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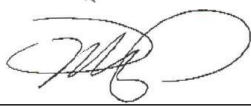
I served as Chief Examiner of the certified court interpreter test for the State of California and as a contract translator and interpreter for various federal agencies through the U.S. Department of State for more than a decade. I served as an instructor at the University of California at Berkeley and 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).

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

Executed this 9th day of April 2025 in Contra Costa County of the State of California.

By: 
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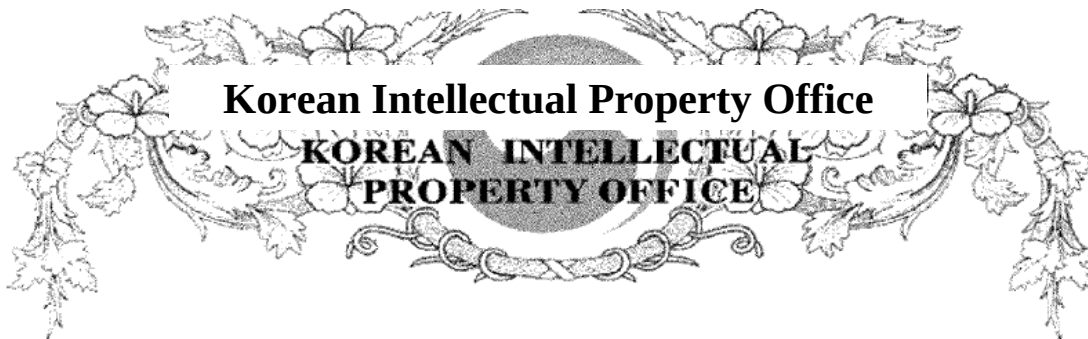
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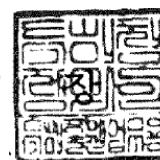
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[Bibliography]

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[Title of the Invention in Korean] ACK TRANSMISSION AND FREQUENCY MASKING
METHODS FOR WIDEBAND WIRELESS LAN MULTIPLE
USER UPLINK DATA TRANSMISSION

[Title of the Invention in English] ACK TRANSMISSION AND FREQUENCY MASKING
METHODS FOR WIDEBAND WIRELESS LAN MULTIPLE
USER UPLINK DATA TRANSMISSION

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<i>Agent or Attorney</i>	Kook Il Lim (signature or seal)

[Fees]		
[Application Filing Fee]	0 page (s)	46,000 KRW
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[Description of the Invention]

[Title of the Invention]

ACK TRANSMISSION AND FREQUENCY MASKING METHODS FOR WIDEBAND
WIRELESS LAN MULTIPLE USER UPLINK DATA TRANSMISSION *[in Korean]* { ACK
TRANSMISSION AND FREQUENCY MASKING METHODS FOR WIDEBAND WIRELESS
LAN MULTIPLE USER UPLINK DATA TRANSMISSION } *[in English]*

[Technical Field]

[0001] The present invention relates to ack transmission and frequency masking methods for wideband wireless LAN multiple user uplink data transmission.

[Background Technology of the Invention]

[0002] Recently, with the widespread adoption of mobile devices, wireless LAN (Wireless LAN) technology, which can provide high-speed wireless internet services to these devices, has been attracting significant attention. Wireless LAN technology enables mobile devices such as smartphones, smart pads, laptop computers, portable multimedia players, and embedded devices to connect to the internet wirelessly based on short-range wireless communication technology.

[0003] Early wireless LAN technology, through IEEE (Institute of Electrical and Electronics Engineers) 802.11, supported speeds of 1 to 2 Mbps by using the 2.4 GHz frequency with frequency hopping, spread spectrum, and infrared communication. Recently, by applying OFDM (Orthogonal Frequency Division Multiplex), it is possible to support speeds of up to 54

Mbps. Additionally, IEEE 802.11 has been commercializing or developing standards for various technologies such as QoS (Quality for Service) enhancement, access point (Access Point, AP) protocol compatibility, security enhancement, radio resource measurement, wireless access in vehicular environments, fast roaming, mesh network, interworking with external networks, and wireless network management.

[0004] Among IEEE 802.11 standards, IEEE 802.11b uses the 2.4GHz band frequency and supports a maximum communication speed of 11 Mbps. IEEE 802.11a, which was commercialized after IEEE 802.11b, uses the 5GHz band frequency instead of the 2.4GHz band, thereby reducing the effect of interference compared to the heavily congested 2.4GHz band, and improved the communication speed up to 54 Mbps by using OFDM technology. However, IEEE 802.11a has a disadvantage of a shorter communication range compared to IEEE 802.11b. IEEE 802.11g, like IEEE 802.11b, uses the 2.4GHz band frequency and supports communication speeds of up to 54 Mbps. It attracted significant attention due to its backward compatibility and also shows superiority over IEEE 802.11a in terms of communication range.

[0005] Additionally, to overcome the limitation in communication speed, which has been pointed out as a vulnerability in wireless LAN, the IEEE 802.11n standard was established. IEEE 802.11n aims to increase the speed and reliability of the network and to extend the operational range of wireless networks. More specifically, IEEE 802.11n supports High Throughput (HT) with data processing speeds exceeding 540 Mbps and is based on MIMO (Multiple Inputs and Multiple

Outputs) technology, which uses multiple antennas on both the transmitting and receiving ends to minimize transmission errors and optimize data speed. Furthermore, this standard not only uses a coding method that transmits multiple redundant copies to increase data reliability, but may also employ Orthogonal Frequency Division Multiplex (OFDM) to increase speed.

[0006] As the adoption of wireless LAN becomes more active and the applications using it become more diverse, there is a growing need for a new wireless LAN system that supports higher throughput (Very High Throughput, VHT) than the data processing speed supported by IEEE 802.11n. Among them, IEEE 802.11ac supports wide bandwidth (80 MHz to 160 MHz) in the 5 GHz frequency band. Although the IEEE 802.11ac standard is defined only for the 5 GHz band, initial 11ac chipsets will also support operation in the 2.4 GHz band for backward compatibility with existing 2.4 GHz band products. In this case, 802.11ac supports a bandwidth of up to 40 MHz in the 2.4 GHz band. Theoretically, under this standard, the wireless LAN speed for multiple terminals can reach at least 1 Gbps, and the maximum single link speed can reach at least 500 Mbps. This is achieved by expanding the wireless interface concepts adopted in 802.11n, such as wider wireless frequency bandwidth (up to 160 MHz), a greater number of MIMO spatial streams (up to 8), multi-user MIMO, and higher-density modulation (up to 256 QAM). In addition, there is IEEE 802.11ad, which uses the 60 GHz band instead of the existing 2.5 GHz/5 GHz bands to transmit data. IEEE 802.11ad is a transmission standard that provides speeds of up to 7 Gbps using beamforming technology, and is suitable for large-capacity data or high-bitrate video streaming

such as uncompressed HD video. However, the 60 GHz frequency band has the disadvantage that it cannot penetrate obstacles, making it usable only between devices in close proximity.

[0007] Wireless LAN can use a wide frequency band. To utilize a wide frequency band, it checks for available bands over a certain period of time before transmitting data and uses the frequency band in an aggregated manner based on the availability of adjacent frequency bands. For example, if the primary 20 MHz band (primary channel) is available, and the next 20 MHz is also available, but the following 20 MHz is unavailable, and the next 20 MHz is available, then a total of 40 MHz is used as the transmission band to transmit data. Since only contiguous frequency bands are used as the data transmission band, there is a problem in that some actually available frequency bands cannot be used. In addition, conventional wireless access technologies support only one-to-one communication between one transmitting terminal and one receiving terminal for each transmission attempt within the same Basic Service Set (BSS), which results in inefficiency as it fails to reflect the connection environment of terminals or the characteristics of the transmitted data.

[Specifics of the Invention]

[Problem to Be Solved by the Invention]

[0008] The present invention is intended to solve the problems of the aforementioned conventional technologies, and has the object of providing a multi-channel uplink packet transmission method, device, and system for wireless LAN.

[Means to Solve the Problem]

[0009] According to an embodiment of the present invention, an apparatus, system and method for a wireless LAN can be provided.

[Effect of the Invention]

[0010] According to an embodiment of the present invention, by utilizing a multiplexed group ACK to reduce unnecessary channel occupancy, it is possible to achieve the effect of increasing the overall spectral efficiency of the network.

[0011] To be more specific, according to an embodiment of the present invention, it is possible to increase the probability of occupancy of the primary channel of an OBSS by using multiplexed group ACK, and it is possible to increase the overall spectral efficiency of the network in an overcrowded OBSS environment.

[0012] In addition, according to an embodiment of the present invention, it is possible to reduce unnecessary channel occupancy during multi-user uplink transmission in a contention-based channel access system.

[0013] The present invention is applicable to various communication devices such as stations or access points using wireless LAN, and stations or base stations using cellular communication.

[Brief Description of the Drawings]

[0014] FIG. 1 illustrates a wireless LAN system according to an 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 showing the configuration of a station according to an embodiment of the present invention.

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

FIG. 5 schematically illustrates a procedure in which a STA establishes a link with an AP in connection with an embodiment of the present invention.

FIG. 6 illustrates a passive scanning method of a STA related to an embodiment of the present invention.

FIG. 7 illustrates an active scanning method of a STA related to an embodiment of the present invention.

FIG. 8 is a diagram illustrating the configuration of a wireless LAN network related to an embodiment of the present invention.

FIG. 9 shows an example of a basic multi-user uplink data transmission procedure.

FIG. 10 is a diagram illustrating an ACK transmission method for multi-user uplink data transmission according to an embodiment of the present invention.

FIG. 11 is a diagram illustrating a NAV setting method according to an embodiment of the present invention.

FIG. 12 is a diagram illustrating a guard band setting method according to another embodiment of the present invention.

FIG. 13 is a diagram illustrating a preamble processing method during multi-user uplink

data transmission according to an embodiment of the present invention.

FIG. 14 is a diagram illustrating a configuration method of an HE preamble according to an embodiment of the present invention.

[Detailed Specifics for Practicing the Invention]

[0015] Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings so that those skilled in the art to which the present invention pertains can easily practice the invention. However, the present invention may be implemented in various different forms and is not limited to the embodiments described herein. Also, parts irrelevant to the description are omitted in order to clearly describe the present invention in the drawings, and throughout the specification, similar reference numerals are used for similar elements.

[0016] Throughout the specification, when a certain part is described as being "connected" to another part, it includes not only cases where they are "directly connected" but also cases where they are "electrically connected" with another element interposed therebetween. In addition, when a certain part is said to "include" a certain component, unless specifically stated otherwise, it does not exclude other components but may further include other components.

[0017] Structure of Wireless LAN System

[0018] FIG. 1 illustrates a wireless LAN system according to one embodiment of the present invention.

[0019] 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.

[0020] 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).

[0021] 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). 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.

[0022] 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

STAs not connected with AP in an infrastructure BSS is carried out, in principle, via an AP, but direct communication between STAs not connected with AP 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.

[0023] 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). STAs included in an ESS can communicate with each other, and STA that are not connected to an AP within the same ESS can communicate seamlessly while moving from one BSS to another.

[0024] FIG. 2 illustrates an independent BSS, which is a wireless LAN system according to another embodiment of the present invention. In the embodiment of FIG. 2, parts that are the same as or correspond to those in the embodiment of FIG. 1 will not be redundantly described.

[0025] 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.

[0026] Configuration of STA (Station)

[0027] FIG. 3 is a block diagram showing the configuration of a station according to an

embodiment of the present invention.

[0028] As shown, the STA 100 according to an embodiment of the present invention may include a processor 110, one or more network interface cards (NIC, Network Interface Card) 120, a user interface unit 140, a display unit 150, and a memory 160.

[0029] First, the network interface card 120 is a module for performing wireless LAN access and may be embedded in or externally connected to the STA 100. According to an embodiment of the present invention, the network interface card 120 may include a plurality of network interface card modules 120_1 to 120_n that use different frequency bands. For example, the network interface card modules 120_1 to 120_n may include network interface card modules for different frequency bands such as 2.4 GHz, 5 GHz, and 60 GHz. According to an embodiment of the present invention, the STA 100 may include at least one network interface card module that uses a frequency band of 6 GHz or higher and at least one network interface card module that uses a frequency band of 6 GHz or lower. Each of the network interface card modules 120_1 to 120_n may perform wireless communication with an AP or an external STA according to the wireless LAN standard for the frequency band supported by the corresponding network interface card module 120_1 to 120_n. The network interface card 120 may operate only one of the network interface card modules 120_1 to 120_n at a time or operate multiple network interface card modules 120_1 to 120_n simultaneously depending on the performance and requirements of the STA 100.

[0030] Meanwhile, in the block diagram of FIG. 3, the plurality of network interface card modules 120_1 to 120_n of the STA 100 are illustrated as being separated from each other, and the MAC/PHY layers of each network interface card module 120_1 to 120_n operate independently. However, the present invention is not limited thereto and the plurality of network interface card modules for different frequency bands may also be integrated into a single chip and provided in the STA 100.

[0031] 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.

[0032] 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.

[0033] 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 controls communication operations of the STA 100, such as the transmission/reception of sector sweep signals and the transmission/reception of corresponding feedback signals.

[0034] In addition, the processor 110 executes a program stored in the memory 160 to establish a connection with the AP, receives a communication setup message transmitted by the AP, reads information on the priority condition of the STA 100 included in the communication setup message, and requests a connection to the AP based on the information regarding the priority condition of the STA 100. A detailed description of this will be provided later.

[0035] 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.

[0036] Configuration of AP (Access Point)

[0037] FIG. 4 is a block diagram illustrating the configuration of an AP 200 according to one embodiment of the present disclosure.

[0038] 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.

[0039] 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 220_1 to 220_m 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 220_1 to 220_m can perform wireless communication with stations in accordance with the wireless LAN specifications for the frequency band supported by that network interface card module 220_1 to 220_m. The network interface card 220 may operate only one network interface card module 220_1 to 220_m at a time or may operate multiple network interface card modules 220_1 to 220_m together simultaneously, depending on the performance and requirements of the AP 200.

[0040] 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.

[0041] In addition, 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. Further, the processor 210 performs the connection setting according to the connection request of the station 100, while the communication setup message includes information about the access priority conditions of each station. A specific description of this will be stated later.

[0042] Link Establishment Procedure

[0043] FIG. 5 schematically illustrates a procedure in which a STA establishes a link with an AP according to an embodiment of the present invention.

[0044] Referring to FIG. 5, the process in which the STA 100 connects to the AP 200 according to the present invention is largely divided into three stages: scanning, authentication, and association. The scanning stage is the stage in which the STA 100 acquires access information of the BSS operated by the AP 200. Methods for performing scanning include passive scanning S101, in which the STA acquires information by using only the beacon messages periodically transmitted by the AP, and active scanning, in which the STA transmits a probe request to the AP S103, and receives a probe response from the AP S105 to acquire access information.

[0045] The STA 100 that has successfully received wireless access information in the scanning stage transmits an authentication request S107a, and receives an authentication response S107b to perform the authentication procedure.

[0046] After successfully completing the authentication procedure at the IEEE 802.11 layer, the association steps S109a and S109b are performed, and additionally, 802.1X-based authentication S111 and IP address acquisition via DHCP S113 may be carried out. The AS 300, as an Authentication Server, handles 802.1X-based authentication with the STA 100 and may be physically integrated with the AP 200 or exist as a separate server.

[0047] FIG. 6 illustrates a passive scanning method of a STA related to an embodiment of the present invention.

[0048] Referring to FIG. 6, the first STA 110 according to the present invention receives beacon messages periodically transmitted from the first AP 210 and the second AP 220 located nearby, and acquires the wireless access information of each AP.

[0049] FIG. 7 illustrates an active scanning method of a STA related to an embodiment of the present invention.

[0050] Referring to FIG. 7, the first STA 110 according to the present invention transmits a probe request message to acquire information of APs located nearby, and receives corresponding probe response messages from the first AP 210 and the second AP 220, thereby acquiring the wireless access information of each AP.

[0051] Multi-User Uplink Transmission

[0052] FIG. 8 illustrates the configuration of a wireless LAN network related to an embodiment of the present invention.

[0053] In conventional wireless LANs, communication is fundamentally based on one-to-one transmission within a BSS. However, when additional channels and OFDM technology or extra RF modules are utilized, an environment can be created in which multiple terminals can communicate simultaneously. In a typical wireless LAN environment, a single AP communicates with multiple terminals, and in the case of uplink transmission, multiple terminals transmit data to the AP simultaneously. Therefore, proper coordination in terms of frequency and timing among the terminals is required to ensure successful data transmission, and the performance of multi-user uplink access can be determined by the efficiency of this coordination process. In addition, in a wireless LAN environment where multiple BSSs are adjacent, the channel conditions occupied by each BSS may differ. As shown in FIG. 8, even among terminals within the same BSS, the available channels may vary depending on the influence of neighboring BSSs. Therefore, differing channel conditions must also be considered in supporting multi-user uplink access.

[0054] FIG. 9 illustrates an example of a basic multi-user uplink data transmission procedure. In the case of multi-user uplink transmission, unlike downlink transmission, multiple terminals must transmit data simultaneously. Therefore, it is highly likely that the AP, which can communicate with all terminals within the BSS, manages the transmission procedure. Accordingly, before the actual data transmission begins, the AP needs to acquire information on whether uplink

transmission data exists in the buffers of wireless terminals in the BSS and information such as TXOP. Additionally, the AP must provide terminals with information on the precise transmission timing. These procedures can be divided into an initiation process S901 and a scheduling process S902 for multi-user uplink data transmission. It is possible to collect scheduling-related information in advance and then perform the initiation when specific conditions are satisfied, or to perform the initiation based on a time condition and immediately carry out scheduling. The initiation and scheduling processes include an exchange of information between the AP and wireless terminals regarding channels available for transmission. Therefore, the procedure may proceed such that the AP first limits the available channels, and then the wireless terminals provide feedback on all channels available among those. The present invention does not address the detailed structure and method of initiation and scheduling.

[0055] Once both the initiation and scheduling processes are completed, multiple terminals simultaneously transmit data at the designated time through the subcarriers allocated by the AP S903. After the data transmission, the AP must transmit an ACK to all terminals that participated in the uplink data transmission to indicate whether the data was successfully received S904. Since the 802.11ax standard considers allocating resources in 2.5 / 5 / 10 MHz subchannel units within each 20 MHz channel, multiple terminals can participate in transmission on a single channel. Therefore, the AP must transmit an ACK in the form of a group ACK for each channel to acknowledge the terminals that transmitted on each respective channel.

[0056] In multi-user uplink data transmission, if the BSS deployment environment is congested and affected by multiple OBSS, the available channels may vary depending on the geographical location of each wireless terminal. In such cases, the number of terminals capable of transmitting on each channel may vary, resulting in different airtime usage across channels involved in actual uplink data transmission. However, in cases where the AP does not have the capability to perform transmission and reception simultaneously, it cannot transmit the ACK for a channel that has completed uplink data transmission while still receiving data on a channel with a longer air time. As a result, wireless terminals must wait, using methods such as zero padding S905, until the data reception on the channel with the longest air time is complete in order to receive the ACK. In such cases, since the terminals occupy the corresponding channels regardless of actual data transmission, overall spectral efficiency is reduced. This impact is particularly significant for OBSSs that use the affected channel as a primary channel, as no operation can be performed during the padding period, leading to direct performance degradation. Therefore, the present invention proposes an ACK transmission method for multi-user uplink data transmission to resolve the aforementioned problems.

[0057] FIG. 10 illustrates an ACK transmission method for multi-user uplink data transmission according to an embodiment of the present invention.

[0058] In the present invention, following the philosophy of the existing 802.11, it is assumed that all wireless terminals first receive the UL-OFDMA initiation through the primary

channel, and then provide feedback on available secondary channels. Therefore, wireless terminals that cannot use the primary channel cannot participate in multi-user uplink transmission, and as a result, the primary channel may always have the highest number of assigned wireless terminals.

[0059] As shown in the example of FIG. 10, when the air time assigned to each channel differs, rather than transmitting ACKs per channel, the ACKs for all channels used in the multi-user uplink data transmission may be multiplexed and transmitted on the primary channel, which has the longest air time S1002. Therefore, wireless terminals assigned to secondary channels set an ACK reception timer from the point at which the uplink air time for their channel ends, and wait until the ACK transmission on the primary channel, at which point they receive the ACK S1002. To support this, all channels must be aware of the transmission timing of the multiplexed group ACK, and this information can be individually transmitted during the initiation or scheduling process. Until the ACK reception timer expires, the terminals may transition into a power-saving mode (sleep) to conserve energy.

[0060] In the case of using a multiplexed group ACK, the secondary channels can be immediately released once their uplink data transmission air time ends, allowing OBSSs that use those channels as their primary channel to access the channel at an earlier point in time. Therefore, an improvement in overall spectral efficiency of the network can be expected.

[0061] FIG. 11 illustrates a NAV setting method according to an embodiment of the present invention.

[0062] In multi-user uplink data transmission, since the exact transmission completion time cannot be known until the wireless terminals' channel status feedback and resource allocation are completed, the AP transmits a CTS-to-self or CTS-to-group at the start of the UL-OFDMA procedure to initially set the NAV up to the initiation and scheduling stage S1101. After the resource allocation is completed during the scheduling process, the transmission air time allocated to each channel is determined. Therefore, at the end of the initiation and scheduling process, the AP and the wireless terminals assigned to each channel simultaneously transmit a common CTS with an identical waveform, through which the required NAV per channel can be set S1102. Accordingly, OBSSs that receive the NAV on the secondary channels can immediately attempt to access the corresponding channel once the NAV duration ends. The STAs that transmitted uplink data on secondary channels receive the ACK on a different channel than the one used for data transmission. If these STAs only set NAV for the secondary channel used for uplink data transmission, the secondary channel will be protected during transmission, but the primary channel will remain unprotected. As a result, APs or STAs adjacent to the secondary uplink STA may consider the primary channel idle and attempt to access it. In such cases, the secondary uplink STAs may fail to receive the ACK from the AP, leading to unnecessary retransmissions. Therefore, the present invention proposes that STAs transmitting data via secondary channels additionally provide protection for the primary channel where the multiplexed group ACK will be transmitted, by transmitting the common CTS in S1102 on both the primary and secondary channels. In this case,

the duration of the common CTS transmitted on the primary channel must indicate the completion time of the multiplexed group ACK on the primary channel. STAs transmitting uplink data on the primary channel do not need to transmit an additional common CTS on the secondary channels.

[0063] FIG. 12 illustrates a guard band setting method according to another embodiment of the present invention.

[0064] In 802.11, when different terminals communicate through adjacent channels, a frequency masking technique is used at the channel boundary frequencies to intentionally reduce power and minimize mutual interference. Frequency masking is implemented by reducing the power at the minimum and maximum portions of the currently used overall frequency band to form guard frequencies. Therefore, frequency masking differs depending on whether it is performed for a full 40 MHz transmission S1201, or for two independent transmissions occurring on adjacent 20 MHz channels S1202, especially with respect to whether a central guard frequency S1203 is present. Accordingly, as in S1204, if a specific STA begins transmission with a 40 MHz unit and then, based on scheduling and resource allocation results, only a certain 20 MHz transmission is removed while the rest continues, the frequency masking of the RF chain may remain unchanged from the original configuration. This may result in a 20 MHz transmission without a guard frequency. In such a case, if an OBSS attempts transmission in the empty 20 MHz band, mutual interference may occur due to the absence of a guard frequency. Therefore, in the present invention, during multi-user uplink data transmission, it is proposed that a 20 MHz guard frequency be always maintained S1205. To

achieve this, either no single terminal is allocated more than 20 MHz of resources, or regardless of frequency masking configuration, the frequency components corresponding to the guard frequency are nulled to prevent interference with OBSS transmissions.

[0065] FIG. 13 illustrates a preamble processing method during multi-user uplink data transmission according to an embodiment of the present invention.

[0066] In 802.11ax, both the HE preamble for ax-capable terminals and the legacy preamble for backward compatibility are inserted at the front of the PSDU and transmitted together. While previous versions of 802.11 supported only a 64-point FFT size, the 802.11ax standard supports up to 256-point FFT, so each uplink transmitting terminal includes its own common control information in the HE preamble using a 256 FFT size, and transmits it on the sub-channel it has been assigned. However, since the legacy preamble is transmitted in 20 MHz units, it is not possible for uplink transmitting terminals assigned to sub-channels to partially transmit a legacy preamble within their sub-channel. Accordingly, the present invention proposes two methods for terminals participating in multi-user uplink data transmission to transmit the legacy preamble: First, one terminal selected based on a specific criterion may transmit the legacy preamble alone as a representative of the terminals assigned to the same 20 MHz channel. Criteria for selecting the terminal may include the terminal with the highest RSSI, or the terminal assigned to the highest sub-channel within the 20 MHz channel. The selected terminal transmits the legacy preamble in 20 MHz and then transmits the HE preamble with 256 FFT size on its assigned sub-channel. The

remaining terminals, after the selected terminal finishes transmitting the legacy preamble, simultaneously transmit their own HE preambles on their assigned sub-channels. Second, all terminals assigned to the same 20 MHz channel simultaneously transmit the legacy preamble in the form of an identical waveform using the same common control information. After this identical legacy preamble transmission, each terminal proceeds to transmit the HE preamble on its assigned sub-channel. To enable the transmission of the preamble as described above, values corresponding to the legacy preamble must be shared in advance among the terminals through means such as scheduling, wherein the AP delivers the relevant information prior to transmission.

[0067] FIG. 14 illustrates a configuration method of an HE preamble according to an embodiment of the present invention.

[0068] The 802.11ax standard specifies that the HE preamble for ax terminal operation and control must be transmitted immediately after the legacy preamble. Among these, the HE-SIG A, which contains common control information for ax terminals, is expected to be composed using a 64 FFT size, similar to the legacy preamble. Therefore, the HE-SIG A may be configured such that all terminals participating in the multi-user uplink data transmission transmit the same common control information in 20 MHz units. Alternatively, it may be constructed independently for each sub-channel based on the minimum sub-channel allocation using 64 FFT, allowing each terminal to transmit different information. Accordingly, a terminal assigned one or more sub-channels as the minimum unit must replicate the same HE-SIG A across all its allocated sub-channels and transmit

it. In addition, the HE-SIG A may include an indication bit to notify other terminals whether the transmission is uplink or downlink, in order to distinguish among control messages, data, or ACK transmissions.

[0069] Although the present invention has been described by using wireless LAN communication as an example, the present invention is not limited thereto and may equally be applied to other communication systems such as cellular communication. In addition, while the methods, devices, and systems of the present invention have been described with reference to specific embodiments, all or part of the components and operations of the present invention may be implemented using a computer system having a general-purpose hardware architecture.

[0070] The foregoing description of the present invention is for illustrative purposes, and those skilled in the art will understand that various modifications can be made to specific forms without altering the technical spirit or essential characteristics of the present invention. Therefore, the embodiments described above should be interpreted as illustrative rather than limiting in all respects. For example, each component described as being implemented in a single form may be implemented in a distributed manner, and similarly, components described as being distributed may also be implemented in a combined form.

[0071] The scope of the present invention should be defined not by the above detailed description but by the following claims, and all modifications or variations derived from the meaning and scope of the claims and their equivalents should be construed as being included within the scope of the present invention.

[Description of Referential Numerals]

[0072] 100: Station

200: Access Point

[What is claimed is]

[Claim 1]

An apparatus, system and method for wireless LANs.

[Summary]

[Abstract]

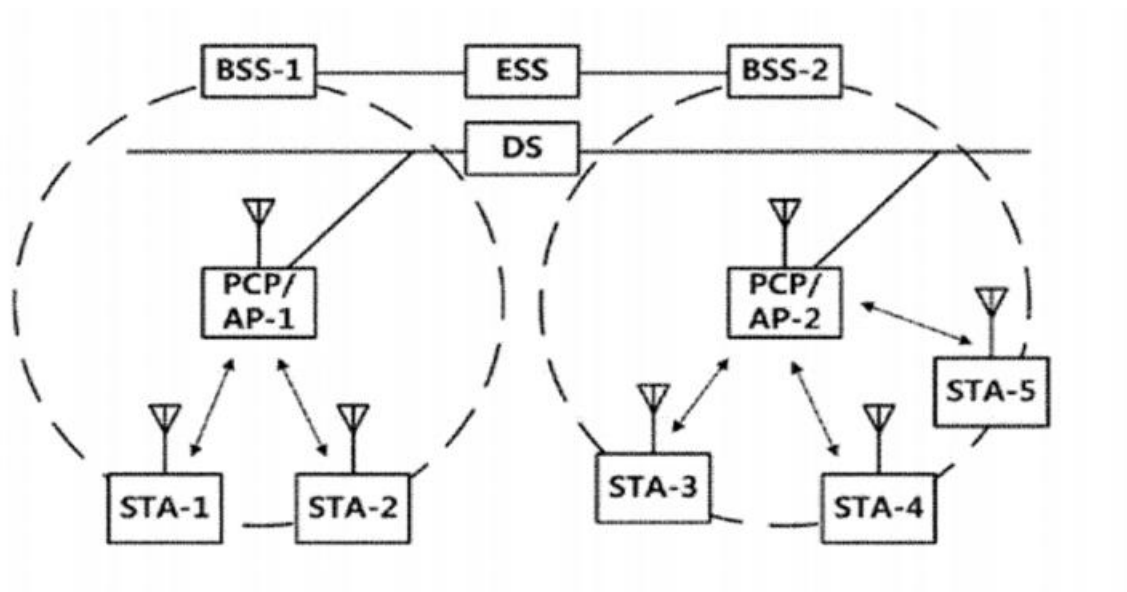
The present invention relates to ack transmission and frequency masking methods for wideband wireless LAN multiple user uplink data transmission. To this end, the present invention proposes an ACK processing method for multi-user uplink transmission in a contention-based channel access system.

[Representative Drawings]

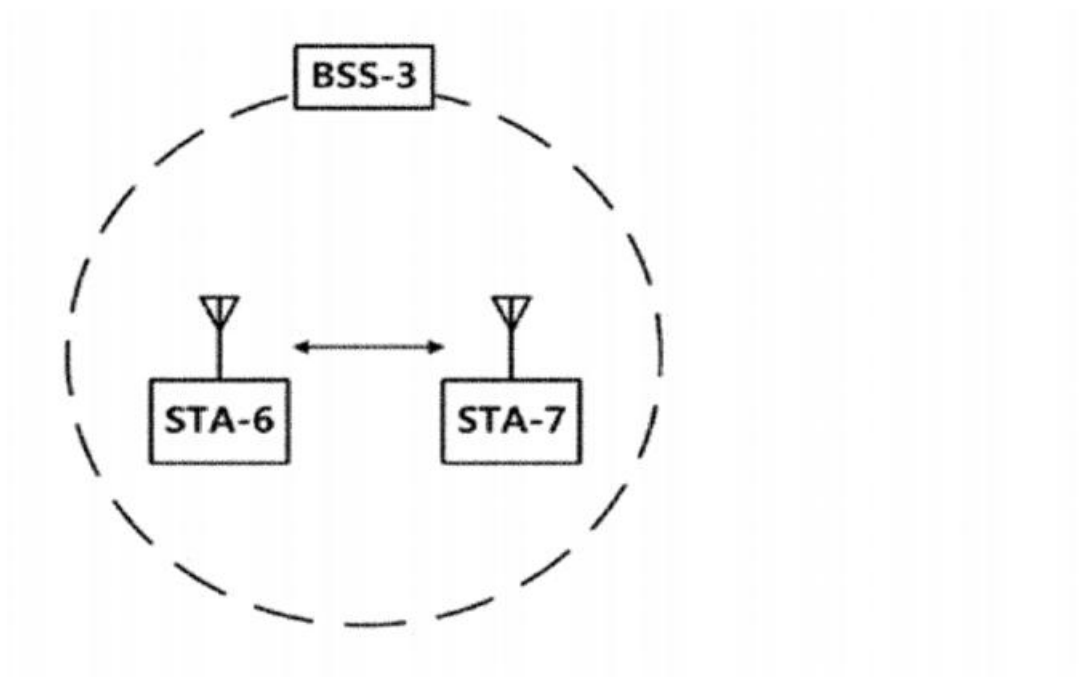
FIG. 10

[Drawings]

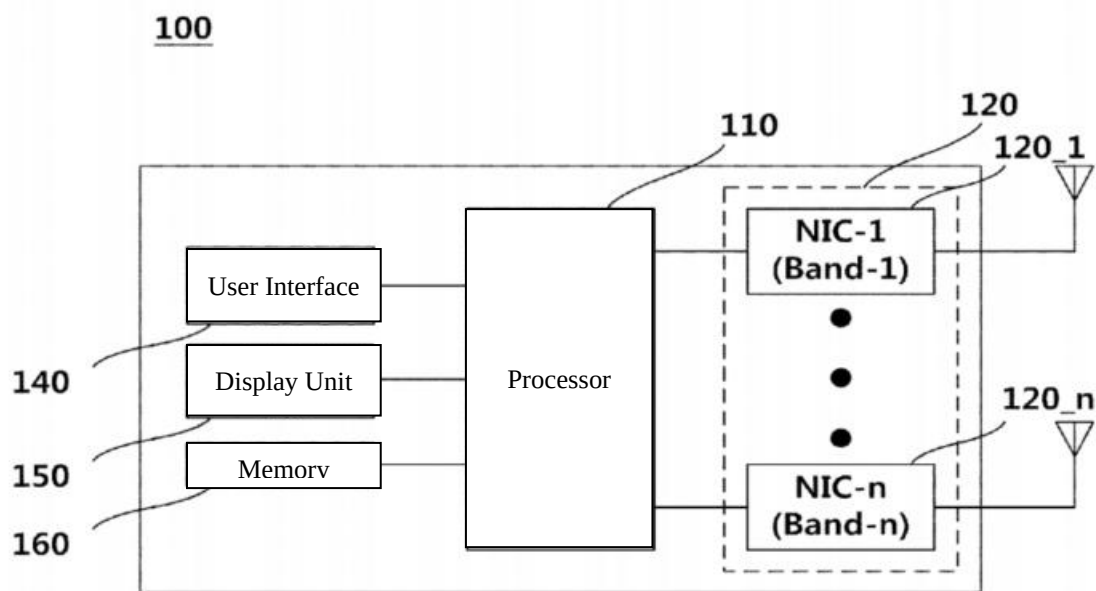
[FIG. 1]



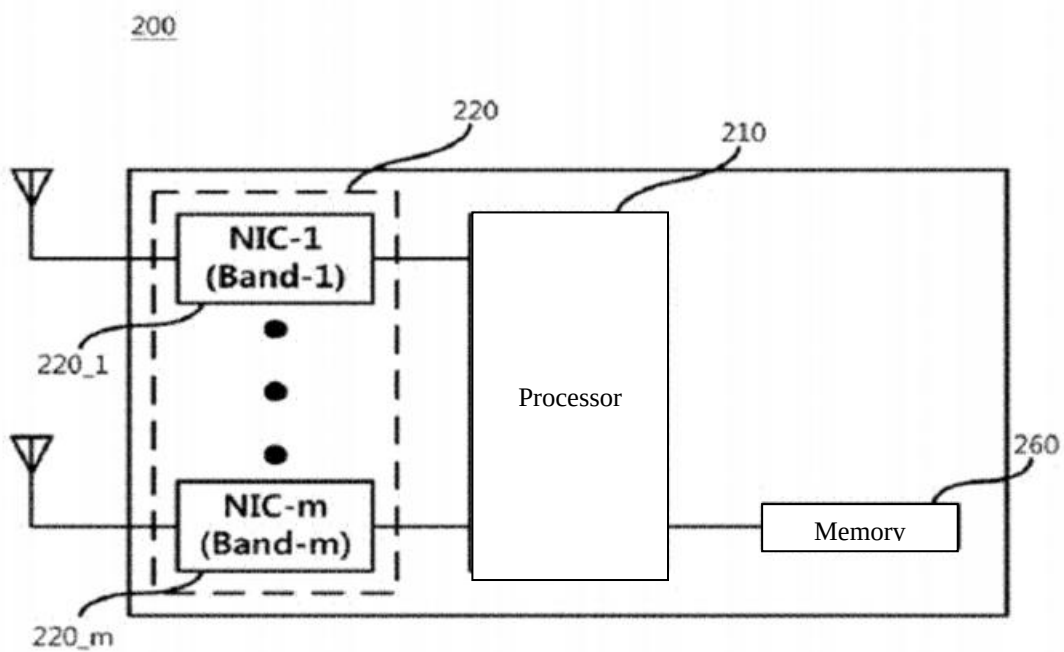
[FIG. 2]



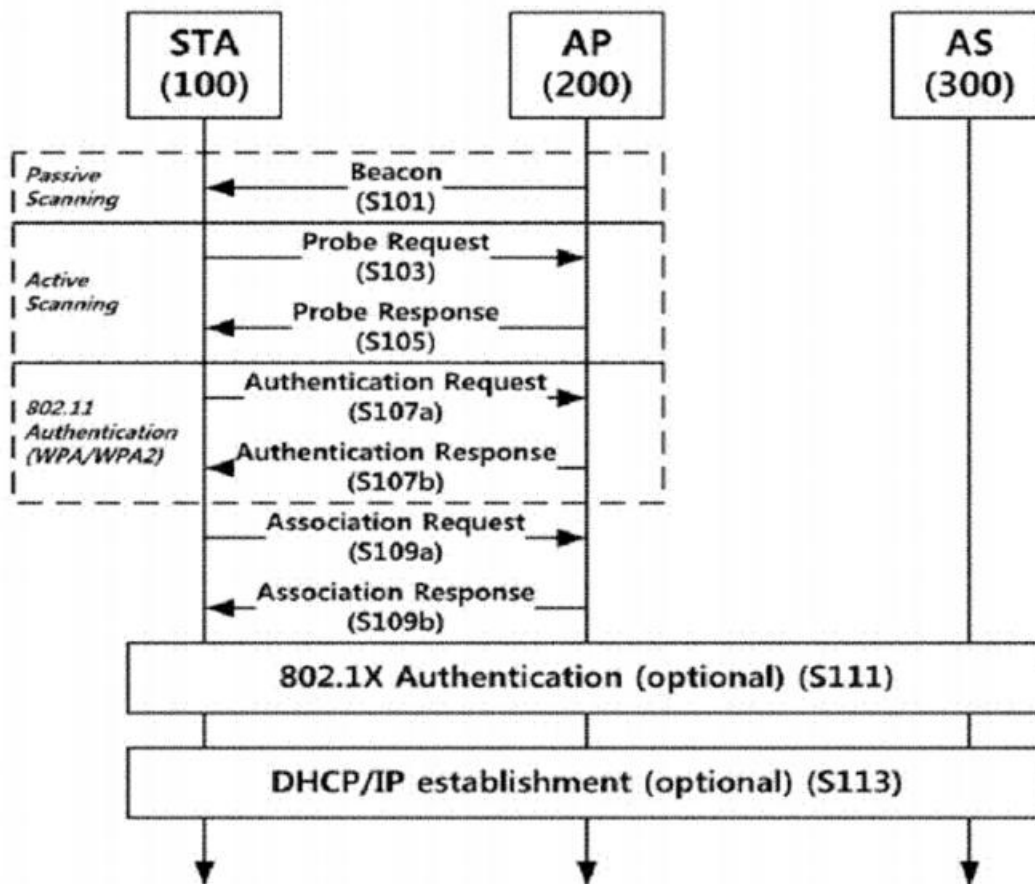
[FIG. 3]



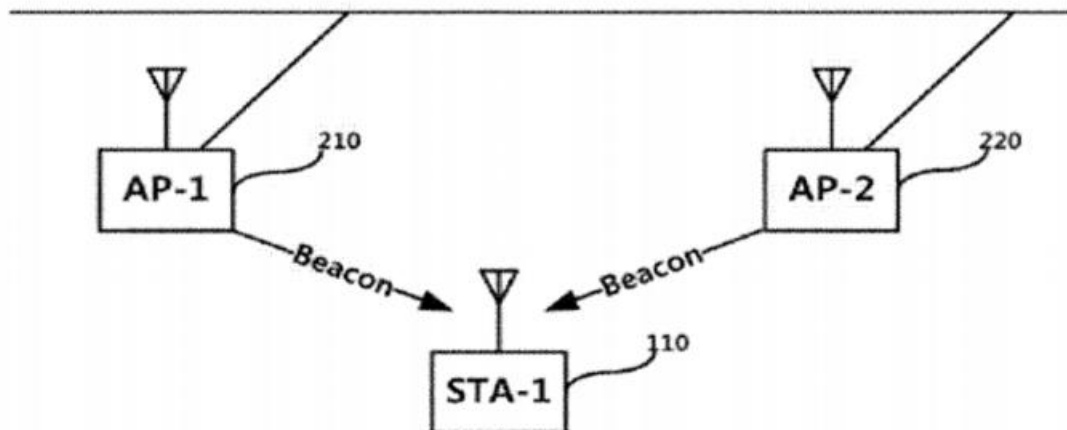
[FIG. 4]



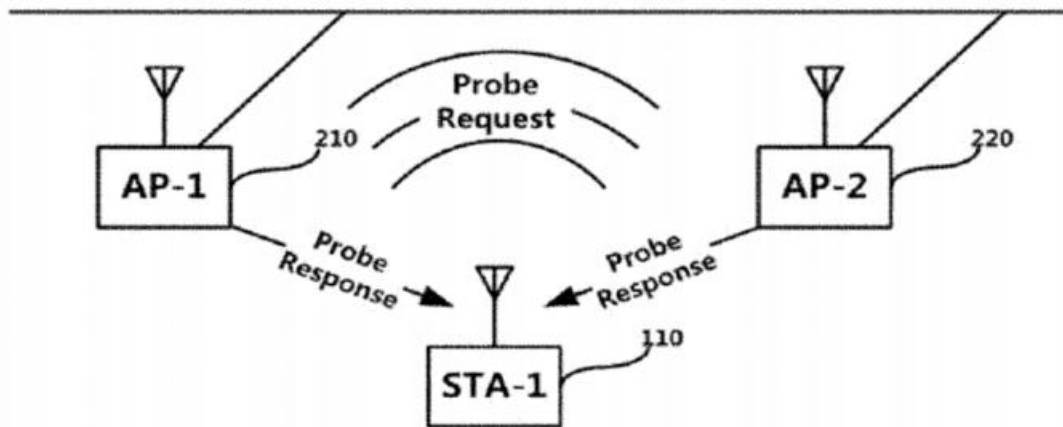
[FIG. 5]



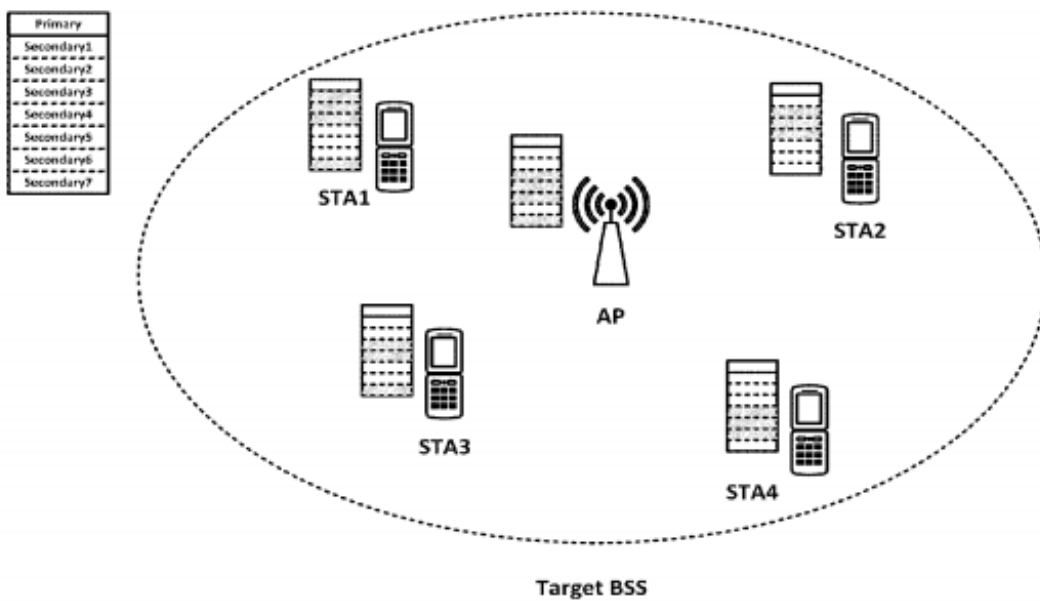
[FIG. 6]



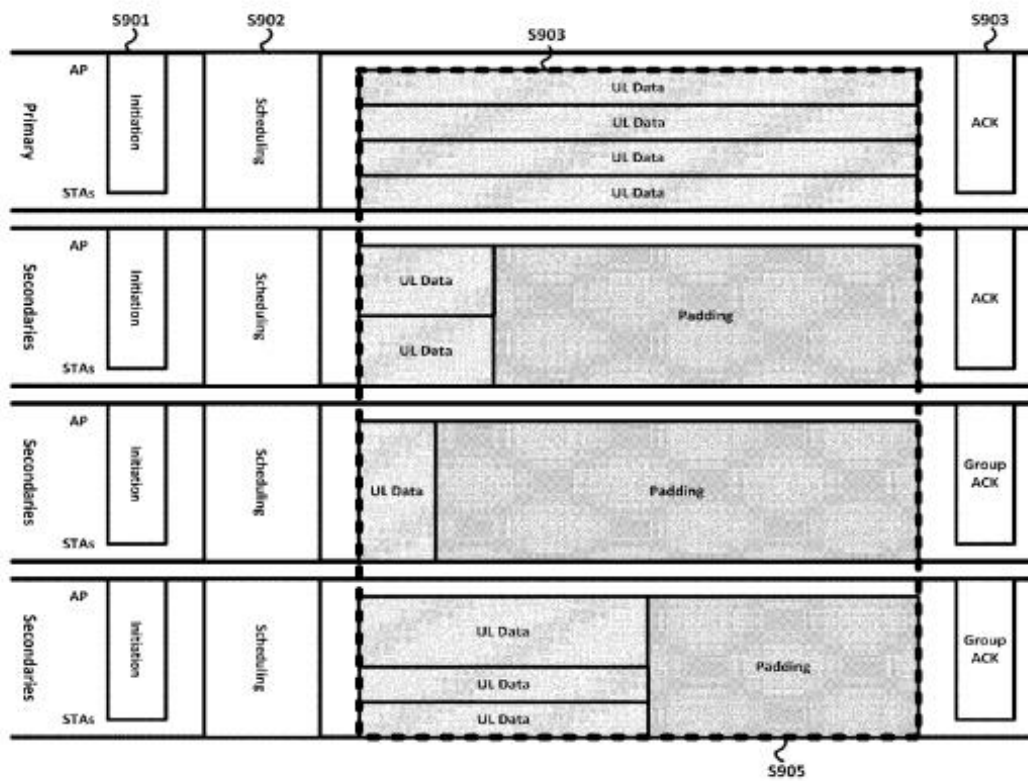
[FIG. 7]



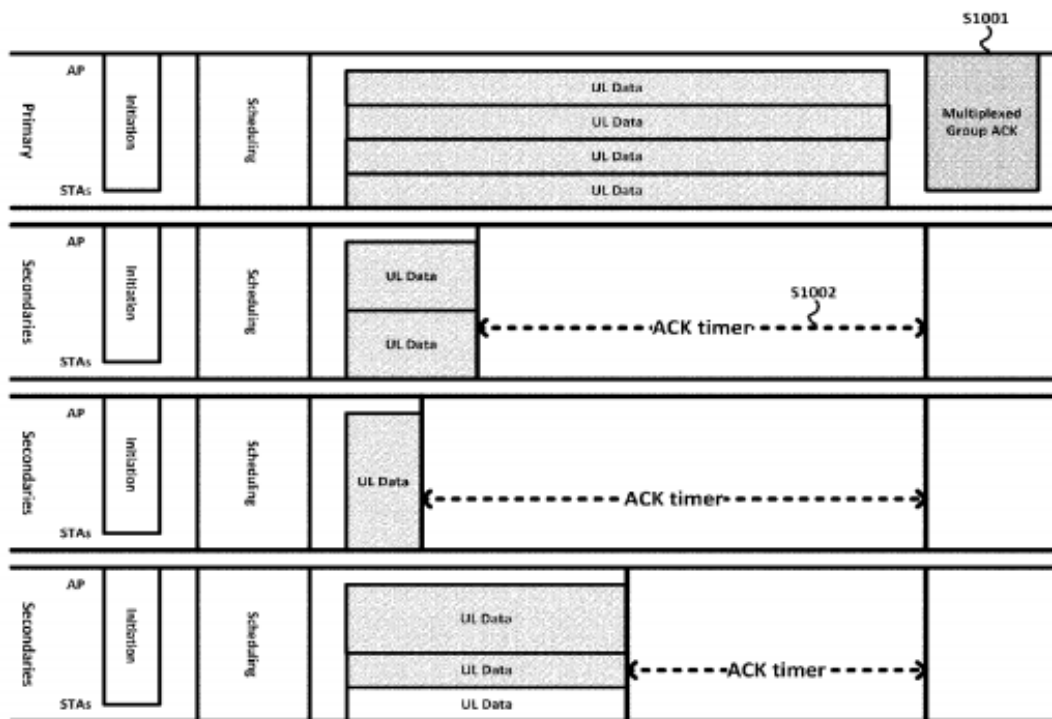
[FIG. 8]



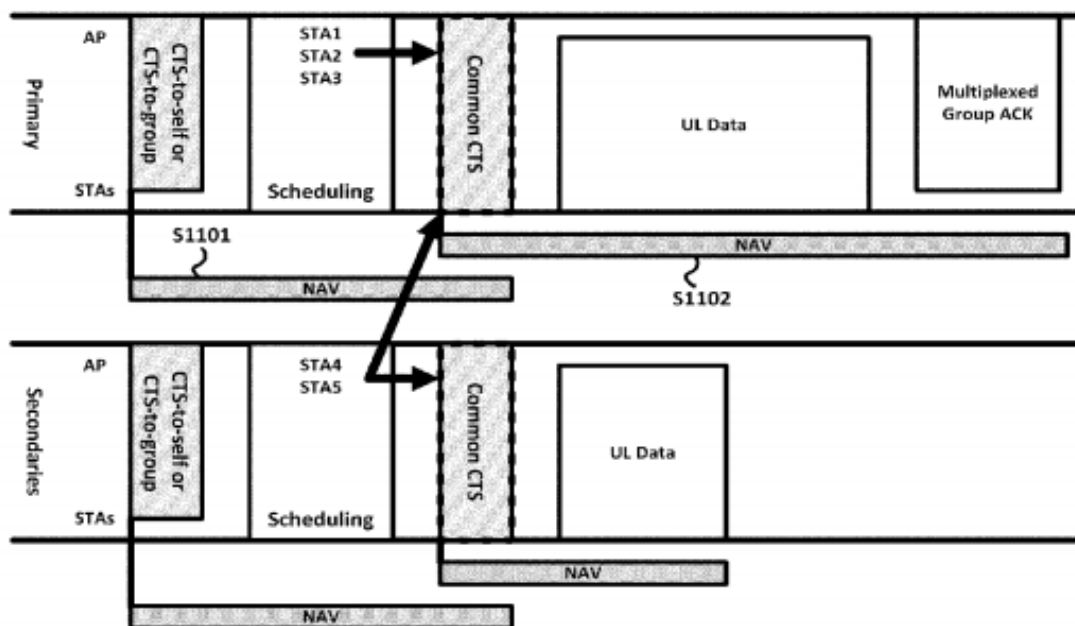
[FIG. 9]



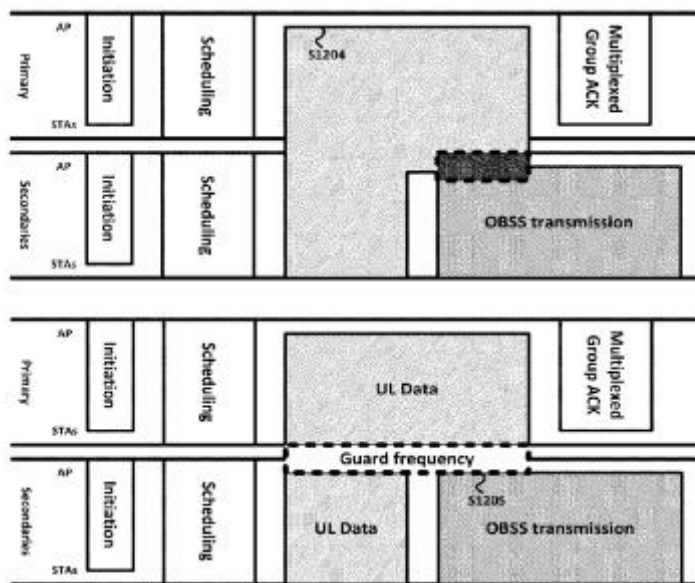
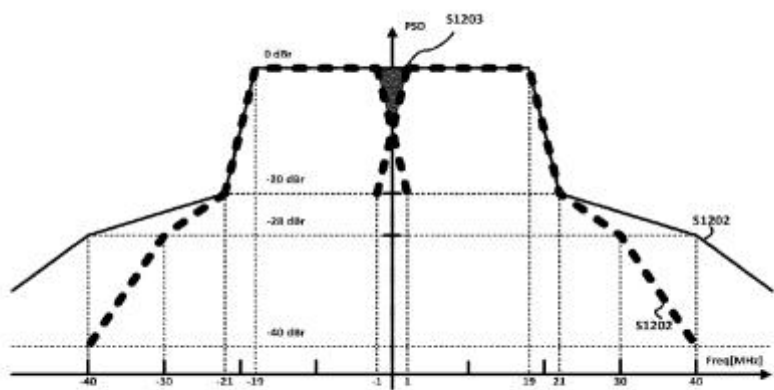
[FIG. 10]



[FIG. 11]

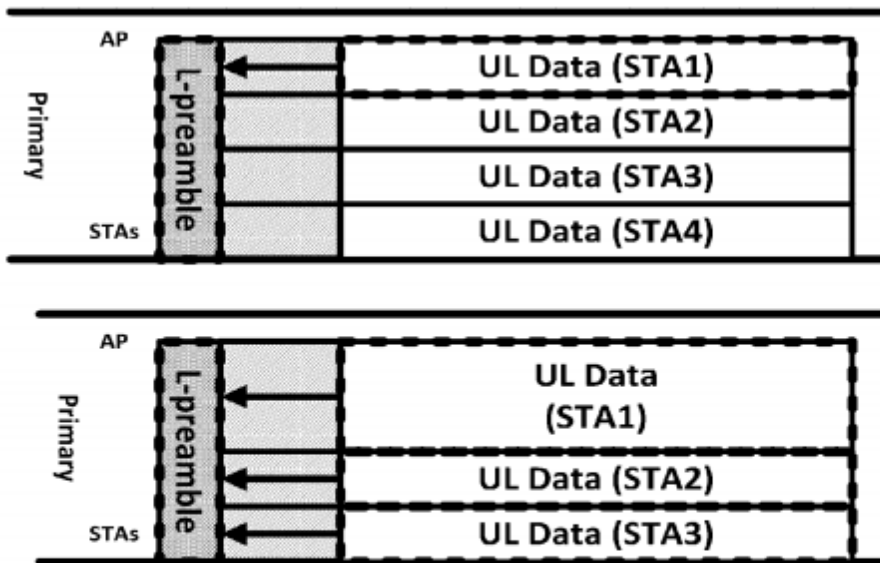


[FIG. 12]



UL Data

[FIG. 13]



[FIG. 14]

