

[0001] METHOD AND SYSTEM FOR
IMPLICIT USER EQUIPMENT IDENTIFICATION

[0002] BACKGROUND

[0003] The present invention relates to the field of wireless communications. One of the applications of the present invention is directed to a downlink signaling approach employing a modified cyclic redundancy check for both data protection and unique/group UE identification.

[0004] Wireless communication systems have become an integral link in today's modern telecommunications infrastructure. As such, they have become increasingly relied upon not only to support voice communications, but also data communications. Voice communications are relatively low-rate, symmetrical in the upstream and downstream bandwidths and are predictable in the amount of bandwidth required.

[0005] However, data communications can place severe burdens upon a telecommunication system, particularly a wireless telecommunication system. First, data communications can often require extremely high data rates. Second, the amount of bandwidth for a data related application can vary greatly from several kilohertz of bandwidth to several megahertz. Third, the amount of bandwidth in the upstream and downstream directions can be drastically different. For example, with a typical Internet browsing application, very little data is sent in the upstream direction while vast amounts of data are downloaded in the downstream direction. These factors can place severe constraints upon a wireless telecommunication system.

[0006] The Wideband CDMA (WCDMA) standard, as the leading global third generation (3G) (IMT-2000) standard, supports data rates up to 2 Mb/s in indoor/small-cell-outdoor environments and up to 384 kb/switch wide-area coverage, as well as support for both high-rate packet data and high-rate circuit-switched data. However to satisfy the future demands for packet-data services, there is a need for a substantial increase in this data rate, especially in the downlink. High speed downlink packet access (HSDPA) would allow WCDMA to support downlink peak data rates in the range of approximately 8-10 Mb/s for best-effort packet-data services. This

rate is far beyond the IMT-2000 requirement of 2 Mb/s. It also enhances the packet-data capability in terms of lower delay and improved capacity.

[0007] One solution for supporting data communications is the allocation of dedicated channels to each user equipment (UE). However, this results in an extremely inefficient use of the bandwidth since such channels often remain idle for long durations.

[0008] An alternative to dedicated channels for each UE is the use of the high speed shared data channels and the packeting of data. In this method, a plurality of high speed data channels are shared between a plurality of UEs. Those UEs having data for transmission or reception are dynamically assigned one of the shared data channels. This results in a much more efficient use of the spectrum.

[0009] One such process for assigning a high speed shared data channel when a base station has data waiting for transmission to a particular UE is shown in Figs. 1A-1C. Referring to Fig. 1A, an associated downlink dedicated physical channel (DPCH) is transmitted to each UE. The UE monitors associated downlink DPCH as well as the shared control channels (SCCH-HS). When there is no data being transmitted to the UE from the base station, the UE enters a standby mode whereby it periodically "wakes up" to attempt to monitor its associated downlink DPCH as well as SCCH-HSs. This permits the UE to save processing and battery resources.

[00010] If data at the base station is ready for transmission to the UE, a High Speed Downlink Shared Channel (HS-DSCH) indicator (HI) is transmitted in the associated DPCH. The HI has n-bit length, which points to one of 2^n SCCH-HSs shown in Fig. 1B. For example, a 2 bit HI can point to 4 SCCH-HSs, i.e., 00, 01, 10 or 11.

[00011] For the example shown in Fig. 1A, the HI is (1, 0) which points to the third channel shown in Fig. 1B. When the UE accesses the control channel identified by the HI, that particular SCCH-HS will direct the UE to the proper HS-DSCH, which has been allocated to the UE for reception of the data. As shown in Fig. 1C, for example, the UE tunes to HS-DSCH (001) that was identified by SCCH-HS (1, 0).

The UE then receives the data intended for it over the HS-DSCH (001). It should be noted that the graphical representation of Fig. 1A-1C has been presented to illustrate the process of assigning HS-DSCHs, and the configuration and use of channels may differ slightly from actual implementation in HSDPA standards.

[00012] The process as described with reference to Figs. 1A-1C provides an efficient method for assigning common data channels for transmission of data. Since packet data is intended for one or more, specific UEs, the UE identity (ID) is a critical parameter for signaling from the base station to the UE.

[00013] There are several prior art methods for signaling the UE ID between the base station and the UE. Referring to Fig. 2A, the first method appends the UE ID onto the data for transmission. The combination is fed to a cyclic redundancy check (CRC) generator, which outputs a CRC. The resulting data packet, which is ultimately transmitted, includes an X-bit data field, an M-bit UE ID and an N-bit CRC as shown in Fig. 2B. Although this provides adequate signaling of both the CRC and the UE ID, it is wasteful of signaling bandwidth.

[00014] Another prior art technique shown in Fig. 3A appends the UE ID onto the data field for input into the CRC generator. The CRC generator outputs a CRC. As shown in Fig. 3B, the data burst for transmission includes an X-bit data field and an N-bit CRC field. Although this also adequately signals the UE ID and the CRC between the base station and the UE, it is undesirable since it can only be used for unique UE identification. This method also causes increase complexity of UE when a group UEs need to be identified.

[00015] SUMMARY

[00016] The present invention discloses several implementations for data related downlink signaling. The embodiments disclose selectively tailoring the UE ID to create a UE ID value, which is then modulo 2 added to a data field to create a data mask. This data mask may be further processed as the CRC field. The CRC field is then transmitted with the data burst to provide CRC-related functions. An alternative

embodiment discloses initializing a CRC generator with UE identification prior to CRC generation. This implicitly includes the UE ID within the CRC without requiring additional overhead signaling.

In accordance with a first aspect of the present invention, there is provided a system for transmitting a communication burst from a first communicating unit to a second communicating unit; the system comprising: at said first communicating unit: a cyclic redundancy check (CRC) generator for receiving data and generating a CRC; a first combiner for combining said CRC with an identification of the second communicating unit to generate a mask; and a transmitter for transmitting the burst comprising said mask and said data; and at said second communicating unit: a memory for storing the identification of the second communicating unit; a receiver for receiving said communication burst including said mask and said data; a second combiner for combining said mask with said stored identification to recover the CRC; and means for determining whether said recovered CRC is valid.

In accordance with a second aspect of the present invention, there is provided a system for transmitting a communication burst from a first communicating unit to at least a second communicating unit; the second communicating unit being associated with an identification number; the system comprising: at said first communicating unit: a cyclic redundancy check (CRC) generator for receiving data and generating a CRC; a combiner for combining said CRC with the identification number to generate a mask; and a transmitter for transmitting a communication burst comprising said mask and said data; and at said second communicating unit: a memory for storing said identification number; a receiver for receiving said communication burst including said mask and said data; a combiner for combining said mask with said stored identification number to recover the CRC; means for determining whether said recovered CRC is valid.

In accordance with a third aspect of the present invention, there is provided a system for transmitting a communication burst from a first communicating unit to a second communicating unit; said second communicating unit being associated with an identified number; the system comprising: at said first communicating unit: a cyclic redundancy check (CRC) generator for receiving data and generating a CRC, the CRC generator being initialized with said identification number; and a transmitter for

transmitting a communication burst comprising said CRC and said data; and at said second communicating unit: a receiver for receiving said communication burst including said CRC and said data; and means for determining whether said recovered CRC is valid.

In accordance with a fourth aspect of the present invention, there is provided a system for transmitting a communication burst from a first communicating unit to a second communicating unit; the second unit being associated with an identification; the system comprising: at said first communicating unit: a combiner for receiving data and combining the data with an identification field including said identification to generate a mask; a cyclic redundancy check (CRC) generator for receiving the mask and generating a CRC; and a transmitter for transmitting a communication burst comprising said CRC and said data; and at said second communicating unit: a receiver for receiving said communication burst including said CRC and said data; and means for determining whether said recovered CRC is valid.

In accordance with a fifth aspect of the present invention, there is provided a method for transmitting a data burst from a first unit to a second unit comprising: at said first unit: receiving data for transmission; generating a cyclic redundancy check (CRC) based upon said data; combining the CRC with an identification of the second unit to generate a mask; appending the mask onto the data to form a data burst; and transmitting the data burst; and at said second unit: receiving said data burst; retrieving the identification of the second unit from memory; and combining the retrieved identification with said mask to generate said CRC; and determining whether said CRC is valid.

In accordance with a sixth aspect of the present invention, there is provided in a wireless digital communications system in which messages are transmitted from a node B to a user equipment (UE) wherein the system utilizes code-division multiple access (CDMA) technology for transmission and reception of the messages, the method comprising the steps of: (a) at said node B, performing a cyclic redundancy check on a message; (b) overlaying the cyclic redundancy check with a UE identity and transmitting the message and the overlaid UE identity and cyclic redundancy check to the UE ; (c) said UE, receiving the message with the overlaid UE identity and cyclic redundancy check; (d) extracting the UE identity from the message received at step (c);

and (e) comparing the extracted identity with the identity of the UE receiving the message at step (c).

In accordance with a seventh aspect of the present invention, there is provided in a wireless digital communications system in which messages are transmitted from a network to a user equipment (UE) wherein the system utilizes code-division multiple access (CDMA) technology for transmission and reception of the messages, the method comprising the steps of: (a) at said network, performing a cyclic redundancy check on a message; (b) overlaying the cyclic redundancy check with a UE identity and transmitting the message and the overlaid UE identity and cyclic redundancy check to the UE; (c) said UE, receiving the message with the overlaid UE identity and cyclic redundancy check; and (d) comparing the cyclic redundancy check at the UE combined with the identification code of the UE with the CRC and overlaid UE ID received from said network.

In accordance with an eighth aspect of the present invention, there is provided a wireless digital communications system employing code-division multiple access technology comprising a network and at least one user equipment (UE); (a) said network including a cyclic redundancy check (CRC) generator performing a CRC on a message to be transmitted to a given UE; (b) means for overlaying the CRC with an identity code of the UE intended to receive the message; (c) means for transmitting the message and overlaid UE identity and CRC to the intended UE; (d) said intended UE including a receiver for receiving the transmission and coupling the received transmission to a CRC extractor; and (e) said CRC extractor for extracting said higher layer message when the received UE identity extracted from the received message compares with a locally provided UE identity of said intended UE.

In accordance with a ninth aspect of the present invention, there is provided a wireless digital communications system employing code-division multiple access technology including a network and at least one user equipment (UE); the system comprising: (a) said network performing a cyclic redundancy check on a message to be transmitted to a given UE; (b) said network including means for overlaying the CRC with an identity code of the UE intended to receive the message; (c) said network including means for transmitting the message and overlaid UE identity and CRC to the intended UE; (d) said intended UE including means for receiving the transmission; and

(e) a data extractor for extracting said message when the received UE identity extracted from the received message compares with a locally provided UE identity of said intended UE.

In accordance with a tenth aspect of the present invention, there is provided a wireless digital communications system employing code-division multiple access technology comprising a station and at least one user equipment (UE); said station including: a cyclic redundancy check generator for performing a cyclic redundancy check on at least a portion of a message to be transmitted to a given UE; means for overlaying the CRC with an identity code of the UE intended to receive the message; and a transmitter for transmitting the message and overlaid UE identity and CRC to the intended UE; and said intended UE including: a receiver for receiving the transmission from the station; means for extracting the UE identity from the received messages and comparing it with a locally stored UE identity; and means for extracting said message only when there is a match between the extracted UE identity and the stored UE identity.

In accordance with an eleventh aspect of the present invention, there is provided a method for identifying one or more user equipments (UES) each having a unique identification UID among a plurality of UEs comprising: receiving a data packet; generating a cyclic redundancy check (CRC) based upon said data packet; module 2 adding said CRC to the UID to create a mask; and appending said mask onto said data packet for transmission.

[00017] BRIEF DESCRIPTION OF THE DRAWING(S)

[00018] Figs. 1A-1C represent a prior art method for assigning shared data channels, where Fig. 1A illustrates the associated downlink channel, Fig. 1B illustrates a plurality of control channels and Fig. 1C illustrates a plurality of data channels.

[00019] Fig. 1D is a block diagram of the universal mobile telecommunication system network architecture.

[00020] Fig. 2A is a prior art user equipment identification (UE ID) specific cyclic redundancy check (CRC) method:

[00021] Fig. 2B illustrates the transmitted data burst including a data field, a UE ID field and a CRC field.

[00022] Fig. 3A is a second prior art user equipment identification (UE ID) specific cyclic redundancy check (CRC) method.

[00023] Fig. 3B illustrates the transmitted data burst including a data field and a CRC field.

[00024] Fig. 4A is a first embodiment of the present invention utilizing modulo 2 addition of the UE ID with the CRC to create a mask.

[00025] Fig. 4B is a data burst transmitted by the system of Fig. 4A including a data field and a mask field.

[00026] Fig. 5A is a second embodiment of the present invention including a CRC generator which is initialized using the UE ID.

[00027] Fig. 5B is a data burst transmitted by the embodiment of Fig. 5A including a data field and a CRC field.

[00028] Fig. 6A is a third embodiment of the present invention which modulo 2 adds the data field to a UE ID field padded with trailing zeros to create a mask.

[00029] Fig. 6B is a fourth embodiment of the present invention which modulo 2 adds the data field to a UE ID field padded with leading zeros to create a mask.

[00030] Fig. 6C is the data burst transmitted by the embodiments of Fig. 6A and 6B including a data field and a CRC field.

[00031] Fig. 7A is a fifth embodiment of the present invention which modulo 2 adds the data field to a UE ID field repeated and padded a truncated UE ID in the trailing bits.

[00032] Fig. 7B is a sixth embodiment of the present invention which modulo 2 adds the data field to a UE ID field repeated and padded a truncated UE ID in the leading bits.

[00033] Fig. 7C is the data burst transmitted by the embodiments of Fig. 7A and 7B including a data field and a CRC field.

[00034] Fig. 8 is a tabulation of global, subset, subsubset and unique IDs.

[00035] Fig. 9 is a flow diagram of the processing of a message in accordance with the present invention.

[00036] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[00037] The presently preferred embodiments are described below with reference to the drawing figures wherein like numerals represent like elements throughout.

[00038] Referring to Fig. 1D, a Universal Mobile Telecommunications System (UMTS) network architecture used by the present invention includes a core network (CN), a UMTS Terrestrial Radio Access Network (UTRAN), and a User Equipment (UE). The two general interfaces are the Iu interface, between the UTRAN and the core network, as well as the radio interface Uu, between the UTRAN and the UE. The UTRAN consists of several Radio Network Subsystems (RNS). They can be interconnected by the Iur interface. This interconnection allows core network independent procedures between different RNSs. The RNS is further divided into the Radio Network Controller (RNC) and several base stations (Node-B). The Node-Bs are connected to the RNC by the Iub interface. One Node-B can serve one or multiple

cells, and typically serves a plurality of UEs. The UTRAN supports both FDD mode and TDD mode on the radio interface. For both modes, the same network architecture and the same protocols are used. Only the physical layer and the air interface Uu are specified separately.

[00039] Referring to Fig. 4A, one embodiment of the present invention is shown.

In this embodiment, the system 100 utilizes the data for transmission (hereinafter referred to as "data") from the data field 102, a CRC generator 104 (which has been initialized to zero), the resulting CRC from the CRC field 106 output from the CRC generator 104, the UE ID from the UE ID field 108, a modulo 2 adder 110 and a mask 112. It should be noted that in this embodiment and all of the embodiments described hereinafter, the number of bits of each field is noted above the field as an example. However, the specific number of bits is exemplary and should not be construed to limit the present invention.

[00040] The system 100 receives the data field 102 and inputs the data from the data field 102 into the CRC generator 104. The CRC generator 104 generates the CRC field 106 and outputs the CRC from the CRC field 106 to a first input of the modulo 2 adder 110. The UE ID from the UE ID field 108 is output to the second input to the modulo 2 adder 110. The CRC and UE ID are then modulo 2 added to create a mask 112.

[00041] Preferably, the number of bits of the UE ID field 108 (M bits) is the same as the number of bits of the CRC field 106 (N bits). If $M=N$, then the UE ID may be directly modulo 2 added to the CRC as shown in Fig. 4A. However, if M and N are not equal, then an interim step is necessary to make them equal. If $M<N$, then the UE ID is padded with either leading zeros or trailing zeros to be equal in length to the CRC. This "padded UE ID" is N modulo 2 added to the CRC 106. If $M>N$, then the least significant $M-N$ bits are truncated from the UE ID. The truncated UE ID is then modulo 2 added to the CRC.

[00042] Referring to Fig. 4B, the mask 112 that is generated is appended to the data field 102 for transmission.

[00043] Referring to Fig. 5A, a second embodiment of the present invention is shown. In this embodiment, the system 200 utilizes the data from the data field 202, a CRC generator 204, the UE ID from the UE ID field 208, and the resulting CRC field 212. The system 200 receives the data field 202 and outputs the data from data field 202 into the CRC generator 204. The CRC generator 204 is the same type of generator as the CRC generator 104 from Fig. 4A, except that the CRC generator 204 is initialized with the UE ID from the UE ID field 208. This initialization is illustrated by the dotted line in Fig. 5A. As is well known by those of skill in the art, a CRC generator is typically initialized to all zeros, as was the case with the CRC generator 104 shown in Fig. 4A. Accordingly, the CRC generator 204 generates a CRC based upon the input data from the data field 202 and the initialization of the CRC generator 204 with UE ID. No modulo 2 addition is required in this embodiment.

[00044] Preferably, the number of bits of the UE ID from the UE ID field 208 (M bits) is the same as the size of the CRC generator 204, although this is not necessary. If the size of the UE ID (M-bits) is less than the size of the CRC generator 204, then the UE ID may be padded with either leading zeros or trailing zeros to be equal in length to the size of the CRC generator 204. This "padded UE ID" may then be used to initialize the CRC generator 204. Alternatively, the value in the UE ID field 208 may be loaded to initialize the CRC generator 204, and any bit positions not filled by the UE ID would be zero. If the size of the UE ID (M bits) is greater than the size of the CRC generator 204, then the least significant bits are truncated from the UE ID in order to fit the UE ID to CRC generator 204. The truncated UE ID is then used to initialize the CRC generator 204.

[00045] Referring to Fig. 5B, the CRC field 212 that is generated is appended to the data field 202 for transmission.

[00046] This second embodiment of the present invention utilizing implicit UE ID presents a simplistic, yet robust, alternative since it does not require assembly and disassembly of the UE ID with the SCCH-HS, at the transmitter or the receiver, as required by UE-specific CRC methods of the prior art and the first embodiment.

[00047] Referring to Fig. 6A, a third embodiment of the present invention is shown. In this embodiment, the system 300 utilizes the data from the data field 302, the UE ID from the UE ID field 308A, a modulo 2 adder 310 and a mask 311, a CRC generator 304 and the resulting CRC field 312. The system 300 receives the data field 302 and inputs the data from the data field 302 into a first input of the modulo 2 adder 310. The UE ID from UE ID field 308A is output to the second input to the modulo 2 adder 310. Accordingly, the data from the data field 302 and the UE ID from the UE ID field 308A are modulo 2 added to create a mask 311. The mask 311 is input into the CRC generator 304 which generates a CRC field 312.

[00048] In this embodiment, the number of bits of the UE ID field 308A (M bits) must be the same as the number of bits (X bits) of the data field 302 in order to perform the modulo 2 addition. If M and X are equal, then the value from the UE ID field 308A may be directly modulo 2 added to the data from the data field 302. However, if M and X are not equal, then an interim step is necessary to make them equal. If M is less than X, then the UE ID is padded with X-M trailing zeros such that the value from the UE ID field 308A is equal in length to the data field 302. This "padded UE ID value" as shown in Fig. 6A is then modulo 2 added to the data from the data field 302.

[00049] Due to the length X of the data field 302, it is not expected that M will be greater than X. However, if this were to occur, then the least significant M-X bits are truncated from the value in UE ID field 308A. The truncated UE ID is then modulo 2 added to the data from the data field 302.

[00050] Referring to Fig. 6B, a fourth embodiment of the present invention is shown. In this embodiment, the system 301 operates in the exact same manner as the third embodiment shown in Fig. 6A. The only difference in this embodiment is the method in which the value from the UE ID field 308B is generated. In this embodiment, the UE ID is padded with X-M leading zeros such that the UE ID from the UE ID field 308B is equal in length to the data field 302. This "padded UE ID value", as shown in Fig. 6B, is then modulo 2 added to the data from the data field

302. It should be noted that the padding may alternatively comprise a combination of leading and trailing zeros (not shown) in order to make the UE ID the same length as the data field.

[00051] Referring to Fig. 6C, the CRC field 312 that is generated from the system 300 of the third embodiment shown in Fig. 6A, or the CRC 314 that is generated from the system 301 of the fourth embodiment shown in Fig. 6B, is appended to the data field 302 for transmission. Accordingly, either type of CRC field 312, 314 may be used and appended onto the data field 302.

[00052] Referring to Fig. 7A, a fifth embodiment of the present invention is shown. In this embodiment, the system 400 utilizes the data from the data field 402, the UE ID from the UE ID field 408A, a modulo 2 adder 410, a mask 411, a CRC generator 404 and the resulting CRC field 412. The system 400 receives the data field 402 and inputs the data from the data field 402 into a first input of the modulo 2 adder 410. The UE ID from UE ID field 408A is output to the second input to the modulo 2 adder 410. The data from the data field 402 and the UE ID from the UE ID field 408A are modulo 2 added to create a mask 411. The mask 411 is input into the CRC generator 404, which generates the CRC field 412.

[00053] In this embodiment, the number of bits of the UE ID field 408A (M bits) must be the same as the number of bits of the data field 402 in order to perform the modulo 2 addition. If the M is equal to X , then the UE ID from the UE ID field 408A may be directly modulo 2 added to the data from the data field 402. Due to the length of the data field 402, it is not expected that M will be greater than X . However, if this were to occur, then the least significant bits are truncated from the UE ID field 408A until the length of the UE ID field is equal to X . The truncated UE ID is then modulo 2 added to the value from the data field 402.

[00054] If the length of the UE ID is shorter than the data field 402, then a "composite UE ID" is created such that the value from the UE ID field 408A is equal to X . The composite UE ID is created by repeating the UE ID as many times as it will fit within an X -bit field, then filling in the remaining trailing bits with a truncated UE

ID. This is represented in the UE ID field 408A in Fig. 7A. The composite UE ID is then modulo 2 added to the data from the data field 402.

[00055] Referring to Fig. 7B, a sixth embodiment of the present invention is shown. The system 401 of this embodiment operates in the same manner as the fifth embodiment shown in Fig. 7A. The only difference in this embodiment is the value from the UE ID field 408B. Although the composite UE ID created in the same manner as in Fig. 7A, the truncated UE ID portion is added as leading bits, as opposed to the trailing bits in the UE ID field 408A shown in Fig. 7A. It should be noted that the truncated UE ID "padding" may include a combination of leading and trailing truncated bits in order to make the UE ID the same length as the data field 402.

[00056] Referring to Fig. 7C, the CRC field 412 that is generated from either the system 400 of the fifth embodiment shown in Fig. 7A, or the CRC field 414 that is generated from the system 401 of the sixth embodiment shown in Fig. 7B, is appended to the data field 402 for transmission. Accordingly, either type of CRC field 412, 414 may be used and appended onto the data field 402.

[00057] It should be noted that all of the above-described embodiments can be used to support multiple identities (IDs). A UE may be required to process messages addressed at several levels: 1) the UE's unique ID, 2) an ID corresponding to a subset or group of UEs, where the UE belongs to the subset; or 3) a broadcast (global ID) corresponding to all UEs in the system. For example, as shown in Fig. 8, UE ID 12 has been highlighted to indicate that it will be able to receive and process IDs at four different levels: 1) the UE-specific ID (#12); 2) subsubset C ID; 3) subset 2 ID; and 4) global ID. It should also be noted that alternate group identifications A-E, may also be created such that a different group of UEs may be included. For example, group B will include all of the UEs identified next to group B which include UE numbers 2, 7, 12, 17, 22 and 27. Additionally, any group or subgroup may be created by specifically identifying individual UEs as desired by a user.

[00058] To support this requirement, the transmitter generates the CRC as described above with each of the embodiments. At the receiver, the UE processes the message and generates the expected CRC, without the ID-based modification. The UE processor then modulo 2 adds the received CRC to the calculated CRC. The resultant output is the transmitted ID, which can be any one of the IDs described above. If the ID is none of these, then the UE discards the transmission.

[00059] In accordance with the present invention, using the CRC code of the length N , the undetected error probability on the identified SCCH-HS approaches 2^{-N} .

Using a 24-bit CRC to protect data transmitted on HS-DSCH, a 16-bit CRC to protect control information transmitted on SCCH-HS, and assuming 10^{-3} false acceptance probability for HI bits by an unintended UE, the embodiments in accordance with the present invention hereinbefore described will provide the probability of the false acceptances as follows:

$$P_{fa} = P_{faHI} \times P_{faH} \times P_{SD} \quad \text{Equation (1)}$$

where P_{fa} is the probability of a false acceptance; P_{faHI} is the probability of a false acceptance of HI; P_{faH} is the probability of a false acceptance of SCCH-HS; and P_{SD} is the probability of a successful detection of HS-DSCH (P_{SD}).

[00060] Using the above identified values for the present example with Equation (1):

$$[00061] \quad P_{fa} = 10^{-3} \times 2^{-16} \times 2^{-24} = 9.1 \times 10^{-16}$$

[00062] The reliability computation indicates that for the same length CRC, the probability of a user passing erroneous data up to a higher layer, will be extremely low.

[00063] Referring to Fig. 9, the flow diagram illustrates a method for processing downlink messages between a node B and a UE in accordance with the present invention. This method provides a general overview and should not be interpreted as a comprehensive description of all of the detailed medium access control (MAC) layer and physical layer signaling required for processing a message, (i.e., a data packet). The node B first generates a downlink control message in the MAC layer (step 1) and

then forwards the message and the UE ID to the physical layer (step 2). The physical layer generates the CRC and applies the UE ID for forwarding with the message (step 3) as a data burst. The message is then transmitted from the node B to the UE (step 4).

At the physical layer, the UE ID and the CRC are checked to determine if they are correct (step 5). If so, the message is forwarded to the MAC layer (step 6) which then further processes the message (step 7).

[00064] It should be noted that step 6 in Fig. 9 includes an additional signal between the physical layer and the MAC layer, which comprises a control message that indicates the CRC/UE ID is valid. However, this is an optional step. In the preferred embodiment, only valid messages will be forwarded from the physical layer to the MAC layer. Accordingly, in the preferred embodiment, the MAC layer will assume that any message that is forwarded to the MAC is valid. In the alternative embodiment, the additional CRC/UE ID valid signaling will be forwarded along with the message as an additional confirmation.

[00065] The present invention has the advantage of eliminating separate processing steps for the UE ID and the CRC. When the two fields are combined as hereinbefore described, the UE will not further process any message until both the CRC and the UE ID (or other type of ID shown in Fig. 8) are correct.

[00066] While the present invention has been described in terms of the preferred embodiment, other variations, which are within the scope of the invention, as outlined in the claims below will be apparent to those skilled in the art.

* * *

CLAIMS

What is claimed is:

1. A system for transmitting a communication burst from a first communicating unit to a second communicating unit; the system comprising:
 - at said first communicating unit:
 - a cyclic redundancy check (CRC) generator for receiving data and generating a CRC;
 - a first combiner for combining said CRC with an identification of the second communicating unit to generate a mask; and
 - a transmitter for transmitting the burst comprising said mask and said data; and
 - at said second communicating unit:
 - a memory for storing the identification of the second communicating unit;
 - a receiver for receiving said communication burst including said mask and said data;
 - a second combiner for combining said mask with said stored identification to recover the CRC; and
 - means for determining whether said recovered CRC is valid.
2. The system of claim 1, wherein said first and second combiners are modulo-2 adders.
3. A system for transmitting a communication burst from a first communicating unit to at least a second communicating unit; the second communicating unit being associated with an identification number; the system comprising:
 - at said first communicating unit:

a cyclic redundancy check (CRC) generator for receiving data and generating a CRC;

a combiner for combining said CRC with the identification number to generate a mask; and

a transmitter for transmitting a communication burst comprising said mask and said data; and

at said second communicating unit:

a memory for storing said identification number;

a receiver for receiving said communication burst including said mask and said data;

a combiner for combining said mask with said stored identification number to recover the CRC;

means for determining whether said recovered CRC is valid.

4. The system of claim 3, further including at least a third communication unit, whereby said third communication unit is also associated with said identification number.

5. The system of claim 3, further including a plurality of communication units, wherein only a portion of said plurality of communication units is associated with said identification number.

6. A system for transmitting a communication burst from a first communicating unit to a second communicating unit; said second communicating unit being associated with an identified number; the system comprising:

at said first communicating unit:

a cyclic redundancy check (CRC) generator for receiving data and generating a CRC, the CRC generator being initialized with said identification number; and

a transmitter for transmitting a communication burst comprising said CRC and said data; and

at said second communicating unit:

a receiver for receiving said communication burst including said CRC and said data; and

means for determining whether said recovered CRC is valid.

7. The system of claim 6, further including a plurality of communicating units, wherein only a portion of said plurality of communicating units is associated with said identification number.

8. A system for transmitting a communication burst from a first communicating unit to a second communicating unit; the second unit being associated with an identification; the system comprising:

at said first communicating unit:

a combiner for receiving data and combining the data with an identification field including said identification to generate a mask;

a cyclic redundancy check (CRC) generator for receiving the mask and generating a CRC; and

a transmitter for transmitting a communication burst comprising said CRC and said data; and

at said second communicating unit:

a receiver for receiving said communication burst including said CRC and said data; and

means for determining whether said recovered CRC is valid.

9. The system of claim 8, wherein said data comprises a data block and wherein said identification field includes both said identification and a plurality of

additional bits such that the length of the identification field is the same as the length of the data block.

10. The system of claim 9, wherein at least a portion of said additional bits includes said identification.

11. A method for transmitting a data burst from a first unit to a second unit comprising:

at said first unit:

receiving data for transmission;

generating a cyclic redundancy check (CRC) based upon said data;

combining the CRC with an identification of the second unit to generate a mask;

appending the mask onto the data to form a data burst; and

transmitting the data burst; and

at said second unit:

receiving said data burst;

retrieving the identification of the second unit from memory; and

combining the retrieved identification with said mask to generate said CRC; and

determining whether said CRC is valid.

12. In a wireless digital communications system in which messages are transmitted from a node B to a user equipment (UE) wherein the system utilizes code-division multiple access (CDMA) technology for transmission and reception of the messages, the method comprising the steps of:

(a) at said node B, performing a cyclic redundancy check on a message;

(b) overlaying the cyclic redundancy check with a UE identity and transmitting the message and the overlaid UE identity and cyclic redundancy check to the UE;

(c) said UE, receiving the message with the overlaid UE identity and cyclic redundancy check;

(d) extracting the UE identity from the message received at step (c);
and

(e) comparing the extracted identity with the identity of the UE receiving the message at step (c).

13. The method of claim 12 further comprising said UE extracting the message if, and only if, the comparison at step (e) indicates a match.

14. The method of claim 12 further comprising said UE ignoring the message if there is no match at step (e).

15. The method of claim 12 wherein performing the cyclic redundancy check at step (a) further includes performing a mathematical calculation on the data of the message for generating a binary number that uniquely identifies the data.

16. The method of claim 12 wherein the step (a) further comprises performing polynomial arithmetic modulo two addition on at least a portion of the message to obtain a check sum which is the cyclic redundancy check.

17. The method of claim 12 wherein step (b) further comprises combining the cyclic redundancy check generated at step (a) with the identity of the UE employing modulo two addition.

18. The method of claim 12 wherein step (b) further comprises padding out a field of the UE identity with zeros to make the field of the UE identity equal to a field of the CRC.

19. In a wireless digital communications system in which messages are transmitted from a network to a user equipment (UE) wherein the system utilizes code-division multiple access (CDMA) technology for transmission and reception of the messages, the method comprising the steps of:

(a) at said network, performing a cyclic redundancy check on a message;

(b) overlaying the cyclic redundancy check with a UE identity and transmitting the message and the overlaid UE identity and cyclic redundancy check to the UE;

(c) said UE, receiving the message with the overlaid UE identity and cyclic redundancy check; and

(d) comparing the cyclic redundancy check at the UE combined with the identification code of the UE with the CRC and overlaid UE ID received from said network.

20. A wireless digital communications system employing code-division multiple access technology comprising a network and at least one user equipment (UE);

(a) said network including a cyclic redundancy check (CRC) generator performing a CRC on a message to be transmitted to a given UE;

(b) means for overlaying the CRC with an identity code of the UE intended to receive the message;

(c) means for transmitting the message and overlaid UE identity and CRC to the intended UE;

(d) said intended UE including a receiver for receiving the transmission and coupling the received transmission to a CRC extractor; and

(e) said CRC extractor for extracting said higher layer message when the received UE identity extracted from the received message compares with a locally provided UE identity of said intended UE.

21. The system of claim 20 further comprising said CRC extractor ignoring the message when the comparison of step (e) fails.

22. A wireless digital communications system employing code-division multiple access technology including a network and at least one user equipment (UE); the system comprising:

(a) said network performing a cyclic redundancy check on a message to be transmitted to a given UE;

(b) said network including means for overlaying the CRC with an identity code of the UE intended to receive the message;

(c) said network including means for transmitting the message and overlaid UE identity and CRC to the intended UE;

(d) said intended UE including means for receiving the transmission;
and

(e) a data extractor for extracting said message when the received UE identity extracted from the received message compares with a locally provided UE identity of said intended UE.

23. The system of claim 22 further comprising said UE processing the message when the comparison matches.

24. A wireless digital communications system employing code-division multiple access technology comprising a station and at least one user equipment (UE);

said station including:

a cyclic redundancy check generator for performing a cyclic redundancy check on at least a portion of a message to be transmitted to a given UE;

means for overlaying the CRC with an identity code of the UE intended to receive the message; and

a transmitter for transmitting the message and overlaid UE identity and CRC to the intended UE; and

said intended UE including:

a receiver for receiving the transmission from the station;

means for extracting the UE identity from the received messages and comparing it with a locally stored UE identity; and

means for extracting said message only when there is a match between the extracted UE identity and the stored UE identity.

25. The system of claim 24 wherein said intended UE further includes means for verifying the UE identity.

26. A method for identifying one or more user equipments (UEs) each having a unique identification UID among a plurality of UEs comprising:

receiving a data packet;

generating a cyclic redundancy check (CRC) based upon said data packet;

modulo 2 adding said CRC to the UID to create a mask; and

appending said mask onto said data packet for transmission.