK/NACK report for a certain TBF as a "piggyback" on an RLC/MAC data block that may be addressed to another TBF. The field that carries the ACK/NACK report is referred to as a piggybacked ACK/NACK (PAN) field.

[0009] Since the PAN field is included in a data block that may be addressed to a different TBF, it is necessary to identify to which TBF the PAN

field is addressed. Various proposals have been made to identify the correct TBF in the PAN field, including using a TFI or an uplink (UL) state flag (USF). During establishment of the uplink TBF, a USF is assigned to each mobile station. The USF is used by the network to indicate which mobile terminal is allowed to transmit in the following uplink radio block.

[0010] In either case, some number of bits, (typically ranging from three to five), should be dedicated to the TBF identity in the PAN field. It would be desirable to have an efficient method of sending the TBF identity in the PAN field such that no dedicated bits are needed to identify the TBF.

[0011] SUMMARY

[0012] A method and apparatus are described for indicating a TBF to which a PAN field is addressed. A PAN check sequence (PCS) is created, for example using a cyclic redundancy check (CRC) encoding. The PCS is masked with a TFI assigned to a TBF or a mask generated based on the TFI. A data block including the PAN field and the masked PCS is then processed for transmission. The mask may be generated by converting the TFI using an (M, N) code, M being the number of bits of the PCS and N being the number of bits of the TFI. With this scheme, a TFI may be transmitted in a PAN field without using explicit bits to identify the TBF.

[0013] BRIEF DESCRIPTION OF THE DRAWINGS

[0014] A more detailed understanding may be had from the following description, given by way of example in conjunction with the accompanying drawings wherein:

[0015] Figure 1 shows an example radio block;

[0016] Figure 2 is an example block diagram of a transmitting station; and

[0017] Figure 3 is an example block diagram of a receiving station.

[0018] DETAILED DESCRIPTION

[0019] When referred to hereafter, the terminology "wireless transmit/receive unit (WTRU)" includes but is not limited to a user equipment (UE), a mobile station (MS), 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. When referred to hereafter, 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.

[0020] Figure 1 shows an example radio block 100. The radio block 100 for data transfer includes one RLC/MAC header 102, a header check sequence (HCS) 104, one or more RLC data block(s) 106, a block check sequence (BCS) 108, a PAN field 110, and a PCS 112. The RLC/MAC header 102, the RLC data block(s) 106 and the PAN field 110 are coded separately for error detection and correction, and a separate checksum, (e.g., a cyclic redundancy check (CRC) checksum), is attached to each of them. The RLC/MAC header 102 contains a control field indicating whether a PAN field 110 is included or not in the radio block 100. The HCS 104 is used for error detection of the RLC/MAC header 102. The BCS 108 is used for error detection of the RLC data block 106. A separate BCS may be included for each RLC data block. The PAN field 110 contains piggy-backed ACK/NACK information sent in one direction to provide acknowledgement for a TBF in the other direction. The PCS 112 is used for error detection of the PAN field 110.

[0021] Figure 2 is an example block diagram of a transmitting station 200. The transmitting station 200 may be a WTRU, a Node-B, or any other apparatus or device. The transmitting station 200 includes an encoder 202, a masking unit 204, and a transceiver 206. A PAN field is input into the encoder 202. The encoder 202 generates a PCS based on the PAN field 201. For example, the encoder may be a cyclic redundancy check (CRC) encoder and the PCS may be a CRC checksum generated based on the PAN field 110. The masking unit 204 then masks the PCS with a TFI, (i.e., TFI is used as a mask). The masking of the

PCS bits with the TFI may be performed by modulo-2 addition, (i.e., an exclusive OR (XOR) operation). The transceiver 206 sends a data block 100 including the PAN field 110 and the masked PCS 112. With this scheme, a TFI may be transmitted in a PAN field without using explicit bits to identify the TBF. Before transmission, a channel coding, (such as forward error correction (FEC) coding, rate matching, interleaving, or the like), may be performed.

[0022] At least one bit of the TFI is masked with at least one bit of the PCS. For example, when the number of PCS bits (M) is greater than the number of TFI bits (N), (e.g., N=5 and M=10), the TFI bits may be mapped to a portion or all of the PCS bits, (e.g., first N bits, last N bits, or a subset of the M bits). The opposite case is also possible if N is greater than M.

[0023] Alternatively, the transmitting station 200 may include a mask generator 208. The mask generator 208 generates a mask from the TFI, and the masking unit 204 masks the PCS with the mask generated by the mask generator 208. The N-bit TFI may be converted into an M-bit mask using an (M, N) code, (M is the number of bits of the PCS), and then the mask may be XORed with the PCS.

[0024] Alternatively, the N-bit TFI may be converted into an L-bit mask using an (L, N) code, where L<M, (M is the number of bits of the PCS), and then the mask may be XORed with the PCS. For example, when the number of PCS bits (M) is greater than the number of mask bits (L), (e.g., L=8 and M=10), the mask bits may be mapped to a portion or all of the PCS bits, (e.g., first L bits, last L bits, or a subset of the L bits). The opposite case is also possible.

[0025] The M-bit mask may be selected to provide improved separation, (e.g., Hamming distance), between the M bit sequences. For example, it may be obtained by binary multiplying the N-bit TFI with a generator matrix. A good masking code shall have the largest possible minimum distance and the lowest frequency of occurrence of this minimum value.

[0026] Example generator matrices of the linear binary codes with maximal minimum distances are provided below. In these examples, the TFI is assumed to be 5 bits long.

(1) A (6,5) code with minimum distance 2 (applicable if M=6):

1 0 0 0 0 1
0 1 0 0 0 1
0 0 1 0 0 1.
0 0 0 1 0 1
0 0 0 0 1 1

(2) A (7,5) code with minimum distance 2 (applicable if M=7):

1 0 0 0 0 1 1
0 1 0 0 0 1 1
0 0 1 0 0 1 1.
0 0 0 1 0 1 1
0 0 0 0 1 1 1

(3) An (8, 5) code with minimum distance 2 (applicable if M=8):

1 0 0 0 0 1 1 0
0 1 0 0 0 1 0 1
0 0 1 0 0 0 1 1.
0 0 0 1 0 1 1 1
0 0 0 0 1 1 1 1

(4) A (9, 5) code with minimum distance 3 (applicable if M=9):

1 0 0 0 0 0 1 1 1
0 1 0 0 0 1 0 1 1
0 0 1 0 0 1 1 0 1.
0 0 0 1 0 1 1 1 0
0 0 0 0 1 1 1 1 1

(5) A (10, 5) code with minimum distance 4 (applicable if M=10):

1 0 0 0 0 0 1 1 1 1
0 1 0 0 0 1 0 1 1 1
0 0 1 0 0 1 1 0 1 1.
0 0 0 1 0 1 1 1 0 1
0 0 0 0 1 1 1 1 1 0

(6) An (11, 5) code with minimum distance 4 (applicable if M=11):

$$\begin{matrix} 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 \end{matrix}.$$

[0027] It should be noted that the above generator matrices are provided as an example, not as a limitation, and any other variances are also possible. For example, the matrices set forth above may be pre-multiplied and post-multiplied by binary permutation matrices, resulting in new matrices with the rows and/or the columns permuted. This column and/or row permutation will preserve the distance properties of the code.

[0028] Figure 3 is an example block diagram of a receiving station 300. The receiving station 300 may be a WTRU, a base station, or any other apparatus or device. The receiving station 300 includes a transceiver 302, a de-masking unit 304, and a decoder 306. The receiving station 300 may optionally further include a mask generator 308. The transceiver 302 receives a radio block including a PAN field and a masked PCS, such as the one shown in Figure 1. The transceiver 302 outputs the PAN field and the masked PCS. The de-masking unit 304 de-masks the received masked PCS with its own TFI assigned to a TBF or alternatively with a mask generated by the mask generator 308 using its own TFI. The de-masking unit 304 outputs PAN bits and de-masked PCS bits. The decoder 306 then computes a PCS, (e.g., CRC bits), based on the received PAN field and compares the computed PCS with the de-masked received PCS. If the two PCSs agree, then the received PAN field is declared to be addressed to the receiving station 300. If the two PCSs do not agree, the PAN field is declared to be not addressed to the receiving station 300 and then may be discarded.

[0029] Alternatively, the decoder 306 may compute a PCS, (e.g., using CRC), and then mask the computed PCS with its TFI or a mask generated based on the TFI and then compare the computed masked PCS to the received masked PCS.

[0030] The receiving station 300 may need to decode the received PAN against more than 1 stored TFIs because the receiving station 300 may be

allocated more than one TBF, and each TBF has a TFI of its own. When multiple TBFs are allocated to the receiving station 300, the receiving station 300 determines which TBF the PAN is addressed by de-masking against each possible TFI corresponding to its allocated TBFs.

[0031] Embodiments.

[0032] 1. A method for indicating a TBF to which a PAN field is addressed.

[0033] 2. The method of embodiment 1 comprising generating a PCS based on the PAN field.

[0034] 3. The method of embodiment 2 comprising masking the PCS with a mask, the mask being related to the TBF.

[0035] 4. The method of embodiment 3 comprising sending a data block including the PAN field and the masked PCS.

[0036] 5. The method as in any one of embodiments 3-4, wherein the mask is a TFI assigned to the TBF.

[0037] 6. The method as in any one of embodiments 3-5, wherein the masking of the PCS with the TFI is performed by bit-wise modulo-2 addition of at least one bit of the PCS with at least one bit of the TFI.

[0038] 7. The method as in any one of embodiments 3-6, wherein a length of the PCS and a length of the TFI are different and N bits of the TFI are masked with N bits of the PCS.

[0039] 8. The method of embodiment 7, wherein the N bits of the PCS are one of first N bits of the PCS, last N bits of the PCS, and a subset of the PCS.

[0040] 9. The method as in any one of embodiments 3-8, wherein the PCS is generated by performing CRC encoding with the PAN field.

[0041] 10. The method as in any one of embodiments 2-3, wherein the mask is generated based on a TFI assigned to the TBF.

[0042] 11. The method of embodiment 10 wherein the mask is generated by converting the TFI using an (M, N) code, M being not greater than the number of PCS bits and N being the number of TFI bits.

[0043] 12. The method of embodiment 10 wherein the mask is obtained

by binary multiplying the TFI with a generator matrix.

[0044] 13. The method of embodiment 12 wherein M equals 6 and the generator matrix is as follows:

$$\begin{matrix} 1 & 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 1 \end{matrix}.$$

[0045] 14. The method of embodiment 12 wherein M equals 7 and the generator matrix is as follows:

$$\begin{matrix} 1 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 \end{matrix}.$$

[0046] 15. The method of embodiment 12 wherein M equals 8 and the generator matrix is as follows:

$$\begin{matrix} 1 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \end{matrix}.$$

[0047] 16. The method of embodiment 12 wherein M equals 9 and the generator matrix is as follows:

$$\begin{matrix} 1 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 \end{matrix}.$$

[0048] 17. The method of embodiment 12 wherein M equals 10 and the generator matrix is as follows:

1	0	0	0	0	0	1	1	1	1
0	1	0	0	0	1	0	1	1	1
0	0	1	0	0	1	1	0	1	1
0	0	0	1	0	1	1	1	0	1
0	0	0	0	1	1	1	1	1	0

[0049] 18. The method of embodiment 12 wherein M equals 11 and the generator matrix is as follows:

1	0	0	0	1	1	0	0	0	1	0
0	1	0	0	1	0	1	0	0	1	0
0	0	1	0	1	0	0	1	0	1	0
0	0	0	1	1	0	0	0	1	1	0
0	0	0	0	0	1	1	1	1	1	1

[0050] 19. A method for processing a PAN field addressing a TBF.

[0051] 20. The method of embodiment 19 comprising receiving a data block including a PAN field and a masked PCS.

[0052] 21. The method of embodiment 20 comprising de-masking the masked PCS with a mask, the mask being related to the TBF.

[0053] 22. The method of embodiment 21 comprising performing PCS decoding with the PAN field and the de-masked PCS.

[0054] 23. The method as in any one of embodiments 21-22, wherein the mask is a TFI assigned to the TBF.

[0055] 24. The method as in any one of embodiments 21-22, wherein the mask is generated based on a TFI assigned to the TBF.

[0056] 25. The method as in any one of embodiments 22-24, wherein the PCS decoding is performed by CRC decoding with the received PAN field.

[0057] 26. A method for processing a PAN field addressing a TBF.

[0058] 27. The method of embodiment 26 comprising receiving a data block including a PAN field and a masked PCS.

[0059] 28. The method of embodiment 27 comprising computing a PCS with the received PAN field.

[0060] 29. The method of embodiment 28 comprising masking the computed PCS with a mask, the mask being related to the TBF.

[0061] 30. The method of embodiment 29 comprising comparing the received masked PCS and the computed masked PCS.

[0062] 31. The method as in any one of embodiments 29-30, wherein the mask is a TFI assigned to the TBF.

[0063] 32. The method as in any one of embodiments 29-30, wherein the mask is generated based on a TFI assigned to the TBF.

[0064] 33. The method as in any one of embodiments 28-32, wherein the PCS is computed by performing CRC encoding with the received PAN field.

[0065] 34. The method as in any one of embodiments 29-30, wherein the mask is generated by converting the TFI using an (M, N) code, M being not greater than the number of PCS bits and N being the number of TFI bits.

[0066] 35. An apparatus for indicating a TBF to which a PAN field is addressed.

[0067] 36. The apparatus of embodiment 35 comprising a PCS generator for processing a PAN field to generate a PCS.

[0068] 37. The apparatus of embodiment 36 comprising a masking unit for masking the PCS with a mask, the mask being related to the TBF.

[0069] 38. The apparatus of embodiment 37 comprising a transceiver for sending a data block including the PAN field and the masked PCS.

[0070] 39. The apparatus as in any one of embodiments 37-38, wherein the mask is a TFI assigned to the TBF.

[0071] 40. The apparatus of embodiment 39 wherein the masking unit performs the masking of the PCS and the TFI by bit-wise modulo-2 addition of at least one bit of the PCS with at least one bit of the TFI.

[0072] 41. The apparatus as in any one of embodiments 39-40, wherein a length of the PCS and a length of the TFI are different and N bits of the TFI are masked with N bits of the PCS.

[0073] 42. The apparatus of embodiment 41 wherein the N bits of the PCS are one of first N bits of the PCS, last N bits of the PCS, and a subset of the PCS.

[0074] 43. The apparatus as in any one of embodiments 37-42, wherein

the PCS is generated by performing CRC encoding with the PAN field.

[0075] 44. The apparatus as in any one of embodiments 37-43, further comprising a mask generator for generating the mask based on a TFI assigned to the TBF.

[0076] 45. The apparatus of embodiment 44 wherein the mask generator converts the TFI into the mask using an (M, N) code, M being not greater than the number of PCS bits and N being the number of TFI bits.

[0077] 46. The apparatus of embodiment 44 wherein the mask is generated by binary multiplying the TFI with a generator matrix.

[0078] 47. The apparatus of embodiment 46 wherein M equals 6 and the generator matrix is as follows:

1 0 0 0 0 1
0 1 0 0 0 1
0 0 1 0 0 1
0 0 0 1 0 1
0 0 0 0 1 1.

[0079] 48. The apparatus of embodiment 46 wherein M equals 7 and the generator matrix is as follows:

1 0 0 0 0 1 1
0 1 0 0 0 1 1
0 0 1 0 0 1 1
0 0 0 1 0 1 1
0 0 0 0 1 1 1.

[0080] 49. The apparatus of embodiment 46 wherein M equals 8 and the generator matrix is as follows:

1 0 0 0 0 1 1 0
0 1 0 0 0 1 0 1
0 0 1 0 0 0 1 1
0 0 0 1 0 1 1 1
0 0 0 0 1 1 1 1.

[0081] 50. The apparatus of embodiment 46 wherein M equals 9 and the generator matrix is as follows:

1 0 0 0 0 0 1 1 1
0 1 0 0 0 1 0 1 1
0 0 1 0 0 1 1 0 1
0 0 0 1 0 1 1 1 0
0 0 0 0 1 1 1 1 1.

[0082] 51. The apparatus of embodiment 46 wherein M equals 10 and the generator matrix is as follows:

1 0 0 0 0 0 1 1 1 1
0 1 0 0 0 1 0 1 1 1
0 0 1 0 0 1 1 0 1 1
0 0 0 1 0 1 1 1 0 1
0 0 0 0 1 1 1 1 1 0.

[0083] 52. The apparatus of embodiment 46 wherein M equals 11 and the generator matrix is as follows:

1 0 0 0 1 1 0 0 0 1 0
0 1 0 0 1 0 1 0 0 1 0
0 0 1 0 1 0 0 1 0 1 0
0 0 0 1 1 0 0 0 1 1 0
0 0 0 0 0 1 1 1 1 1 1.

[0084] 53. An apparatus for processing a PAN field addressing a TBF.

[0085] 54. The apparatus of embodiment 53 comprising a transceiver for receiving a data block including a PAN field and a masked PCS.

[0086] 55. The apparatus of embodiment 54 comprising a de-masking unit for de-masking the masked PCS with a mask, the mask being related to the TBF.

[0087] 56. The apparatus of embodiment 55 comprising a PCS decoder for performing PCS decoding with the PAN field and the de-masked PCS.

[0088] 57. The apparatus as in any one of embodiments 55-56, wherein the mask is a TFI assigned to the TBF.

[0089] 58. The apparatus as in any one of embodiments 55-56, wherein the mask is generated based on a TFI assigned to the TBF.

[0090] 59. The apparatus as in any one of embodiments 56-58, wherein the PCS decoder is a CRC decoder.

[0091] 60. An apparatus for processing a PAN field addressing a TBF.

[0092] 61. The apparatus of embodiment 60 comprising a transceiver for receiving a data block including a PAN field and a masked PCS.

[0093] 62. The apparatus of embodiment 61 comprising a PCS encoder for computing a PCS with the received PAN field.

[0094] 63. The apparatus of embodiment 62 comprising a masking unit for masking the computed PCS with a mask, the mask being related to the TBF.

[0095] 64. The apparatus of embodiment 63 comprising a comparator for comparing the received masked PCS and the computed masked PCS.

[0096] 65. The apparatus as in any one of embodiments 63-64, wherein the mask is a TFI assigned to the TBF.

[0097] 66. The apparatus as in any one of embodiments 63-64, wherein the mask is generated based on a TFI assigned to the TBF.

[0098] 67. The apparatus of embodiment 66 wherein the mask generator converts the TFI into the mask using an (M, N) code, M being not greater than the number of PCS bits and N being the number of TFI bits.

[0099] 68. The apparatus as in any one of embodiments 62-67, wherein the PCS encoder is a CRC encoder and the PCS is a CRC checksum.

[00100] Although features and elements are described above in particular combinations, each feature or element can be used alone without the other features and elements or in various combinations with or without other features and elements. The methods or flow charts provided herein may be implemented in a computer program, software, or firmware incorporated 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).

[00101] 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.

[00102] 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) or Ultra Wide Band (UWB) module.

* * *

What is claimed is:

1. A method for indicating a temporary block flow (TBF) to which a piggybacked acknowledgement/non-acknowledgement (PAN) field is addressed, the method comprising:

generating a PAN check sequence (PCS) based on the PAN field;

masking a subset of PCS bits with temporary flow identity (TFI) bits to generate a masked PCS, the TFI bits being shorter than the PCS bits;

generating a data block including a header, a data part, the PAN field and the masked PCS, wherein the data part and the PAN field are addressed to different TBFs; and

sending the data block.

2. The method of claim 1 wherein the TFI bits are masked first N bits of the PCS, or last N bits of the PCS.

3. The method of claim 1 wherein the PCS is generated by performing cyclic redundancy check (CRC) encoding with the PAN field.

4. A method for processing a piggybacked acknowledgement/non-acknowledgement (PAN) field addressing a temporary block flow (TBF), the method comprising:

receiving a data block including a header, a data field, a PAN field and a masked PAN check sequence (PCS), wherein the data part and the PAN field are addressed to different TBFs; and

performing PCS decoding with the PAN field and either the masked PCS or a de-masked PCS to determine a TBF to which the PAN field is addressed, wherein the de-masked PCS is generated by masking the

masked PCS bits with temporary flow identity (TFI) bits, and the TFI bits are shorter than the PCS bits.

5. An apparatus for indicating a temporary block flow (TBF) to which a piggybacked acknowledgement/non-acknowledgement (PAN) field is addressed, the apparatus comprising:

a PAN check sequence (PCS) generator for processing a PAN field to generate a PCS;

a masking unit for masking a subset of PCS bits with temporary flow identity (TFI) bits to generate a masked PCS, the TFI bits being shorter than the PCS bits; and

a transceiver for generating a data block including a header, a data part, the PAN field and the masked PCS and sending the data block, wherein the data part and the PAN field are addressed to different TBFs.

6. The apparatus of claim 5 wherein the TFI bits are masked with first N bits of the PCS, or last N bits of the PCS.

7. The apparatus of claim 5 wherein the PCS is generated by performing cyclic redundancy check (CRC) encoding with the PAN field.

8. An apparatus for processing a piggybacked acknowledgement/non-acknowledgement (PAN) field addressing a temporary block flow (TBF), the apparatus comprising:

a transceiver for receiving a data block including a header, a data part, a PAN field and a masked PAN check sequence (PCS), wherein the data part and the PAN field are addressed to different TBFs; and

a PCS decoder for performing PCS decoding with the PAN field and either the masked PCS or a de-masked PCS to determine a TBF to which the PAN field is addressed, wherein the de-masked PCS is generated by masking the masked PCS bits with temporary flow identity (TFI) bits, and the TFI bits are shorter than the PCS bits.

9. The method of claim 4 wherein the de-masking is performed simultaneously with a plurality of TFIs and the decoding is performed to determine one of the plurality of TBFs to which the PAN field is addressed.

10. The apparatus of claim 8 wherein the de-masking unit is configured to perform the de-masking simultaneously with a plurality of TFIs and the PCS decoder performs decoding to determine one of the plurality of TBFs to which the PAN field is addressed.