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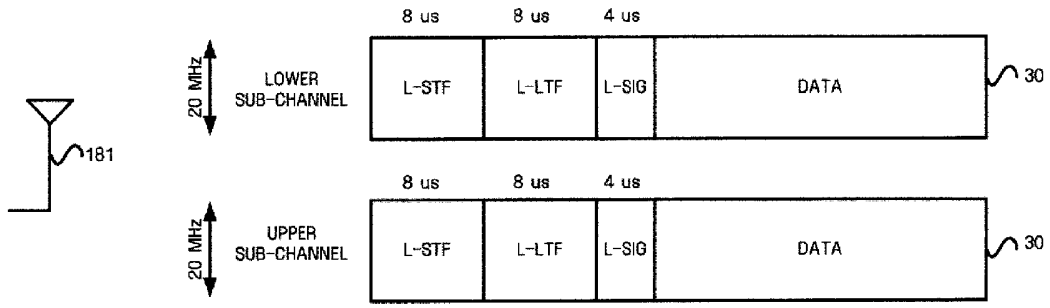
(54) Title: METHOD AND APPARATUS FOR RECEIVING DATA WITH DOWN COMPATIBILITY IN HIGH THROUGHPUT WIRELESS NETWORK



(57) Abstract: A method and apparatus are provided for enabling a legacy station to perform virtual carrier sensing when a plurality of stations with heterogeneous capabilities coexist in a wireless network. The method includes transmitting first data via a bonded channel which is formed by channel bonding first and second adjacent channels, and receiving second data via each of the first and second adjacent channels, the second data comprising a clear-to-send (CTS) frame or a request-to-send (RTS) frame.

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Description

METHOD AND APPARATUS FOR RECEIVING DATA WITH DOWN COMPATIBILITY IN HIGH THROUGHPUT WIRELESS NETWORK

Technical Field

[1] Methods and apparatuses consistent with the present invention relate to transmitting and receiving legacy format data in a high throughput wireless network.

Background Art

[2] Recently, there has been an increasing demand for ultra high-speed communication networks due to widespread public use of the Internet and a rapid increase in the amount of available multimedia data. Since local area networks (LANs) emerged in the late 1980s, the data transmission rate over the Internet has drastically increased from about 1 Mbps to about 100 Mbps. Thus, high-speed Ethernet transmission has gained popularity and wide spread use. Currently, intensive research into a gigabit-speed Ethernet is under way. An increasing interest in the wireless network connection and communication has triggered research into and development of wireless LANs (WLANs), and greatly increased availability of WLANs to consumers. Although use of WLANs may reduce performance due to lower transmission rate and poorer stability as compared to wired LANs, WLANs have various advantages, including wireless networking capability, greater mobility and so on. Accordingly, WLAN markets have been gradually growing.

[3] Due to the need for a higher transmission rate and the development of wireless transmission technology, the initial Institute of Electrical and Electronics Engineers (IEEE) 802.11 standard, which specifies a transfer rate of 1 to 2 Mbps, has evolved into advanced standards including IEEE 802.11a, 802.11b and 802.11g. The IEEE 802.11g standard, which utilizes a transmission rate of 6 to 54 Mbps in the 5 GHz-National Information Infrastructure (NII) band, uses orthogonal frequency division multiplexing (OFDM) as its transmission technology. With an increasing public interest in OFDM transmission and use of a 5 GHz-band, much greater attention is been paid to the IEEE 802.11g standard and OFDM transmission technology than to other wireless standards.

[4] Recently, wireless Internet services using WLAN, so-called 'Nespot,' have been launched and offered by Korea Telecommunication (KT) Corporation of Korea. Nespot services allow access to the Internet using a WLAN according to IEEE 802.11b standard, commonly called Wi-Fi (wireless fidelity). Communication standards for wireless data communication systems, which have been completed and promulgated or

are being researched and discussed, include Wide Code Division Multiple Access (WCDMA), IEEE 802.11x, Bluetooth, IEEE 802.15.3, etc., which are known as 3rd Generation (3G) communication standards. The most widely known, cheapest wireless data communication standard is IEEE 802.11b, a series of IEEE 802.11x. An IEEE 802.11b WLAN standard delivers data transmission at a maximum rate of 11 Mbps and utilizes the 2.4 GHz-Industrial, Scientific, and Medical (ISM) band, which can be used below a predetermined electric field without permission. With the recent widespread use of the IEEE 802.11a WLAN standard, which delivers a maximum data rate of 54 Mbps in the 5 GHz-band by using OFDM, IEEE 802.11g developed as an extension to the IEEE 802.11a standard for data transmission in the 2.4 GHz-band using OFDM and is intensively being researched.

[5] The Ethernet and the WLAN, which are currently being widely used, both utilize a carrier sensing multiple access (CSMA) method. According to the CSMA method, it is determined whether a channel is in use. If the channel is not in use, that is, if the channel is idle, then data is transmitted. If the channel is busy, retransmission of data is attempted after a predetermined period of time has elapsed. A carrier sensing multiple access with collision detection (CSMA/CD) method, which is an improvement of the CSMA method, is used in a wired LAN, whereas a carrier sensing multiple access with collision avoidance (CSMA/CA) method is used in packet-based wireless data communications. In the CSMA/CD method, a station suspends transmitting signals if a collision is detected during transmission. Compared with the CSMA method, which pre-checks whether a channel is occupied before transmitting data, in the CSMA/CD method, the station suspends transmission of signals when a collision is detected during the transmission of signals and transmits a jam signal to another station to inform it of the occurrence of the collision. After the transmission of the jam signal, the station has a random backoff period for delay and restarts transmitting signals. In the CSMA/CD method, the station does not transmit data immediately even after the channel becomes idle and has a random backoff period for a predetermined duration before transmission to avoid collision of signals. If a collision of signals occurs during transmission, the duration of the random backoff period is increased by two times, thereby further lowering a probability of collision.

[6] The CSMA/CA method is classified into physical carrier sensing and virtual carrier sensing. Physical carrier sensing refers to the physical sensing of active signals in the wireless medium. Virtual carrier sensingis performed such that information regarding duration of a medium occupation is set to a media access control (MAC) protocol data unit / physical (PHY) service data unit (MPDU/PSDU) and transmission of data is then started after the estimated duration has elapsed. However, if the MPDU/PSDU cannot be interpreted, the virtual carrier sensing mechanism cannot be adopted.

[7] IEEE 802.11n provides coverage for IEEE 802.11a networks at 5 GHz and IEEE 802.11g networks at 2.4 GHz and enables stations of various data rates to coexist. For operating the stations of various data rates using the CSMA/CA method, the stations must interpret MPDU/PSDU. However, some stations, that is, legacy stations, may not often process data transmitted/received at high rates. In such a case, the legacy stations cannot perform virtual carrier sensing.

[8] FIG. 1 is a data structure of a related art format Physical Layer Convergence Procedure (PLCP) Protocol Data Unit (PPDU) as defined by the IEEE 802.11a protocol. The PPDU includes a PLCP header and Physical Layer Service Data Unit (PSDU). A data rate field 3 and a data length field 4 are used to determine a length of a data field that follows the PLCP header of the PPDU. The data rate field 3 and the data length field 4 are also used to determine the time of the data being received or transmitted, thereby performing virtual carrier sensing . In addition, in a case where a Message Protocol Data Unit (MPDU) is accurately filtered from the received PPDU, a 'Dur/ID' field, which is one field among the header fields of the MPDU, is interpreted and the medium is virtually determined to be busy for an expected use time period of the medium. In a case where a preamble field and a signal field of a PPDU frame being received are only erroneously interpreted, media may attempt data transmission by a backoff at a predetermined Extended Inter-Frame Space (EIFS), which is longer than a Distributed Coordination Function (DCF) Inter-Frame Space (DIFS), so that fairness in media access of all stations available in DCF is not ensured.

[9] In a network where an existing station using a conventional protocol or a legacy station and a High Throughput (HT) station coexist, the legacy station may be upgraded for transmission and reception of HT data. However, a legacy station or a conventional station cannot perform virtual carrier sensing because these stations cannot interpret the 'Dur/ID' field present in the data which was transmitted and received by the HT station.

Disclosure of Invention

Technical Problem

[10] FIG. 2 is a diagram illustrating that a legacy station with a low transmission rate is incapable of performing virtual carrier sensing when a plurality of stations having a variety of transmission capabilities coexist.

[11] A transmitter-side high throughput station (abbreviated as transmitter-side HT STA) 101 is a station complying with the IEEE 802.11n protocols and operating using a channel bonding technique or a multiple input multiple output (MIMO) technique. Channel bonding is a mechanism in which data frames are simultaneously transmitted over two adjacent channels. In other words, according to a channel bonding technique,

since two adjacent channels are bonded during data transmission, channel extension exists. The MIMO technique is one type of adaptive array antenna technology that electrically controls directivity using a plurality of antennas. Specifically, in an MIMO system, directivity is enhanced using a plurality of antennas by narrowing a beam width, thereby forming a plurality of transmission paths that are independent from one another. Accordingly, a data transmission speed of a device that adopts the MIMO system increases as many times as there are antennas in the MIMO system. In this regard, when data is transmitted/received using the channel bonding or MIMO technique, capable stations can read the transmitted/received data but incapable stations, i.e., legacy stations, cannot read the transmitted/received data. Physical carrier sensing enables a physical layer to inform an MAC layer whether a channel is busy or idle by detecting whether the physical layer has received a predetermined level of reception power. Thus, the physical carrier sensing is not associated with interpreting of data transmitted and received.

[12] If the transmitter-side HT STA 101 transmits HT data, a receiver-side HT STA 102 receives the HT data and transmits an HT acknowledgement (Ack) to the transmitter-side HT STA 101 in response to the received HT data. An additional HT STA 103 is able to interpret the HT data and the HT Ack. Assuming a duration in which the HT data and the HT Ack are transmitted and received, is set to a Network Allocation Vector (NAV), the medium is considered as being busy. Then, the additional HT STA 103 waits for an DIFS after the lapse of an NAV period of time, and then performs a random backoff, and finally transmits data.

[13] Meanwhile, a legacy station 201 is a station complying with the IEEE 802.11a, 802.11b, or 802.11g protocols but is incapable of interpreting HT data. Thus, after a duration of the HT Ack is checked by physical carrier sensing, the legacy station 201 waits for the duration of an EIFS and then perform a backoff. Thus, the legacy station 201 waits longer than other stations, that is, the transmitter-side HT STA 101, the receiver-side HT STA 102 and the additional HT STA 103, before being assigned media, thereby adversely affecting data transmission efficiency.

[14] The IEEE 802.11 standard specifies a control response frame, such as an ACK, a Request-to-Send (RTS) or a Clear-to-Send (CTS) frame, is transmitted at the same data rate as the directly previous frame. However, if the control response frame cannot be transmitted at the same data rate as the directly previous frame, it must be transmitted at a highest rate in a basic service set (BSS) as specified in the IEEE 802.11 standard. In addition, unlike the legacy format data, the HT data has HT preamble and HT signal fields added thereto, which leads to an increase in the overhead of an PPDU, which may cause the ACK frame to result in deteriorated performance compared to the legacy format PPDU. That is to say, the length of the legacy format PPDU complying

with the IEEE 802.11a standard is approximately 20 μs while the length of a newly defined HT PPDU is 40 μ s or greater.

Technical Solution

[15] Consequently, there exists a need for enhancing performance of network utilization by transmitting legacy format data, e.g., an ACK frame, without an HT preamble when a legacy station cannot interpret data transmitted from an HT station, which may prevent virtual carrier sensing from being performed properly.

[16] The present invention provides a method and apparatus for enabling a station with low capability to perform virtual carrier sensing when a plurality of stations with heterogeneous capabilities coexist in a wireless network.

[17] The present invention also provides a method and apparatus for transmitting short data for high efficiency.

[18] According to an aspect of the present invention, there is provided a method of transmitting data in a wireless network, the method comprising accessing the wireless network, transmitting first data to first station using channel bonding, and receiving second data from respective channels associated with the channel bonding, the second data being a CTS frame or an RTS frame.

[19] According to yet another aspect of the present invention, there is provided a wireless network apparatus comprising a transmitting unit that accesses a wireless network and transmits first data to a first station accessed to the wireless network using channel bonding, and a receiving unit that receives second data from respective channels associated with the channel bonding, the second data being a CTS frame or an RTS frame.

Description of Drawings

[20] The above and other aspects of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings in which:

[21] FIG. 1 is a schematic diagram of a related art format PPDU as defined by the IEEE 802.11 protocol;

[22] FIG. 2 is a diagram illustrating that a legacy station with a low transmission rate is incapable of performing virtual carrier sensing when a plurality of stations having a variety of transmission capabilities coexist;

[23] FIG. 3 is a diagram illustrating a method of transmitting a response frame according to an exemplary embodiment of the present invention;

[24] FIGS. 4A and 4B are diagrams illustrating data structures of a PPDU transmitted and received by an HT station;

[25] FIG. 5 is a diagram showing a procedure in which a receiving unit transmits a

legacy response frame when a transmitting unit transmits an HT data using channel bonding according to an exemplary embodiment of the present invention;

[26] FIG. 6 is a diagram showing a procedure in which a receiving unit transmits a legacy response frame when a transmitting unit transmits an HT data using channel bonding according to another exemplary embodiment of the present invention;

[27] FIG. 7 is a diagram showing a procedure in which a receiving unit transmits a legacy response frame when the transmitting unit transmits an HT data without using channel bonding;

[28] FIG. 8 is a schematic illustrating an HT station of transmitting legacy format data according to an embodiment of the present invention; and

[29] FIG. 9 is a flowchart illustrating a procedure in which an HT station receives an HT frame and transmits a legacy frame as a response frame according to an exemplary embodiment of the present invention..

Mode for Invention

[30] The present invention and methods of accomplishing the same may be understood more readily by reference to the following detailed description of exemplary embodiments and the accompanying drawings. The present invention may, however, be embodied in many different forms and should not be construed as being limited to exemplary embodiments set forth herein. Rather, these exemplary embodiments are provided so that this disclosure will be thorough and complete and will fully convey the concept of the invention to those skilled in the art, and the present invention will only be defined by the appended claims. Like reference numerals refer to like elements throughout the specification.

[31] A method and apparatus for transmitting and receiving legacy format data in an HT wireless network is described hereinafter with reference to flowchart illustrations of methods according to exemplary embodiments of the invention. It will be understood that each block of the flowchart illustrations, and combinations of blocks in the flowchart illustrations, can be implemented by computer program instructions. These computer program instructions can be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which are executed via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions specified in the flowchart block or blocks.

[32] These computer program instructions may also be stored in a computer usable or computer-readable memory that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer usable or computer-readable memory produce an article of manufacture including instruction means that implement the function specified in the

flowchart block or blocks.

[33] The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer implemented process such that the instructions that are executed on the computer or other programmable apparatus provide steps for implementing the functions specified in the flowchart block or blocks.

[34] Each block of the flowchart illustrations may represent a module, segment, or portion of code, which comprises one or more executable instructions for implementing the specified logical functions. It should also be noted that in some alternative implementations, the functions noted in the blocks may occur out of the order. For example, two blocks shown in succession may in fact be executed substantially concurrently or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved.

[35] HT wireless networks according to exemplary embodiments of the present invention include wireless networks capable of transmitting and receiving HT data, e.g., an HT wireless network complying with the IEEE 802.11n protocol, a wireless network having compatibility with one of the legacy format IEEE 802.11a, 802.11b, and 802.11g standards, and so on.

[36] FIG. 3 is a diagram illustrating a method of transmitting a response frame according to an exemplary embodiment of the present invention.

[37] Referring to FIG. 3, a transmitter-side HT STA 101, a receiver-side HT STA 102, an additional HT STA 103, and a legacy station 201 exist in a wireless network. In operation S10, the transmitter-side HT STA 101 transmits HT data to the receiver-side HT STA 102. As stated above, the HT data is transmitted at a high rate using a channel bonding or MIMO technique. The HT stations include stations enabling high rate data transmission, e.g., stations in compliance with the IEEE 802.11n protocol. Since the receiver-side HT STA 102 and the additional HT STA 103 can interpret HT data, they perform virtual carrier sensing. However, since the legacy station 201 is not capable of interpreting HT data, it cannot perform virtual carrier sensing. Instead, the legacy station determines that a medium is currently busy, thereby performing physical carrier sensing. After completing of transmission of the HT data, operation S11 begins and the legacy station 201 waits for the duration of an EIFS before it performs a backoff.

[38] If the transmitter-side HT STA 101 completes transmission of the HT data, the procedure goes to operation S11. At this time, the receiver-side HT STA 102 transmits a legacy Ack after a duration of a short inter-frame space (SIFS) to the transmitter-side HT STA 101. The legacy Ack is a response frame generated according to the IEEE 802.11a, 802.11b, or 802.11g protocol. The legacy Ack can be transmitted to and

received from both a legacy station and an HT station. After receiving each legacy Ack, each of the HT stations 101, 102, and 103 capable of interpreting a legacy response frame goes to operation S12 after the duration of a DIFS, and then performs a backoff procedure.

[39] In addition, since the legacy station 201 is capable of interpreting a legacy Ack frame but incapable of interpreting HT data, it is allowed to wait for the duration of the DIFS in o peration S12 to prohibit the legacy station 201 from performing the backoff procedure. Consequently, the legacy station 201 is able to participate in the backoff procedure as well as the HT stations 101, 102, and 103, thereby avoiding performance deterioration.

[40] FIGS. 4A and 4B are diagrams illustrating a data structure of a PPDU transmitted and received by an HT station.

[41] The HT station enables data transmission and reception in two ways, both of which start with legacy preambles, so that a legacy station can interpret data transmitted/ received by the HT station with legacy preamble.

[42] As shown in FIG. 4A, a legacy format PPDU 30 includes a legacy preamble including a Legacy Short Training Field (L-STF), a Legacy Long Training Field (L-LTF) and a Legacy Signal Field (L-SIG), and a Legacy Data (DATA) payload. Similar to FIG. 1, the L-SIG includes RATE, Reserved, LENGTH, and Parity fields. The legacy format PPDU 30 has the DATA payload following the L-STF, L-LTF, L-SIG fields containing information regarding power management, signal and so on, respectively. Thus, the legacy format PPDU 30 can be interpreted by both an HT station and a legacy station.

[43] As shown in FIG. 4B, when a PPDU 40 has an HT preamble added to a legacy preamble, the HT station considers the PPDU 40 as being HT data. The HT preamble contains information regarding HT data. The HT preamble consists of an HT signal field (HT-SIG), an HT short training field (HT-STF), and an HT long training field (HT-LTF). In detail, the HT-SIG consists of multiple fields including a LENGTH field defining a length of HT data, an MCS field defining modulation and coding schemes, an Advanced coding field specifying the presence of advanced coding, a Sounding packet field indicating whether transmission has been performed on all antennas, a number HT-LTF field specifying the number of HT-LTFs in a transmitted PPDU, a Short GI field specifying a short guard interval in a data region of a frame, a ScramblerINIT field specifying an initial value of a scrambler, 20/40 indicating whether the PPDU is converted into a signal at a bandwidth of 20 or 40 MHz, a CRC field for error checking, and a Tail field. As shown in FIG. 4B, HT-SIG, HT-STF, HT-SIG, ..., HT-LTF, each contain a specific number of bits, followed by HT data.

[44] As shown in FIG. 4B, if short data is transmitted in the HT PPDU 40, a con-

siderable increase in the HT preamble is caused, thereby significantly increasing overhead. Thus, in order to transmit frames including only short data, e.g., Ack or control frames, it is efficient to use the legacy PPDU 30. In addition, the legacy PPDU 30 enables a legacy station to perform virtual carrier sensing when the legacy station exists in a wireless network.

[45] FIG. 5 is a diagram showing a procedure in which a receiving unit transmits a legacy response frame when a transmitting unit transmits an HT data using channel bonding according to an exemplary embodiment of the present invention.

[46] When a transmitting unit selects two adjacent channels of a current channel, that is, the current channel and a directly next channel or a directly previous channel and the current channel, bonded to each other, and transmits the same to a receiving unit, the receiving unit receives the same and transmits a legacy Ack to each channel. FIG. 5 shows an example in which each antenna is incapable of handling different channels. A receiver-side HT STA employs an overlap mode in which data containing a legacy response frame 30 overlaps from a lower sub-channel to an upper sub-channel through a single antenna 181. In such an instance, the legacy response frame 30 can be transmitted through the upper and lower sub-channels. In addition, the legacy response frame 30 can be received by HT stations and legacy stations existing in the upper and lower sub-channels. A PPDU including a legacy response frame consists of an L-STF (Legacy Short Training Field), an L-LTF (Legacy Long Training Field), an L-SIG (Legacy Signal Field), and a DATA (Legacy Data) payload, as described above with reference to FIG. 4.

[47] FIG. 6 is a diagram showing a procedure in which a receiving unit transmits a legacy response frame when a transmitting unit transmits an HT data using channel bonding according to another exemplary embodiment of the present invention, in which antennas 181 and 182 transmit data to different channels, unlike in FIG. 5.

[48] When the transmitting unit selects two adjacent channels of a current channel, that is, the current channel and a directly next channel or a directly previous channel and the current channel, bonded to each other, and transmits the same to the receiving unit, the receiving unit receives the same and transmits a legacy Ack to either channel. Unlike in FIG. 5, the respective antennas 181 and 182 are capable of handling different channels. The receiving unit accesses lower and upper sub-channels using the respective antennas 181 and 182 and transmits the same legacy Ack frame 300. A structure of a legacy format frame is the same as described in FIG. 4.

[49] Legacy format data is simultaneously transmitted to both a control channel and an extension channel in response to a frame transmitted using channel bonding, as shown in FIG. 5 and 6, which allows the legacy format data to be received by stations in the extension channel as well.

[50] FIG. 7 is a diagram showing a procedure in which a receiver-side HT station transmits a legacy response frame when the transmitter-side HT station transmits HT data using an MIMO technique according to an exemplary embodiment of the present invention.

[51] When the transmitter-side HT station transmits HT data using an MIMO technique, the receiver-side HT station utilizes one antenna 181 to transmit a legacy response frame via a current channel. The transmitter-side HT station is capable of receiving the legacy response frame received through the current channel. Other HT stations can interpret the legacy response frame to enable virtual carrier sensing. Further, legacy stations communicating via the current channel can also interpret the legacy response frame to enable virtual carrier sensing. A structure of a legacy format frame is the same as described in FIG. 4A.

[52] [01] As illustrated in FIGS. 5 through 7, the receiver-side HT STA 102 transmits the legacy PPDU 30 in various manners according to the transmission method employed by the transmitter-side HT STA 101. The receiver-side HT STA 102 can be informed of the transmission method employed by the transmitter-side HT STA 101 from MCS values in the HT-SIG field of the HT PPDU shown in FIG. 4B. That is, the number of antennas used in data transmission or the number of spatial streams, modulation schemes used, coding rate, guard interval, and use or non-use of channel bonding (40 MHz) can be deduced from the MCS values enumerated in the Table below. Table 1 illustrates an exemplary modulation and coding scheme (MCS) table.

[53]

Table 1

MCS	Number of streams	Modulation schemes	Coding rate	GI = 800ns		GI = 400ns	
				20MHz	40MHz	20MHz	40MHz
0	1	BPSK	1/2	6.50	13.50	7.22	15.00
1	1	QPSK	1/2	13.00	27.00	14.44	30.00
2	1	QPSK	3/4	19.50	40.50	21.67	45.00
3	1	16-QAM	1/2	26.00	54.00	28.89	60.00
4	1	16-QAM	3/4	39.00	81.00	43.33	90.00
5	1	64-QAM	2/3	52.00	108.00	57.78	120.00
6	1	64-QAM	3/4	58.50	121.50	65.00	135.00
7	1	64-QAM	5/6	65.00	135.00	72.22	150.00
8	2	BPSK	1/2	13.00	27.00	14.44	30.00
9	2	QPSK	1/2	26.00	54.00	28.89	60.00
10	2	QPSK	3/4	39.00	81.00	43.33	90.00
11	2	16-QAM	1/2	52.00	108.00	57.78	120.00
12	2	16-QAM	3/4	78.00	162.00	86.67	180.00
13	2	64-QAM	2/3	104.52	216.00	116.13	240.00
14	2	64-QAM	3/4	117.00	243.00	130.00	270.00
15	2	64-QAM	5/6	130.00	270.00	144.44	300.00
16	3	BPSK	1/2	19.50	40.50	21.67	45.00

[54] An HT station can transmit not only the Ack frame but also an PPDU of a control frame including short data such as a CTS frame or an RTS frame. During legacy format transmission, it is not necessary add an HT preamble to the data, a legacy station can perform virtual carrier sensing, thereby reducing overhead.

[55] In a case of a considerable amount of data, an HT format PPDU is transmitted. In a case of short data, that is, a small amount of data, e.g., a control frame, a legacy format PPDU is transmitted, thereby reducing a total amount of data transmitted and received in the overall wireless network and implementing a wireless network in which the HT station and a legacy station coexist.

[56] The term 'unit' as used herein, means, but is not limited to, a software or hardware component or module, such as a Field Programmable Gate Array (FPGA) or Application Specific Integrated Circuit (ASIC), which performs certain tasks. A unit may advantageously be configured to reside on the addressable storage medium and configured to be executed on one or more processors. Thus, a unit may include, by way of example, components, such as software components, object-oriented software components, class components and task components, processes, functions, attributes,

procedures, subroutines, segments of program code, drivers, firmware, microcode, circuitry, data, databases, data structures, tables, arrays, and variables. The functionality provided for in the components and units may be combined into fewer components and modules or further separated into additional components and units. In addition, the components and units may be implemented such that they are executed on one or more CPUs in a communication system.

[57] FIG. 8 is a schematic illustrating an HT station which transmits legacy format data according to an exemplary embodiment of the present invention. The HT station 100 includes a transmitting unit 110, a receiving unit 120, an encoding unit 130, a decoding unit 140, a controlling unit 150, a legacy transmission controlling unit 160, and two antennas 181 and 182. The antennas 181 and 182 receive and transmit wireless signals.

[58] The transmitting unit 110 transmits signals to the antennas 181 and 182, and the encoding unit 130 encodes data to generate signals to be transmitted to the antennas 181 and 182 by the transmitting unit 110. In order to transmit signals via two or more antennas using an MIMO technique, the signal data must be divided and then encoded separately. Alternatively, in order to transmit signals using channel bonding, the transmitting unit 110 selects two adjacent channels, including a current channel and a directly next channel or a directly previous channel, to be bonded to each other, and transmits the signals via the bonded channels.

[59] The receiving unit 120 receives signals from the antennas 181 and 182, and the decoding unit 140 decodes the signals received by the receiving unit 120 into data. When the data is received using an MIMO technique, it is necessary to integrate the data transmitted via the two channels.

[60] The legacy transmission controlling unit 160 controls short-length data, e.g., an Ack frame, a CTS frame, or an RTS frame, to be transmitted in a legacy format. The control unit 150 manages and controls the exchange of information among various elements of the HT station 100.

[61] FIG. 9 is a flowchart illustrating a procedure in which an HT station receives an HT frame and transmits a legacy frame as a response frame according to an exemplary embodiment of the present invention.

[62] The HT station accesses a wireless network in operation S301. In this case, the accessing the wireless network encompasses not only accessing an existing wireless network but also newly generating a wireless network. In an exemplary embodiment, operation S301 may include generating a basic service set (BSS), e.g., an Access Point (AP). Next, a first station existing in the wireless station receives first data compliant with a first protocol in operation S302. The first protocol includes protocols transmitted and received in an HT format, e.g., the IEEE 802.11n protocols. In addition, the first protocol may include protocols having downward compatibility with

legacy format protocols.

[63] The term 'downward compatibility' used herein means that an upgraded protocol or software is compatible with past proposed protocols or software. For example, the IEEE 802.11n protocols can interpret data that is transmitted and received in the IEEE 802.11a, 802.11b, or 802.11g protocol, and can transmit/receive HT data in the IEEE 802.11a, 802.11b, or 802.11g protocol. The same is true when upgraded software is available to allow data generated from existing version software to be interpreted or managed.

[64] After receiving the first data, it is determined whether the first data is transmitted using channel bonding in operation S310. If the first data is transmitted using channel bonding (YES in operation S310), second data compliant with a second protocol is transmitted via the respective channels used in channel bonding in operation S320. According to the second protocol, frames that can be interpreted by legacy stations receiving channels associated in channel bonding are transmitted. Thus, if the first protocol is compliant with the IEEE 802.11n, the second protocol includes protocols with which the IEEE 802.11n protocol is downward compatible, e.g., IEEE 802.11a, 802.11b, 802.11g, or the like. The transmission procedures have been described above with reference to FIG. 5.

[65] If the first data is transmitted without using channel bonding (NO in operation S310), that is, if the first data is transmitted using, e.g., an MIMO technique, second data compliant with the second protocol is transmitted in operation S330. The transmission procedure has been described above with reference to FIG. 6. As described above, the second protocol includes protocols with which the first protocol is downward compatible.

[66] The wireless network shown in FIG. 8 may be an BSS with an AP, or an Independent Basic Service Set (IBSS) without an AP. The second data is short data including control frames, such as Ack, CTS, RTS, etc.

[67] The second data can be interpreted by legacy stations, so that the legacy stations can perform virtual carrier sensing. Accordingly, the use of the second data enhances transmission efficiency in a wireless network without legacy stations.

Industrial Applicability

[68] As described above, according to exemplary embodiments of the present invention, when HT stations and legacy stations each having different transmission capabilities coexist in a wireless network, the legacy stations can perform virtual carrier sensing.

[69] In addition, according to exemplary embodiments of the present invention, short data is transmitted in a legacy format, thereby enhancing transmission efficiency.

[70] It will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of

the present invention as defined by the following claims. Therefore, it is to be appreciated that the above described exemplary embodiments are for purposes of illustration only and not to be construed as a limitation of the invention. The scope of the invention is given by the appended claims, rather than the preceding description, and all variations and equivalents which fall within the range of the claims are intended to be embraced therein.

Claims

[1] A method for receiving data at a station in a wireless network, the method comprising:
transmitting first data via a bonded channel which is formed by channel bonding first and second adjacent channels; and
receiving second data via each of the first and second adjacent channels, the second data comprising a clear-to-send (CTS) frame or a request-to-send (RTS) frame.

[2] The method of claim 1, wherein the wireless network is compliant with the IEEE 802.11n standard.

[3] The method of claim 2, wherein the first data is compliant with the IEEE 802.11n standard.

[4] The method of claim 3, wherein the second data is compliant with the IEEE 802.11a standard, the IEEE 802.11b standard or the IEEE 802.11g standard.

[5] The method of claim 4, wherein the second data is received in a Physical Layer Convergence Procedure (PLCP) Protocol Data Unit.

[6] The method of claim 1, wherein the receiving of the second data comprises separately and simultaneously receiving the second data via each of the first and second adjacent channels.

[7] The method as claimed in claim 1, wherein the first data is compliant with a first protocol and the second data is compliant with a second protocol, and the first protocol is downward compatible with the second protocol.

[8] The method as claimed in claim 1, wherein the station is compliant with the IEEE 802.11n protocol.

[9] A wireless network apparatus comprising:
a transmitting unit that transmits first data via a bonded channel which is formed by channel bonding first and second adjacent channels; and
a receiving unit that receives second data via each of the first and second adjacent channels, the second data comprising a clear to send (CTS) frame or a request to send (RTS) frame.

[10] The wireless network apparatus of claim 9, wherein the wireless network is compliant with the IEEE 802.11n standard.

[11] The wireless network apparatus of claim 9, wherein the first data is compliant with the IEEE 802.11n standard.

[12] The wireless network apparatus of claim 9, wherein the second data is data compliant with the IEEE 802.11a standard, the IEEE 802.11b standard, or the IEEE 802.11g standard.

[13] The wireless network apparatus of claim 11, wherein the second data is received in a Physical Layer Convergence Procedure (PLCP) Protocol Data Unit.

[14] The wireless network apparatus of claim 9, wherein the second data, which is received by the receiving unit, is separately and simultaneously received via each of the first and second channels.

[15] The wireless network apparatus as claimed in claim 9 , wherein the first data is compliant with a first protocol and the second data is compliant with a second protocol, wherein the first protocol is downward compatible with the second protocol.

FIG. 1

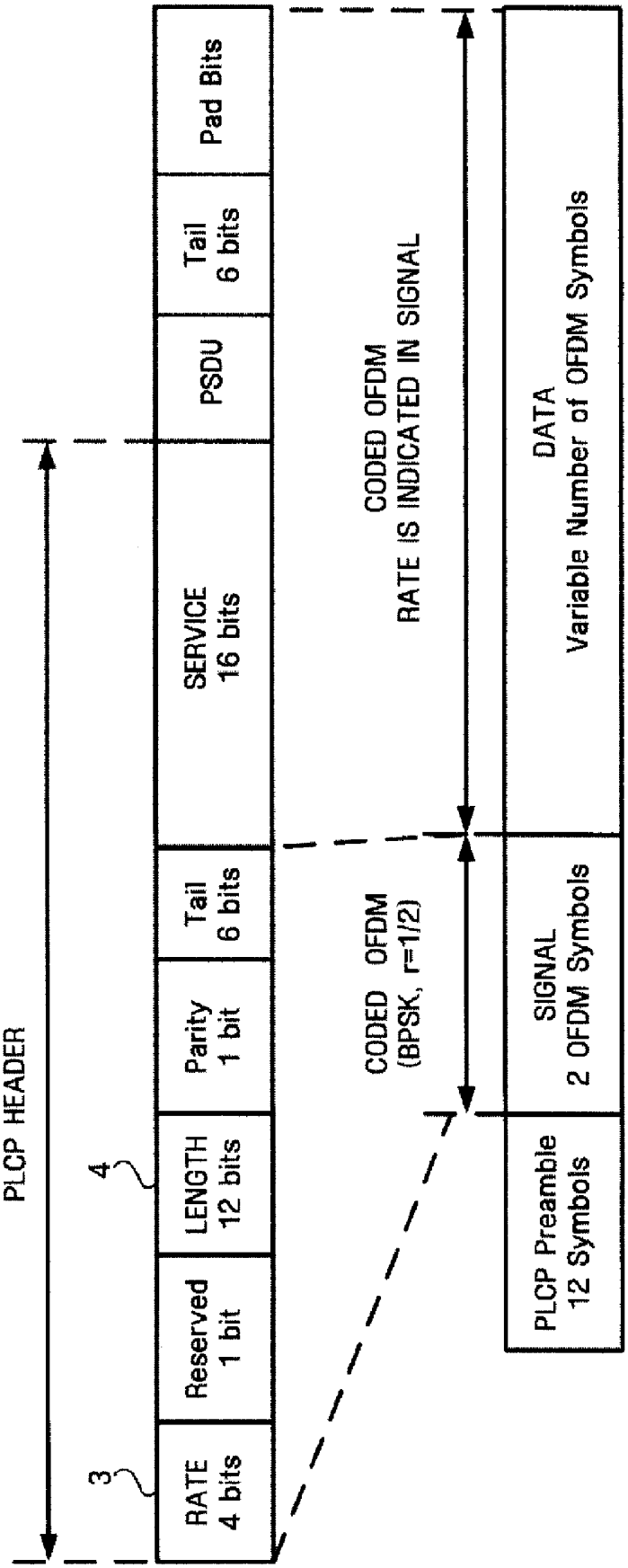

PLCP HEADER
3
4
RATE 4 bits
Reserved 1 bit
LENGTH 12 bits
Parity 1 bit
Tail 6 bits
SERVICE 16 bits
PSDU
Tail 6 bits
Pad Bits
CODED OFDM (BPSK, r=1/2)
CODED OFDM RATE IS INDICATED IN SIGNAL
PLCP Preamble 12 Symbols
SIGNAL 2 OFDM Symbols
DATA Variable Number of OFDM Symbols

FIG. 2

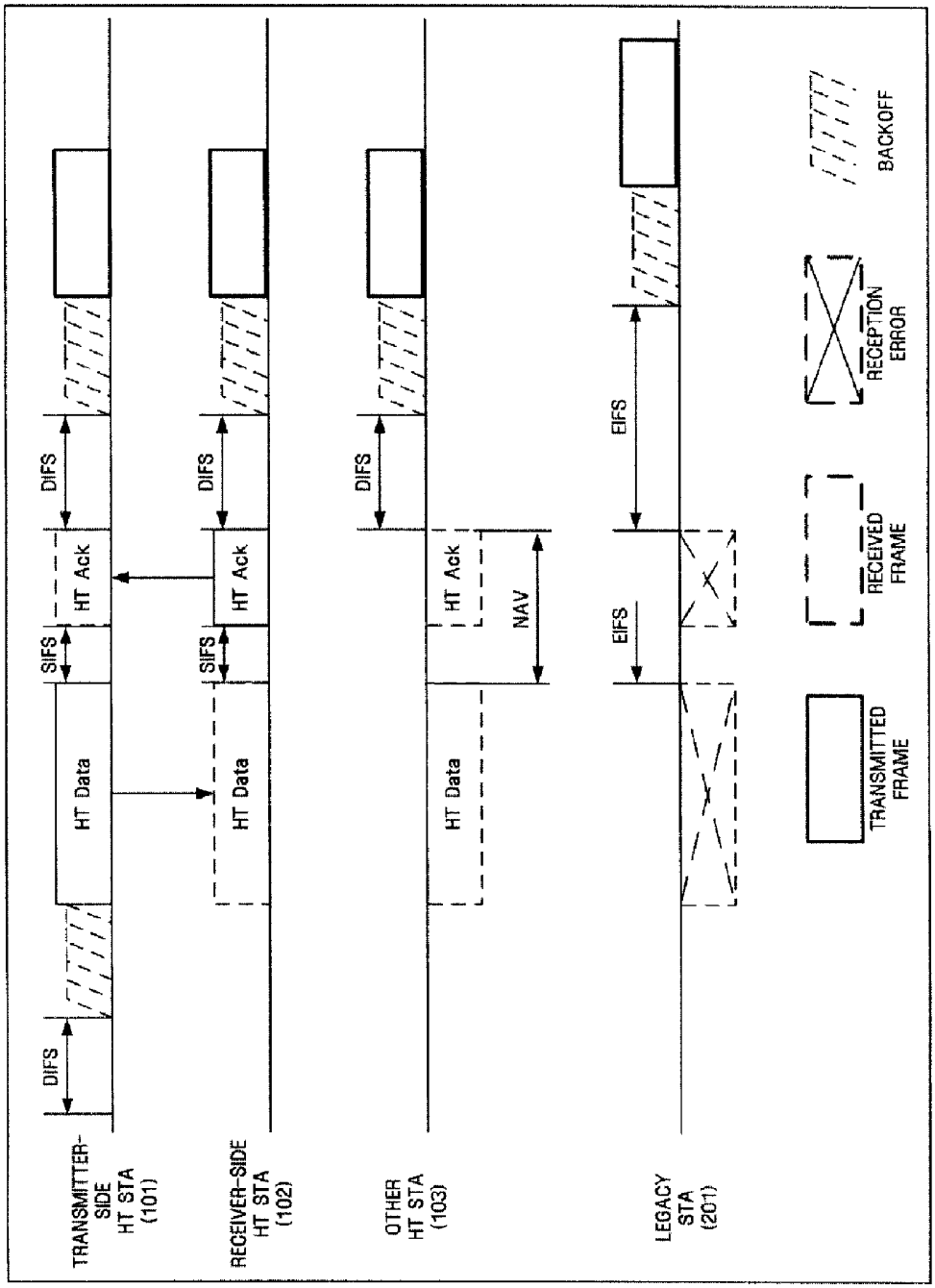

TRANSMITTER-SIDE HT STA (101)
RECEIVER-SIDE HT STA (102)
OTHER HT STA (103)
LEGACY STA (201)
DIFS
SIFS
HT Data
HT Ack
NAV
EIFS
BACKOFF
RECEPTION ERROR
RECEIVED FRAME
TRANSMITTED FRAME

FIG. 3

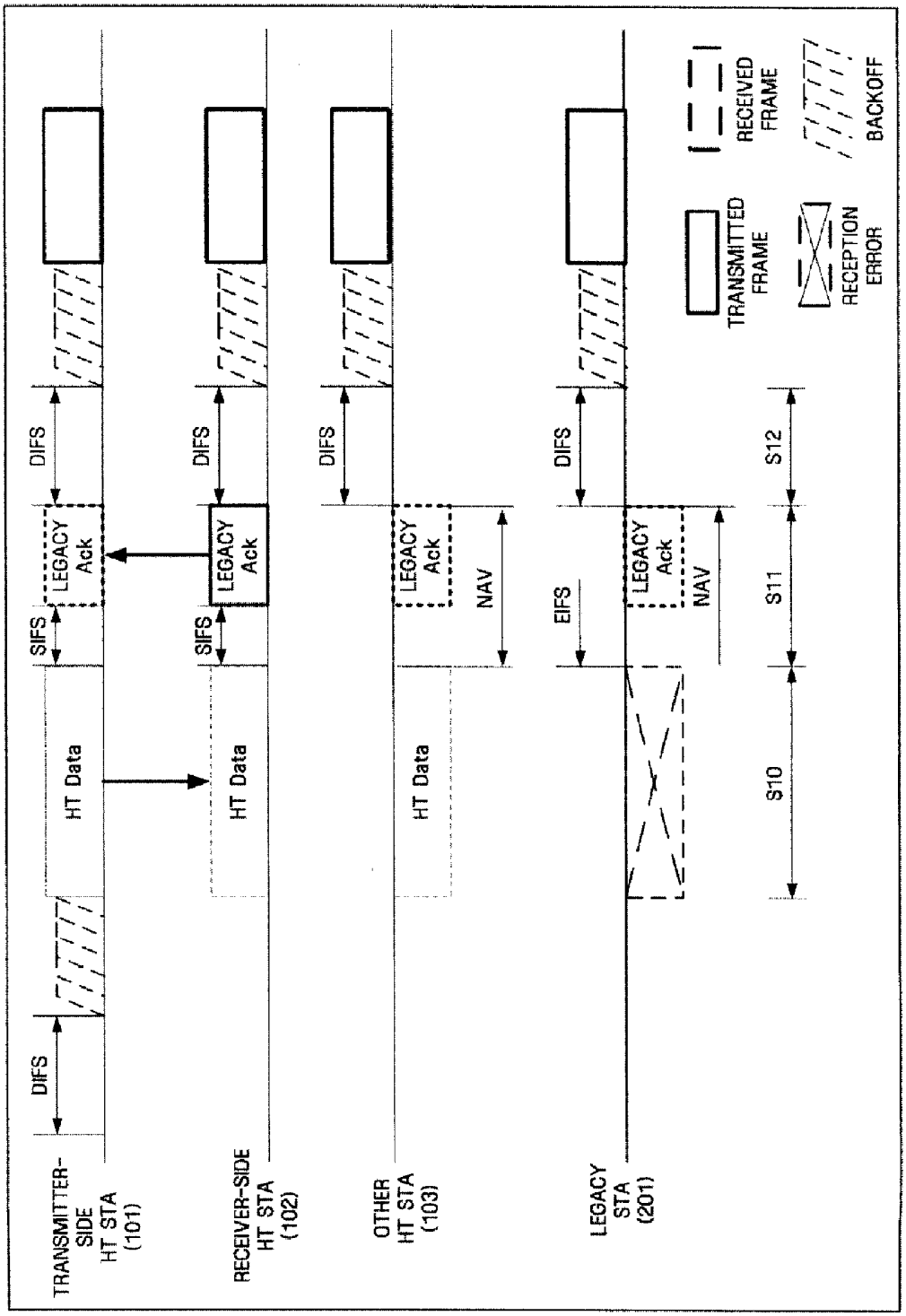

TRANSMITTER-SIDE HT STA (101)
RECEIVER-SIDE HT STA (102)
OTHER HT STA (103)
LEGACY STA (201)
DIFS
SIFS
EIFS
LEGACY Ack
HT Data
NAV
S10
S11
S12
TRANSMITTED FRAME
RECEIVED FRAME
RECEPTION ERROR
BACKOFF

FIG. 4A

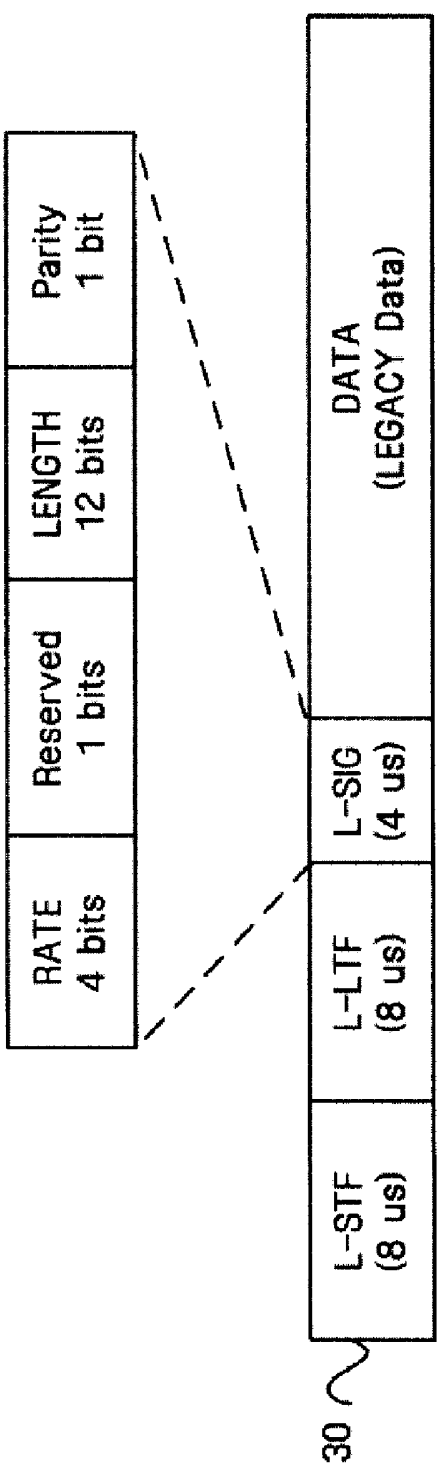

RATE
4 bits
Reserved
1 bits
LENGTH
12 bits
Parity
1 bit
L-STF
(8 us)
L-LTF
(8 us)
L-SIG
(4 us)
DATA
(LEGACY Data)
30

FIG. 4B

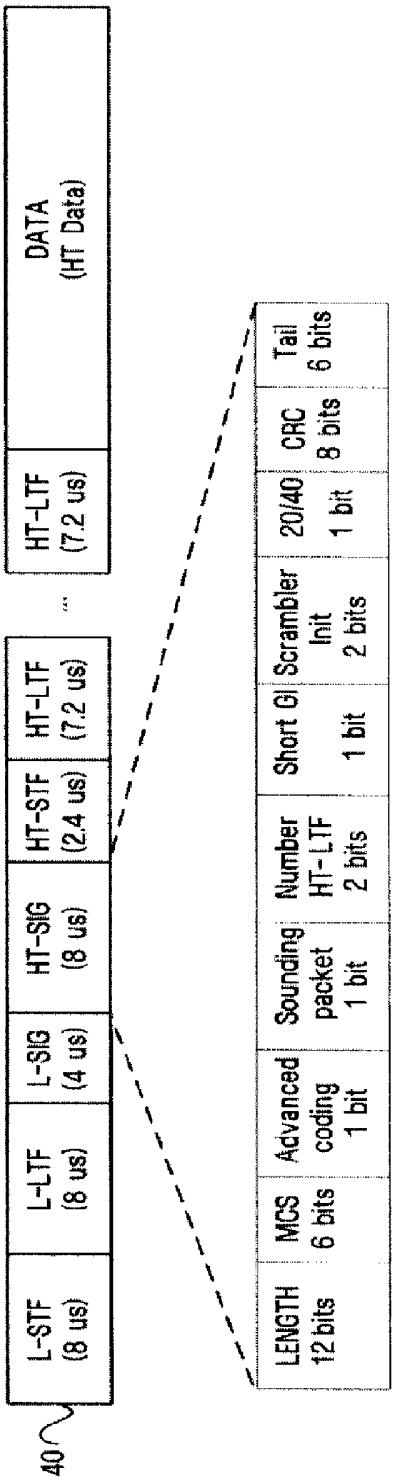

L-STF
(8 us)
L-LTF
(8 us)
L-SIG
(4 us)
HT-SIG
(8 us)
HT-STF
(2.4 us)
HT-LTF
(7.2 us)
...
HT-LTF
(7.2 us)
DATA
(HT Data)
40
LENGTH
12 bits
MCS
6 bits
Advanced
coding
1 bit
Sounding
packet
1 bit
Number
HT-LTF
2 bits
Short GI
1 bit
Scrambler
Init
2 bits
20/40
1 bit
CRC
8 bits
Tail
6 bits

FIG. 5

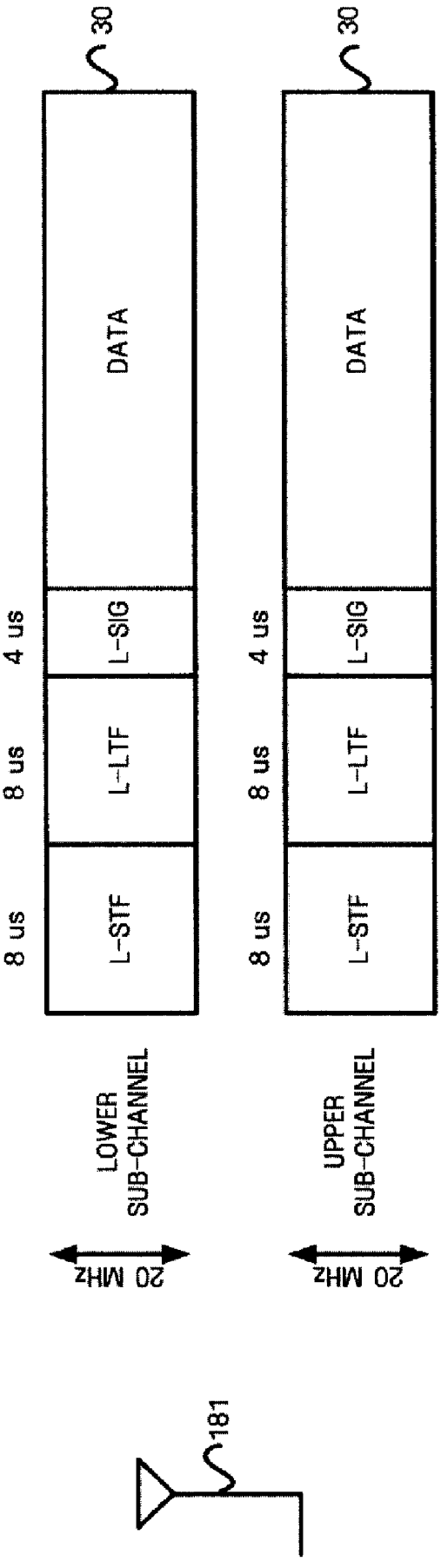

30
30
DATA
DATA
L-SIG
L-SIG
L-LTF
L-LTF
L-STF
L-STF
4 us
8 us
8 us
8 us
LOWER SUB-CHANNEL
UPPER SUB-CHANNEL
20 MHz
20 MHz
181

FIG. 6

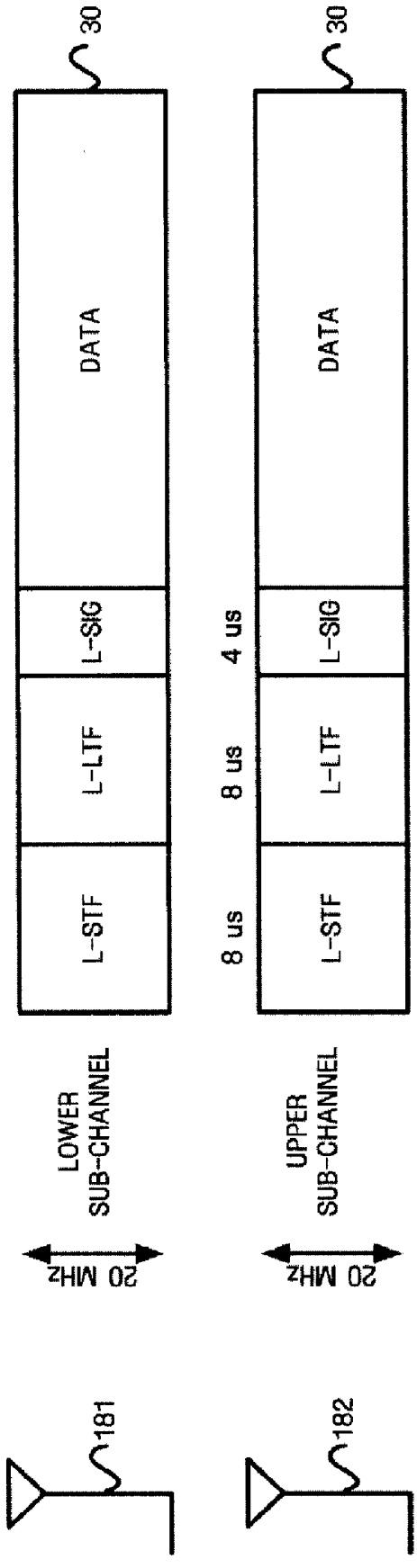

30
DATA
L-SIG
L-LTF
L-STF
4 us
8 us
8 us
LOWER SUB-CHANNEL
UPPER SUB-CHANNEL
20 MHz
181
182

FIG. 7

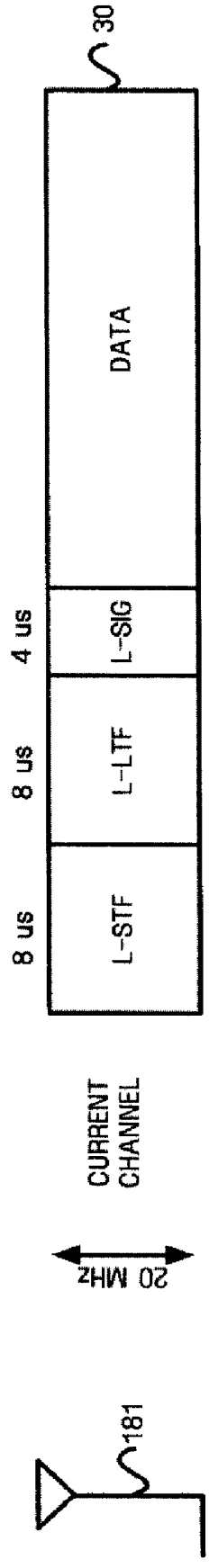

30
DATA
L-SIG
L-LTF
L-STF
4 us
8 us
8 us
CURRENT CHANNEL
20 MHz
181

FIG. 8

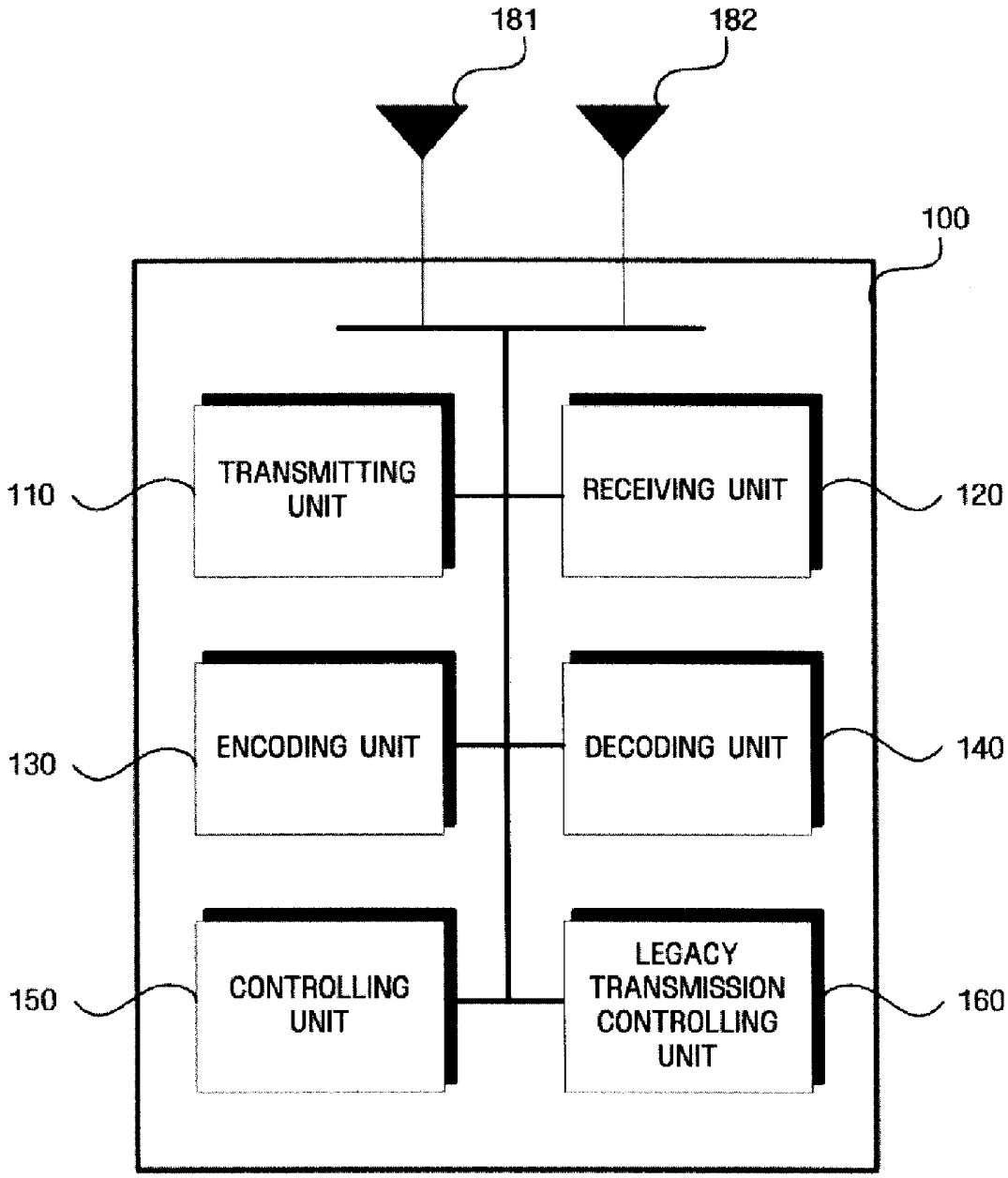
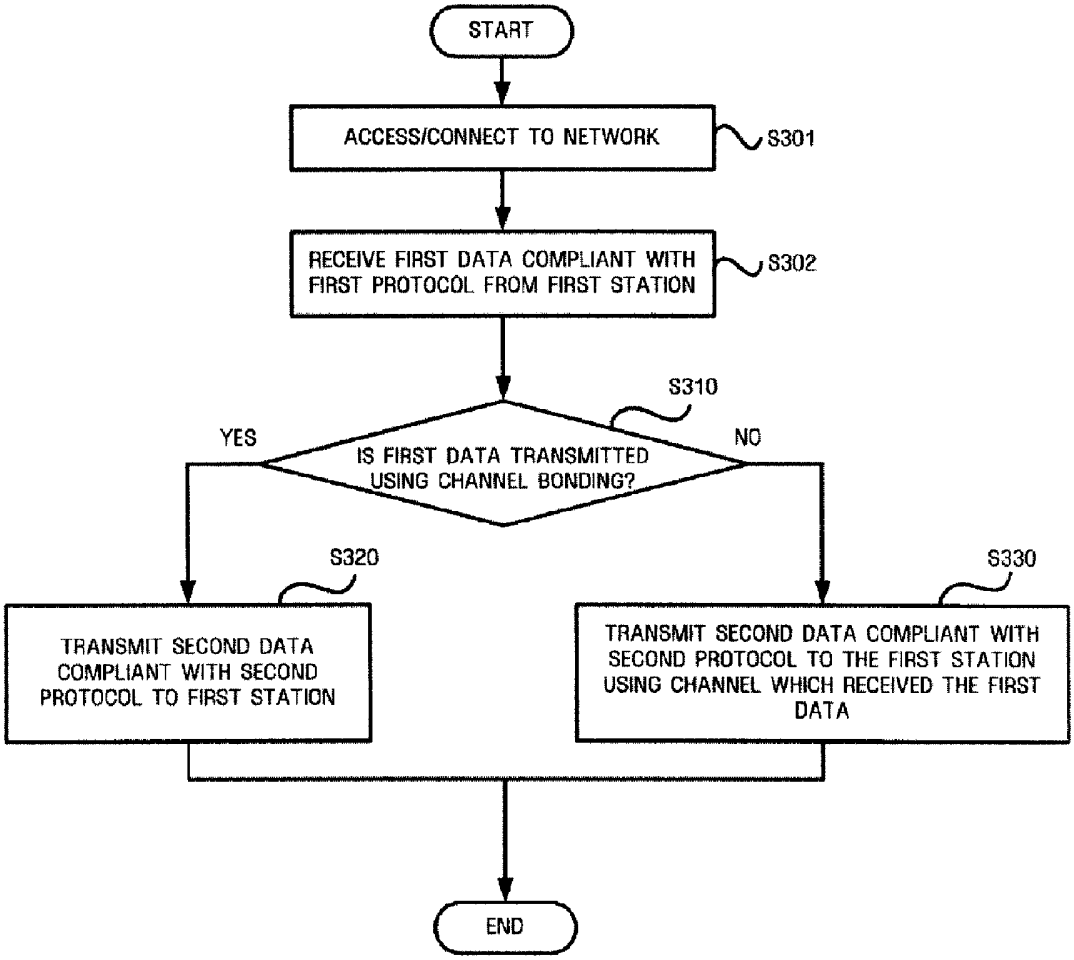

181
182
100
TRANSMITTING UNIT
110
RECEIVING UNIT
120
ENCODING UNIT
130
DECODING UNIT
140
CONTROLLING UNIT
150
LEGACY TRANSMISSION CONTROLLING UNIT
160

FIG. 9


START
ACCESS/CONNECT TO NETWORK
S301
RECEIVE FIRST DATA COMPLIANT WITH FIRST PROTOCOL FROM FIRST STATION
S302
S310
IS FIRST DATA TRANSMITTED USING CHANNEL BONDING?
YES
NO
S320
TRANSMIT SECOND DATA COMPLIANT WITH SECOND PROTOCOL TO FIRST STATION
S330
TRANSMIT SECOND DATA COMPLIANT WITH SECOND PROTOCOL TO THE FIRST STATION USING CHANNEL WHICH RECEIVED THE FIRST DATA
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2006/002212

A. CLASSIFICATION OF SUBJECT MATTER

H04L 29/06(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC8 H04L 29/06, H04L 12/56, H04B 1/38

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS(KIPO internal), Keyword "bond, combine, channel, link, cts, rts, clear-to-send, request-to-send"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 05/018180 A1 (INTEL CORPORATION) 24 FEBURARY 2005 see abstract, page 2 : 27-page 3 : 16, page 4 : 9-22	1 -15
A	EP 1202515 A2 (SHARP KABUSHIKI KAISHA) 02 MAY 2002 see description [0005]	1 -15
A	US 2002-197998 A (DOMINIK J. SCHMIDT) 26 DECEMBER 2002 see abstract, [0017],[0019],[0037]	1 -15
A	US 5856999 B (MOTOROLA INC.) 05 JANUARY 1999 see abstract, column 1 : 50-57	1 -15
A	US 6393032 B (NEC CORPORATION) 21 MAY 2002 see abstract. column 3 : 6-19, column 6 : 21-40, claim 2	1 -15

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 SEPTEMBER 2006 (26.09.2006)	**27 SEPTEMBER 2006 (27.09.2006)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office 920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea	IN, Chi Bock
Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-8533

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2006/002212

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		WO2005015812A1	17.02.2005
		WO2005015843A1	17.02.2005
		WO2005015844A1	17.02.2005
		WO2005015846A2	17.02.2005
		WO2005015847A2	17.02.2005
		WO2005015848A1	17.02.2005
		WO2005015866A1	17.02.2005
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