

CERTIFICATE OF TRANSLATION ACCURACY

I am a professional translator, reviewer, and coordinator specializing in translating Korean, Japanese and Chinese to English and vice versa.

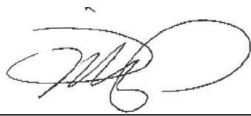
I served as Chief Examiner of the certified court interpreter test for the State of California and as a contract translator and interpreter for various federal agencies through the U.S. Department of State for more than a decade. I served as an instructor at the University of California at Berkeley and the Middlebury Institute of International Studies at Monterey (MIIS) Graduate Program in Translation.

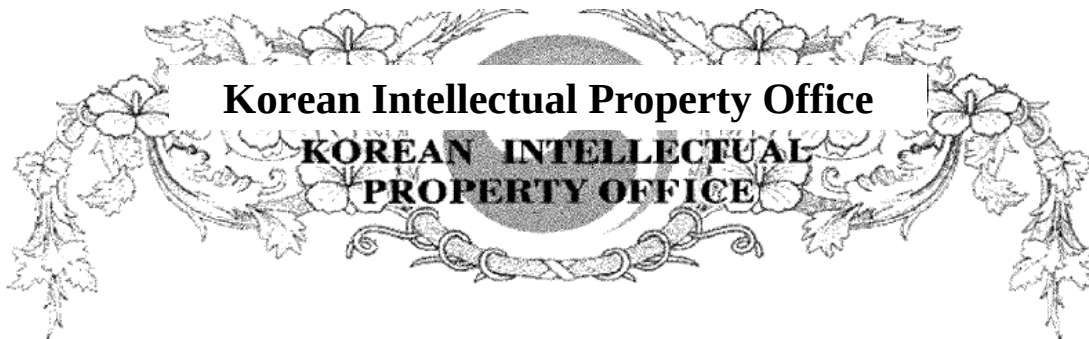
I have more than 30 years of experience translating thousands of technical, legal, and business documents from Korean to English submitted to, among others, Korean judicial authorities, U.S. federal courts, the U.S. International Trade Commission (ITC), and the USPTO Patent Trial and Appeal Board (PTAB).

I certify that I translated the following document from Korean into the English language. I also certify that this is a true, correct, and complete translation of the corresponding source text to the best of my knowledge and ability.

I certify under penalty of perjury that the foregoing is true and correct.

Executed this 29th day of April 2025 in Contra Costa County of the State of California.

By: 
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This is to certify that the following application annexed hereto is a true and correct copy as filed with the Korean Intellectual Property Office (KIPO). [*Korean*]

This is to certify that the following application annexed hereto is a true copy from the records of the Korean Intellectual Property Office. [*English*]

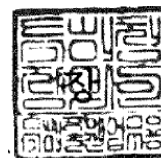
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Aug. 1, 2018

Commissioner of the Korean Intellectual Property Office
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[*seal affixed*: Commissioner of the Korean Intellectual Property Office
This seal is for patent filing purposes]

[Bibliography]

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[General Power of Attorney Registration Number] 2014-036557-3

[Title of the Invention in Korean] METHOD, APPARATUS, AND SYSTEM OF WIRELESS LAN PHYSICAL LAYER HEADER FILED CONSTRUCTIONS FOR MULTI USER COMMUNICATION UNDER INDOOR AND OUTDOOR ENVIRONMENTS

[Title of the Invention in English] METHOD, APPARATUS, AND SYSTEM OF WIRELESS LAN PHYSICAL LAYER HEADER FILED CONSTRUCTIONS FOR MULTI USER COMMUNICATION UNDER INDOOR AND OUTDOOR ENVIRONMENTS

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[Application Language]	Korean

[National R&D Project That Supported This Invention]

[Project Number]	RO166-16-1030
[Ministry Name]	Ministry of Science, ICT and Future Planning
[Name of the Project Manager]	National IT Industry Promotion Agency
[Project Name]	Information and Broadcasting Standards Development Support
[R&D Name]	IEEE802.11 High Efficiency WLAN (HEW) Standard Development
[Contribution Rate]	1/1
[R&D Conducted by]	WILUS Institute of Standards and Technology Inc.
[R&D Period]	Apr. 1, 2014 to Feb. 28, 2017

[Purport]

It is hereby submitted to the Commissioner of the Korean Intellectual Property Office (KIPO) as above.

Agent or Attorney

Kook Il Lim

(signature or seal)

[Fees]

[Application Filing Fee]	0 page (s)	46,000 KRW
[Additional Appl. Filing Fee]	58 page (s)	0
[Priority Claim Fee]	0 case (s)	0
[Fee for Examination Request]	0 claim (s)	0
[Total]	46,000 KRW	
[Reason for Fee Reduction]	Small Business (70% reduction) [1]	
[Fee after Reduction]	13,800 KRW	

[Description of the Invention]

[Title of the Invention]

METHOD, APPARATUS, AND SYSTEM OF WIRELESS LAN PHYSICAL LAYER
HEADER FIELD CONSTRUCTIONS FOR MULTI USER COMMUNICATION UNDER
INDOOR AND OUTDOOR ENVIRONMENTS *[in Korean]* {METHOD, APPARATUS, AND
SYSTEM OF WIRELESS LAN PHYSICAL LAYER HEADER FIELD CONSTRUCTIONS
FOR MULTI USER COMMUNICATION UNDER INDOOR AND OUTDOOR
ENVIRONMENTS} *[in English]*

[Technical Field]

<1> The present invention relates to a wireless communication method, and more particularly,
to a method for efficient wideband PPDU transmission.

[Background Technology of the Invention]

<2> In recent years, as mobile devices have become increasingly popular, wireless LAN
technologies that can provide fast wireless Internet services to these devices have received a great
deal of attention. Wireless LAN technology is a technology that enables mobile devices such as
smartphones, smart pads, laptop computers, portable multimedia players, embedded devices, etc.,
to wirelessly access the Internet in a home or business or in a specific service area based on wireless
communication technology at a short distance.

<3> Since the Institute of Electrical and Electronics Engineers (IEEE) 802.11 supported early
wireless LAN technologies using the 2.4 GHz frequency, standards for a variety of technologies

have been put to practical use or under development. First, IEEE 802.11b supports communication speeds of up to 11 Mbps while using frequencies in the 2.4 GHz band. IEEE 802.11a, which was commercialized after IEEE 802.11b, uses frequencies in the 5 GHz band rather than the 2.4 GHz band, which reduces the impact of interference compared to frequencies in the 2.4 GHz band, which is significantly more congested, and uses OFDM technology to increase communication speeds up to 54 Mbps. However, IEEE 802.11a has the disadvantage of shorter communication distances compared to IEEE 802.11b. And IEEE 802.11g, like IEEE 802.11b, uses frequencies in the 2.4 GHz band to realize communication speeds of up to 54 Mbps/day and satisfies backward compatibility, so it has received considerable attention, and it has an advantage over IEEE 802.11a in terms of communication distance as well.

<4> IEEE 802.11n is a technical specification designed to overcome the limitations on communication speed that have been noted as a weakness in wireless LANs. IEEE 802.11n aims to increase the speed and reliability of networks and extend the operating distance of wireless networks. More specifically, IEEE 802.11n supports High Throughput (HT) with data rates of up to 540 Mbps or more, and is based on Multiple Inputs and Multiple Outputs (MIMO) technology, which uses multiple antennas at both the transmitter and receiver ends to minimize transmission errors and optimize data rates. The standard can also use a coding scheme that transmits multiple redundant copies of the data to increase data reliability.

<5> As wireless LANs have become more widespread and the applications utilizing them have diversified, a need has arisen for new wireless LAN systems to support higher throughput called VHT (Very High Throughput) than the data rates supported by IEEE 802.11n. Of these, IEEE

802.11ac supports a wide bandwidth (80 MHz to 160 MHz) in the 5 GHz frequency. Although the IEEE 802.11ac standard is only defined in the 5 GHz band, early 11ac chipsets will also support operation in the 2.4 GHz band for backward compatibility with existing 2.4 GHz band products. In theory, the standard will allow multi-station wireless LAN speeds of at least 1 Gbps and maximum single link speeds of at least 500 Mbps. This is achieved by expanding the wireless interface concept adopted by 802.11n, including wider radio frequency bandwidth (up to 160 MHz), more MIMO spatial streams (up to 8), multi-user MIMO, and higher-density modulation (up to 256 QAM). There is also IEEE 802.11ad, which uses the 60 GHz band to transmit data instead of the existing 2.4 GHz/5GHz band. IEEE 802.11ad is a transmission standard that provides speeds of up to 7 Gbps using beamforming technology, making it suitable for streaming high-bitrate videos, such as large-capacity data or uncompressed HD video, etc.

<6> More recently, as a next-generation wireless LAN standard after 802.11ac and 802.11ad, discussions continue to be held to provide high-efficiency and high-performance wireless LAN communication technology in high-density environments. In other words, in the next-generation wireless LAN environment, high-frequency efficient communication must be provided indoors and outdoors in the presence of high-density stations and access points (APs), and various technologies are required to realize this.

[Specifics of the Invention]

[Problem to Be Solved by the Invention]

<7> It is an object of the present invention to provide high-efficiency/high-performance wireless LAN communications in high-density environments as described above.

[Means to Solve the Problem]

<8> According to an embodiment of the present invention, an apparatus, system, and method of wireless LAN communication for a wireless LAN can be provided.

[Effect of the Invention]

<9> The present invention relates to a wireless communication method, and more particularly, to a method for configuring wireless LAN physical layer header fields that support simultaneous multi-user transmission in indoor and outdoor environments.

[Brief Description of the Drawings]

<10> FIG. 1 is a drawing illustrating a wireless LAN system according to one embodiment of the present invention.

FIG. 2 illustrates an independent BSS, which is a wireless LAN system according to another embodiment of the present invention.

FIG. 3 is a block diagram illustrating the configuration of a station 100 according to one embodiment of the present invention.

FIG. 4 is a block diagram illustrating the configuration of an AP 200 according to one embodiment of the present invention.

FIG. 5 illustrates the configuration of L-SIG and RL-SIG and the utilization of the L_LENGTH field according to an embodiment of the present invention.

FIG. 6 illustrates a method for indicating a WLAN PPDU format by utilizing the L_LENGTH field of the L-SIG and RL-SIG parts along with the HE-SIG-A part, according to an embodiment of the present invention.

FIG. 7 illustrates a power save operation scenario based on the PPDU format according to an embodiment of the present invention.

FIG. 8 illustrates the structure of the HE-SIG-A field that varies according to the PPDU format, in accordance with an embodiment of the present invention.

FIG. 9 illustrates a method for setting the TXOP by utilizing the TXOP and MAC Duration fields of HE-SIG-A, in accordance with an embodiment of the present invention.

FIG. 10 illustrates a technique for improving the efficiency of the HE-SIG-A portion transmitted in an HE Trigger-based UL PPDU, in accordance with an embodiment of the present invention.

FIG. 11 illustrates the structure of HE-SIG-B according to an embodiment of the present invention.

FIG. 12 illustrates the structure of HE-SIG-B in an HE PPDU transmitted over an 80 MHz bandwidth, according to an embodiment of the present invention.

FIG. 13 illustrates the structure of HE-SIG-B in a full-band MU-MIMO PPDU transmitted over 80 MHz, according to an embodiment of the present invention.

FIG. 14 illustrates the structure of HE-SIG-B used to signal a centrally located 26RB in an HE PPDU transmitted over 80 MHz, according to an embodiment of the present invention.

FIG. 15 illustrates a method for accelerating the decoding of HE-SIG-B for each 20 MHz band in an HE PPDU transmitted over 80 MHz, according to an embodiment of the present invention.

FIG. 16 illustrates a method of configuring HE-SIG-B when transmitting an HE PPDU as a non-contiguous OFDMA in units of 20/40/80 MHz, according to an embodiment of the present invention.

FIG. 17 illustrates a method of configuring HE-SIG-B when transmitting an HE PPDU as a non-contiguous OFDMA between a single AP and a single STA, according to an embodiment of the present invention.

FIG. 18 illustrates a method of configuring HE-SIG-B when transmitting an HE PPDU as a non-contiguous OFDMA in 20 MHz units, according to an embodiment of the present invention.

[Detailed Specifics for Practicing the Invention]

<11> The terms used in this specification have been chosen to be as generic as possible in current common usage, taking into account their function in the invention, but they may vary according to the intent of a person having ordinary skill in the art of this technical field, custom, or emergence of new technologies, etc. In addition, in certain cases, terms have been chosen at will by the applicant, in which case their meaning will be given in the description of the invention to which they relate. It is therefore intended that the terms used in this specification should be construed based on the actual meaning of the term and the context of the specification as a whole, and not merely as a designation of a term.

<12> Throughout the specification, when a configuration is the to be "connected" to another configuration, this includes not only being "directly connected" but also being "electrically connected" with another constituent element in between. Also, when a configuration is the to "include" a particular constituent element, it is meant to be capable of including additional constituent elements, not to the exclusion of other constituent elements, unless specifically to the

contrary. In addition, the limitation of "same or more" or "same or less" with respect to a particular threshold may be appropriately substituted with "more than" or "less than," respectively, depending on the embodiment.

<13> FIG. 1 illustrates a wireless LAN system according to one embodiment of the present invention. A wireless LAN system includes one or more Basic Service Sets (BSS), which represent a set of devices that can communicate with each other by successfully synchronizing. Generally, BSS can be divided into infrastructure BSS (BSS) and independent BSS (IBSS), and FIG. 1 shows infrastructure BSS.

<14> As illustrated in FIG. 1, infrastructure BSS (BSS1, BSS2) includes or more stations (STA-1, STA-2, STA-3, STA-4, STA-5), access point (PCP/AP-1, PCP/AP- 2) that is a station that provides a distribution service (DS), and a distribution system (DS) that connects multiple access points (PCP/AP-1, PCP/AP- 2).

<15> A station (station, STA) is any device that includes a medium access control (MAC) and a physical layer interface to a wireless medium as defined by the IEEE 802.11 standard, and broadly includes both non-access point (Non-AP) stations as well as access points (APs). Also, the term "terminal" may be used in this specification as a concept that includes both stations and wireless LAN communication devices such as APs. A station for wireless communication includes a processor and a transceiver, and may further include a user interface portion, a display unit, and the like, depending on the embodiment. The processor may generate frames to be transmitted over the wireless network, process frames received over the wireless network, and perform various other processing to control the station. The transceiver is functionally connected to the processor and

transmits and receives frames over the wireless network for the station.

<16> An access point (AP) is a discrete entity that provides access to a distribution system (DS) via a wireless medium for stations associated with it. In principle, communication between non-AP stations in an infrastructure is carried out, in principle, via an AP, but direct communication between non-AP stations is also possible if a link is established. In this invention, AP is used as a concept that includes PCP (Personal BSS Coordination Point), and broadly speaking, it can include all concepts of centralized controller, base station (BS), node-B, base transceiver system (BTS), and/or site controller, etc.

<17> A plurality of infrastructure BSSs may be connected via a distribution system (DS). The plurality of BSSs connected via the distribution system may be referred to as an Extended Service Set (ESS).

<18> FIG. 2 illustrates an independent BSS, which is a wireless LAN system according to another embodiment of the present disclosure. In the embodiment of FIG. 2, portions that are identical or corresponding to the embodiment of FIG. 1 are intended to omit redundant description.

<19> BSS-3 shown in FIG. 2 is an independent BSS and does not include an AP, so none of the stations (STA-6, STA-7) are in the state of being connected to an AP. An independent BSS is not allowed to connect to the distribution system and forms a self-contained network. In an independent BSS, each station (STA-6, STA-7) can be directly connected to each other.

<20> FIG. 3 is a block diagram illustrating the configuration of a station 100 according to one embodiment of the present invention.

<21> As shown, a station 100 according to an embodiment of the present invention may comprise a processor 110, a network interface card (NIC) 120, a user interface portion 140, a display unit 150, and a memory 160.

<22> First, the network interface card 120 is a module for performing wireless LAN connectivity, and performs packet transmission and reception for the station 100. The network interface card 120 may be built into or external to the station 100, and may include at least one network interface card module utilizing different frequency bands, depending on the embodiment. For example, the network interface card may include network interface card modules of different frequency bands, such as 2.4 GHz, 5 GHz, and 60 GHz. According to one embodiment, the station 100 may comprise a network interface card module utilizing a frequency band above 6 GHz and a network interface card module utilizing a frequency band below 6 GHz. Each network interface card module can perform wireless communication with an AP or an external station in accordance with the wireless LAN specifications for the frequency band supported by that network interface card module. The network interface card 120 may operate only one network interface card module at a time or may operate multiple network interface card modules together simultaneously, depending on the performance and requirements of the station 100. When the station 100 includes a plurality of network interface card modules, each of the network interface card modules may be provided in a

standalone form or may be integrated into a single chip.

<23> Next, the user interface portion 140 includes various forms of input/output means provided in the station 100. That is, the user interface portion 140 can receive user input using various input means, and the processor 110 can control the station 100 based on the received user input. Further, the user interface portion 140 may utilize various output means to perform outputs based on instructions from the processor 110.

<24> Next, the display unit 150 outputs an image on a display screen. The display unit 150 may output various display objects, such as content executed by the processor 110 or a user interface based on control instructions of the processor 110. In addition, the memory 160 stores control programs used in the station 100 and various data accordingly. Such control programs may include connection programs required for the station 100 to perform connections with APs or external stations.

<25> The processor 110 of the present invention may execute various instructions or programs, and process data within the station 100. The processor 110 may also control each of the units of the station 100 described above, and may control data transmission and reception between the units. According to an embodiment of the present invention, the processor 110 may execute a program for establishing a connection with an AP stored in the memory 160 and receive a communication setup message transmitted by the AP. Further, the processor 110 may read information about a priority condition of the station 100 included in the communication setup message, and may request

access to the AP based on the information about the priority condition of the station 100. Specific embodiments of this will be described later.

<26> The station 100 illustrated in FIG. 3 is a block diagram according to one embodiment of the present invention, wherein the separated blocks represent logically distinct elements of the device. Accordingly, the elements of the device described above may be mounted on a single chip or a plurality of chips, depending on the design of the device. Furthermore, in an embodiment of the present invention, some components of the station 100, such as the user interface portion 140 and the display unit 150, may be optionally equipped in the station 100.

<27> FIG. 4 is a block diagram illustrating the configuration of an AP 200 according to one embodiment of the present disclosure.

<28> As shown, an AP 200 according to an embodiment of the present invention may comprise a processor 210, a network interface card 220, and a memory 260. With respect to FIG. 4, portions of the configuration of the AP 200 that are identical or equivalent to the configuration of the station 100 of FIG. 3 will be omitted to avoid redundant description.

<29> Referring now to FIG. 4, an AP 200 according to the present disclosure comprises a network interface card 220 for operating a BSS in at least one frequency band. As described above in the embodiment of FIG. 3, the network interface card of the AP 200 may also a plurality of network interface modules utilizing different frequency bands from each other. In other words, the AP 200 according to an embodiment of the present invention may comprise two or more network interface

card modules in different frequency bands, such as 2.4 GHz, 5 GHz, and 60 GHz. Preferably, the AP 200 may comprise a network interface card module utilizing a frequency band above 6 GHz and a network interface card module utilizing a frequency band below 6 GHz. Each network interface card module can perform wireless communication with stations in accordance with the wireless LAN specifications for the frequency band supported by that network interface card module. The network interface card 220 may operate only one network interface card module at a time or may operate multiple network interface card modules together simultaneously, depending on the performance and requirements of the AP 200.

<30> Next, the memory 260 stores control programs used by the AP 200 and various data associated therewith. These control programs may include an access program that manages access to the station. Further, the processor 210 controls each unit of the AP 200 and may control data transmission and reception between the units. According to an embodiment of the present invention, the processor 210 may execute a program for connecting with a station stored in the memory 260 and transmit a communication setting message for one or more stations. The communication setup message may include information about the access priority conditions of each station. Further, the processor 210 performs the connection setting according to the connection request of the station. A specific embodiment of this will be described later.

<32> FIG. 5 illustrates the configuration of L-SIG and RL-SIG and the utilization of the

L_LENGTH field, according to an embodiment of the present invention.

<33> FIGS. 5(a)/(b) illustrate the frame formats of 11a/g and 11ax PPDU, respectively, according to an embodiment of the present invention. FIG. 5(c) presents the detailed field structure of L-SIG and RL-SIG, which are commonly used across the aforementioned PPDU formats.

<34> The L-SIG utilizes 64 FFT OFDM (-32 to 0 to 31, a total of 64 subcarriers). In this configuration, the leftmost 6 subcarriers (-32 to -27) and the rightmost 5 subcarriers (27 to 31) are used as guard carriers, while the central subcarrier (0) is used as a DC carrier. Excluding these 6 + 5 + 1 = 12 subcarriers, there remain 52 subcarriers, of which 4 subcarriers (-21, -7, 7, 21) are allocated as pilot subcarriers, while the remaining 48 subcarriers are used for data transmission. When employing BPSK modulation with a coding rate of 1/2 (MCS = BPSK, Rate = 1/2), a total of 24 bits of information can be transmitted. The configuration of these 24-bit information fields is shown in FIG. 5(c).

<35> L_RATE (4 bits) indicates the MCS (Modulation and Coding Scheme) used for data transmission, representing one of the transmission rates (6/9/12/18/24/36/48/54 Mbps) derived from a combination of modulation schemes (BPSK, QPSK, 16-QAM, 64-QAM) and coding rates (1/2, 2/3, 3/4). By referring to the L_RATE and L_LENGTH fields, the total length of the PPDU can be determined. An 11ax STA always sets the L_RATE field to the minimum transmission rate of 6 Mbps.

<36> L_LENGTH (12 bits), when combined with the L_RATE field, indicates the length of the PPDU. The interpretation method of this field differs between legacy nodes and 11ax nodes.

<37> When a legacy STA receives the PPDU, the L_RATE field set to 6 Mbps indicates that 3

bytes (24 bits) can be transmitted within one 64-FFT OFDM symbol duration of 4us. Approximating SVC (16 bits) and Tail (6 bits) as one symbol (24 bits), the PPDU length (PPDU_LENGTH) can be calculated as $PPDU_LENGTH = RXTIME = TXTI = (1 + \lceil L_LENGTH/3 \rceil) \times 4 + 20$ (Refer to FIG. 5(e)). In the equation above, the additional 20us accounts for the transmission time of L-STF, L-LTF, and L-SIG. The ceil [x] operation represents the smallest integer greater than or equal to x. The maximum value of L_LENGTH (12 bits) is 4095, which results in a maximum PPDU_LENGTH of 5.484 ms. However, legacy devices based on the 11a/g standard may consider an L_LENGTH field greater than 2340 bytes as invalid, since such values were not permitted under earlier standards. Considering this limitation, the maximum PPDU_LENGTH is effectively reduced to 3.144 ms.

<39> When an 11ax STA receives the PPDU, the symbol count based on 64-FFT can be obtained by adding 3 bytes (corresponding to SVC/TAIL) to the L_LENGTH field and then dividing by the symbol transmission capacity of 3 bytes per symbol. Multiplying the number of symbols by 4 us (time per symbol) and adding 20 us (corresponding to L-STF, L-LTF, and L-SIG transmission) results in the PPDU_LENGTH or RXTIME. $RXTIME (us) = \lceil (L_LENGTH + 3) / 3 \rceil \times 4 + 20$. Conversely, an 11ax STA transmitting the PPDU must set as $L_LENGTH = \lceil (TXTIME - 20) / 4 \rceil \times 3 - 3$, where TXTIME represents the total transmission time of the 11ax PPDU (refer to FIG. 5(e)).

<40> In the equations above, for an 11ax STA, the L_LENGTH value is always computed as $\lceil (L_LENGTH / 3) \rceil$ after reception, meaning that three different L_LENGTH values map to the same PPDU_LENGTH. For example, the three values $L_LENGTH = \{3k+1, 3k+2, 3(k+1)\}$ all yield the

same result $(k+1)$ when applying $(L_LENGTH/3)$.

<41> In an embodiment of the present invention, the three L_LENGTH values are used to indicate $PPDU_LENGTH$ while performing additional signaling. Specifically, L_LENGTH values $\{3k+1, 3k+2, 3(k+1)\}$ may be used to represent different PPDU Cyclic Prefix (or Guard Interval) applied to the 11ax PPDU.

<42> First, when L_LENGTH is expressed in the form of $3k$, the 11ax PPDU has the shortest CP length and is a PPDU intended for indoor STAs. The R HE-SIG-A field does not exist, and the CP value of HE-SIG-A is $0.8\mu s$. The CP value of HE-SIG-B is also $0.8\mu s$. In the 256 FFT domain starting from the HE-STF, the CP length is $0.8\mu s$.

<43> Second, when L_LENGTH is expressed in the form of $3k+1$, the 11ax PPDU has a medium CP length and is a PPDU intended for both indoor and outdoor STAs. If the R HE-SIG-A field exists, the CP value of HE-SIG-A may be $0.8\mu s$. If the R HE-SIG-A field does not exist, the CP value of HE-SIG-A must be greater than $0.8\mu s$. The CP value of HE-SIG-B is also greater than $0.8\mu s$. In the 256 FFT domain starting from the HE-STF, the CP length is $1.6\mu s$.

<44> Third, when L_LENGTH is expressed in the form of $3k+2$, the 11ax PPDU has the longest CP length and is a PPDU intended for outdoor STAs. The R HE-SIG-A field exists, and the CP values of both HE-SIG-A and R HE-SIG-A are $0.8\mu s$. The CP value of HE-SIG-B is greater than $0.8\mu s$. In the 256 FFT domain starting from the HE-STF, the CP length is $3.2\mu s$.

<45> The mapping between the L_LENGTH field value and the CP length, as described above, may be rearranged within a range of configurations having similar meanings.

<47> FIG. 6 illustrates a method for indicating a WLAN PPDU format using the L_LENGTH field in the L-SIG and RL-SIG parts, along with the HE-SIG-A part, according to an embodiment of the present invention.

<48> As mentioned in FIG. 5, three different L_LENGTH values can be used not only to indicate PPDU_LENGTH but also to perform additional signaling.

<49> First, when L_LENGTH is expressed in the form of $3k+1$, the 11ax PPDU can indicate an HE SU PPDU, an HE Trigger-based PPDU, or an Extension PPDU, which are exchanged between an AP and a single STA. For this purpose, additional signaling is performed using the modulation of two symbols in the HE-SIG-A part. If the PPDU is an HE SU PPDU or an HE Trigger-based PPDU, both symbols of HE-SIG-A are modulated using BPSK. If the PPDU is an Extension PPDU, the two symbols of HE-SIG-A are modulated using BPSK and QBPSK, respectively. The Extension PPDU may be used to indicate PPDU formats supported by future standards beyond 11ax or to define additional PPDU formats within 11ax.

<50> Second, when L_LENGTH is expressed in the form of $3k+2$, the 11ax PPDU can indicate an HE MU PPDU exchanged between an AP and multiple STAs, or an HE Extended Range (ER) SU PPDU or HE ER Trigger-based PPDU exchanged between an AP and an outdoor STA. For this purpose, additional signaling is performed using the modulation of two symbols in the HE-SIG-A part. If the PPDU is an HE MU PPDU, both symbols of HE-SIG-A are modulated using BPSK. If the PPDU is an HE ER SU PPDU or an HE ER Trigger-based UL PPDU, the two symbols

of HE-SIG-A are modulated using BPSK and QBPSK, respectively.

<51> The mapping between L_LENGTH field values and PPDU types, as mentioned above, can be modified in order while maintaining the same conceptual meaning.

<53> FIG. 7 illustrates a power save operation scenario based on the PPDU format according to an embodiment of the present invention.

<54> In a BSS operated by an 11ax AP, both STAs that support Extended Range (ER) mode and STAs that do not support ER mode may coexist.

<55> STAs that do not support ER mode may enter Power Save mode under the following conditions:

<56> For an arbitrary non-ER STA (e.g., STA A), upon receiving an ER PPDU whose BSS Color matches that of its own BSS, the STA may enter Power Save mode for the duration of the received PPDU.

<57> This is because, during the association procedure with its AP, the STA has negotiated whether or not it supports ER mode. Therefore, when it receives an ER PPDU from its own BSS, it is evident that the PPDU is not intended for the STA. Accordingly, the STA may enter Power Save mode immediately without any additional processing.

<59> FIG. 8 illustrates the structure of the HE-SIG-A field, which varies depending on the PPDU format, according to an embodiment of the present invention.

<60> HE-SIG-A indicates PPDU common information for receiving 11ax PPDUs, and may be modulated using BPSK ($R = 1/2$) over two symbols with 64 FFT. The PPDU common information includes the bandwidth of the PPDU, BSS Color, Number_of_HE-LTF, SIG-B MCS, and others.

<61> In this case, for outdoor STAs, the two symbols of HE-SIG-A may be repeated, and this repeated portion is referred to as R HE-SIG-A. The presence or absence of R HE-SIG-A may be indicated as previously described with respect to FIG. 5.

<62> In addition, the HE-SIG-A field has different bit field configurations depending on whether the PPDU is an HE SU PPDU, HE MU PPDU, or HE Trigger-based UL PPDU.

<63> In the case of an HE SU PPDU format, as shown in FIG. 8(a), the HE-SIG-A includes the following bit fields:

<64> DL/UL indicates the transmission direction of the SU PPDU.

<65> Format is used to distinguish whether the PPDU is an HE SU PPDU or an HE Trigger-based UL PPDU.

<66> BSS Color is used to indicate the identifier of the BSS in which the PPDU is exchanged.

<67> Spatial Reuse delivers information such as SINR Margin and TX Power, which can be referenced by other STAs intending to perform spatial reuse transmission during the duration of the given PPDU.

- <68> TXOP Duration indicates the TXOP period during which continuous transmission is expected after the current PPDU. This allows surrounding STAs to set a NAV (Network Allocation Vector) to defer their own transmissions during that period.
- <69> Bandwidth indicates the total bandwidth over which the given PPDU is transmitted. It may specify one of 20 MHz, 40 MHz, 80 MHz, or 160 MHz (including 80+80 MHz).
- <70> MCS indicates the Modulation and Coding Scheme value applied to the MPDU of the given PPDU.
- <71> CP+LTF Size represents the combination of the type of LTF (Long Training Field) used — among 1x, 2x, or 4x LTF — and the value of the Cyclic Prefix (CP) applied for MPDU transmission.
- <72> Coding indicates which coding scheme is used between BCC and LDPC, and whether an Extra Symbol is transmitted in the case that LDPC is used.
- <73> NSS indicates the Number of Spatial Streams (NSTS) transmitted in the case of SU-MIMO transmission.
- <74> STBC indicates whether Space Time Block Coding is used.
- <75> TxBF indicates whether Transmit Beamforming is applied.
- <76> DCM indicates whether Dual Carrier Modulation (DCM) is used, in which the same information is transmitted over two subcarriers to combat narrowband interference.
- <77> Packet Extension indicates the level of packet extension applied to the given PPDU.

<78> Beam Change indicates whether a beam change was applied between the L-LTF and HE-LTF of the PPDU.

<79> CRC/Tail is used to verify the integrity of the information contained in the HE-SIG-A field.

<81> As shown in FIG. 8(b), in the case of the HE MU PPDU format, the HE-SIG-A includes the following bit fields. Redundant explanations overlapping with those in FIG. 8(a) may be omitted.

<82> DL/UL indicates the transmission direction of the MU PPDU. While currently, MU PPDU consist only of DL MU, and thus the direction is clearly set to DL, exceptions may be made through the following embodiments:

<83> First, even in the case of PPDU exchange between a single AP and a single STA, if transmission of the HE-SIG-B field is necessary, the HE MU PPDU may be selected, and in such case, the transmission direction of the PPDU can be explicitly indicated.

<84> This is because, even in the case of PPDU exchange between a single AP and a single STA, it is possible to selectively transmit data over specific frequency bands using Contiguous OFDMA or Non-contiguous OFDMA.

<85> For example, if STA1 performs CCA before transmitting an 80 MHz PPDU to the AP and determines that only the Secondary 20 MHz channel is busy, then under conventional methods, STA1 would transmit only on the Primary 20 MHz.

<86> However, in this case, it is possible to transmit over the Primary 20 MHz and Secondary 40

MHz, excluding the busy Secondary 20 MHz. In such a case, Resource Allocation Signaling for the corresponding PPDU necessarily requires the HE-SIG-B field.

<87> Therefore, although the PPDU is transmitted by a single STA, STA1 may use the HE MU PPDU format and set the DL/UL bit field to UL for transmission.

<88> Details related to Non-contiguous OFDMA are further described in other figures.

<89> In the HE MU PPDU, the Bandwidth field can indicate a wider variety of bandwidth options than the Bandwidth field in the HE SU PPDU.

<90> This is because, in addition to the conventional contiguous bandwidths of 20/40/80/160 MHz, additional signaling bits may be required to indicate the non-contiguous bandwidths described above.

<91> The SIG-B MCS field indicates the MCS used for HE-SIG-B, and SIG-B may employ a variable MCS (0 to 5) depending on the amount of signaling information to be transmitted.

<92> In HE MU PPDU, the CP+LTF Size field excludes the combination of $1x_LTF + 0.8us_CP$ used in HE SU PPDU, and only signals the remaining combinations.

<93> SIG-B Compression indicates that compression mode has been used in order to reduce the amount of information when signaling SIG-B. For example, when the HE MU PPDU occupies the full bandwidth (Full-BW), it becomes unnecessary to indicate frequency resource allocations for each 20 MHz band, allowing SIG-B compression to be applied.

<94> Details related to SIG-B Compression are further explained in other figures.

<95> SIG-B Dual MCS applies when transmitting a PPDU with a bandwidth of 40 MHz or greater, where different information may be transmitted over the Primary 20 MHz and Secondary 20 MHz channels. In such cases, different MCS values may be applied to each of the Primary and Secondary 20 MHz channels in order to maintain similar HE-SIG-B symbol durations. SIG-B Dual MCS signals the MCS levels applied to each 20 MHz channel in SIG-B.

<96> SIG-B DCM indicates whether Dual Carrier Modulation (DCM) has been applied to the SIG-B portion in order to ensure more reliable transmission.

<97> Num of SIG-B Sym indicates the number of symbols used to transmit SIG-B.

<99> In the case of an HE Trigger-based UL PPDU, as shown in FIG. 8(c), the HE-SIG-A includes the following bit fields. Redundant explanations overlapping with those in FIGS. 8(a) and 8(b) may be omitted.

<100> Format is used to distinguish whether the PPDU is an HE SU PPDU or an HE Trigger-based UL PPDU.

<101> Subsequently, bit fields such as BSS Color, Spatial Reuse, TXOP Duration, and Bandwidth are transmitted. In the case of an HE Trigger-based UL PPDU, where one or more STAs transmit uplink PPDU's simultaneously, the SIG-A field is shared among them and thus cannot contain individual information for each STA. Only information that is common across the PPDU's can be included. However, this leads to a problem where approximately 20 bits out of the 52 available bits

in the SIG-A portion remain unused. Details of a method for addressing this issue are further described in other figures.

<103> FIG. 9 illustrates a method for setting the TXOP using the TXOP field in HE-SIG-A and the Duration field in the MAC, according to an embodiment of the present invention.

<104> As shown in FIG. 9(a), when the AP exchanges UL MU with STA1 and STA2, hidden nodes located around the AP (L1, H1) and hidden nodes located around STA2 (H2, L2) may set their NAVs (Network Allocation Vectors) as shown in FIG. 9(b).

<105> First, when the MU-RTS frame is transmitted over multiple channels (e.g., 40 MHz), the L-Preamble portion, including L-STF, L-LTF, and L-SIG, is repeated for each 20 MHz channel. If the MU-RTS is transmitted in legacy format, the MC frame containing the MU-RTS information is transmitted directly. Upon receiving this, both the H1 STA (which supports the HE standard) and the L1 STA (which supports the legacy standard) set their NAVs for the TXOP duration specified in the Duration field within the MPDU of the MU-RTS frame, thereby restricting channel access.

<106> Second, the UL STAs that received the above MU-RTS frame transmit CTS MPDUs simultaneously on each 20 MHz channel, after a SIFS duration, along with the corresponding repeated L-Preambles. Each STA may limit CTS transmission based on its previously set NAV status. STAs H2 and L2, upon receiving the CTS, may use the MAC Duration field of the CTS to set their NAVs accordingly.

<107> Third, the AP that receives the above CTS (sCTS) frames may transmit a Trigger frame in HE PPDU format. In this case, the HE-Preamble may contain both a TXOP Duration field in HE-SIG-A and a MAC Duration field in the Trigger MPDU. If the bit structures of these two Duration fields differ—particularly if the TXOP Duration field has fewer bits—the method of interpreting both Duration values is as follows.

<108> In a first embodiment, when the TXOP Duration field is t bits and the MAC Duration field is m bits, both bit fields may be interpreted in the same manner, provided that the value represented by the m -bit field does not exceed the range of values representable by the t -bit field. For example, if $t = 12$ bits and $m = 15$ bits, the value of the m -bit field must not exceed the maximum TXOP duration expressible with 12 bits, i.e., $2^{12} = 4096\mu\text{s}$.

<109> In a second embodiment, when the TXOP Duration field is t bits and the MAC Duration field is m bits, the two-bit fields may be interpreted differently, such that the range of durations representable by t bits is approximately aligned with that of m bits. For example, if $t = 12$ bits and $m = 15$ bits, the value indicated by the t -bit field may be implicitly scaled by a scaling factor of 8, allowing it to approximate the value range indicated by the m -bit field. However, in this case, the TXOP Duration indicated in HE-SIG-A may differ from the MAC Duration by up to $7\mu\text{s}$. In such a scenario, STAs that parse both fields may set their NAV based on the more accurate MAC Duration. On the other hand, STAs that parse only the HE-SIG-A field may set their NAV based solely on the TXOP Duration value in HE-SIG-A. To account for this case, the TXOP Duration value in the HE-SIG-A field may always be set to a value up to the offset (e.g., $7\mu\text{s}$) greater than the MAC Duration, within the same PPDU.

<110> To elaborate further on FIG. 9(b), the H1 STA that receives the above Trigger frame is

capable of interpreting both the SIG-A TXOP Duration and the MAC Duration, and as previously described, it may update its NAV using both values.

<111> Meanwhile, the L1 STA that receives the above Trigger frame cannot interpret either the preamble portion or the MPDU portion of the HE PPDU, and therefore cannot update its NAV.

<112> Fourth, the STA1 and STA2 that receive the above Trigger frame transmit HE Trigger-based UL PPDU in HE PPDU format. The H2 STA, upon receiving the HE Trigger-based UL PPDU, is capable of interpreting both the SIG-A TXOP Duration and the MAC Duration, and thus can update its NAV using the two values as described earlier.

<113> In contrast, the L2 STA, which receives the HE Trigger-based UL PPDU frame, is unable to interpret the preamble or MPDU portions of the HE PPDU and therefore cannot update its NAV.

<115> FIG. 10 illustrates a technique for improving the efficiency of the HE-SIG-A portion transmitted in an HE Trigger-based UL PPDU, according to an embodiment of the present invention.

<116> As shown in FIG. 10(a), although the HE-SIG-A field transmitted in an HE Trigger-based UL PPDU can convey 52 bits of information over two symbols, it has limitations in delivering a large amount of information due to the requirement that it only contains information common to multiple UL STAs. Various methods to improve this limitation and enhance efficiency are described as follows.

<117> First, as shown in FIG. 10(b), the number of HE-SIG-A symbols may be reduced from two symbols to one symbol. To achieve this, the corresponding symbol may be transmitted using an MCS higher than MCS 0 (BPSK, Rate 1/2) in order to deliver the content of the HE-SIG-A field

within a single symbol. In this case, the change in MCS may refer only to a change in the coding rate, not in the modulation scheme. This is because modifying the modulation itself may interfere with the functionality of identifying the PPDU format using modulation schemes such as QPSK. To indicate that the HE-SIG-A is transmitted in one symbol, the $L_LENGTH \bmod 3 = 1$ condition may be used in combination with the first symbol of the SIG-A field being modulated with QPSK, as shown in FIG. 10(b). This allows receiving STAs to recognize that the HE-SIG-A is transmitted in one symbol using a higher MCS than MCS 0, and that it corresponds to an HE Trigger-based UL PPDU.

<118> Second, as shown in FIG. 10(a), the HE-SIG-A may still be transmitted using two symbols, MCS 0, and BPSK, as described in FIG. 6(a). However, the transmission reliability can be improved by repeating certain fields at the bit level within the symbols. For example, critical fields such as BSS Color, Spatial Reuse, and TXOP Duration may be repeated twice within the bit space, thereby improving the reception performance of nearby STAs.

<119> Third, another method to improve bit-level efficiency is to allocate larger bit fields for items such as BSS Color, Spatial Reuse, TXOP Duration, and Bandwidth, which were previously used in HE SU PPDU and HE MU PPDU, allowing for more detailed value representation. For example, in the case of TXOP Duration, as explained in FIG. 9, HE-SIG-A must represent the same functionality with fewer bits compared to the 15-bit MAC Duration. However, in the HE Trigger-based UL PPDU, the HE-SIG-A TXOP Duration may be expanded to 15 bits, enabling TXOP representation with the same granularity as MAC Duration. Similarly, fields such as Spatial Reuse and Bandwidth may also utilize a greater number of bits in the HE Trigger-based UL PPDU, allowing more detailed information to be conveyed.

<121> FIG. 11 illustrates the structure of HE-SIG-B according to an embodiment of the present invention.

<122> HE-SIG-B is present only in HE MU PPDU and contains the information required to receive Multi-User PPDU. This information is categorized into Common Info and User-Specific Info. The detailed structure of HE-SIG-B is illustrated in FIG. 11(a). It includes RA (Resource Allocation) information indicating the OFDMA frequency division allocation for the corresponding 20 MHz band, as well as a CRC/Tail field for verifying its integrity. This RA field is 8 bits in length and is structured as shown in FIG. 11(b). By analyzing this RA information, one can determine how many STA-specific information blocks are included. These STA-specific information blocks are grouped in pairs, and each group is followed by a CRC/Tail. For example, if three STA-specific information blocks are transmitted, then one CRC/Tail is appended to the first and second STA information, and a separate CRC/Tail is appended to the third STA information. When the target STA is an OFDMA STA, the STA-specific information consists of 21 bits, as illustrated in FIG. 11(c)-1. When the target STA is a MU-MIMO STA, the STA-specific information also consists of 21 bits, as illustrated in FIG. 11(c)-2.

<124> FIG. 12 illustrates the structure of HE-SIG-B in an HE PPDU transmitted over 80 MHz, according to an embodiment of the present invention.

<125> As shown in FIG. 12(a), when an 80 MHz PPDU is transmitted, the fields L-STF, L-LTF, L-SIG, RL-SIG, and HE-SIG-A transmitted in the first 20 MHz band ('A' band) are identically repeated in the second ('B' band), third ('B' band), and fourth ('B' band) 20 MHz bands. In the case of HE-SIG-B, the information transmitted over the first 20 MHz and second 20 MHz may

differ. However, the information transmitted in the first and third 20 MHz bands must be identical, and likewise, the information in the second and fourth 20 MHz bands must be identical. In this case, the information transmitted in each 20 MHz band must contain information relevant to the STAs that will receive MPDUs on that specific 20 MHz band.

<126> In this case, the receiving STA must simultaneously decode the HE-SIG-B fields transmitted in at least the 1st 20 MHz and 2nd 20 MHz bands to quickly determine whether its STA-specific information is included.

<127> FIG. 12(b) illustrates the detailed structure of HE-SIG-B (A, C) transmitted in the 1st 20 MHz (A) and 3rd 20 MHz (C) bands. The RA_A | | RA_C information, which contains the OFDMA frequency division allocation information for each A and C 20 MHz band, is transmitted, along with a CRC/Tail field for verifying its integrity. Each RA field is 8 bits in length and is structured as shown in FIG. 12(b). By analyzing the MU information, it is possible to determine how many STA-specific information blocks are included. These STA-specific information blocks are grouped in pairs, and each pair is followed by a CRC/Tail. FIG. 12(b) represents a case where the number of STAs allocated to each of the A and C bands is even. In this case, the information for the STAs assigned to the A band is grouped in pairs and followed by a CRC/Tail, and subsequently, the information for the STAs assigned to the C band is also grouped in pairs and followed by a CRC/Tail.

<128> FIG. 12(c) illustrates the detailed structure of HE-SIG-B (B, D) transmitted in the 2nd 20 MHz (B) and 4th 20 MHz (D) bands. FIG. 12(c) also represents a case where the number of STAs assigned to the B and D bands is even. The detailed structure and method are the same as those described in FIG. 12(b).

<129> FIG. 12(d)-1 illustrates the detailed structure of HE-SIG-B (A, C) transmitted in the 1st 20 MHz (A) and 3rd 20 MHz (C) bands, where the number of STAs allocated to the A and C bands is odd.

<130> In this case, the information for the STAs assigned to the A band is grouped in pairs and appended with a CRC/Tail, and then a separate CRC/Tail is appended to the last single STA (A_n). Subsequently, the information for the STAs assigned to the C band is also grouped in pairs and appended with a CRC/Tail, and a separate CRC/Tail is appended to the last single STA (C_n). This configuration introduces two issues. First, during the decoding of the STA-specific fields in HE-SIG-B, a block containing the information of only a single STA may suddenly appear, which increases decoding complexity. Second, since the last STAs in each band are assigned their own CRC/Tail, it results in an unnecessary increase in CRC/Tail overhead.

<131> FIG. 12(d)-2 illustrates a new structure of HE-SIG-B that can resolve the issues described in FIG. 12(d)-1. In this structure, the STA-specific information of the last STA (A_n) in the A band and the first STA (C_1) in the C band is combined into a single block and appended with a single CRC/Tail. This approach solves the two aforementioned problems. That is, except for the final block, all STA-specific information blocks are consistently formed by pairing two STA entries with a shared CRC/Tail, which reduces decoding complexity, and also allows for the elimination of one CRC/Tail, thereby reducing signaling overhead.

<132> FIG. 12(e)-1 illustrates the detailed structure of HE-SIG-B (A, C) transmitted over the 1st 20 MHz (A) and 3rd 20 MHz (C) bands, in a scenario where the number of STAs assigned to the A band is odd, and the number of STAs assigned to the C band is even. In this case, the first issue of decoding complexity, as previously described in FIG. 12(d)-1, still occurs.

<133> FIG. 12(e)-2 illustrates a configuration in which the STA-specific information of the last STA (An) in the A band and the first STA (C1) in the C band is combined, in order to address the problem described in FIG. 12(e)-1.

<135> FIG. 13 illustrates the structure of HE-SIG-B in a full-band MU-MIMO PPDU transmitted over 80 MHz, according to an embodiment of the present invention.

<136> In FIG. 13(a), the HE-SIG-A field, which is transmitted repeatedly for each 20 MHz band, includes the BW field and the SIG-B Compression field.

<137> The BW field indicates contiguous 80 MHz, and the SIG-B Compression field indicates that the corresponding PPDU is a full-band MU-MIMO PPDU.

<138> For example, it is assumed in this case that a total of seven STAs are receiving the MU-MIMO transmission over the full 80 MHz bandwidth.

<139> FIG. 13(b)-1 illustrates the detailed structure of HE-SIG-B (A, C) transmitted in the 1st 20 MHz (A) and 3rd 20 MHz (C) bands. FIG. 13(b)-2 illustrates the detailed structure of HE-SIG-B (B, D) transmitted in the 2nd 20 MHz (B) and 4th 20 MHz (D) bands. In this case, since there is no need to transmit OFDMA frequency division allocation information for each 20 MHz band, the corresponding RA fields are omitted, and STA-specific information is transmitted directly. Because RA information is absent, it is not possible to determine in advance how many STA-specific information blocks are included. Therefore, receiving STAs must perform blind decoding,

attempting to decode blocks of STA-specific information that may be grouped in pairs or as single entries. FIG. 13(b) illustrates that the STA-specific information for all seven STAs receiving full-band MU-MIMO is repeated identically across all 20 MHz bands. This results in a problem where the same seven STA-specific information blocks are unnecessarily repeated per 20 MHz, leading to an increase in the overall length of the HE-SIG-B symbols.

<140> FIG. 13(c) illustrates a configuration in which, under the same conditions as in FIG. 13(b), the seven STA-specific information blocks for STAs receiving full-band MU-MIMO are divided and transmitted separately for each 20 MHz band. In this case, because the seven STA-specific information blocks are partitioned across the 20 MHz bands, the length of the HE-SIG-B symbols can be reduced, which is advantageous. To minimize padding, it is preferable to divide the seven STA-specific information blocks in an approximately balanced manner, such as 4+3 or 3+4. If the division is unbalanced, such as 2+5 or 5+2, the HE-SIG-B that contains more STA-specific information may be encoded with a higher MCS, thereby minimizing padding and allowing the symbol lengths across the bands to be matched.

<142> FIG. 14 illustrates the structure of HE-SIG-B signaling for the centrally located 26RB in an 80 MHz HE PPDU, according to an embodiment of the present invention.

<143> As shown in FIG. 14(a), when transmitting an 80 MHz OFDMA PPDU, a 26RB (Resource Block) composed of 26 subcarriers is located at the center frequency region.

<144> Since this central 26RB cannot be clearly considered part of either the A and C bands or the B and D bands, the signaling for the central 26RB in HE-SIG-B can be performed using the

following methods:

<145> First, as shown in FIG. 14(b), the signaling for the central 26RB may always be transmitted within the HE-SIG-B (A, C) located in the Primary 20 MHz channel. In this case, after identifying the number of STAs assigned to each of the (A, C) bands through the RA information, if one additional STA-specific information block is included, the STA identified in that block is automatically assumed to receive data over the central 26RB.

<146> Second, as shown in FIG. 14(c), the signaling for the central 26RB may be arbitrarily added to either HE-SIG-B (A, C) or HE-SIG-B (B, D), depending on which side has less information to transmit. Again, after identifying the number of STAs assigned to each band through the RA information, if one more STA-specific information block is transmitted than expected, the corresponding STA is determined to be allocated to the central 26RB. Furthermore, even in the case where the number of assigned STAs is greater on either the (A, C) or (B, D) side, if a higher MCS is applied on that side, the central 26RB information may still be added and transmitted through that band.

<147> Third, as shown in FIG. 14(c), the signaling of the central 26RB may be transmitted simultaneously in both the Primary 20 MHz channel and the Secondary 20 MHz channel. In this case, after identifying the number of STAs belonging to each band through the RA information of the corresponding (A, C) or (B, D) bands, if one additional STA-specific information block is transmitted beyond that number, the STA referred to in that extra information block is automatically determined to receive data over the central 26RB band. Furthermore, since the same STA-specific information is transmitted twice across HE-SIG-B (A, C) and HE-SIG-B (B, D), the transmission reliability can be improved. In addition, the receiving STA, which sees its STA-specific information

called in two separate 20 MHz bands, can be more confident that it has been assigned to the central 26RB.

<149> FIG. 15 illustrates a method for faster decoding of HE-SIG-B for each 20 MHz band in an 80 MHz HE PPDU, according to an embodiment of the present invention.

<150> As shown in FIG. 15(a), in the case of transmitting an 80 MHz OFDMA PPDU, the STAs assigned to each 20 MHz band may differ.

<151> For example, in the case of STAs A1 to A3, which are allocated to the A band, by decoding the HE-SIG-B (A, C) transmitted in the corresponding 20 MHz band, their RA and STA-specific information are located near the front of the HE-SIG-B, allowing them to quickly identify their information.

<152> However, in the case of C1 to C3 STAs assigned to the C band, if the HE-SIG-B (A, C) transmitted to that 20 MHz band is simply a repetition of the HE-SIG-B originally transmitted for the A band, then the RA and STA-specific information for the C band appears toward the end of the HE-SIG-B. This makes it difficult for the receiving STAs to quickly identify their corresponding information.

<153> FIG. 15(b) illustrates a method to address this issue, using the configuration of HE-SIG-B in each 20 MHz band of the HE PPDU shown in FIG. 15(a) as an example.

<154> In this case, unlike FIG. 12, while the HE-SIG-B (A, C) information transmitted in the A band is repeated in the C band, it is reversed in structure and transmitted as HE-SIG-B (C, A). That is, in HE-SIG-B (A, C), the RA and STA-specific information for the A and C bands are arranged

in the order A -> C, whereas in HE-SIG-B (C, A), the same information is arranged in the reverse order C -> A. Although the content of the two HE-SIG-B transmissions is essentially the same, the order of arrangement is reversed so that STAs receiving data in each specific 20 MHz band can more quickly access their RA and STA-specific information.

<155> The same technique may be applied to HE-SIG-B (B, D) and HE-SIG-B (D, B), where the information is reversed in structure to accelerate the reception of RA and STA-specific data by STAs assigned to each respective band.

<157> FIG. 16 illustrates a method for configuring HE-SIG-B when transmitting an HE PPDU using non-contiguous OFDMA in 20/40/80 MHz units, according to an embodiment of the present invention.

<158> FIG. 16(a) shows the configuration of HE-SIG-B when an HE MU PPDU is transmitted across a full 160 MHz band. If each 20 MHz channel is denoted as A through H, starting from the Primary 20 MHz channel, the Primary 20 MHz transmits HE-SIG-B (A, C, E, G), and the Secondary 20 MHz transmits HE-SIG-B (B, D, F, H). This structure is repeated across each 40 MHz unit.

<159> FIG. 16(b) illustrates a case where the HE MU PPDU is transmitted over a total 80 MHz band, using only the Primary 20 MHz and Secondary 40 MHz channels, without utilizing the Secondary 20 MHz. In this case, the BW bit field in HE-SIG-A signals the bandwidth in the form of P20 + S40, and HE-SIG-B is constructed as HE-SIG-B (A, C, D), which contains the information for all A, C, and D bands. This HE-SIG-B is repeated in each available 20 MHz channel. This

approach effectively transfers the signaling role of the unavailable Secondary 20 MHz band to the Primary 20 MHz channels.

<160> FIG. 16(c) illustrates a case where the HE MU PPDU is transmitted over the entire 160 MHz band, but again without using any Secondary 20 MHz channels, and instead using only the Primary 20 MHz, Secondary 40 MHz, and Secondary 80 MHz channels. In this case, the BW bit field in HE-SIG-A signals the bandwidth as $P20 + S40 + S80$, and the HE-SIG-B is constructed as HE-SIG-B (A, C, D, E, F, G, H), containing information for all relevant bands. This composite HE-SIG-B is then repeated in each available 20 MHz channel. As in the previous case, because the Secondary 20 MHz channels are unavailable, their signaling responsibilities within HE-SIG-B are transferred to the Primary 20 MHz channels.

<161> FIG. 16(d) illustrates a case in which an HE MU PPDU is transmitted over a total 160 MHz band, using only the Primary 20 MHz and Secondary 80 MHz channels, while the Secondary 40 MHz channels are not used. In this case, the BW bit field in HE-SIG-A signals the bandwidth in the form of $P40 + S80$, and HE-SIG-B is constructed separately as HE-SIG-B (A, E, G) and HE-SIG-B (B, F, H), containing the information for the A, E, G and B, F, H bands, respectively. These HE-SIG-B structures are transmitted in an alternating pattern, repeating one at each Primary 20 MHz channel, each Secondary 20 MHz channel, and every 20 MHz channel thereafter, in an interleaved manner. Unlike the cases described in FIGS. 16(b) and 16(c), here the Secondary 20 MHz channels are available, so the signaling role of those channels in HE-SIG-B is not transferred to the Primary 20 MHz channels.

<162> All of the variable HE-SIG-B configurations described above can be recognized through

the BW field in HE-SIG-A. In this case, the BW field of HE-SIG-A may signal one of the configurations of P20, P40, P80, P160, P20 + S40, P20 + S40 + S80 and P40 + S80.

<164> FIG. 17 illustrates a method for configuring HE-SIG-B when an HE PPDU is transmitted using Non-Contiguous OFDMA between a single AP and a single STA, according to an embodiment of the present invention.

<165> FIG. 17(a) illustrates a case where STA A1 transmits an HE SU PPDU over the entire 160 MHz band. In this case, information regarding the entire PPDU bandwidth is transmitted via SIG-A in the Primary 20 MHz channel, and the same SIG-A is repeated across all 20 MHz channels, in 20 MHz units.

<166> FIG. 17(b) illustrates a case where STA A1 transmits an HE MU PPDU over a total 80 MHz band, using only the Primary 20 MHz and Secondary 40 MHz channels, and not using the Secondary 20 MHz channel. In this case, the HE-SIG-A field, originally defined for HE SU PPDU, is not suitable for signaling non-contiguous PPDU transmission, so the transmission is performed in HE MU PPDU format, including HE-SIG-B. The BW bit field in HE-SIG-A signals the bandwidth in the form of P20 + S40, and HE-SIG-B is constructed as HE-SIG-B (A, C+D), containing the information for the A, C, and D bands. This HE-SIG-B is repeated across each available 20 MHz channel. Since the Secondary 20 MHz channel is unavailable, its signaling responsibilities are transferred to the Primary 20 MHz channel. Unlike in FIG. 16, however, a single STA's data is transmitted over the C and D bands, so the C and D bands are combined and signaled as a single entity (C+D).

<167> FIG. 17(c) illustrates a case where STA A1 transmits an HE MU PPDU over the entire 160 MHz band, using only the Primary 20 MHz, Secondary 40 MHz, and Secondary 80 MHz channels, while excluding the Secondary 20 MHz channels. In this case, the BW bit field in HE-SIG-A signals the bandwidth in the form of P20 + S40 + S80, and HE-SIG-B is constructed as HE-SIG-B (A, C+D, E+F+G+H), which includes information for all listed bands. This composite HE-SIG-B is repeated across each available 20 MHz channel. Since the Secondary 20 MHz channels are unavailable, their signaling functions are also transferred to the Primary 20 MHz channel. Unlike in FIG. 16, however, where multiple STAs may be present, in this case a single STA's data is transmitted across the C, D and E, F, G, H bands. Thus, the C and D bands are combined and signaled as C+D, and the E, F, G, H bands are combined and signaled as E+F+G+H, each requiring only a single signaling block.

<168> FIG. 17(d) illustrates a case in which STA A1 transmits an HE MU PPDU over the entire 160 MHz band, using only the Primary 20 MHz and Secondary 80 MHz channels, while not using the Secondary 40 MHz channels. In this case, the BW bit field in HE-SIG-A signals the bandwidth in the form of P40 + S80, and HE-SIG-B is constructed as HE-SIG-B (A+B, E+F+G+H), which includes information for the A and B bands combined, and the E, F, G, H bands combined. This HE-SIG-B is repeated in each available 20 MHz channel. In contrast to FIG. 16, where multiple STAs may be involved, in this case a single STA's data is transmitted across the A and B bands and the E, F, G, H bands. Therefore, the A and B bands are grouped as A+B, and the E, F, G, H bands are grouped as E+F+G+H, requiring only a single signaling block for each group.

<169> Such variable configurations of HE-SIG-B can be recognized through the BW field and the SIG-B Compression field in HE-SIG-A. The BW field in HE-SIG-A may signal one of the configurations of P20, P40, P80, P160, P20 + S40, P20 + S40 + S80 and P40 + P80. In this case,

the SIG-B Compression field indicates that the HE MU PPDU is transmitted by a single STA.

<171> FIG. 18 illustrates a method for configuring HE-SIG-B when an HE PPDU is transmitted using non-contiguous OFDMA in 20 MHz units, according to an embodiment of the present invention.

<172> FIG. 18(a) shows the configuration of HE-SIG-B when an HE MU PPDU is transmitted over the entire 80 MHz band. If each 20 MHz channel from the Primary 20 MHz channel is referred to as A to D, then HE-SIG-B (A, C) is transmitted in the Primary 20 MHz channels, and HE-SIG-B (B, D) is transmitted in the Secondary 20 MHz channels. These structures are repeated in 40 MHz units.

<173> FIG. 18(b) illustrates a case where an HE MU PPDU is transmitted over a total 40 MHz band, using only the Primary 20 MHz and Secondary 40 MHz channels, without using the Secondary 20 MHz channel. In this case, the BW bit field in HE-SIG-A signals the bandwidth in the form of P20 + S40, and the HE-SIG-B is constructed as HE-SIG-B (A, C, D), which includes information for the A, C, and D bands. This HE-SIG-B is repeated in each available 20 MHz channel. Since the Secondary 20 MHz channel is not available, its signaling responsibility within HE-SIG-B is transferred to the Primary 20 MHz channel.

<174> FIG. 18(c) illustrates a case where an HE MU PPDU is transmitted over the total 80 MHz band, but neither the Secondary 20 MHz channel nor the upper 20 MHz portion of the Secondary 40 MHz (S40A) is used. Only the Primary 20 MHz and Secondary 40B channels are used. In this case, the BW bit field in HE-SIG-A signals the bandwidth in the form of P20 + S40B, and the HE-

SIG-B is constructed as HE-SIG-B (A, D), which includes information for the A and D bands. This HE-SIG-B is repeated in each available 20 MHz channel.

<175> FIG. 18(d) illustrates a case where an HE MU PPDU is transmitted over the total 80 MHz band, but neither the Secondary 20 MHz channel nor the lower 20 MHz portion of the Secondary 40 MHz (S40B) is used. Only the Primary 20 MHz and Secondary 40A channels are used. In this case, the BW bit field in HE-SIG-A signals the bandwidth in the form of P20 + S40A, and the HE-SIG-B is constructed as HE-SIG-B (A, C), which includes information for the A and C bands. This HE-SIG-B is also repeated in each available 20 MHz channel.

<176> FIG. 18(e) illustrates a case in which an HE MU PPDU is transmitted over the total 80 MHz band, using only the Primary 40 MHz and the lower 20 MHz portion of the Secondary 40 MHz (S40B), while not using the upper 20 MHz portion (S40A). In this case, the BW bit field in HE-SIG-A signals the bandwidth in the form of P40 + S40B, and HE-SIG-B is constructed as HE-SIG-B (A) and HE-SIG-B (B, D), which include information for the A band and the B and D bands, respectively. Each of these HE-SIG-B blocks is repeated in every 20 MHz channel.

<177> FIG. 18(f) illustrates a case in which an HE MU PPDU is transmitted over the total 80 MHz band, using only the Primary 40 MHz and the upper 20 MHz portion of the Secondary 40 MHz (S40A), while not using the lower 20 MHz portion (S40B). In this case, the BW bit field in HE-SIG-A signals the bandwidth in the form of P40 + S40A, and HE-SIG-B is constructed as HE-SIG-B (A, C) and HE-SIG-B (B), which include information for the A and C bands and the B band, respectively. Each HE-SIG-B block is repeated across each available 20 MHz channel.

<178> Such variable configurations of HE-SIG-B can all be recognized based on the BW field in HE-SIG-A. When considering configurations up to 80 MHz, the BW field in HE-SIG-A may signal

one of P20, P40, P80, P20 + S40, P20 + S40A, P20 + S40B, P40 + S40A and P40 + PMU. If 160 MHz configurations are also considered, then the BW field must additionally signal combinations that incorporate 20 MHz-level usage across higher bands such as S80A, S80B, S80C, and S80D, along with their respective combinations.

<180> As described above, the present invention has been explained using wireless LAN communication as an example. However, the invention is not limited thereto and may be equally applied to other communication systems, including cellular communication. Furthermore, while the methods, devices, and systems of the present invention have been described in relation to specific embodiments, all or part of the components and operations of the invention may be implemented using a computer system with a general-purpose hardware architecture.

<181> The foregoing description of the present invention is provided for illustrative purposes, and the person having ordinary skill in the art of this field will understand that various modifications can be made without departing from the technical spirit or essential characteristics of the invention. Therefore, the embodiments described above should be interpreted as exemplary rather than limiting. For example, each component described as a single entity may be implemented in a distributed manner, and likewise, components described as being distributed may be implemented in a combined form.

<182> The scope of the present invention is defined by the following claims rather than the foregoing detailed description, and all modifications or variations derived from the meaning and scope of the claims and their equivalents should be construed as falling within the scope of the present invention.

[Description of Referential Numerals]

<183> 100: Station

 200: Access Point

[What is claimed is]

[Claim 1]

A wireless communication method for a terminal,
wherein the method comprises,
receiving a wireless signal of a particular channel;
and using preamble information of the received wireless signal to obtain at least one of
length information of the signal and full-length information of a corresponding data sequence.

[Summary]

[Abstract]

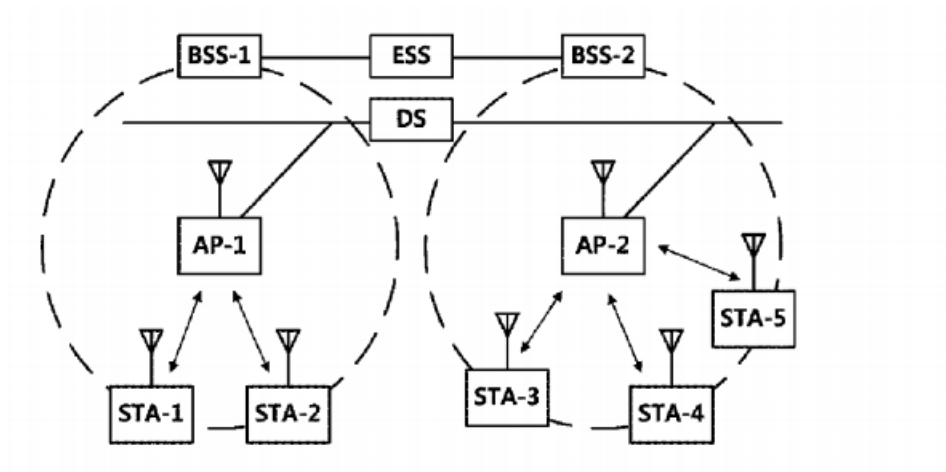
The present invention relates to a wireless communication method, and according to an embodiment of the present invention, there is provided a method for configuring physical layer header fields in a wireless LAN that supports simultaneous multi-user transmission in indoor and outdoor environments.

[Representative Drawings]

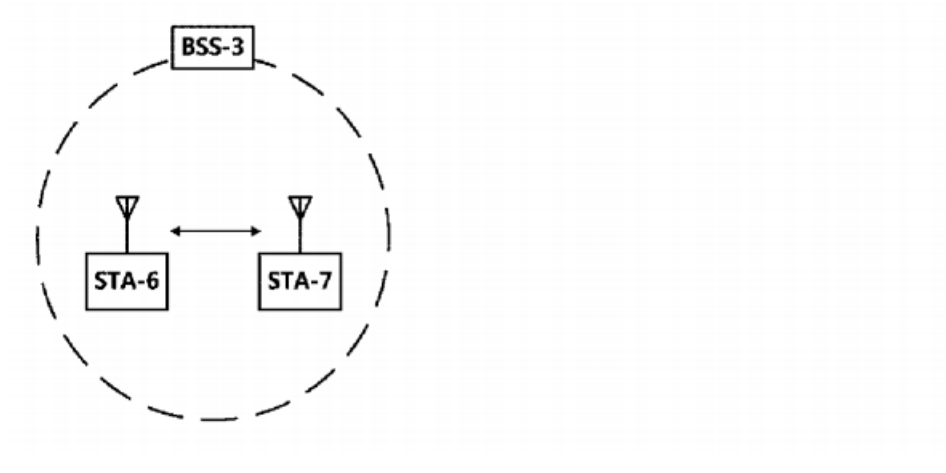
FIG. 6

[Drawings]

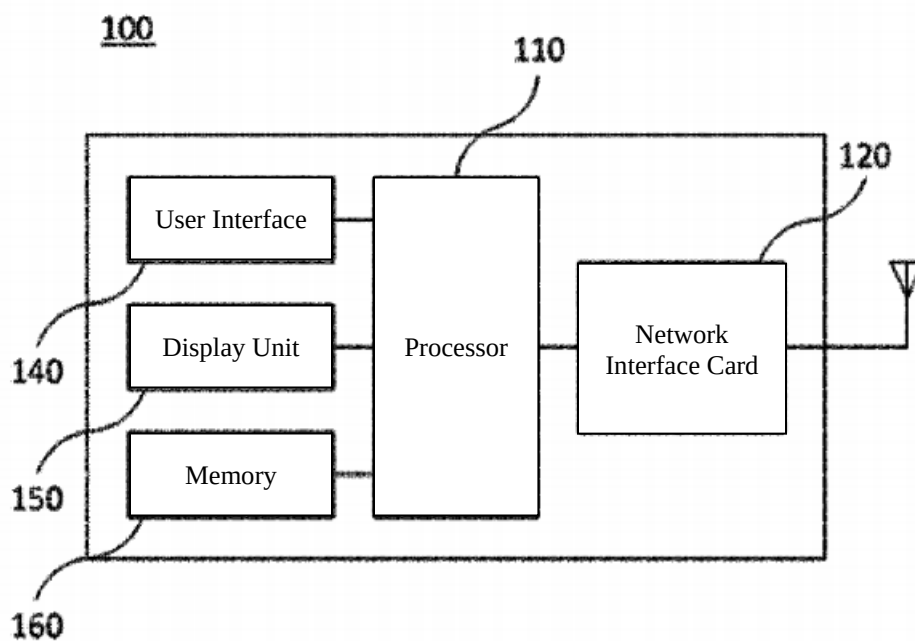
[FIG. 1]



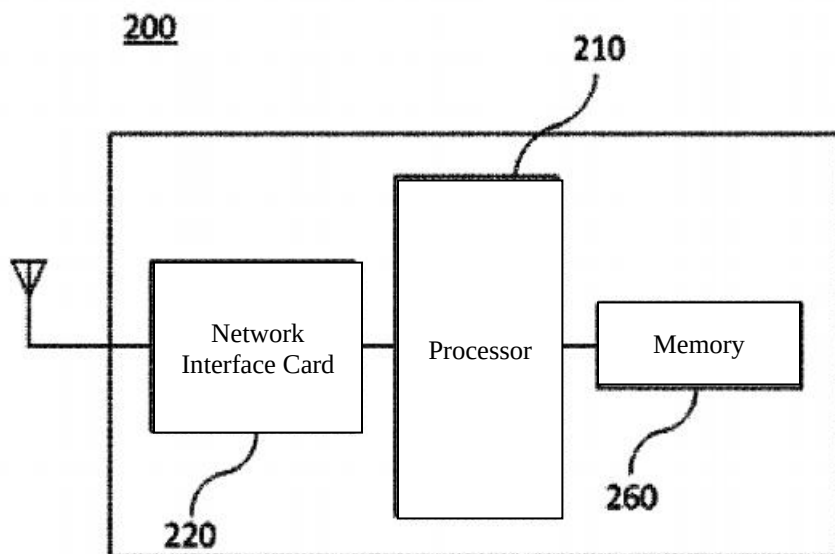
[FIG. 2]



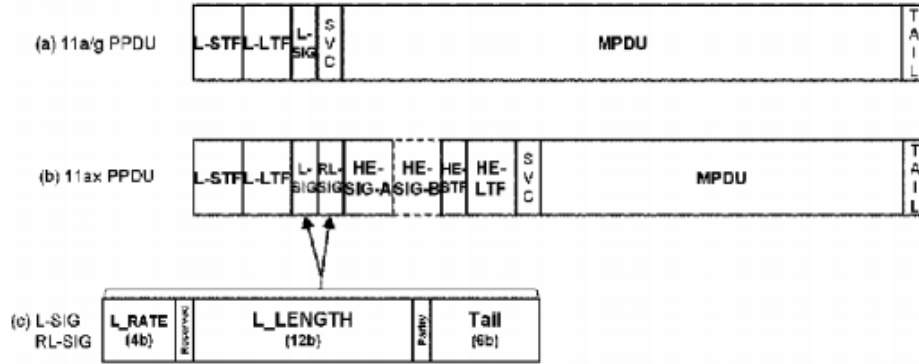
[FIG. 3]



[FIG. 4]



[FIG. 5]



$$\text{PPDU_LENGTH(us)} = \left(1 + \left\lceil \frac{\text{L_LENGTH}}{3} \right\rceil \right) \times 4 + 20$$

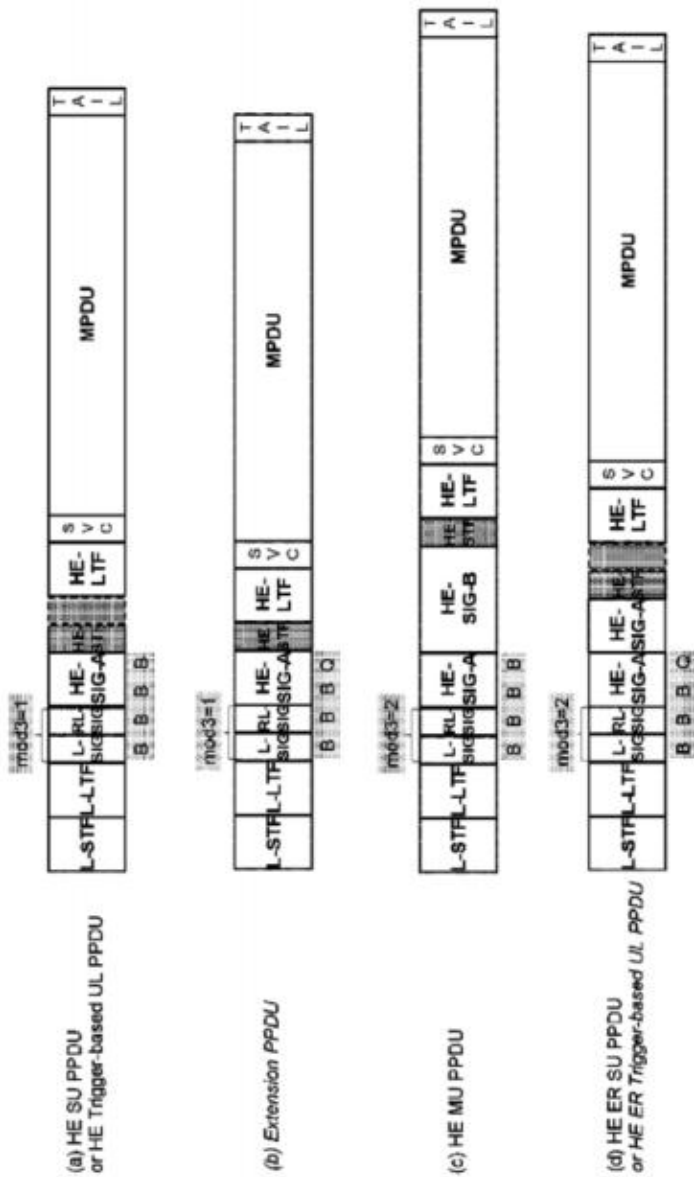
$$\text{RXTIME(us)} = \left(\left\lceil \frac{\text{L_LENGTH} + 3}{3} \right\rceil \right) \times 4 + 20$$

(d)

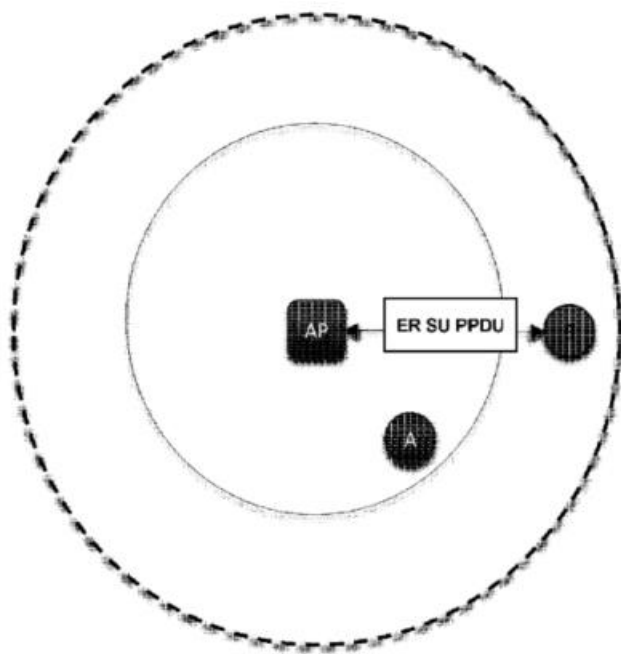
$$\text{L_LENGTH(byte)} = \left(\left\lceil \frac{\text{TXTIME} - 20}{4} \right\rceil \right) \times 3 - 3$$

$$\text{TXTIME(us)} = T_{\text{L-STF}} + T_{\text{L-LTF}} + T_{\text{L-SIG}} + T_{\text{RL-SIG}} + T_{\text{HE-SIG-A}} + (T_{\text{HE-SIG-B}}) + T_{\text{HE-SIG-B}} + N_{\text{HE-LTF}} \cdot T_{\text{HE-LTF}} + T_{\text{Data}}$$

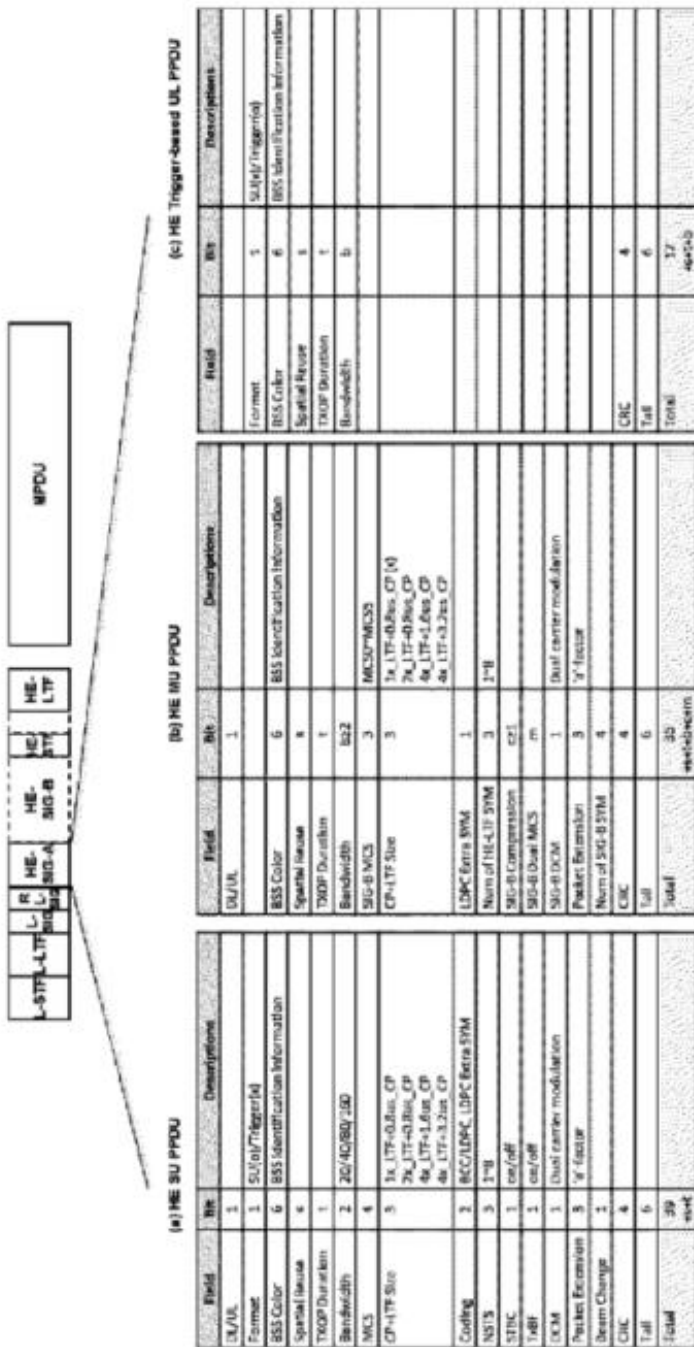
[FIG. 6]



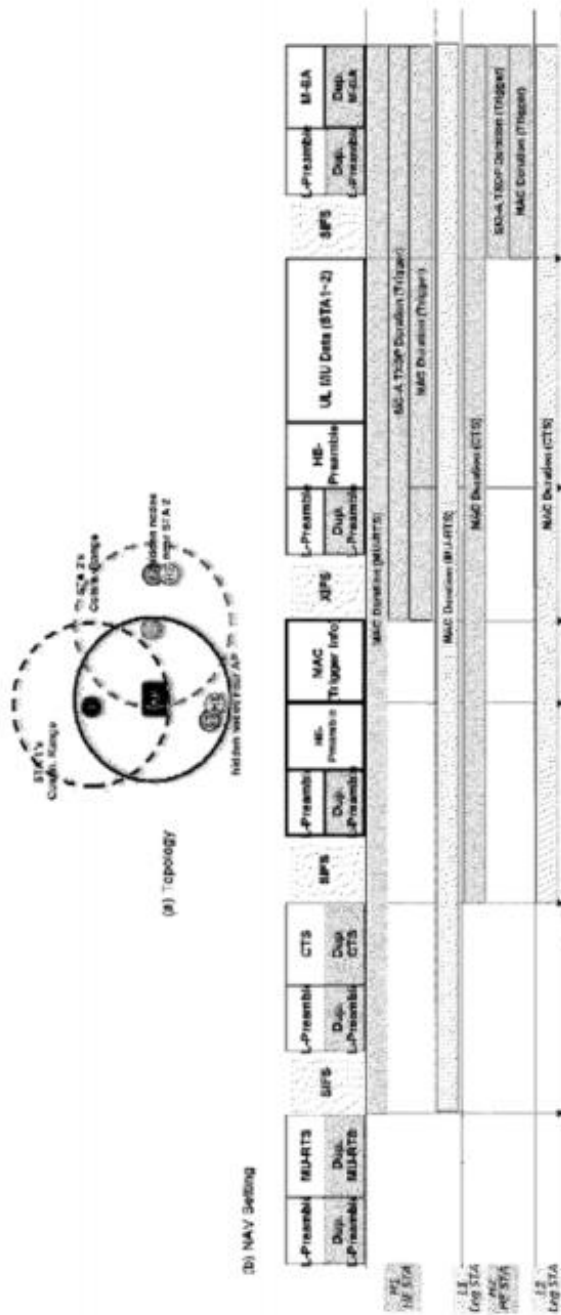
[FIG. 7]



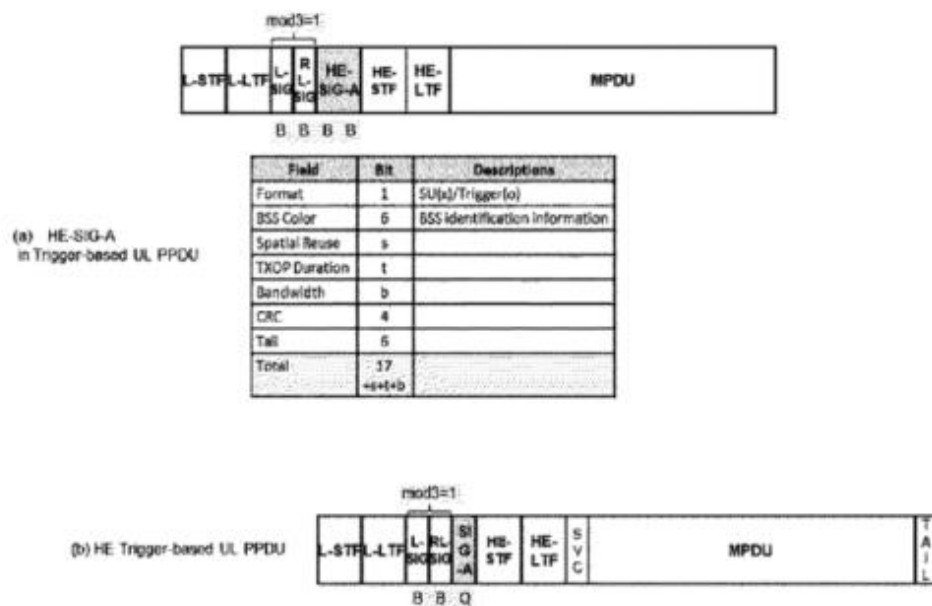
[FIG. 8]



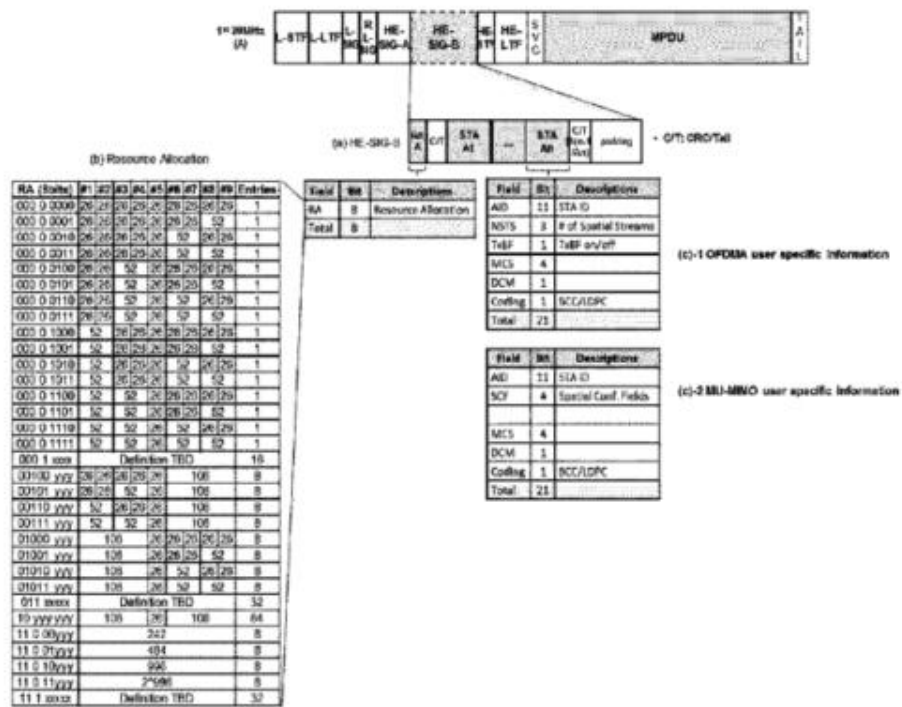
[FIG. 9]



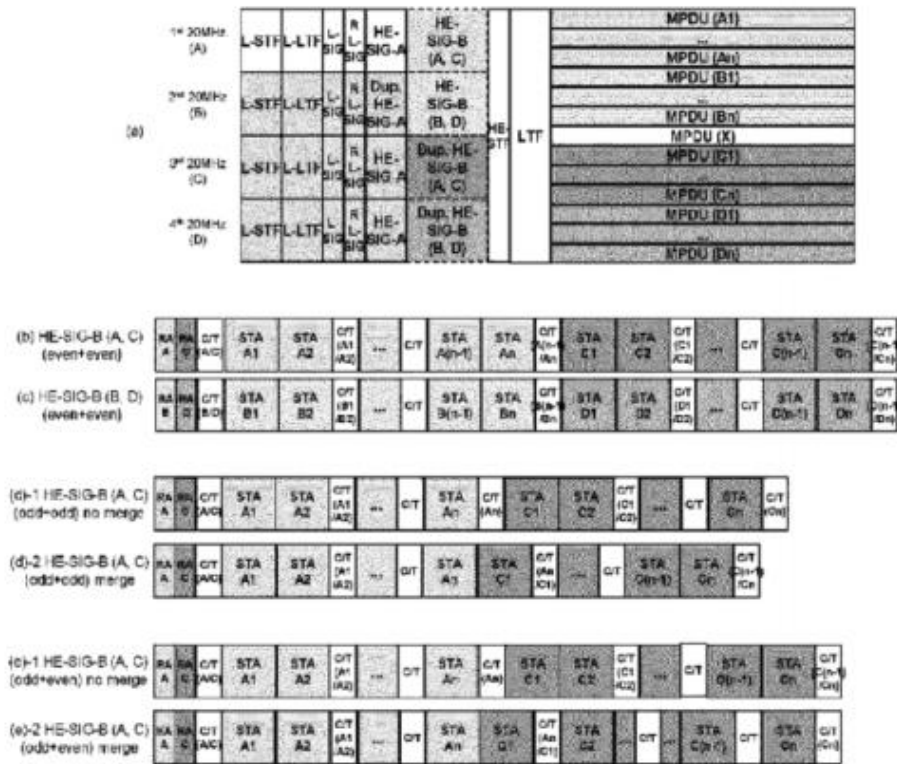
[FIG. 10]



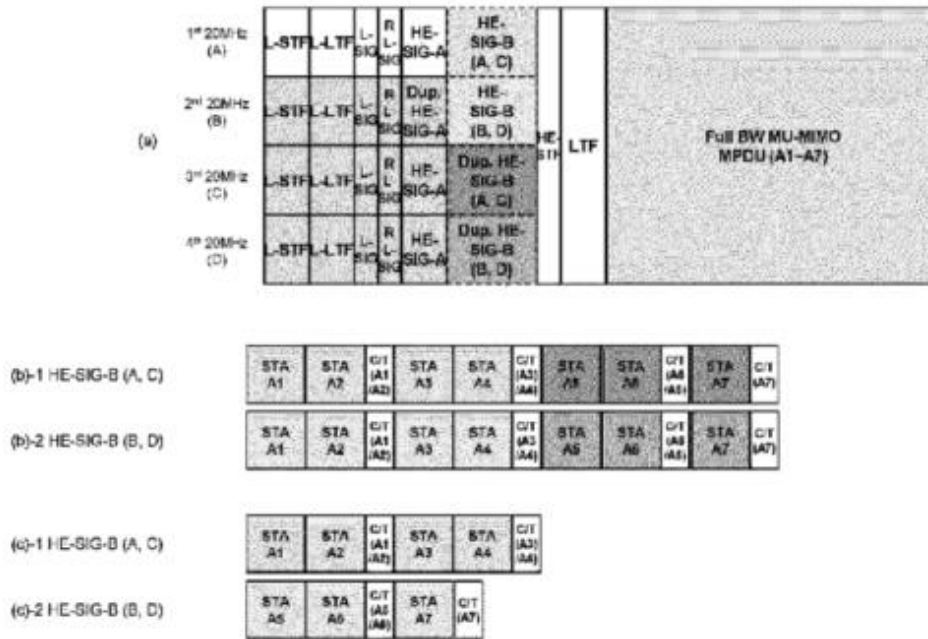
[FIG. 11]



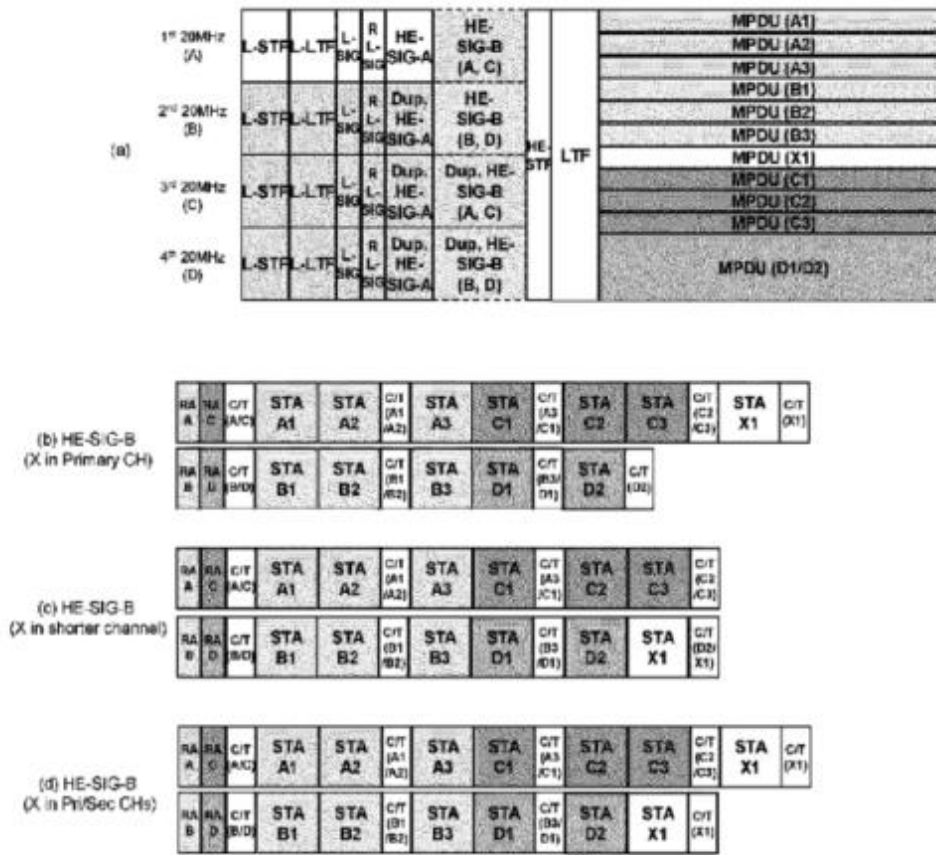
[FIG. 12]



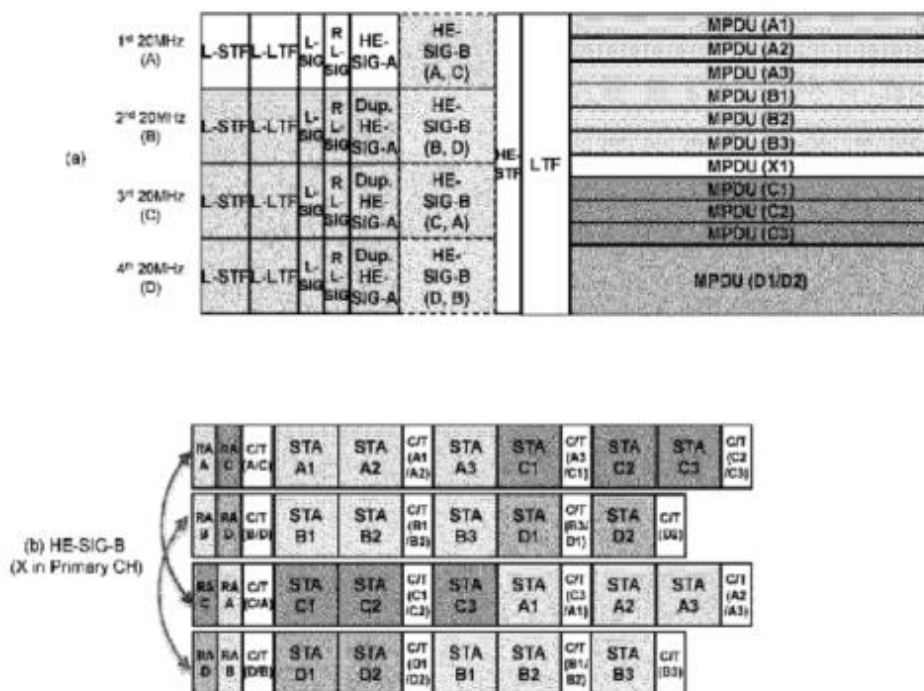
[FIG. 13]



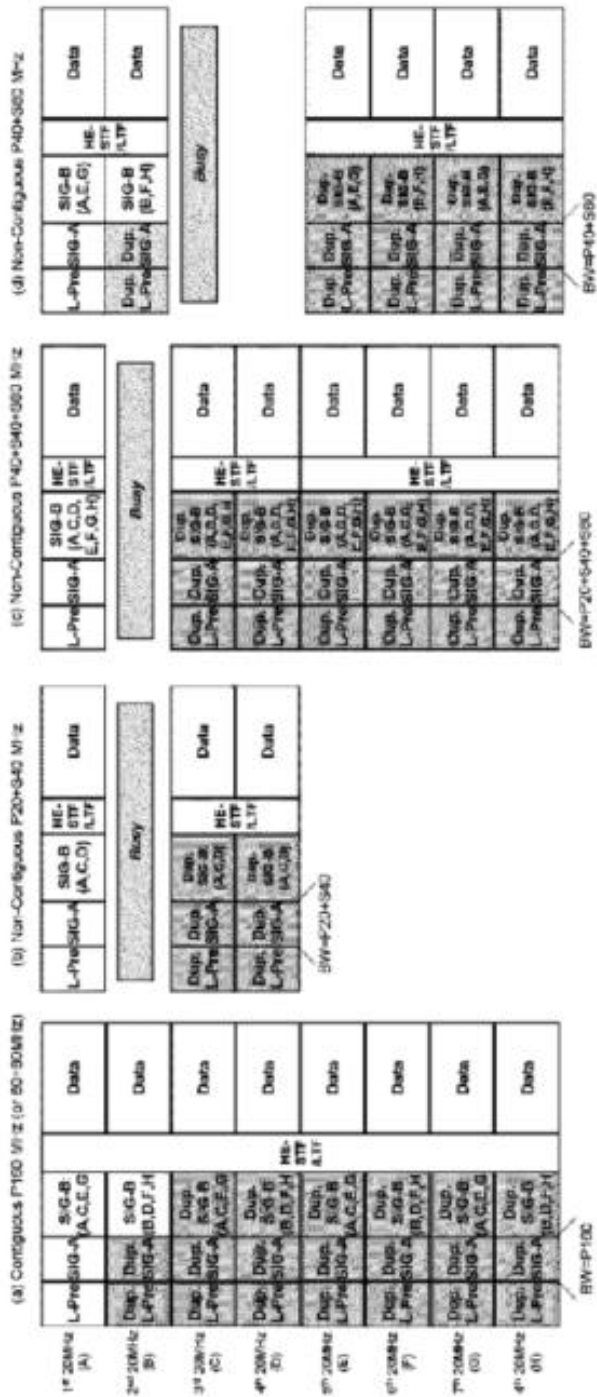
[FIG. 14]



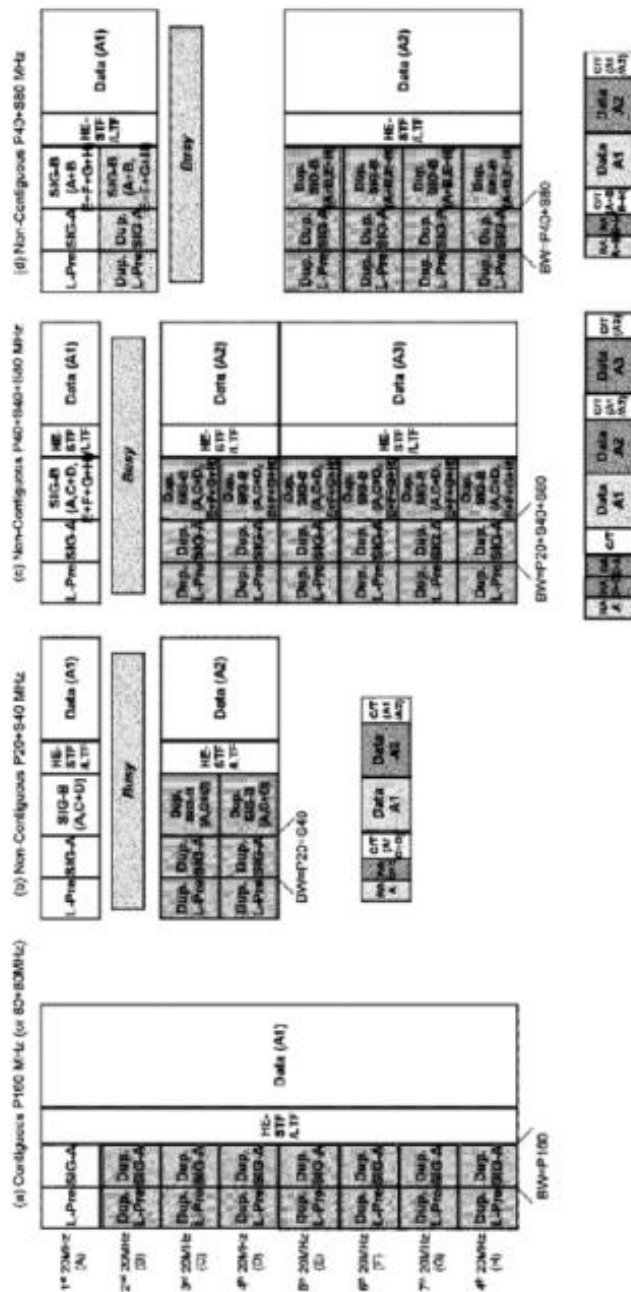
[FIG. 15]



[FIG. 16]



[FIG. 17]



[FIG. 18]

