

ORDERING OF LONG TRANSPORT CHANNELS AND SHORT TRANSPORT CHANNELS

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FIELD OF INVENTION

The present invention relates to the field of wireless local area network (LAN) communication, and more particularly, to the use of Automatic Repeat Request (ARQ) to convey protocol data unit (PDU) reception status information between a sending entity and a receiving entity in the LAN, and to facilitate the retransmission of PDUs, when retransmission is required.

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BACKGROUND

The new standard for wireless LAN services is known as ETSI HIPERLAN Type 2. The high throughput capability associated with HIPERLAN Type 2 is expected to open new opportunities for both existing applications and new applications.

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HIPERLAN Type 2 uses a Time Division Duplex (TDD) scheme, wherein an access point (AP) and a mobile terminal (MT) use different time slots over the same frequency channel to communicate with one another.

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Figure 1 illustrates a portion of a typical HIPERLAN Type 2 system, wherein the APs are connected to the Operator's Intranet. The MTs, however, may serve as wireless network interface cards (NICs) to a personal computer (PC), or they may be mobile telephones. Each of the cells in HIPERLAN Type 2, for example, cell A and cell B, may be self-configured in that the AP in each cell will automatically select the most effective frequencies using measurements it has taken regarding the interference level at other frequencies, as well as measurements received from the MTs operating in the cell.

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The Medium Access Control (MAC) protocol used by HIPERLAN Type 2 is a reservation based protocol. Figure 2 provides an overview of a typical MAC protocol frame structure. As shown, a typical MAC frame includes a broadcast

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control channel (BCCH), a frame control channel (FCCH), a random access feedback channel (RFCH), a downlink (DL) channel (DLCH), an uplink (UL) channel (ULCH), and a random access channel (RACH).

Assuming a MT has been authenticated and a connection has been
5 established between the MT and a corresponding AP, the MT monitors the BCCH for random access opportunities (i.e., time slot availability). The MT must then request UL resources via the RACH. Thereafter, the AP acknowledges the request and starts scheduling UL resources for the MT, i.e., the scheduler begins
10 reserving UL resources for the MT. The RFCH conveys to the MT information which the MT can use to determine if its request for resources in the RACH of the previous MAC frame was successfully transmitted to and received by the AP.

Upon receiving DL data from the network, the AP either buffers the data and defers transmission, if the MT is "sleeping," or the AP transmits the data at the next possible opportunity. Data is announced by broadcasting the MT's MAC-
15 ID in the FCCH. The FCCH also contains the exact location (i.e., time slot) of the data in the DLCH.

The MAC protocol supports three data service modes: acknowledged mode, unacknowledged mode and repetition mode. The acknowledged data service mode, in particular, provides error-free delivery of service data units
20 (SDU), in both the UL and DL directions, wherein the sender has the ability to discard PDUs depending on channel quality. Error correction is achieved by employing an Automatic Repeat Request (ARQ) mechanism, where ARQ PDU reception status acknowledgments are sent from the intended receiving entity to the sending entity in a reverse data flow direction, as one skilled in the art will readily
25 appreciate.

Further in accordance with the MAC protocol, user data is sent in long transport channels (LCHs), whereas short transport channels (SCHs) are used to

send ARQ PDU reception status acknowledgments, as well as other messages, such as resource request messages, which reflect the number of pending PDUs in the UL direction for a given MT. As one skilled in the art will readily appreciate, a NIC may simultaneously support multiple user connections, wherein the SCHs and the LCHs for any one of the multiple connections are arranged such that the SCHs are transmitted prior to the LCHs. Moreover, the SCHs and the LCHs associated with each connection are concatenated in the UL and DL channels to form a PDU chain, comprising a SCH portion, LCH portion pair, which is herein referred to as a SCH/LCH pair, where the SCH portion may contain one or more SCHs and the LCH portion may contain one or more LCHs. For example, a PDU train associated with a NIC that is supporting two connections may be represented as follows: $SCHs_1 - LCHs_1 - SCHs_2 - LCHs_2$, where the subscript "1" denotes a first of the two connections and the subscript "2" denotes a second of the two connections.

A DL or UL PDU train is decoded by the MT or the AP respectively, and PDU reception status is stored in an ARQ table. Based on opportunities provided by the scheduler, the MT and/or AP create an ARQ status acknowledgment message(s) that reflects the PDU reception status in the ARQ table. The ARQ message(s) is then sent as a SCH PDU(s) to the sender via the UL, if the sender is the AP, or via the DL if the sender is a MT. The sender then analyzes the PDU reception status information contained in the ARQ message, and if appropriate, the sender retransmits one or more of the PDUs that were not successfully received.

A short retransmission turnaround time (RTT), where RTT refers to the amount of time required (e.g., in terms of a number of frames) to retransmit a PDU, is highly beneficial for many reasons. In general, a short RTT means shorter transmission delays and/or additional PDU retransmission opportunities for delay sensitive applications, such as real-time video or voice applications. Short

RTT also means faster reaction upon changes in channel quality. It also means a decrease in memory requirements.

In order to achieve a short RTT, both the amount of time required to send ARQ status acknowledgment messages and the time required by the scheduling
5 entity to schedule the retransmission of any PDUs should be minimized.

Minimizing RTT depends, to some extent, on the order in which the DL and UL channels appear in the MAC frame relative to each other. For instance, the DLCH may precede the ULCH. In this instance, it is desirable to transmit the ARQ status acknowledgment for DL traffic in the same MAC frame as the DL data to which it
10 corresponds, as illustrated in Figure 3, in order to minimize RTT. With respect to ARQ status acknowledgments for UL data traffic, it is desirable to transmit the ARQ status acknowledgment message in the DLCH of the very next MAC frame, as illustrated in Figure 4. In another instance, the ULCH may precede the DLCH. In the case, just the opposite is true with respect to transmitting ARQ status
15 acknowledgment.

Of the two instances described above, it is far more preferable that the DLCH precede the ULCH in a given MAC frame. The reason for this is that each MT must monitor the FCCH, which follows the BCCH in the MAC frame structure, wherein the FCCH contains information elements which indicate the
20 composition of the MAC frame. By locating the DLCH prior to the ULCH, a MT can buffer all incoming DL data, while it processes the content of the FCCH. In doing so, the processing of the DL data can be deferred in order to determine when the uplink transmission is to begin. The opposite is not possible if the ULCH is located prior to the DLCH since the UL transmission cannot be delayed.

In the scenario depicted in Figure 4, the duration of time covering the RACH, BCCH, FCCH and RFCH is presumed to be sufficient in order to generate
25 ARQ status acknowledgments for an ARQ implementation in hardware. However,

with respect to the case reflected in Figure 3, the time period between receipt of the last DL PDU and the time the ARQ status acknowledgment message is sent in an ULCH SCH PDU may not be sufficient. More specifically, since the location of a SCH/LCH pair in the ULCH for a given connection is arbitrary, the
5 probability exists that the time needed to generate corresponding ARQ messages is insufficient. Again, the opposite problem arises when the ULCH is located prior to the DLCH during the same MAC frame.

The same type of problem occurs with respect to the transmission of incorrectly received PDUs announced in the ARQ status acknowledgment
10 message. For the case where the DLCH precedes the ULCH, the presence of a SCH may include an ARQ acknowledgment message. Since the location of the SCH in the DLCH relative to the LCH in the ULCH is arbitrary when the DLCH precedes ULCH, the amount of time available for the MT to decode PDUs in the DLCH, update the ARQ table, and, if necessary, generate and retransmit ARQ
15 messages may be insufficient. The opposite problem may arise when the ULCH precedes the DLCH, depending on whether the scheduler has scheduled DL LCH PDUs at the beginning of the DLCH phase of the frame. Since the scheduler is unaware of the content of the ARQ status acknowledgment message to be sent in the ULCH at the creation of the frame, the amount of time needed by the AP to
20 decode PDUs in the ULCH, update the ARQ table, and, if necessary, generate and retransmit ARQ messages may be insufficient.

SUMMARY OF THE INVENTION

The present invention provides for the scheduling of LCH and SCH PDUs
25 based on an awareness of a desired ARQ response time. Accordingly, the MTs and APs are afforded a maximum amount of time to generate ARQ messages, while still achieving a fast response time. In general, for the more preferable case

where the DLCH precedes the ULCH, the amount of time that is available to generate ARQ messages may be maximized by having the SCH portion follow the LCH portion in the one or more LCH/SCH pairs in the ULCH of the MAC frame. In the less preferable case, where the ULCH precedes the DLCH, the amount of time that is available to generate ARQ messages may be maximized by having the SCH portion follow the LCH portion in the one or more LCH/SCH pairs in the DLCH of the MAC frame.

It should be noted that both the AP and the MTs, at association time, announce any extra processing delay for both the send and receive directions. This delay is expressed in terms of a number of MAC frames. Therefore, the extra processing delay in the send direction (i.e., denoted by $d_{tx,AP}$ and $d_{tx,MT}$) defines the number of MAC frames before the sender can transmit PDUs based on the processing of an ARQ message after reception of the ARQ message. The extra processing delay in the receive direction (i.e., denote by $d_{rx,AP}$ and $d_{rx,MT}$) defines the number of MAC frames that the receiver must wait before it can produce an ARQ message following the successful or unsuccessful receipt of PDUs. The "round-trip" time in the uplink and downlink directions may be expressed, in terms of a number of frames, as follows.

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$$RTT_{uplink} = d_{rx,MT} + d_{tx,AP} + 1$$

$$RTT_{downlink} = d_{tx,MT} + d_{rx,AP} + 1$$

In accordance with a first exemplary embodiment of the present invention, maximizing the amount of time required to generate an ARQ message without compromising response time is achieved through a MAC protocol data structure that includes a first channel for communicating information from a first

communication entity to a second communication entity, where the first channel contains a plurality of LCH/SCH pairs, where each LCH/SCH pair is associated with a corresponding connection between the first and second communication entities, each of the LCH/SCH pairs including a SCH portion for conveying ARQ messages and a LCH portion for conveying user data, and where the LCH portion precedes the SCH portion. The MAC protocol data structure also includes a second channel for communicating information from the second communication entity to the first communication entity, where the second channel precedes the first channel, and the second channel contains a plurality of SCHs, each of which conveys an ARQ message from the second communication entity to the first communication entity.

In accordance with a second exemplary embodiment of the present invention, maximizing the amount of time required to generate an ARQ message without compromising response time is achieved through a MAC protocol data structure that includes an ULCH containing a LCH/SCH pair associated with a connection between an AP and a MT, where the LCH/SCH pair includes an SCH portion containing one or more SCHs that convey, for example, ARQ messages, and where the LCH/SCH pair further includes an LCH portion containing one or more LCHs that convey user data, and where the LCH portion precedes the SCH portion. In addition, the MAC protocol data structure includes a DLCH that precedes the ULCH, where the DLCH contains a SCH/LCH pair associated with the connection between the AP and the MT, where the SCH/LCH pair includes an SCH portion to convey, for example, ARQ messages and an LCH portion to convey user data, and where the SCH portion precedes the LCH portion.

In accordance with a third exemplary embodiment of the present invention, maximizing the amount of time required to generate an ARQ message without compromising response time is achieved through a MAC protocol data structure

that includes a DLCH containing a LCH/SCH pair associated with a connection between an AP and a MT, where the LCH/SCH pair includes an LCH portion containing one or more LCHs for conveying user data and an SCH portion containing one or more SCHs for conveying ARQ messages, and where the LCH portion precedes the SCH portion. In addition, the MAC protocol data structure includes an ULCH that precedes the DLCH, where the ULCH contains an SCH/LCH pair associated with the connection between the AP and the MT, where the SCH/LCH pair includes an SCH portion for conveying ARQ messages and an LCH portion for conveying user data, and where the SCH portion precedes the LCH portion.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects, features and advantages of the present invention will be readily apparent to one skilled in the art from the following written description, read in conjunction with the drawings, in which:

Fig. 1 illustrates an exemplary portion of a typical HIPERLAN Type 2 system;

Fig. 2 illustrates a typical medium access control (MAC) protocol frame structure;

Fig. 3 illustrates the generation and transmission of an automatic repeat request (ARQ) message for a DL PDU;

Fig. 4 illustrates the generation and transmission of an ARQ message for an UL PDU;

Fig. 5 illustrates a MAC frame structure in accordance with a preferred embodiment of the present invention, wherein the ULCH follows the DLCH; and

Fig. 6 illustrates a MAC frame structure in accordance with an alternative embodiment, wherein the DLCH follows the ULCH.

DETAILED DESCRIPTION OF THE INVENTION

In the following description, for purposes of explanation and not limitation, specific details are set forth, such as particular frame protocols, frame structures, techniques, etc. in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. In other instances, detailed descriptions of well-known methods, devices, and frame structures are omitted so as not to obscure the description of the present invention.

In accordance with a preferred embodiment of the present invention, the DLCH precedes the ULCH in the MAC frame structure, as illustrated in Figure 5. In accordance with the preferred embodiment, the scheduler, in general, allocates an ARQ feedback space (i.e., one or more time slots) in the ULCH, $d_{tx,MT}$ frames after the transmission of a corresponding DL LCH PDU(s). Similarly, the scheduler allocates an ARQ feedback space (i.e., one or more time slots) in the DLCH, $d_{tx,AP}$ frames after the transmission of a corresponding UL LCH PDU(s).

Further in accordance with the preferred embodiment, and with specific reference to the ULCH as illustrated in FIG. 5, the SCH portion 501 of the LCH/SCH pair associated with a given connection, for example, connection "A", is arranged such that it follows the LCH portion 503. In doing this, additional time is available for the MT to generate and ultimately transmit ARQ status acknowledgement messages in the present MAC frame. This is particularly important with regard to "time critical" connections (i.e., connections having a response time of $d_{tx,MT}$ equal to zero). The additional time that is made available to the MT as a result of this arrangement is at least equal to the time associated with the generation of the corresponding LCH portion 503 in the ULCH.

In FIG. 5, the LCH/SCH pair associated with only one connection (i.e.,

connection "A") is shown. However, as stated previously, a NIC in a single MT may support multiple connections. Thus, the ULCH may contain multiple LCH/SCH pairs, where each is associated with a different one of the multiple connections. In accordance with the preferred embodiment of the present invention, the scheduler reserves the earliest time slots in the ULCH for those LCH/SCH pairs that are associated with non-time critical connections (i.e., connections having a response time ($d_{n,MT}$) that is greater than zero MAC frames. Thus, the latter time slots in the ULCH may be reserved for those LCH/SCH pairs that are associated with time critical connections, where DL data associated with these time critical connections was present in the DLCH of the present MAC frame. Consequently, there is more time available for the MT to decode DL PDUs, update the ARQ status table, generate, if necessary, ARQ status acknowledgment messages and retransmit PDUs, particularly for time critical connections.

Still further in accordance with the preferred embodiment of the present invention, the scheduler reserves time slots in the ULCH for those LCH/SCH pairs that are associated with time critical connections in such a way that the order in which these LCH/SCH pairs appear in the ULCH is the same as the order associated with the corresponding SCH/LCH pairs in the DLCH. Thus, for example, if three connections A, B and C associated with a MT are deemed to be time critical connections and the order in which the corresponding SCH/LCH pairs appear in the DLCH is as follows: SCH/LCH_A - SCH/LCH_B - SCH/LCH_C, then the order in which the corresponding LCH/SCH pairs appear in the ULCH is: LCH/SCH_A - LCH/SCH_B - LCH/SCH_C. As one skilled in the art will readily appreciate, this further increases the probability that there will be sufficient time available for the AP and MT to decode PDUs, update the ARQ status table, generate, if necessary, ARQ status acknowledgment messages and retransmit

PDU(s) for time critical connections.

With reference now to the DLCH of the present MAC frame illustrated in FIG. 5, the SCH portion 505 of the SCH/LCH pair associated with connection "A" precedes the LCH portion 507. This increases the amount of time that the MT has to receive an ARQ message from the AP, indicating that a particular PDU should be retransmitted, and if necessary, retransmit the PDU in the ULCH of the present MAC frame.

If bandwidth is scheduled for retransmission of PDUs only, the bandwidth may be unused. But for occasions where UL data is pending, the scheduler will not jeopardize the bandwidth by allocating ULCH LCH PDUs.

FIG. 6 illustrates an alternative embodiment of the present invention, which covers the less likely instance where the ULCH precedes the DLCH in the MAC frame. In accordance with this alternative embodiment, the scheduler, in general, allocates an ARQ feedback space (i.e., one or more time slots) in the DLCH, $d_{TX,AP}$ frames after the transmission of a corresponding UL LCH PDU(s). Similarly, the scheduler allocates an ARQ feedback space (i.e., one or more time slots) in the ULCH, $d_{TX,MT}$ frames after the transmission of a corresponding DL LCH PDU(s).

Further in accordance with this alternative embodiment, and with specific reference to the DLCH illustrated in FIG. 6, the SCH portion 601 of the LCH/SCH pair associated with a given connection, for example, connection "B", is arranged such that it follows the LCH portion 603. In doing this, additional time is available for the AP to generate and ultimately transmit ARQ status acknowledgement messages to the MT during the present MAC frame. Again, this is particularly important with regard to "time critical" connections. The additional time that is made available to the AP as a result of this arrangement is at least equal to the time associated with the generation of the corresponding LCH portion 603 in the DLCH.

The DLCH may, of course, contain multiple LCH/SCH pairs, where each corresponds with a different connection between the AP and the MT. In accordance with the alternative embodiment of the present invention, the scheduler reserves the earliest time slots in the DLCH for those LCH/SCH pairs that are associated with non-time critical connections. Thus, the latter time slots in the DLCH may be reserved for those LCH/SCH pairs that are associated with time critical connections, where UL data associated with these time critical connections was present in the ULCH of the present MAC frame. Consequently, there is more time available for the AP to decode UL PDUs, update the ARQ status table, and generate, if necessary, ARQ status acknowledgment messages, particularly for time critical connections.

With specific reference now to the ULCH illustrated in FIG. 6, the SCH portion 605 of each SCH/LCH pair precedes the corresponding LCH portion 607. This, of course, increases the amount of time that is available for the AP to decode an ARQ status acknowledgement message in the ULCH and, if necessary, retransmit the appropriate PDU to the MT in the DLCH of the present MAC frame. Again, this is particularly important with regard to "time critical" connections.

Still further in accordance with the alternative embodiment, the scheduler reserves time slots in the ULCH for those SCH/LCH pairs that are associated with time critical connections in such a way that the order in which these SCH/LCH pairs appear in the ULCH is the same as the order associated with the corresponding LCH/SCH pairs in the DLCH of the previous MAC frame. Thus, for example, if three connections D, E and F are deemed to be time critical connections and the order in which the LCH/SCH pairs appear in the DLCH of the previous MAC frame is as follows: LCH/SCH_D - LCH/SCH_E - LCH/SCH_F, then the order in which the corresponding SCH/LCH pairs appear in the ULCH of the

present MAC frame is as follows: SCH/LCH_D - SCH/LCH_E - SCH/LCH_F. As one skilled in the art will readily appreciate, this further increases the probability that there will be sufficient time available for the AP and MT to decode PDUs, update the ARQ status table, generate, if necessary, ARQ status acknowledgment messages and retransmit PDUs for time critical connections.

If bandwidth is scheduled for retransmission of PDUs only, the bandwidth may be unused. But for occasions where DL data is pending, the scheduler will not jeopardize the bandwidth by allocating DLCH LCH PDUs. Since the required time probably is well known by the vendor of the AP, and since the scheduler and the ARQ are located in the same unit, this problem can be avoided.

It should be noted that exemplary methods of the present invention are not limited to application described above. The present invention has been described in terms of specific embodiments to facilitate understanding. The above embodiments, however, are illustrative rather than restrictive. It will be readily apparent to one skilled in the art that departures may be made from the specific embodiments shown above without departing from the central spirit and scope of the invention. Therefore, the invention should not be regarded as being limited to the above examples, but should be regarded instead as being fully commensurate in scope with the following claims.

WHAT IS CLAIMED IS:

1. In a wireless LAN, wherein user data is transported between a first communication entity and a second communication entity in accordance with a Medium Access Control (MAC) protocol, a MAC protocol data structure comprising:
 - a first channel for communicating information from the first communication entity to the second communication entity, said first channel containing a plurality of long channel (LCH)/short channel (SCH) pairs, wherein each LCH/SCH pair is associated with a corresponding connection between the first and second communication entities, each of said LCH/SCH pairs including a SCH portion for conveying Automatic Repeat Request (ARQ) messages and a LCH portion for conveying user data, and wherein the LCH portion precedes the SCH portion; and
 - a second channel for communicating information from the second communication entity to the first communication entity, said second channel preceding the first channel in the MAC protocol data structure, said second channel containing a plurality of SCHs, each of which conveys an ARQ message from the second communication entity to the first communication entity.
2. The MAC protocol data structure of claim 1, wherein each of a first number of the LCH/SCH pairs in said first channel and each of a first number of the SCHs in the second channel are associated with a time critical connection between the first and second communication entities.
3. The MAC protocol data structure of claim 2, wherein the order of said first number of LCH/SCH pairs in the first channel is the same as the order of said first number of corresponding SCHs in the second channel.



4. The MAC protocol data structure of claim 1, wherein said second channel further comprises a plurality of SCH/LCH pairs, and wherein each of a first number of the SCH/LCH pairs in said second channel are associated with a time critical connection between the first and second communication entities.
5. The MAC protocol data structure of claim 4, wherein the order of said first number of SCH/LCH pairs is the same as a first number of corresponding LCH/SCH pairs in a first channel of a previous MAC frame.
- 10 6. The MAC protocol data structure of claim 1, wherein each of a second number of the SCH/LCH pairs in said second channel are associated with a non-time critical connection between the first and the second communication entities, and wherein the second number of SCH/LCH pairs precedes the first number of SCH/LCH pairs in said second channel.
- 15 7. The MAC protocol data structure of claim 1, wherein each of a first number of the LCH/SCH pairs in said first channel are associated with a time critical connection between the first and second communication entities, wherein each of a second number of the LCH/SCH pairs in said first channel are associated with a non-time critical connection between the first and the second communication entities, and wherein the second number of LCH/SCH pairs precedes the first number of LCH/SCH pairs in said first channel.
- 20 8. In a wireless LAN, wherein user data is transported between an access point (AP) and a mobile terminal (MT) in accordance with a Medium Access Control (MAC) protocol, a MAC protocol data structure comprising:
an uplink channel (ULCH) containing a long channel (LCH)/short channel



(SCH) pair associated with a connection between the AP and a MT, wherein the LCH/SCH pair includes a SCH portion containing one or more SCHs for conveying Automatic Repeat Request (ARQ) messages and a LCH portion containing one or more LCHs for conveying user data, and wherein the LCH

5 portion precedes the SCH portion; and

a downlink channel (DLCH) preceding said ULCH in the MAC protocol data structure, said DLCH containing a SCH/LCH pair associated with the connection between the AP and the MT, wherein the SCH/LCH pair includes a SCH portion for conveying ARQ messages and a LCH portion for conveying user

10 data, and wherein the SCH portion precedes the LCH portion.

9. The MAC protocol data structure of claim 8, wherein said DLCH comprises a plurality of SCH/LCH pairs, each associated with one of a plurality of connections between the AP and the MT, and wherein said ULCH comprises a

15 plurality of LCH/SCH pairs, each associated with a different one of the plurality of connections between the AP and the MT.

10. The MAC protocol data structure of claim 9, wherein each of the plurality of LCH/SCH pairs in the ULCH is associated with a corresponding one of the plurality of SCH/LCH pairs in the DLCH, and wherein the order of each

20 LCH/SCH pair in the ULCH is the same as the order of the corresponding SCH/LCH pair in the DLCH.

11. The MAC protocol data structure of claim 9, wherein each of the plurality of SCH/LCH pairs in the DLCH is associated with a corresponding one of a

25 plurality of SCH/LCH pairs in an ULCH of a previous MAC frame, and wherein the order of each LCH/SCH pair in the ULCH of the previous MAC frame is the

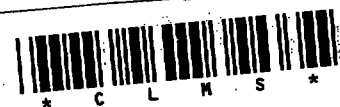


same as the order of the corresponding SCH/LCH pair in the DLCH.

- 5 12. The MAC protocol data structure of claim 9, wherein each of a first number of the of SCH/LCH pairs in said DLCH and each of a corresponding number of LCH/SCH pairs in said ULCH are associated with a different time critical connection between the MT and the AP, and wherein each of a second number of the SCH/LCH pairs in said DLCH and each of a corresponding number of LCH/SCH pairs in said ULCH are associated with a different non-time critical connection between the MT and the AP.
- 10 13. The MAC protocol data structure of claim 12, wherein the order of the LCH/SCH pairs in the ULCH that are associated with the time critical connections is the same as the order of the corresponding SCH/LCH pairs in the DLCH that are associated with the time critical connections.
- 15 14. The MAC protocol data structure of claim 12, wherein the order of the SCH/LCH pairs in the DLCH that are associated with the time critical connections is the same as the order of a corresponding number of LCH/SCH pairs in an ULCH of a previous MAC frame.
- 20 15. The MAC protocol data structure of claim 12, wherein the LCH/SCH pairs in the ULCH that are associated with the non-time critical channels precede the LCH/SCH pairs in the ULCH that are associated with time critical connections.
- 25 16. The MAC protocol data structure of claim 12, wherein the SCH/LCH pairs in the DLCH that are associated with the non-time critical channels precede the SCH/LCH pairs in the DLCH that are associated with time critical connections.



17. The MAC protocol data structure of claim 12, wherein a time critical connection has a retransmission delay requirement of zero (0) MAC data frames.
18. In a wireless LAN, wherein user data is transported between an access point (AP) and a mobile terminal (MT) in accordance with a Medium Access Control (MAC) protocol, a MAC protocol data structure comprising:
- 5 a downlink channel (DLCH) containing a long channel (LCH)/short channel (SCH) pair associated with a connection between the AP and the MT, wherein the LCH/SCH pair includes a LCH portion containing one or more LCHs for conveying user data and a SCH portion containing one or more SCHs for conveying Automatic Repeat Request (ARQ) messages, and wherein the LCH
- 10 portion precedes the SCH portion; and
- an uplink channel (ULCH) preceding said DLCH in the MAC protocol data structure, said ULCH containing a SCH/LCH pair associated with the connection
- 15 between the AP and the MT, wherein the SCH/LCH pair includes a SCH portion for conveying ARQ messages and a LCH portion for conveying user data, and wherein the SCH portion precedes the LCH portion.
19. The MAC protocol data structure of claim 18, wherein said ULCH
- 20 comprises a plurality of SCH/LCH pairs, each being associated with a different one of a plurality of connections between the AP and the MT, and wherein said DLCH comprises a plurality of LCH/SCH pairs, each being associated with a different one of the plurality of connections between the AP and the MT.
- 25 20. The MAC protocol data structure of claim 19, wherein each of the plurality of LCH/SCH pairs in the DLCH is associated with a corresponding one of the plurality of SCH/LCH pairs in the ULCH, and wherein the order of each



LCH/SCH pair in the DLCH is the same as the order of the corresponding SCH/LCH pair in the ULCH.

21. The MAC protocol data structure of claim 19, wherein each of the plurality
5 of SCH/LCH pairs in the ULCH is associated with a corresponding one of a plurality of LCH/SCH pairs in a DLCH of a previous MAC frame, and wherein the order of each SCH/LCH pair in the ULCH is the same as the order of the corresponding LCH/SCH pair in the DLCH of the previous MAC frame.
- 10 22. The MAC protocol data structure of claim 19, wherein each of a first number of the SCH/LCH pairs in said ULCH and each of a corresponding number of LCH/SCH pairs in a preceding DLCH are associated with a different time critical connection between the MT and the AP, and wherein each of a second
15 number of the SCH/LCH pairs in said ULCH and each of a corresponding number of LCH/SCH pairs in the preceding DLCH are associated with a different non-time critical connection between the MT and the AP.
- 20 23. The MAC protocol data structure of claim 22, wherein the SCH/LCH pairs in said ULCH that are associated with non-time critical connections between the AP and the MT precede each of the SCH/LCH pairs in said ULCH that are associated with time critical connections between the AP and the MT.
- 25 24. The MAC protocol data structure of claim 22, wherein the LCH/SCH pairs in said DLCH that are associated with non-time critical connections between the AP and the MT precede each of the LCH/SCH pairs in said DLCH that are associated with time critical connections between the AP and the MT.



25. The MAC protocol data structure of 22, wherein the order of the SCH/LCH pairs in the ULCH that are associated with the time critical connections is the same as the order of the corresponding LCH/SCH pairs in the preceding DLCH that are associated with the time critical connections.

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26. The MAC protocol data structure of claim 22, wherein the order of the LCH/SCH pairs in the DLCH that are associated with the time critical connections is the same as the order of the corresponding SCH/LCH pairs in the ULCH that are associated with the time critical connections.

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27. The MAC protocol data structure of claim 22, wherein a time critical connection has a retransmission delay requirement of zero (0) MAC data frames.

