METHOD AND APPARATUS FOR INDICATING A TEMPORARY BLOCK FLOW TO WHICH A PIGGYBACKED ACK/NACK FIELD IS ADDRESSED

[0002] FIELD OF INVENTION

[0003] The present invention is related to wireless communications.

[0004] BACKGROUND

[0005] Latency reduction is one of the well recognized work items in GSM/EDGE Release 7 radio access network (GERAN) evolution. There are primarily two techniques being worked on in this area; namely the reduced transmission time interval (RTTI) feature and the fast positive acknowledgement/negative acknowledgement (ACK/NACK) reporting (FANR) feature.

[0006] Both the RTTI feature and the FANR feature can either work separately, or in conjunction with each other. Furthermore, both the RTTI feature and the FANR feature can be used in conjunction with evolved general packet radio services (EGPRS) modulation and coding schemes MCS-1 to MCS-9 (except for MCS-4 and MCS-9 where FANR cannot be implemented) or with the novel Release 7 and beyond EGPRS-2 modulation and coding schemes DAS-5 to DAS-12, DBS-5 to DBS-12, UAS-7 to UAS-11 and UBS-5 to UBS-12. RTTI mode of operation and FANR mode of operation are also possible with other existing Release 7 GERAN evolution features, such as the Downlink Dual-Carrier (DLDC) feature or Downlink Advanced Receiver Performance (DARP) operation.

[0007] In the prior art described by pre-Release 7 global system for mobile communication (GSM), general packet radio services (GPRS) and EGPRS modes of operation, an ACK/NACK report was typically sent in explicit radio link control (RLC)/medium access control (MAC) protocol messages, also referred to as RLC/MAC control blocks. Examples for such explicit RLC/MAC protocol messages include Packet Downlink (DL) ACK/NACK or Packet Uplink (UL) ACK/NACK messages. The RLC/MAC

control block is addressed to a certain radio resource, called a temporary block flow (TBF).

[0008] A TBF is a temporal connection between a mobile station and a network to support a uni-directional transfer of data. If supported by the mobile station and the network, more than one (1) TBF can be allocated to a mobile station. A TBF is temporary and 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. For example, in GPRS and EGPRS modes of operation, the same TFI is included in every RLC/MAC header belonging to a particular TBF in order to allow the intended receiver, (i.e., the wireless transmit/receive unit (WTRU) or network), to determine the addressee of a received radio block.

[0009] In order to reduce transmission latencies associated with the use of an entire RLC/MAC control block, it has been proposed in GSM/(E)GPRS Release 7 to send the ACK/NACK report for a certain TBF "piggybacked" onto an RLC/MAC data block by puncturing a number of bits from the channel-coded data portion of the radio block at no loss of data. This new field is inserted, when needed, into the RLC/MAC data block and carries the ACK/NACK report as part of the radio block referred to as a piggybacked ACK/NACK (PAN) field. The insertion of PAN is possible, and can be configured, both for the DL and UL directions. The PAN field, when sent to a WTRU in the DL, carries ACKs or NACKs for data units or protocol data units (PDUs) previously sent by the WTRU in the UL direction, and vice versa. The presence or absence of the PAN field in a radio block is indicated by the RLC/MAC header, either by a bit or bit field setting, or by setting other code points depending on the RLC/MAC header type accordingly, and therefore depends on the EGPRS/EGPRS-2 modulation and coding scheme chosen for the transmission of the radio block. In the DL direction, the PAN field of an RLC/MAC data block can possibly be addressed to a WTRU that is not the intended receiver of the data units (or PDUs) in the radio block.

Alternatively, the PAN field and the data units (or PDUs) of the radio block can be intended for the same WTRU. Both for DL and UL directions, the TBF to which the PAN field refers can possibly be different from the TBF corresponding to the data units (or PDUs) of the radio block, even if the receiver is the same physical unit (WTRU, or network).

[0010] The actual bit field(s) carrying the ACKs or NACKs in the PAN field can be encoded according to different procedures, for example using a starting sequence number (SSN)-based approach or a time-based approach.

[0011] 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. In addition, a need for additional methods for PAN transmission and reception modes arises from additional operation scenarios in GSM/(E)GPRS networks. For example, identification of the TBF to which the PAN is addressed should also be possible in the case of multiple TBFs assigned to one (1) receiver, such as one WTRU. This mode of operation is needed to facilitate multiple TBFs mode of operation with FANR.

[0012] PAN transmissions may be made for special cases, such as when a PAN field not actually addressed to a TBF is sent. This mode of operation is needed to facilitate transmission and reception of a PAN field not pertaining to data units (or PDUs) and their associated TFI(s). PAN transmissions may also be made where a PAN is to be addressed and to be reliably decoded by more than one receiver. For example, this mode of operation is needed when the PAN is sent to a group of receivers. Therefore, methods are sought after that allow for such modes of operation.

[0013] SUMMARY

[0014] A method and apparatus for indicating a TBF to which a PAN field is addressed are disclosed. A sequence may be generated from a TFI to which the PAN field is addressed and used to mask a PAN check sequence (PCS) derived from the PAN field. The length of the PCS may be larger than the length of the TFI. For example, the PCS may be N3=10 bits while the TFI

may be N2=5 bits. A radio block including the PAN field and the masked PCS is then transmitted. The sequence may be generated by using Reed-Muller coding, cyclic redundancy check (CRC) encoding, convolutional coding, pseudo noise generation, table mapping, or the like. The PCS may be masked with one of a plurality of TFIs which is selected in accordance with a pre-agreed or deterministic rule. An identifier may indicate a TBF to which the PAN field is addressed. In addition, either one or more special value(s) for the identifier may be chosen. A special or selected identifier chosen to generate the PCS in a radio block may represent all TBFs assigned to receiving station(s), or it may represent actions affecting more than one receiving stations decoding a radio block, or it may be used to simplify PAN encoder and decoder operation.

[0015] BRIEF DESCRIPTION OF THE DRAWINGS

[0016] A more detailed understanding may be had from the following description, given by way of example in conjunction with the accompanying drawings wherein:

[0017] Figure 1 shows an example radio block;

[0018] Figure 2 is an example block diagram of a transmitting station;

[0019] Figure 3 is an example block diagram of a receiving station; and

[0020] Figure 4 shows an example block diagram of a receiving station in accordance with another embodiment.

[0021] DETAILED DESCRIPTION

[0022] When referred to hereafter, 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. When referred to hereafter, the terminology "Node-B" includes but is not limited to a base station, a site controller, an access point (AP), or any other type of interfacing device capable of operating in a wireless environment.

[0023] Embodiments disclosed herein are applicable to any wireless communication system including GERAN evolution, etc.

[0024] 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 and for receiver identification of the PAN field 110.

[0025] 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. One of the methods is generating a PCS which is a function of the PAN information bits and masking the PCS with a TFI value using an exclusive OR (XOR) operation. A transmitting station performs XOR operation of the calculated PCS with the TFI. A receiving station first calculates a PCS and performs XOR operation of the calculated PCS with its own TFI in order to make sure that the PAN field is addressed to it. An advantage of this technique is that the transmitter does not need to send TFI bits explicitly in the PAN field. Unlike the TFI of the intended receiving station of the radio block, which is explicitly included in the RLC/MAC header, the PCS is decoded by implicit knowledge of the TFI during the decoding process by the receiving station.

[0026] Without loss of generality, the TFI associated with a particular TBF that is used for addressing the intended receiving station of an RLC/MAC data or control block may be N1=5 bits long. Similarly, the TFI for the PAN field may also be N2=5 bits long. The PCS may be N3=10 bits long. As is obvious to someone skilled in the art, other choices for N1, N2 and N3 are possible, and the embodiments disclosed herein may equally be applied. If the N2 TFI bits are shorter than the PCS length, the TFI may be mixed only with the first or last N2 bits of the PCS. Alternatively, the N2 TFI bits may be mixed with a selected subset of N2 bits chosen amongst the N3 PCS bits, where N2<N3. For example, a subset of five (5) PCS bits b1, b5, b6, b9, b10 may be chosen amongst the available ten (10) PCS bits, b1, b2, ... , b9, b10.

[0027] However, this approach has a disadvantage that, if two TFIs, (one used by the transmitting side and one used by the receiving side), are close to one another, (e.g., differ only in one bit value), there is an increased chance of mistaken acceptance. To overcome this problem, the N2 bits TFI, (e.g., N2=5 TFI), may first be mapped into an N bits sequence, and then masked, (i.e., XOR operation), with the PCS. N may be same as the length of the PCS. Alternatively, N may be chosen to be smaller than the PCS length.

[0028] 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 a PCS generator 202, a sequence generator 204, a masking unit 206, and a transceiver 208. A PAN field is input into the PCS generator 202. The PCS generator 202 generates a PCS based on the PAN field 201. For example, the PCS generator 202 may be a cyclic redundancy check (CRC) encoder and the PCS may be a CRC checksum generated based on the PAN field. The sequence generator 204 generates an N-bit sequence from the N2-bit TFI. The masking unit 206 then masks the PCS with the N-bit sequence. The masking of the PCS bits with the sequence may be performed by modulo-2 addition, (i.e., an XOR operation). The transceiver 208 sends a data block including the PAN field and the masked PCS. 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.

[0029] The sequence used for making the PCS may be as simple as using the sequence itself. For example, if the TFI is N2=5 bits and the PCS is N=11 bits then the prescribed procedure may be simply to modulo 2 add the first N2 bits of the PCS with the TFI, or the last N2 bits, or any predefined set of N2 bits within the N bits. Alternatively, the sequence may be generated in many different ways that maximize the difference, (i.e., Hamming distance), between pairs of resultant patterns. For example, assuming that N2=5 and N=11, the Reed-Muller (16,5) code may be used to generate a 16 bit sequence from the 5-bit TFI, and the 16 bit sequence may be truncated to 11 bits. Alternatively, the 5 bit TFI may be put through a CRC generator to create an 11 bit sequence. The 5 bit TFI may be put through a convolutional encoder to create an 11 bit sequence. The 5 bit TFI may be used as an input or an initial state to a pseudo noise (PN) generator, (such as a linear shift register sequence), to generate an 11 bit sequence. Alternatively, the 5 bit TFI may simply be repeated.

[0030] Alternatively, an 11×5 mapping table may be used to map the 5 bit sequence to an 11 bit sequence. The mapping table may be generated by a computer optimization algorithm. As example mapping 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

[0031] For example, with this mapping matrix, the 5 bit TFI B={00011} maps into an 11 bit sequence R= {00011111001}. This should result in a mini mum Hamming distance of 4 between any pair of 11 bit sequences generated.

[0032] For the case of mapping the 5 bit TFI into 10 bits, the following (10,5) systematic coding produces minimum distance of 4:

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

[0033] The best sequences may be defined as a set of 32 sequences, (in case that N2=5), that yield the largest minimum distance between the worst case pair.

[0034] The above scheme may be applied to any mapping where an N2 bit identifier is used to modify an N3 bit CRC, where N2<N3. If N2 ≥ N3, only N3 bits of the identifier may be used to modify the CRC and the remaining (N3-N2) bits may be sent explicitly.

[0035] 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 sequence generator 304, a de-masking unit 306, and a PCS decoder 308. The transceiver 302 receives a radio block including a PAN field and a masked PCS. The transceiver 302 outputs the PAN field and the masked PCS. The sequence generator 304 generates the sequence from the TFI assigned to the receiving station 300. The de-masking unit 306 de-masks the received masked PCS with the generated sequence. The de-masking unit 306 outputs PAN bits and de-masked PCS bits. The PCS decoder 308 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 may be discarded.

[0036] Alternatively, the receive processing may be performed in a different way that is mathematically identical to the procedure above. Figure 4 shows a receiving station 400 in accordance with this alternative. A transceiver 402 receives a radio block including a PAN field and a masked PCS. The transceiver 402 outputs the PAN field and the masked PCS. A

sequence generator 404 generates the sequence from the TFI assigned to the receiving station 400. A PCS encoder 406 computes a PCS, (e.g., CRC bits), based on the received PAN field. A masking unit 408 masks the computed PCS with the generated sequence. A comparator 410 then compares the received PCS bits with the regenerated and masked PCS bits. If the two PCSs agree, then the received PAN field is declared to be addressed to the receiving station 400. If the two PCSs do not agree, the PAN field is declared to be not addressed to the receiving station 400 and may be discarded.

[0037] As an alternative embodiment, a rule-based scheme may be implemented between a transmitting station and a receiving station that determines which possible candidate TFI(s) can be used to compute the PCS depending on the occurrence of predetermined conditions. The determination which possible candidate TFI(s) can be used on either one or more occurrences of the PAN field may result in a restriction to either one (1) possible candidate TFI value, or to more than one TFI value but still less than a number of overall possible TFI values. Different conditions to limit or determine the possible TFI values are possible. For example, a dependence on frame numbers or timers or equivalent measures of timing in the GSM system, a dependence of previous events such as types of received radio blocks or signals, a dependence on other identifiers to be decoded in conjunction with the first identifier, etc. may be used.

[0038] A transmitting station and a receiving station may make a pre-agreement on which TFI that may be transmitted at any given time instant (i.e., in a particular downlink radio block). When a receiving station needs to test a received PAN field against more than one allocated TFI values, the receiving station determines a particular TFI to be tested at the given time instant based on the pre-agreed rule. For example, assuming that a receiving station has two allocated TBFs that result in two differently masked CRC values, the transmitting station and the receiving station may agree to employ TFI #1 in even-numbered radio frames, and TFI #2 in odd-numbered radio frames. Instead of testing against both TFI-masked CRC hypotheses per

received PAN field, the receiving station may test with only one TFI value. This scheme may be extended for more than one TBF in a straightforward manner.

[0039] In accordance with another embodiment, the TBF number, (i.e., TFI), indicated through the PCS may be made dependent on another secondary identifier in the RLC/MAC data block. A transmitting station sends a radio block including the PAN field, the masked PCS, and a secondary identifier. The secondary identifier indicates a TBF to which the PAN field is addressed so that the receiving station needs to check only one TFI. For example, the secondary identifier may be placed into the RLC/MAC header to indicate that the intended receiver of the PAN is the same as the addressee of the data units (or PDUs) indicated by the TFI of the RLC/MAC header.

[0040] The receiving station first checks the secondary identifier when it is determined that the received radio block includes a PAN field to determine which TFI that the receiving station needs to check based on the secondary identifier. With this scheme, the receiving station needs to perform only one CRC test rather than multiple tests against all TFIs assigned to the receiving station. The secondary identifier may be an identifier used between the transmitting station and other receiving stations. For example, TFI m may only occur if a certain RLC/MAC header field or a PAN field is present in the RLC/MAC data block.

[0041] In accordance with another embodiment, a special or reserved value that represents all admissible TBFs allocated to a particular receiving station may be used to indicate to the receiving station the existence of a PAN field addressed to the receiving station. A transmitting station sends a radio block including a PAN field, a masked PCS derived using a special or reserved value, and a secondary identifier. The special or reserved value represents all TBFs assigned to the receiving station. The secondary identifier indicates a TBF to which the PAN field is addressed. The special value may be masked with the PCS. The secondary bit field may be a part of the header of the data block.

[0042] The receiving station receives a radio block including a PAN field and a masked PCS and detects the special or reserved value. Upon detection of the special value, the receiving station recognizes that the received radio block includes a PAN field addressed to the receiving station since the special value represents all TBFs assigned to the receiving station. The receiving station detects a secondary identifier indicating a TBF to which the PAN field is addressed. The receiving station then performs PCS decoding with the selected TFI based on the secondary identifier.

[0043] In accordance with still another embodiment, a special or reserved identifier value may be used on the PAN field to mask the PCS to indicate an action affecting a receiving station listening to a radio block, or it may be used to simplify PAN encoder and decoder operation. This scheme may be used either alone or in conjunction with any embodiments described above.

[0044] In a first example, a special or reserved identifier value is employed to mask the PCS when the PAN field included in the radio block and the special or reserved identifier value is used for control purposes. For example, this special or reserved value indicated through the PCS may indicate reset of certain positive acknowledgement (ACK) windows, or it may indicate information pertaining to RLC/MAC protocol information, such as transmit and receive state arrays V(A), V(B), or similar.

[0045] In a second example, a special or reserved identifier value is employed to mask the PCS when the received PAN is to be decoded by more than one receiving station, (such as in the case of time-based PAN encoding), and where the payload of the PAN contains information possibly pertaining to more than one (1) receiving station.

[0046] In a third example, a special or reserved identifier value is used to mask the PCS in order to simplify decoding at the receiving station, such as when the occurrence of the PAN and its association with data units (or PDUs) of a TBF is un-ambiguously tied to or determined from context by the intended receiver. For example, the special or reserved value may be used in

the UL when transmitting to the network, because a single WTRU is usually un-ambiguously associated with a transmission opportunity in the UL timeslots through the uplink state flag (USF) assignment procedure under control by the network and when a WTRU is not assigned more than one (1) TBF in the UL.

[0047] More than one special or reserved value may be used in the system. The receiving station (WTRU or network) may implement a procedure where decoding of received PANs is configured in a flexible manner, depending on received system setup or configuration messages. In one case, the receiving station may decode the PAN against either one (1) or more special or reserved identifiers only. In another case, the receiving station may decode the PAN against one (1) or more assigned TFI(s) only. In yet another case, the receiving station may decode the PAN against either one or more special or reserved values while simultaneously attempting to decode against one or more assigned TFIs.

[0048] The special or reserved value may be a reserved TBF code, e.g. TFI value. For example, all bits of the TFI used to mask the PCS generated from the PAN field may be set to '0s' in order to indicate the special or reserved value. As is obvious to one skilled in the art, other possible choices than an all-zero sequence are equally possible and equivalent, as long as there is no other TFI value assigned to a TBF on at least the assigned set of resources (PDCH(s), or timeslot(s), or WTRUs, or receiver(s)). Alternatively, the special or reserved value to mask the PCS on the PAN field may always be the same, either in the GSM/(E)GPRS system, a group of cells, a cell, set of resources (PDCH), or it may be assigned on a semi-static basic, such as signaling or configuration and set-up messages to either one or more receiving stations.

[0049] Alternatively, the special or reserved value may be realized as another separate PAN field entry or as a bit or bit field or as a code point of any entry in an RLC/MAC data or control block. For example, the special or

reserved value may be an entry in the RLC/MAC header, or it may be a bit set in the PAN field.

[0050] Upon detection of the special or reserved value, the receiving station(s) may perform an action indicated by the special value. One example for such action is to decode and process the PAN field according to rules specific to the context of the use of the special or reserved value, like decoding of the PAN field according to the bitmap in interpretation of time-based PAN encoding. Alternatively, the special or reserved value is employed to simplify the PAN encoding and/or decoding procedure for the PCS in the transmitting stations and/or receiving stations in order to avoid implementation of more than one PAN processing units or constituting components thereof. For example, when a first implementation sequence is used to mask the PCS with a regular assigned TFI (corresponding to an assigned TBF), and a second implementation sequence is used to mask the PCS in the case of no TFI associated with the PAN transmission and its contents. Using such a special or reserved value to mask the PCS for the second implementation sequence makes it possible to employ the first implementation sequence even in the case of no TFI associated with the PAN. In the latter case, using the sequence of bits set to '0' for the masking TFI, the computed PCS corresponds to the constituting CRC. Even in the case where the special or reserved identifier is a different sequence, implementation of the second implementation sequence is still not required, because a simple bit reversal procedure can be used to align it with the first implementation sequence.

[0051] Embodiments.

[0052] 1. A method for indicating a TBF to which a PAN field is addressed.

[0053] 2. The method of embodiment 1 comprising generating a PCS based on a PAN field.

[0054] 3. The method of embodiment 2 comprising generating a sequence from a TFI of a TBF to which the PAN field is addressed.

[0055] 4. The method of embodiment 3 comprising masking the PCS with the sequence.

[0056] 5. The method of embodiment 4 comprising sending a radio block including the PAN field and the masked PCS.

[0057] 6. The method as in any one of embodiments 3-5, wherein wherein the sequence is generated by one of Reed-Muller coding, CRC encoding, convolutional encoding, pseudo noise generation, repetition, and table mapping.

[0058] 7. A method for processing a PAN field addressing a TBF.

[0059] 8. The method of embodiment 7 comprising receiving a radio block including a PAN field and a masked PCS.

[0060] 9. The method of embodiment 8 comprising generating a sequence from a TFI of a TBF.

[0061] 10. The method of embodiment 9 comprising de-masking the masked PCS with the sequence.

[0062] 11. The method of embodiment 10 comprising performing PCS decoding with the PAN field and the de-masked PCS.

[0063] 12. The method as in any one of embodiments 9-11, wherein the sequence is generated by one of Reed-Muller coding, CRC encoding, convolutional encoding, pseudo noise generation, repetition, and table mapping.

[0064] 13. The method of embodiment 1 comprising generating a PCS based on the PAN field.

[0065] 14. The method of embodiment 13 comprising masking the PCS with one of a plurality of TFIs assigned to a communication peer, the TFI being selected in accordance with a rule pre-agreed with the communication peer so that only one TFI needs to be checked at the communication peer.

[0066] 15. The method of embodiment 14 comprising sending a radio block including the PAN field and the masked PCS.

[0067] 16. The method as in any one of embodiments 14-15, wherein the rule specifies a particular TFI to be selected in a particular downlink radio block.

[0068] 17. The method of embodiment 7 comprising receiving a data block including a PAN field and a masked PCS.

[0069] 18. The method of embodiment 17 comprising selecting a TFI among a plurality of TFIs based on a rule pre-agreed with a communication peer.

[0070] 19. The method of embodiment 18 comprising de-masking the masked PCS with the selected TFI.

[0071] 20. The method of embodiment 19 comprising performing PCS decoding with the PAN field and the de-masked PCS.

[0072] 21. The method as in any one of embodiments 18-20, wherein the rule specifies a particular TFI to be selected in a particular downlink radio block.

[0073] 22. The method of embodiment 1 comprising generating a PCS based on the PAN field.

[0074] 23. The method of embodiment 22 comprising masking the PCS with one of a plurality of TFIs assigned to a communication peer.

[0075] 24. The method of embodiment 23 comprising sending a data block including the PAN field, the masked PCS, and a secondary identifier, the secondary identifier indicating a TBF to which the PAN field is addressed so that the communication peer needs to check only one TFI.

[0076] 25. A method for detecting a TBF to which a PAN field is addressed.

[0077] 26. The method of embodiment 25 comprising receiving a data block including a PAN field and a masked PCS, the masked PCS being masked with a TFI.

[0078] 27. The method of embodiment 26 comprising detecting a secondary identifier indicating a TBF to which the PAN field is addressed.

[0079] 28. The method of embodiment 27 comprising de-masking the masked PCS with a TFI selected based on the secondary identifier.

[0080] 29. The method of embodiment 28 comprising performing PCS decoding with the PAN field and the de-masked PCS.

[0081] 30. A method for indicating a TBF to which a PAN field is addressed.

[0082] 31. The method of embodiment 30 comprising generating a PCS based on the PAN field.

[0083] 32. The method of embodiment 31 comprising masking the PCS with one of a plurality of TFIs.

[0084] 33. The method of embodiment 32 comprising sending a radio block including the PAN field, the masked PCS, a special value, and a secondary identifier, the special value representing all TBFs assigned to a particular communication peer and the secondary identifier indicating a TBF to which the PAN field is addressed.

[0085] 34. A method for detecting a TBF to which a PAN field is addressed.

[0086] 35. The method of embodiment 34 comprising receiving a radio block including a PAN field and a masked PCS, the masked PCS being masked with one of a plurality of TFIs assigned to a receiving station.

[0087] 36. The method of embodiment 35 comprising detecting a special value, the special value representing all TBFs assigned to the receiving station.

[0088] 37. The method as in any one of embodiments 35-36, comprising detecting a secondary identifier indicating a TBF to which the PAN field is addressed.

[0089] 38. The method of embodiment 37 comprising de-masking the masked PCS with a TFI selected based on the secondary identifier.

[0090] 39. The method of embodiment 38 comprising performing PCS decoding with the PAN field and the de-masked PCS.

[0091] 40. A method of controlling on a TBF.

[0092] 41. The method of embodiment 40 comprising generating a PAN field.

[0093] 42. The method of embodiment 41 comprising setting a special value on the PAN field, the special value indicating an action affecting a receiving station listening to a radio block.

[0094] 43. The method of embodiment 42 comprising sending the radio block including the PAN field.

[0095] 44. The method as in any one of embodiments 42-43, wherein the special value indicates at least one of reset of a ACK window and information pertaining to RLC/MAC protocol information.

[0096] 45. The method as in any one of embodiments 42-44, wherein the special value is a reserved TBF code.

[0097] 46. The method as in any one of embodiments 42-45, wherein the special value is a TFI set to all '0s'.

[0098] 47. A method of controlling on a TBF.

[0099] 48. The method of embodiment 47 comprising receiving a radio block including a PAN field.

[00100] 49. The method of embodiment 48 comprising detecting a special value on the PAN field, the special value indicating an action affecting a receiving station listening to the radio block.

[00101] 50. The method of embodiment 49 comprising performing an action indicated by the special value.

[00102] 51. The method as in any one of embodiments 49-50, wherein the special value indicates at least one of reset of a ACK window and information pertaining to RLC/MAC protocol information.

[00103] 52. The method as in any one of embodiment 49-51, wherein the special value is a reserved TBF code.

[00104] 53. The method as in any one of embodiments 49-52, wherein the special value is a TFI set to all '0s'.

[00105] 54. A method of controlling on a TBF.

[00106] 55. The method of embodiment 54 comprising generating a PAN field.

[00107] 56. The method of embodiment 55 comprising generating a PCS from the PAN field.

[00108] 57. The method of embodiment 56 comprising masking the PCS with a special value reserved for indicating an action affecting a receiving station listening to a radio block.

[00109] 58. The method of embodiment 57 comprising sending the radio block including the PAN field and the masked PCS.

[00110] 59. The method as in any one of embodiments 57-58, wherein the special value indicated through the PCS indicates at least one of reset of a ACK window and information pertaining to RLC/MAC protocol information.

[00111] 60. The method as in any one of embodiments 57-59, wherein the special value is a TFI set to all '0s'.

[00112] 61. The method as in any one of embodiments 57-60, wherein the special value is used when the PAN needs to be decoded by more than one receiving station.

[00113] 62. A method of controlling on a TBF.

[00114] 63. The method of embodiment 62 comprising receiving a radio block including a PAN field and a masked PCS masked with a special value.

[00115] 64. The method of embodiment 63 comprising detecting the special value through a PCS decoding, the special value indicating an action affecting a receiving station listening to the radio block.

[00116] 65. The method of embodiment 64 comprising performing the action indicated by the special value.

[00117] 66. The method as in any one of embodiments 63-65, wherein the special value indicated through the PCS indicates at least one of reset of a ACK window and information pertaining to RLC/MAC protocol information.

[00118] 67. The method as in any one of embodiments 63-66, wherein the special value is a TFI set to all '0s'.

[00119] 68. An apparatus for indicating a TBF to which a PAN field is addressed.

[00120] 69. The apparatus of embodiment 68 comprising a PCS generator for generating a PCS based on the PAN field.

[00121] 70. The apparatus as in any one of embodiments 68-69, comprising a sequence generator for generating a sequence from a TFI of a TBF to which the PAN field is addressed.

[00122] 71. The apparatus of embodiment 70 comprising a masking unit for masking the PCS with the sequence.

[00123] 72. The apparatus of embodiment 71 comprising a transceiver for sending a radio block including the PAN field and the masked PCS.

[00124] 73. The apparatus as in any one of embodiments 70-72, wherein the sequence generator is one of a Reed-Muller coder, a CRC generator, a convolutional encoder, a pseudo noise generator, a repeater, and a mapping table.

[00125] 74. An apparatus for processing a PAN field addressing a TBF.

[00126] 75. The apparatus of embodiment 74 comprising a transceiver for receiving a radio block including a PAN field and a masked PCS.

[00127] 76. The apparatus as in any one of embodiments 74-75, comprising a sequence generator for generating a sequence from a TFI of a TBF.

[00128] 77. The apparatus of embodiment 76 comprising a de-masking unit for de-masking the masked PCS with the sequence.

[00129] 78. The apparatus of embodiment 77 comprising a PCS decoder for performing PCS decoding with the PAN field and the de-masked PCS.

[00130] 79. The apparatus as in any one of embodiments 76-78, wherein the sequence generator is one of a Reed-Muller coder, a CRC generator, a convolutional encoder, a pseudo noise generator, a repeater, and a mapping table.

[00131] 80. The apparatus of embodiment 68 comprising a PCS generator for generating a PCS based on the PAN field.

[00132] 81. The apparatus of embodiment 80 comprising a masking unit for masking the PCS with one of a plurality of TFIs assigned to a communication peer, the TFI being selected in accordance with a rule pre-agreed with the communication peer.

[00133] 82. The apparatus of embodiment 81 comprising a transceiver for sending a radio block including the PAN field and the masked PCS.

[00134] 83. The apparatus as in any one of embodiments 81-82, wherein the rule specifies a particular TFI to be selected in a particular downlink radio block.

[00135] 84. The apparatus of embodiment 74 comprising a transceiver for receiving a radio block including a PAN field and a masked PCS.

[00136] 85. The apparatus of embodiment 84 comprising a de-masking unit for de-masking the masked PCS with one of a plurality of assigned TFIs, the TFI being selected in accordance with a rule pre-agreed with a communication peer.

[00137] 86. The apparatus of embodiment 85 comprising a PCS decoder for performing PCS decoding with the PAN field and the de-masked PCS.

[00138] 87. The apparatus as in any one of embodiments 85-86, wherein the rule specifies a particular TFI to be selected in a particular downlink radio block.

[00139] 88. The apparatus of embodiment 68, comprising a PCS generator for generating a PCS based on a PAN field.

[00140] 89. The apparatus of embodiment 88 comprising a masking unit for masking the PCS with one of a plurality of TFIs assigned to a communication peer.

[00141] 90. The apparatus of embodiment 89 comprising a transceiver for sending a radio block including the PAN field, the masked PCS, and a secondary identifier, the secondary identifier indicating a TBF to which the

PAN field is addressed so that the communication peer needs to check only one TFI.

[00142] 91. The apparatus of embodiment 74 comprising a transceiver for receiving a radio block including a PAN field and a masked PCS, the masked PCS being masked with a TFI.

[00143] 92. The apparatus of embodiment 91 comprising a controller for detecting a secondary identifier indicating a TBF to which the PAN field is addressed.

[00144] 93. The apparatus of embodiment 92 comprising a de-masking unit for de-masking the masked PCS with a TFI selected based on the secondary identifier.

[00145] 94. The apparatus of embodiment 93 comprising a PCS decoder for performing PCS decoding with the PAN field and the de-masked PCS.

[00146] 95. The apparatus of embodiment 68, comprising a PCS generator for generating a PCS based on the PAN field.

[00147] 96. The apparatus of embodiment 95 comprising a masking unit for masking the PCS with one of a plurality of TFIs.

[00148] 97. The apparatus of embodiment 96 comprising a transceiver for sending a radio block including the PAN field, the masked PCS, a special value, and a secondary identifier, the special value representing all TBFs assigned to a particular communication peer and the secondary identifier indicating a TBF to which the PAN field is addressed.

[00149] 98. The apparatus of embodiment 74 comprising a transceiver for receiving a radio block including a PAN field and a masked PCS, the masked PCS being masked with one of a plurality of TFIs assigned to a receiving station.

[00150] 99. The apparatus of embodiment 98 comprising a controller for detecting a special value, the special value representing all TBFs assigned to the receiving station and detecting a secondary identifier indicating a TBF to which the PAN field is addressed.

[00151] 100. The apparatus of embodiment 99 comprising a de-masking unit for de-masking the masked PCS with a TFI selected based on the secondary identifier.

[00152] 101. The apparatus of embodiment 100 comprising a PCS decoder for performing PCS decoding with the PAN field and the de-masked PCS.

[00153] 102. An apparatus for controlling on a TBF.

[00154] 103. The apparatus of embodiment 102, comprising a processing unit for generating a data block including a PAN field.

[00155] 104. The apparatus of embodiment 103 comprising a controller for setting a special value on the PAN field, the special value indicating an action affecting a receiving station listening to the radio block.

[00156] 105. The apparatus of embodiment 104 comprising a transceiver for sending the radio block including the PAN field.

[00157] 106. The apparatus as in any one of embodiments 104-105, wherein the special value indicates at least one of reset of a ACK window and information pertaining to RLC/MAC protocol information.

[00158] 107. The apparatus as in any one of embodiments 104-106, wherein the special value is a reserved TBF code.

[00159] 108. The apparatus as in any one of embodiments 104-107, wherein the special value is a TFI set to all '0s'.

[00160] 109. An apparatus for controlling on a TBF.

[00161] 110. The apparatus of embodiment 109 comprising a transceiver for receiving a radio block including a PAN field.

[00162] 111. The apparatus of embodiment 110 comprising a controller for detecting a special value on the PAN field, the special value indicating an action affecting a receiving station listening to the radio block; and performing an action indicated by the special value.

[00163] 112. The apparatus of embodiment 111 wherein the special value indicates at least one of reset of a ACK window and information pertaining to RLC/MAC protocol information.

[00164] 113. The apparatus as in any one of embodiments 111-112, wherein the special value is a reserved TBF code.

[00165] 114. The apparatus as in any one of embodiments 111-113, wherein the special value is a TFI set to all '0s'.

[00166] 115. An apparatus for controlling on a TBF.

[00167] 116. The apparatus of embodiment 115 comprising a processor for generating a PAN field and generating a PCS from the PAN field.

[00168] 117. The apparatus of embodiment 116 comprising a controller for masking the PCS with a special value reserved for indicating an action affecting a receiving station listening to a radio block.

[00169] 118. The apparatus of embodiment 117 comprising a transceiver for sending the radio block including the PAN field and the masked PCS.

[00170] 119. The apparatus as in any one of embodiments 117-118, wherein the special value indicated through the PCS indicates one of reset of a ACK window and information pertaining to RLC/MAC protocol information.

[00171] 120. The apparatus as in any one of embodiments 117-119, wherein the special value is a TFI set to all '0s'.

[00172] 121. The apparatus as in any one of embodiments 117-120, wherein the special value is used when the PAN needs to be decoded by more than one receiving station.

[00173] 122. An apparatus of controlling on a TBF.

[00174] 123. The apparatus of embodiment 122 comprising a transceiver for receiving a radio block including a PAN field and a masked PCS masked with a special value.

[00175] 124. The apparatus of embodiment 123 comprising a processor for detecting the special value through a PCS decoding, the special value indicating an action affecting a receiving station listening to the radio block.

[00176] 125. The apparatus of embodiment 124 comprising a controller for performing the action indicated by the special value.

[00177] 126. The apparatus as in any one of embodiments 123-125, wherein the special value indicated through the PCS indicates one of reset of a ACK window and information pertaining to RLC/MAC protocol information.

[00178] 127. The apparatus as in any one of embodiments 123-126, wherein the special value is a TFI set to all '0s'.

[00179] 128. An apparatus for processing a PAN field addressing a TBF.

[00180] 129. The apparatus of embodiment 128 comprising a transceiver for receiving a radio block including a PAN field and a masked PCS.

[00181] 130. The apparatus of embodiment 129 comprising a sequence generator for generating a sequence from a TFI of a TBF.

[00182] 131. The apparatus of embodiment 130 comprising a PCS encoder for performing PCS encoding with the received PAN field to generate a PCS.

[00183] 132. The apparatus of embodiment 131 comprising a masking unit for masking the generated PCS with the sequence.

[00184] 133. The apparatus of embodiment 132 comprising a comparator for comparing the received masked PCS and the generated masked PCS.

[00185] 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).

[00186] 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.

[00187] 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.

CLAIMS

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;

selecting a temporary flow identity (TFI) among a plurality of TFIs assigned to a communication peer based on a rule pre-agreed with the communication peer;

masking the PCS with the selected TFI; and

sending a radio block including the PAN field and the masked PCS.

2. 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 PAN field and a masked PAN check sequence (PCS);

selecting a temporary flow identity (TFI) among a plurality of TFIs assigned to a communication peer based on a rule pre-agreed with the communication peer;

de-masking the masked PCS with the selected TFI; and

performing PCS decoding with the PAN field and the de-masked PCS.

3. 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 the PCS with one of a plurality of temporary flow identities (TFIs) assigned to a communication peer; and

sending a data block including the PAN field, the masked PCS, and a secondary identifier, the secondary identifier indicating a TBF to which the PAN field is addressed so that the communication peer needs to check only one TFI.

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

receiving a data block including a PAN field and a masked PAN check sequence (PCS), the masked PCS being masked with a temporary flow identity (TFI);

detecting a secondary identifier indicating a TBF to which the PAN field is addressed;

de-masking the masked PCS with a TFI selected based on the secondary identifier; and

performing PCS decoding with the PAN field and the de-masked PCS.

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 generating a PCS based on the PAN field;

a masking unit for masking the PCS with one of a plurality of temporary flow identities (TFIs) assigned to a communication peer, the TFI being selected in accordance with a rule pre-agreed with the communication peer; and

a transceiver for sending a radio block including the PAN field and the masked PCS.

6. 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 radio block including a PAN field and a masked PAN check sequence (PCS);

a de-masking unit for de-masking the masked PCS with one of a plurality of assigned temporary flow identities (TFIs), the TFI being selected in accordance with a rule pre-agreed with a communication peer; and

a PCS decoder for performing PCS decoding with the PAN field and the de-masked PCS.

7. 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 generating a PCS based on a PAN field;

a masking unit for masking the PCS with one of a plurality of temporary flow identities (TFIs) assigned to a communication peer; and

a transceiver for sending a radio block including the PAN field, the masked PCS, and a secondary identifier, the secondary identifier indicating a TBF to which the PAN field is addressed so that the communication peer needs to check only one TFI.

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

a transceiver for receiving a radio block including a PAN field and a masked PAN check sequence (PCS), the masked PCS being masked with a temporary flow identity (TFI);

a controller for detecting a secondary identifier indicating a TBF to which the PAN field is addressed;

a de-masking unit for de-masking the masked PCS with a TFI selected based on the secondary identifier; and

a PCS decoder for performing PCS decoding with the PAN field and the de-masked PCS.