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In re Patent Application of:	:	Customer Number: 31824
Yongho SEOK	:	
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Application No.: 62/074,514	:	Confirmation No.: 3021
	:	
Filed: November 3, 2014	:	
	:	
For: HEW PPDU PROTECTION MECHANISM	:	

SUBMISSION OF ENGLISH TRANSLATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Pursuant to 37 CFR. 1.78(a)(5) Applicant hereby submits an English translation of the above-identified provisional application and asserts that the translation is accurate.

Applicant believes no fee is due with this response. However, if a fee is due, please charge our Deposit Account No. 50-2624.

Respectfully submitted,

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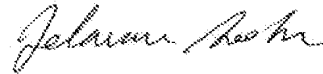
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STATEMENT OF ACCURATE TRANSLATION

I, Je-Kwan Sohn, hereby declare and state that I am knowledgeable of each of the Korean and English languages. I state that Korean to English translation of Specification and Drawings of US provisional application No. 62/074,514, filed on November 3, 2014, titled "HEW PPDU PROTECTION MECHANISM," is an accurate translation.

October 22, 2015
(Date)



(Signature)

Je-Kwan Sohn
(Typed Name)

The present invention relates to an IEEE 802.11ax High Efficiency WLAN (HEW) PPDU transmission which operates in 2.4 GHz and 5 GHz bands, and defines HEW PPDU Protection Mechanism in HEW Basic Service Set (BSS) supporting Orthogonal Frequency Division Multiple Access (OFDMA) technology.

The following figure shows the HEW PPDP format proposed in the present invention.

L-STF	L-LTF	L-SIG	HEW SIG-A	HEW-STF	HEW-LTF	HEW-SIG-B	HEW-LTF	HEW-SIG-C	PSDU (STA4 to AP)			
				HEW-STF	HEW-LTF	HEW-SIG-B	HEW-LTF	HEW-SIG-C	PSDU (STA3 to AP)			
				HEW-STF	HEW-LTF	HEW-SIG-B	HEW-LTF	HEW-SIG-C	PSDU (STA2 to AP)			
				HEW-STF	HEW-LTF	HEW-SIG-B	HEW-LTF	HEW-SIG-C	HEW-LTF	HEW-SIG-C	PSDU (STA1 to AP)	

‘L-STF’ stands for ‘Legacy Short Training Field’ which is used to perform frequency offset estimation and phase offset estimation for preamble decoding of a legacy station (STA) such as that of IEEE 802.11a/g/n/ac. ‘L-LTF’ stands for ‘Legacy Long Training Field’ which is used to perform channel estimation for preamble decoding of a legacy STA, such as that of IEEE 802.11a/g/n/ac. ‘L-SIG’ stands for ‘Legacy Signal Field’ which provides the function of preamble decoding of the legacy STA, such as that of IEEE 802.11a/g/n/ac and protection against PPDU transmission by a third party.

‘HEW SIG-A’ stands for ‘High Efficiency WLAN (HEW) Signal A Field’ which provides HEW PPDU modulation parameters or the like for HEW preamble decoding of a HEW STA. The parameters included in the HEW SIG-A field include very high throughput (VHT) PPDU modulation parameters, which are transmitted by the following IEEE 802.11ac terminals, so as to realize compatibility with the IEEE 802.11ac terminals.

Two parts of VHT SFG. A	Bit	Field	Number of bits	Description
To STA 204	00-01	DM	2	Set to 1 for 20 MHz, 1 for 40 MHz, 2 for 20 MHz, and 2 for 160 MHz and 80+80 MHz.
	02	Reserved	1	Reserved. Set to 1.
	03	STBC ¹	1	For a VHT MU-MIMO: Set to 1 if space-time block coding is used and set to 0 otherwise. For a VHT SISO MU-MIMO: Set to 0.
	04-09	Group ID	6	Set to the value of the IEEE 802.11n parameter GROUP_ID. If A value of 0 is included in a VHT SFG (SFG0), otherwise, indicates a VHT MU-MIMO.
	010-0103	NSS/SPatial SM	12	For a VHT SISO MU-MIMO, NSS/SP is divided into 4 user positions of 3 bits each. User positions i , where $0 \leq i < 4$, are bits 010-0103- i to 010-0103- $i+2$. The number of users can be obtained for each user indicated by user position: $p = 1024 - \text{POSS1024}(i)$ where $p = 0, 1, \dots, 1024, 1024-1$ and the function $f(x)$ denotes the value of entry x in index f . If x is a space-time stream indicated at positions p related to the TIDSS, $\text{POSS1024}(x)$ entry. Each user position is set as follows: Set to 0 for 0 space-time streams Set to 1 for 1 space-time stream Set to 2 for 2 space-time streams Set to 3 for 3 space-time streams Set to 4 for 4 space-time streams Set to 5 for 5 space-time streams Set to 6 for 6 space-time streams Set to 7 for 7 space-time streams Set to 8 for 8 space-time streams Set to 9 for 9 space-time streams Set to 10 for 10 space-time streams Set to 11 for 11 space-time streams Set to 12 for 12 space-time streams Set to 13 for 13 space-time streams Set to 14 for 14 space-time streams Set to 15 for 15 space-time streams Set to 16 for 16 space-time streams Set to 17 for 17 space-time streams Set to 18 for 18 space-time streams Set to 19 for 19 space-time streams Set to 20 for 20 space-time streams Set to 21 for 21 space-time streams Set to 22 for 22 space-time streams Set to 23 for 23 space-time streams Set to 24 for 24 space-time streams Set to 25 for 25 space-time streams Set to 26 for 26 space-time streams Set to 27 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Form part of VISA-Net-A	ISO	Field	Number of bits	Description
VISA-Net-A2	30	Open-GL	1	Set to 1 if short guest journal is not used in the Open-GL Net to 1 if short guest journal is used in the Open-GL Net
	31	Open-GL Memory Access/Ignore on	1	Set to 1 if short guest internal is used and Memory/100=0, otherwise, set to 0. Memory is defined as 22.5 x 1024x1024 and Memory/100 is the calculated value
	32	MTX-MTX Coding	1	Does VISA-MTX-MTX, B2 is set to 0 for 100%, 1 for 1.00%, 2 for 1.01-1.09%, 3 for 1.10-1.19%, 4 for 1.20-1.29%, 5 for 1.30-1.39%, 6 for 1.40-1.49%, 7 for 1.50-1.59%, 8 for 1.60-1.69%, 9 for 1.70-1.79%, 10 for 1.80-1.89%, 11 for 1.90-1.99%, 12 for 2.00-2.09%, 13 for 2.10-2.19%, 14 for 2.20-2.29%, 15 for 2.30-2.39%, 16 for 2.40-2.49%, 17 for 2.50-2.59%, 18 for 2.60-2.69%, 19 for 2.70-2.79%, 20 for 2.80-2.89%, 21 for 2.90-2.99%, 22 for 3.00-3.09%, 23 for 3.10-3.19%, 24 for 3.20-3.29%, 25 for 3.30-3.39%, 26 for 3.40-3.49%, 27 for 3.50-3.59%, 28 for 3.60-3.69%, 29 for 3.70-3.79%, 30 for 3.80-3.89%, 31 for 3.90-3.99%, 32 for 4.00-4.09%, 33 for 4.10-4.19%, 34 for 4.20-4.29%, 35 for 4.30-4.39%, 36 for 4.40-4.49%, 37 for 4.50-4.59%, 38 for 4.60-4.69%, 39 for 4.70-4.79%, 40 for 4.80-4.89%, 41 for 4.90-4.99%, 42 for 5.00-5.09%, 43 for 5.10-5.19%, 44 for 5.20-5.29%, 45 for 5.30-5.39%, 46 for 5.40-5.49%, 47 for 5.50-5.59%, 48 for 5.60-5.69%, 49 for 5.70-5.79%, 50 for 5.80-5.89%, 51 for 5.90-5.99%, 52 for 6.00-6.09%, 53 for 6.10-6.19%, 54 for 6.20-6.29%, 55 for 6.30-6.39%, 56 for 6.40-6.49%, 57 for 6.50-6.59%, 58 for 6.60-6.69%, 59 for 6.70-6.79%, 60 for 6.80-6.89%, 61 for 6.90-6.99%, 62 for 7.00-7.09%, 63 for 7.10-7.19%, 64 for 7.20-7.29%, 65 for 7.30-7.39%, 66 for 7.40-7.49%, 67 for 7.50-7.59%, 68 for 7.60-7.69%, 69 for 7.70-7.79%, 70 for 7.80-7.89%, 71 for 7.90-7.99%, 72 for 8.00-8.09%, 73 for 8.10-8.19%, 74 for 8.20-8.29%, 75 for 8.30-8.39%, 76 for 8.40-8.49%, 77 for 8.50-8.59%, 78 for 8.60-8.69%, 79 for 8.70-8.79%, 80 for 8.80-8.89%, 81 for 8.90-8.99%, 82 for 9.00-9.09%, 83 for 9.10-9.19%, 84 for 9.20-9.29%, 85 for 9.30-9.39%, 86 for 9.40-9.49%, 87 for 9.50-9.59%, 88 for 9.60-9.69%, 89 for 9.70-9.79%, 90 for 9.80-9.89%, 91 for 9.90-9.99%, 92 for 10.00-10.09%, 93 for 10.10-10.19%, 94 for 10.20-10.29%, 95 for 10.30-10.39%, 96 for 10.40-10.49%, 97 for 10.50-10.59%, 98 for 10.60-10.69%, 99 for 10.70-10.79%, 100 for 10.80-10.89%, 101 for 10.90-10.99%, 102 for 11.00-11.09%, 103 for 11.10-11.19%, 104 for 11.20-11.29%, 105 for 11.30-11.39%, 106 for 11.40-11.49%, 107 for 11.50-11.59%, 108 for 11.60-11.69%, 109 for 11.70-11.79%, 110 for 11.80-11.89%, 111 for 11.90-11.99%, 112 for 12.00-12.09%, 113 for 12.10-12.19%, 114 for 12.20-12.29%, 115 for 12.30-12.39%, 116 for 12.40-12.49%, 117 for 12.50-12.59%, 118 for 12.60-12.69%, 119 for 12.70-12.79%, 120 for 12.80-12.89%, 121 for 12.90-12.99%, 122 for 13.00-13.09%, 123 for 13.10-13.19%, 124 for 13.20-13.29%, 125 for 13.30-13.39%, 126 for 13.40-13.49%, 127 for 13.50-13.59%, 128 for 13.60-13.69%, 129 for 13.70-13.79%, 130 for 13.80-13.89%, 131 for 13.90-13.99%, 132 for 14.00-14.09%, 133 for 14.10-14.19%, 134 for 14.20-14.29%, 135 for 14.30-14.39%, 136 for 14.40-14.49%, 137 for 14.50-14.59%, 138 for 14.60-14.69%, 139 for 14.70-14.79%, 140 for 14.80-14.89%, 141 for 14.90-14.99%, 142 for 15.00-15.09%, 143 for 15.10-15.19%, 144 for 15.20-15.29%, 145 for 15.30-15.39%, 146 for 15.40-15.49%, 147 for 15.50-15.59%, 148 for 15.60-15.69%, 149 for 15.70-15.79%, 150 for 15.80-15.89%, 151 for 15.90-15.99%, 152 for 16.00-16.09%, 153 for 16.10-16.19%, 154 for 16.20-16.29%, 155 for 16.30-16.39%, 156 for 16.40-16.49%, 157 for 16.50-16.59%, 158 for 16.60-16.69%, 159 for 16.70-16.79%, 160 for 16.80-16.89%, 161 for 16.90-16.99%, 162 for 17.00-17.09%, 163 for 17.10-17.19%, 164 for 17.20-17.29%, 165 for 17.30-17.39%, 166 for 17.40-17.49%, 167 for 17.50-17.59%, 168 for 17.60-17.69%, 169 for 17.70-17.79%, 170 for 17.80-17.89%, 171 for 17.90-17.99%, 172 for 18.00-18.09%, 173 for 18.10-18.19%, 174 for 18.20-18.29%, 175 for 18.30-18.39%, 176 for 18.40-18.49%, 177 for 18.50-18.59%, 178 for 18.60-18.69%, 179 for 18.70-18.79%, 180 for 18.80-18.89%, 181 for 18.90-18.99%, 182 for 19.00-19.09%, 183 for 19.10-19.19%, 184 for 19.20-19.29%, 185 for 19.30-19.39%, 186 for 19.40-19.49%, 187 for 19.50-19.59%, 188 for 19.60-19.69%, 189 for 19.70-19.79%, 190 for 19.80-19.89%, 191 for 19.90-19.99%, 192 for 20.00-20.09%, 193 for 20.10-20.19%, 194 for 20.20-20.29%, 195 for 20.30-20.39%, 196 for 20.40-20.49%, 197 for 20.50-20.59%, 198 for 20.60-20.69%, 199 for 20.70-20.79%, 200 for 20.80-20.89%, 201 for 20.90-20.99%, 202 for 21.00-21.09%, 203 for 21.10-21.19%, 204 for 21.20-21.29%, 205 for 21.30-21.39%, 206 for 21.40-21.49%, 207 for 21.50-21.59%, 208 for 21.60-21.69%, 209 for 21.70-21.79%, 210 for 21.80-21.89%, 211 for 21.90-21.99%, 212 for 22.00-22.09%, 213 for 22.10-22.19%, 214 for 22.20-22.29%, 215 for 22.30-22.39%, 216 for 22.40-22.49%, 217 for 22.50-22.59%, 218 for 22.60-22.69%, 219 for 22.70-22.79%, 220 for 22.80-22.89%, 221 for 22.90-22.99%, 222 for 23.00-23.09%, 223 for 23.10-23.19%, 224 for 23.20-23.29%, 225 for 23.30-23.39%, 226 for 23.40-23.49%, 227 for 23

However, the HEW PPDU format proposed in the present invention is intended to support MU MIMO-OFDMA and, for this, information about sub-channels allocated to respective HEW STAs may be included in the HEW SIG-A field.

The sub-channel information allocated to each HEW STA is configured by including a group ID and N_{BW} in the HEW SIG-A field. When each HEW STA accesses the HEW AP, the HEW AP allocates a group ID and the STA position information of the corresponding HEW STA for the group ID to the HEW STA.

For example, the following table shows that STA position 1 is allocated to group ID 1, STA position 2 is allocated to group ID 2, STA position 4 is allocated to group ID 61, and STA position 1 is allocated to group ID 62. The HEW STA to which the information of the table of the group IDs and STA positions is allocated receives an HEW PPDU and then determines its own sub-channel in the following manner.

Group ID	Group ID 1	Group ID 2	...	Group ID 61	Group ID 62
STA position	1	2	...	4	1

For example, it is assumed that, in the received HEW PPDU, the group ID value of the HEW SIG-A field is 61 and the values of N_{BW} are b001, b001, b001, and b010.

The N_{BW} value is for notifying the HEW STAs corresponding to STA position 1, STA position 2, STA position 3, and STA position 4 of sub-channel bandwidths respectively allocated thereto. If HEW PPDU transmission of 5 MHz, 10 MHz, 20 MHz, 40 MHz, 80 MHz, and 160 MHz is permitted, N_{BW} is composed of 12 bits to support a total of four HEW STAs in such a way as to include 3 bits of the sub-channel bandwidth of the HEW STA corresponding to STA position 1, 3 bits of the sub-channel bandwidth of the HEW STA corresponding to STA position 2, 3 bits of the sub-channel bandwidth of the HEW STA corresponding to STA position 3, and 3 bits of the sub-channel bandwidth of the HEW STA corresponding to STA position 4.

In the above example, the corresponding HEW STA has been allocated as STA position 4 for group ID 61. Therefore, the HEW STA is aware that sub-channel bandwidth allocated thereto is 10 MHz, with reference to the N_{BW} value of b010 corresponding to the STA position 4 of the received HEW PPDU. Here, for the encoding of N_{BW} , it is assumed that b000 is 0 MHz, b001 is 5 MHz, b010 is 10 MHz, b011 is 20 MHz, b100 is 40 MHz, b101 is 80 MHz, and b110 is 160 MHz. However, the encoding scheme may be set in different forms depending on the implementation.

Further, in relation to the group ID and N_{BW} , it can be seen from the above example that a sub-channel bandwidth of 0 MHz is assigned to the HEW STA to which STA position 1 has been allocated for group ID 61. That is, it means that no HEW PPDU transmission is performed. Further, it can be seen that a sub-channel bandwidth of 5 MHz is assigned to the HEW STA to which STA position 2 has been allocated for group ID 61, and that a sub-channel bandwidth of 5 MHz is assigned to the HEW STA to which STA position 3 has been allocated for group ID 61. The following figure shows the HEW PPDU transmission based on the above example.

L-STF	L-LTF	L-SIG	HEW SIG-A	HEW-STF	HEW-LTF	HEW-LTF	...	HEW-LTF	HEW SIG-B	PSDU (10MHz)
				HEW-STF	HEW-LTF	HEW-LTF	...	HEW-LTF		
				HEW-STF	HEW-LTF	HEW-LTF	...	HEW-LTF	HEW SIG-B	PSDU (5MHz)
				HEW-STF	HEW-LTF	HEW-LTF	...	HEW-LTF	HEW SIG-B	PSDU (5MHz)

In such HEW PPDU transmission, sub-channels allocated to the respective HEW STAs must be sequential to each other, and as a result, empty sub-channels, which are not allocated, must not be present within a single 20 MHz channel. Further, sub-channels allocated to the respective HEW STAs must be implemented only in a single channel on a 20 MHz channel basis. Consequently, in each of multiple 20 MHz channels, the allocation of partially overlapping sub-channels must be prohibited.

The HEW PPDU format proposed in the present invention is intended to support MU MIMO-OFDMA. For this, information about the numbers of spatial streams to be transmitted to HEW STAs that are allocated to respective sub-channels may be included in the HEW SIG-A field. The sequence of fields to be transmitted after the HEW SIG-A field is determined according to the number of spatial streams to be transmitted. A HEW-

STF, a HEW-LTF, a HEW SIG-B, a HEW-LTF, and a HEW-SIG-C are transmitted on the respective sub-channels after the HEW SIG-A field. The HEW-STF is used for frequency offset estimation and phase offset estimation for one sub-channel. The HEW-LTF is used for channel estimation for one sub-channel. The present invention proposes a scheme in which, when the total number of spatial streams to be transmitted is 2, a total of two HEW-LTFs are transmitted, when the total number of spatial streams to be transmitted is 3, a total of four HEW-LTFs are transmitted, when the total number of spatial streams to be transmitted is 4, a total of four HEW-LTFs are transmitted, when the total number of spatial streams to be transmitted is 5, a total of six HEW-LTFs are transmitted, when the total number of spatial streams to be transmitted is 6, a total of six HEW-LTFs are transmitted, when the total number of spatial streams to be transmitted is 7, a total of 8 HEW-LTFs are transmitted, and when the total number of spatial streams to be transmitted is 8, a total of eight HEW-LTFs are transmitted.

In order to more effectively support Multi-User (MU)-MIMO, independent signaling information needs to be transmitted through each sub-channel. In the case of MU-MIMO, different numbers of spatial streams may be transmitted to multiple HEW STAs, which are destination terminals of MU-MIMO transmission. For this, information about the number of spatial streams to be transmitted to each of the HEW STAs must be transferred. If the maximum number of spatial streams that can be transferred to a single HEW STA via MU-MIMO transmission is 4, and the maximum number of destination terminals of MU-MIMO transmission is 4, a total of 12 bits is required for each sub-channel. When a maximum of four sub-channels can be configured in a 20 MHz channel, a total of 48 bits of signaling information is required. Therefore, for the purpose of reducing protocol overhead, it is preferable to independently transmit such spatial stream allocation information for each sub-channel. For this purpose, the HEW SIG-B field in the HEW-PPDU format includes spatial stream allocation information for each sub-channel, and indicates the number of spatial streams (N_{STS}) to be transmitted to STAs belonging to the corresponding group (group ID) of MU-MIMO in the form of a group ID and N_{STS} .

Finally, the HEW-SIG-C field transmitted after the HEW-LTFs includes Modulation and Coding Scheme (MCS) information and PSDU length information for each PSDU.

In the foregoing proposed HEW PPDU format, it is necessary to align the timings of OFDM symbols transmitted on the respective sub-channels according to the implementation complexity of transmitting STAs. For this purpose, the present invention proposes a HEW PPDU format in which the same number of HEW-LTFs are transmitted on the respective sub-channels after the HEW SIG-Bs. Thus, the transmission timings of PSDUs are aligned between the sub-channels.

L-STF	L-LTF	L-SIG	HEW SIG-A	HEW-STF	HEW-LTF	HEW SIG-B	HEW-LTF	HEW-LTF	HEW-LTF	HEW-LTF	HEW SIG-C	PSDU (STA4 to AP)
				HEW-STF	HEW-LTF	HEW SIG-B	HEW-LTF	HEW-LTF	HEW-LTF	HEW-LTF	HEW SIG-C	PSDU (STA3 to AP)
				HEW-STF	HEW-LTF	HEW SIG-B	HEW-LTF	HEW-LTF	HEW-LTF	HEW-LTF	HEW SIG-C	PSDU (STA2 to AP)
				HEW-STF	HEW-LTF	HEW SIG-B	HEW-LTF	HEW-LTF	HEW-LTF	HEW-LTF	HEW SIG-C	PSDU (STA1 to AP)

If the foregoing proposed HEW PPDU format is used, a plurality of STAs can be allocated to their respective sub-channels by the AP and simultaneously transmit PSDUs on the sub-channels. On the other hand, the AP can allocate respective sub-channels to a plurality of STAs and transmit PSDUs simultaneously to the STAs on the sub-channels.

Regarding the configuration of the subfields of an L-SIG field, the L_LENGTH and L_DATARATE HEW subfields of the L-SIG field are set as follows to protect a PPDU from a third legacy STA.

$$L_LENGTH = \left\lceil \frac{((TXTIME - \text{Signal Extension}) - (\text{aPreambleLength} + \text{aPHYHeaderLength}))}{\text{aSymbolLength}} \right\rceil \times N_{OPS} \left\lceil \frac{\text{aPHYServiceLength} + \text{aPHYConvolutionalTailLength}}{8} \right\rceil$$

Signal Extension is 0 μ s when TXVECTOR parameter NO_SIG_EXTN is true and is the duration of signal extension as defined by aSignalExtension (6 μ s for 2.4GHz and 0 μ s for 5GHz) when TXVECTOR parameter NO_SIG_EXTN is false

aSymbolLength is the duration of a symbol (in microseconds). Normally, aSymbolLength is fixed to 4.

(aPreambleLength + aPHYHeaderLength) is the duration (in microseconds) of the non-HT PHY preamble and L-SIG, defined in 6.5.4 (PLME-CHARACTERISTICS.confirm)

N_{ops} is the number of octets transmitted during a period of aSymbolLength at the rate specified by L_DATARATE. Normally, L_DATARATE is fixed to 6 Mbps and N_{ops} is fixed to 4.

aPHYServiceLength is the number of bits in the PHY SERVICE field

aPHYConvolutionalTailLength is the number of bits in the convolutional code tail bit sequence

In the case of a HEW PPDU, L_LENGTH is modified to

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

TXTIME indicates the duration of the HEW PPDU, determined by

TXTIME =

$$T_{L-STF} + T_{L-LTF} + T_{L-SIG} + T_{HEW-SIG-A} + \text{ceiling}((T_{HEW-SIG-B} + N_{HEW-LTF} T_{HEW-LTF} + T_{HEW-SIG-B} + N_{SYM} T_{SYM}) / T_{SYM})$$

T_{L-STF} : Non-HT Short Training field duration (8 μ s)

T_{L-LTF} : Non-HT Long Training field duration (8 μ s)

T_{L-SIG} : Non-HT SIGNAL field duration (4 μ s)

$T_{HEW-SIG-A}$: HEW Signal A field duration (8 μ s or 12 μ s)

$T_{HEW-SIG-B}$: HEW Signal B field duration (16 μ s or 15.6 μ s)

$T_{HEW-STF}$: HEW Short Training field duration (16 μ s or 15.6 μ s)

$T_{HEW-LTF}$: HEW Long Training field duration (16 μ s or 15.6 μ s)

$N_{HEW-LTF}$: Number of HEW-LTF symbols

T_{SYM} : Double GI symbol interval (16 μ s or 15.6 μ s)

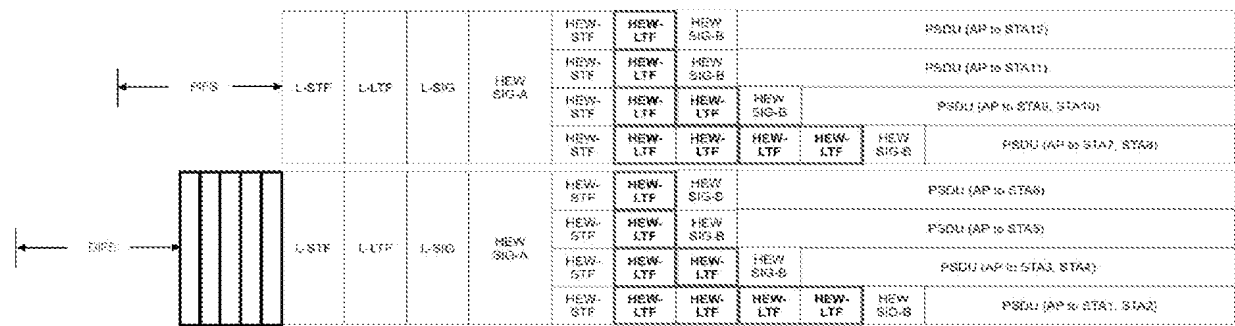
T_{SYM} : Long GI symbol interval (4 μ s)

N_{SYM} : Number of symbols in the Data field

If a plurality of STAs are allocated to respective sub-channels by an AP or the AP allocates the respective channels to the plurality of STAs, the following EDCA Channel Access mechanism is performed as follows.

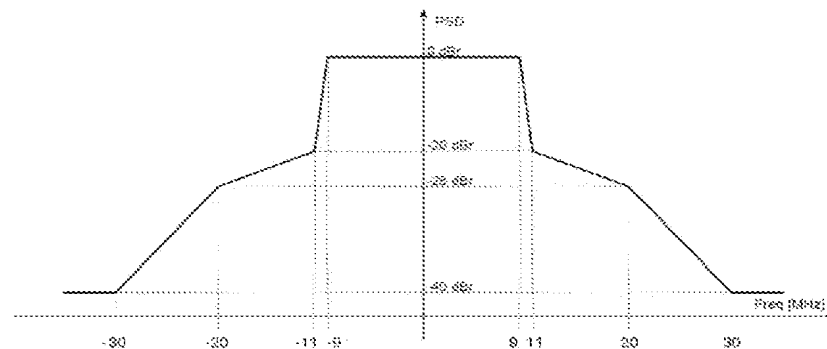
If a HEW STA is permitted to begin a TXOP (as shown in the below figure) and the HEW STA has at least one MSDU pending for transmission for the AC of the permitted TXOP, the STA shall perform exactly one of the following actions:

- Transmit a 160 MHz or 80+80 MHz mask PPDU if the secondary channel, the secondary 40 MHz channel, and the secondary 80 MHz channel were idle during an interval of PIFS immediately preceding the start of the TXOP.
- Transmit an 80 MHz mask PPDU on the primary 80 MHz channel if both the secondary channel and the secondary 40 MHz channel were idle during an interval of PIFS immediately preceding the start of the TXOP.
- Transmit a 40 MHz mask PPDU on the primary 40 MHz channel if the secondary channel was idle during an interval of PIFS immediately preceding the start of the TXOP.
- Transmit a 20 MHz mask PPDU on the primary 20 MHz channel.
- Restart the channel access attempt by invoking the backoff procedure as though the medium is busy on the primary channel as indicated by either physical or virtual CS and the backoff timer has a value of 0.

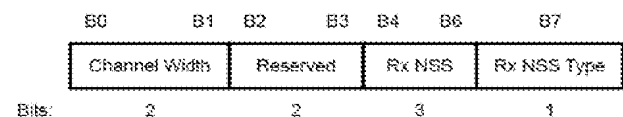


To acquire a TXOP, an STA performs a back-off mechanism on a primary channel. If the primary channel is idle during a Distributed Inter Frame Space (DIFS) or an Arbitrary Inter Frame Space (AIFS), the STA selects a random number from a range of [0, Contention Window] and runs a back-off timer during a time period corresponding to the selected random number. The back-off timer decreases its count by 1 if the primary channel is idle during a back-off slot time. If the back-off timer reaches 0, the STA checks the CCA (idle or busy) of secondary channels. If the secondary channels are idle, the STA transmits a 20MHz/40MHz/80MHz/160MHz/80+80MHz mask PPDU on the secondary channels.

A 20MHz mask PPDU refers to a PPDU corresponding to a TXVECTOR parameter CH_BANDWIDTH equal to CBW20, satisfying a transmit spectral mask as illustrated in the following drawing.



The STA may indicate its Operating Mode to the AP by transmitting an Operating Mode Notification frame or element to the AP. The following drawing illustrates the field format of an Operating Mode Notification (Operating Mode may be included in (Re-)Association Request/Response frames, and Probe Request/Response frames).



Channel Width -

If the Rx NSS Type subfield is 0, indicates the supported channel width:

Set to 0 for 20 MHz

Set to 1 for 40 MHz

Set to 2 for 80 MHz

Set to 3 for 160 MHz or 80+80 MHz

Reserved if the Rx NSS Type subfield is 1.

Rx NSS -

If the Rx NSS Type subfield is 0, indicates the maximum number of spatial streams that the STA can receive.

If the Rx NSS Type subfield is 1, indicates the maximum number of spatial streams that the STA can receive as a beamformee in an SU PPDU using a beamforming steering matrix derived from a Compressed Beamforming

report with Feedback Type subfield indicating MU in the corresponding Compressed Beamforming frame sent by the STA.

Set to 0 for NSS = 1

Set to 1 for NSS = 2

...

Set to 7 for NSS = 8

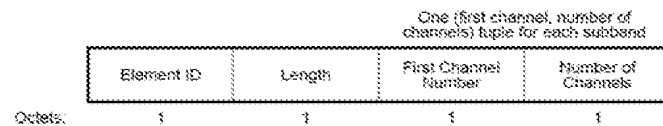
Rx NSS Type -

Set to 0 to indicate that the Rx NSS subfield carries the maximum number of spatial streams that the STA can receive.

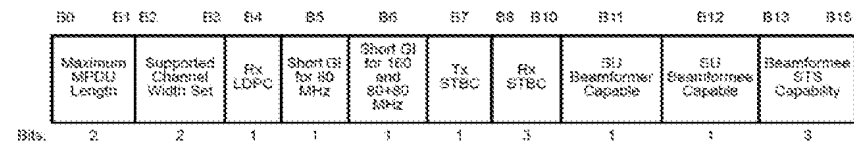
Set to 1 to indicate that the Rx NSS subfield carries the maximum number of spatial streams that the STA can receive in an SU PPDU using a beamforming steering matrix derived from a Compressed Beamforming report with the Feedback Type subfield indicating MU in the corresponding Compressed Beamforming frame sent by the STA.

NOTE—An AP always sets this field to 0.

In addition, the STA may transmit its supported channel list to the AP by a Supported Channel element. The following drawing illustrates a format of a Supported Channel element (the Supported Channel element may be included in (Re-)Association Request/Response frames).



Further, the STA may transmit its Supported Channel Width Set to the AP in a Supported Channel Width Set field of a Capabilities element. The following drawing illustrates a format of a Supported Channel Width Set field (a Capabilities element including a Supported Channel Width Set field may be included in the (Re-)Association Request/Response frames).



Supported Channel Width Set -

Indicates the channel widths supported by the STA.

Set to 0 if the STA does not support either 160 or 80+80 MHz.

Set to 1 if the STA supports 160 MHz.

Set to 2 if the STA supports 160 MHz and 80+80 MHz.

The value 3 is reserved.

If a plurality of STAs are allocated to respective sub-channels by an AP or the AP allocates the respective sub-channels to the plurality of STAs, the AP should allocate the sub-channels, taking into account the Operating Channel Widths, Supported Channels, and Supported Channel Width Sets of the STAs.

In the above drawing, it is assumed that STA1, STA2, STA3, STA4, STA5, and STA6 have notified that they cannot receive a PPDU transmitted on a secondary 20MHz/secondary 40MHz/secondary 80MHz channel by setting the Channel Width field of the Operating Mode Notification element to 20MHz, and STA7, STA8, STA9, STA10, STA11, and STA12 have notified that they can receive a PPDU transmitted on a secondary 20MHz channel but cannot receive a PPDU transmitted on a secondary 40MHz/secondary 80MHz channel by setting the Channel Width field of the Operating Mode Notification element to 40MHz. In the case where the AP allocates sub-channels to STA1, STA2, STA3, STA4, STA5, STA6, STA7, STA8, STA9, STA10, STA11, and STA12 and transmits data simultaneously to them on the sub-channels in downlink OFDMA, the AP should allocate the sub-channels only within the primary 20MHz channel to STA1, STA2, STA3, STA4, STA5, and STA6. This means that STA1, STA2, STA3, STA4, STA5, and STA6 should not be allocated to sub-channels of the secondary 20MHz channel other than their declared Channel Widths, that is, the primary 20MHz channel.

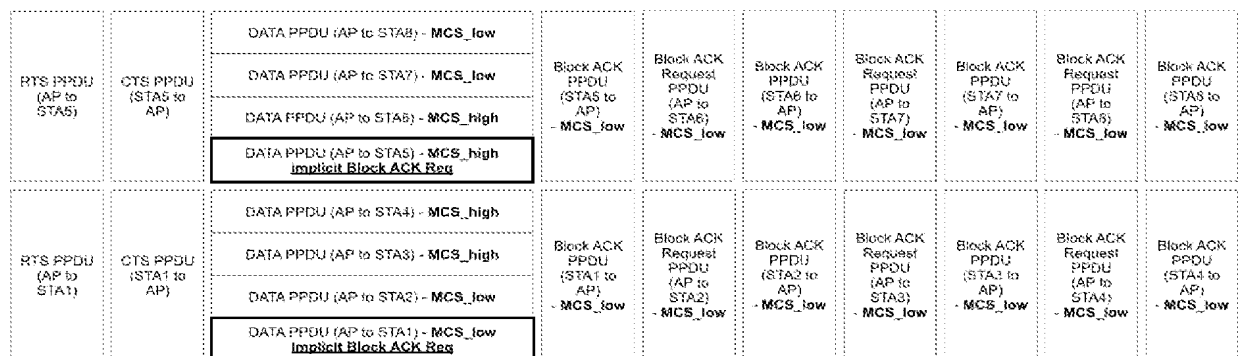
Meanwhile, the AP allocates sub-channels to STA7, STA8, STA9, STA10, STA11, and STA12 in the primary 20MHz channel and the secondary 20MHz channel in which they operate.

If the AP allocates sub-channels to STAs, taking into account the Operating Channel Widths, Supported Channels, and Supported Channel Width Sets of the STAs, the STAs may overcome the constraint that they should set their Channel Widths to receive the total Channel Width (e.g., TXVECTOR parameter CH_BANDWIDTH) of an OFDMA PPDU, when receiving the OFDMA PPDU from the AP. This offers the benefit of reducing the power consumption of the STAs.

Meanwhile, in the case of a Single-User (SU) PPDU or a Multi-User (MU) MIMO PPDU, a channel width that is not included in a receivable Channel Width Set that a destination STA indicates by the Supported Channel Width Set field of the Capabilities element should not be used as the Channel Width of the PPDU, that is, a TXVECTOR parameter CH_BANDWIDTH. Likewise, a Channel Width exceeding a receivable Channel Width that the destination STA indicates by the Channel Width field of the Operating Mode Notification element should not be used as the Channel Width of the PPDU, that is, the TXVECTOR parameter CH_BANDWIDTH. Likewise, a Channel Width including a channel that is not listed in a supported channel list that the destination STA indicates by the Supported Channel element should not be used as the Channel Width of the PPDU, that is, the TXVECTOR parameter CH_BANDWIDTH.

In the case of an OFDMA PPDU proposed by the present invention, however, a channel width that is not included in a receivable Channel Width Set that a destination STA indicates by the Supported Channel Width Set field of the Capabilities element may be used as the Channel Width of the PPDU, that is, a TXVECTOR parameter CH_BANDWIDTH. Likewise, a Channel Width exceeding a receivable Channel Width that the destination STA indicates by the Channel Width field of the Operating Mode Notification element may be used as the Channel Width of the PPDU, that is, the TXVECTOR parameter CH_BANDWIDTH. Likewise, a Channel Width including a channel that is not listed in a supported channel list that the destination STA indicates by the Supported Channel element may be used as the Channel Width of the PPDU, that is, the TXVECTOR parameter CH_BANDWIDTH. For this purpose, the AP is required to allocate sub-channels to STAs, taking into account the Operating Channel Widths, Supported Channels, and Supported Channel Width Sets of the STAs, as described before. If the Channel Width of sub-channels that the AP allocates to STAs when transmitting an OFDMA PPDU is a TXVECTOR parameter SUBCH_BANDWIDTH, a channel width that is not included in a receivable Channel Width Set that a destination STA indicates by the Supported Channel Width Set field of the Capabilities element should not be used as the Channel Width of the PPDU, that is, a TXVECTOR parameter CH_BANDWIDTH. Likewise, a Channel Width exceeding a receivable Channel Width that the destination STA indicates by the Channel Width field of the Operating Mode Notification element should not be used as the Channel Widths of the sub-channels allocated to the STAs, that is, the TXVECTOR parameter CH_BANDWIDTH. Likewise, a Channel Width including a channel that is not listed in a supported channel list that the destination STA indicates by the Supported Channel element should not be used as the Channel Widths of the sub-channels allocated to the STAs.

Upon receipt of an OFDMA DATA PPDU, STAs perform the following Block ACK mechanism.



In the above drawing, the AP has transmitted a plurality of DATA PPDU simultaneously to STA1, STA2, STA3, STA4, STA5, STA6, STA7, and STA8 by configuring a total of eight 5MHz sub-channels out of a 40MHz channel. Also, the AP has transmitted an RTS PPDU simultaneously to STA1 and STA5 on 20-MHz channels and has received CTS PPDU from STA1 and STA5 on the respective 20MHz channels before trans-

mitting the plurality of DATA PPDU.

It is noted that when simultaneously transmitting the plurality of DATA PPDU to STA2, STA3, STA4, STA5, STA6, STA7, and STA8 by configuring the respective 5MHz sub-channels out of the 40MHz channel, the ACK Policy of a DATA PPDU may be set to implicit Block ACK Request only for one destination STA on a 20MHz channel basis. This is done to prevent collision caused by simultaneous transmissions of Block ACK PPDU from the plurality of destination STAs.

When the destination STAs transmit Control Response frames such as Block ACK PPDU as illustrated in the above drawing, they should use the same Transmit Spectrum Mask. This is done to reduce the implementation complexity of a receiving STA. If the destination STAs simultaneously transmit the Control Response frames using different Transmit Spectrum Masks, the receiving STA should have a function of simultaneously receiving a plurality of Spectrum Masks. To enable use of the same transmit Spectrum Mask when the Control Response frames are simultaneously transmitted, the destination STAs determine a Spectrum Mask to be used for transmission of the Control Response frames based on the total Channel Width (RXVECTOR parameter CH_BANDWIDTH) of the received OFDMA PPDU.

For example, if the destination STAs receive a 40MHz OFDMA PPDU (an RXVECTOR parameter CH_BANDWIDTH equal to CBW40) as in the foregoing example, they always use a 40MHz Transmit Spectrum Mask suitable for 40MHz Channel Width transmission in the Control Response frames. In the above example, STA1 and STA5 which receive the OFDMA PPDU and transmit Block ACK PPDU after an SIFS in response to the OFDMA PPDU use the same 40MHz Transmit Spectrum Mask despite the Channel Widths of their Block ACK PPDU being 20MHz. It is apparent that this rule includes the following embodiment. If the destination STAs receive an 80MHz OFDMA PPDU (an RXVECTOR parameter CH_BANDWIDTH equal to CBW80), they always use an 80MHz Transmit Spectrum Mask suitable for 80MHz Channel Width transmission in the Control Response frames. If the destination STAs receive a 160MHz OFDMA PPDU (an RXVECTOR parameter CH_BANDWIDTH equal to CBW160), they always use a 160MHz Transmit Spectrum Mask suitable for 160MHz Channel Width transmission in the Control Response frames. If the destination STAs receive a 20MHz OFDMA PPDU (an RXVECTOR parameter CH_BANDWIDTH equal to CBW20), they always use a 20MHz Transmit Spectrum Mask suitable for 80MHz Channel Width transmission in the Control Response frames.

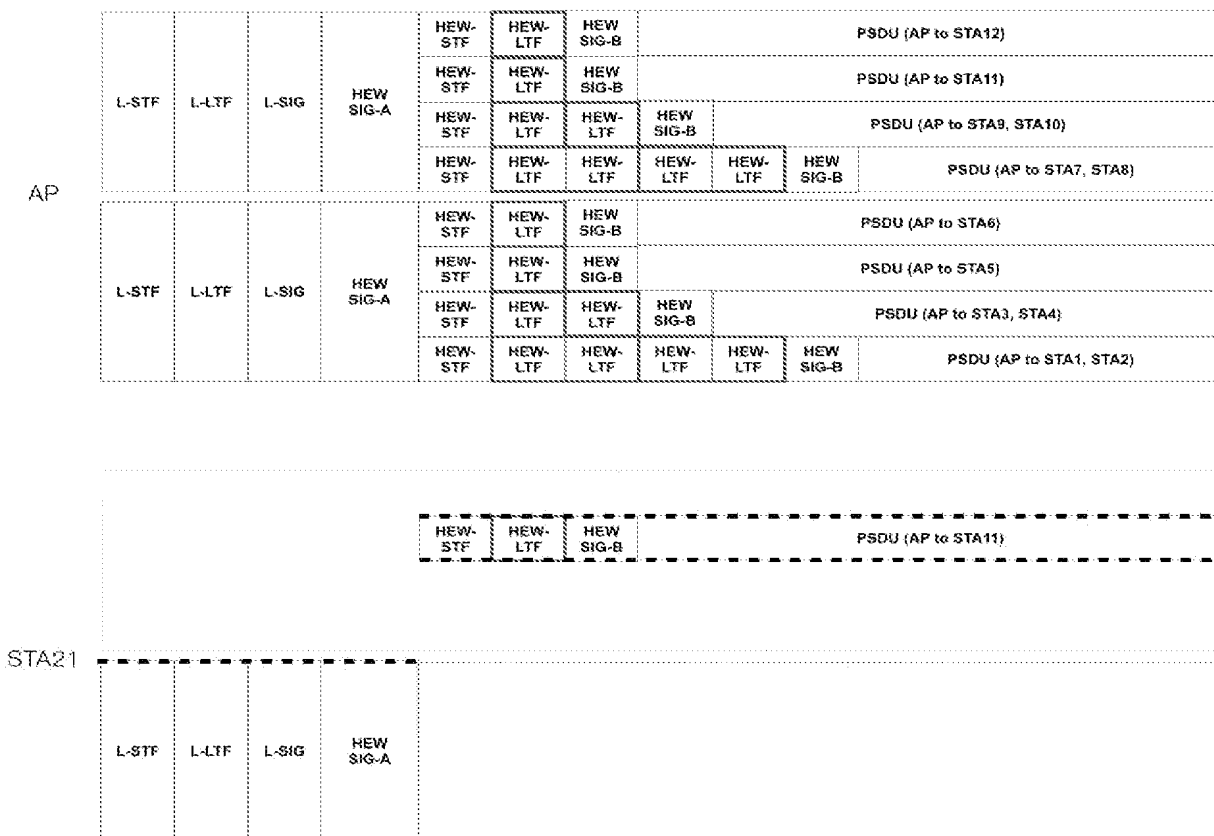
In order to protect transmission of a HEW PPDU from third HEW STAs, a Duration field may be used in the MAC Header of a PSDU included in the HEW PPDU. The third HEW STAs set their Network Allocation Vectors (NAVs) to the value of the Duration field included in the MAC Header and thus regard a channel as busy during the corresponding time. Therefore, even though the channel is physically idle, the third HEW STAs are not allowed to access the channel during the corresponding time.

In the case of a HEW PPDU, the channel bandwidth of a PSDU including a MAC Header may be smaller than the channel bandwidth of the HEW PPDU. If the HEW PPDU and the PSDU have an equal channel bandwidth, a NAV setting of an STA may be defined as follows.

A HEW STA shall update its NAV using the Duration/ID field value in any frame that does not have an RA matching the STA's MAC address and that was received in a 20 MHz PPDU in the primary 20 MHz channel or received in a 40 MHz PPDU in the primary 40 MHz channel or received in an 80 MHz PPDU in the primary 80 MHz channel or received in a 160 MHz or 80+80 MHz PPDU.

However, if the channel bandwidth of the PSDU is smaller than the channel bandwidth of the HEW PPDU, that is, OFDMA is used, the NAV setting of an STA may be defined as follows.

A HEW STA shall update its NAV using the Duration/ID field value in any frame that does not have an RA matching the STA's MAC address and that was received in any sub-channel of a 20 MHz OFDMA PPDU in the primary 20 MHz channel or received in any sub-channel of a 40 MHz OFDMA PPDU in the primary 40 MHz channel or received in any sub-channel of an 80 MHz OFDMA PPDU in the primary 80 MHz channel or received in any sub-channel of a 160 MHz or 80+80 MHz OFDMA PPDU.



The above drawing illustrates an operation of a third HEW STA, STA21, when a downlink OFDMA PPDU is transmitted to STA1, STA2, STA3, STA4, STA5, STA6, STA7, STA8, STA9, STA10, STA11, and STA12.

A plurality of destination STAs may acquire their allocated sub-channel information from a HEW SIG-A field in the downlink OFDMA PPDU. However, the destination STAs to which sub-channels are allocated are not confined to a single STA because the number of available bits for the HEW SIG-A field is limited. In other words, although some of the plurality of STAs receiving the downlink OFDMA PPDU may consider itself to be a destination STA, a sub-channel may actually not be allocated to the STA. Such an STA is STA21 and sub-channel allocation information is shown as shared between STA11 and STA21 in the HEW SIG-A field in the above drawing. In other words, it means that STA11 and STA21 cannot be serviced simultaneously in the downlink OFDMA PPDU.

STA21 considers that a sub-channel allocated to it by the HEW SIG-A field corresponds to the third 5-MHz channel from the bottom in the secondary 20-MHz channel (above 20MHz channel). Accordingly, STA21 starts to receive a HEW-STF, a HEW-LTF, a HEW SIG-B, and a PSDU by switching to the sub-channel after the HEW SIG-A. However, after receiving the PSDU, STA21 may be aware that the destination STA of the PSDU is not STA21 but STA11 from the Receiver Address field of the MAC Header. In this case, STA21 corresponds to the afore-described NAC setting rule for an OFDMA PPDU, that is, a case in which a received frame has been transmitted on an arbitrary sub-channel of a 40-MHz OFDMA PPDU on a primary 40-MHz channel and an RA field does not match, and thus the NAV is set to the value of the Duration field of the MAC Header of the received frame.

It is concluded that third HEW STAs receiving an OFDMA PPDU set their NAVs to the value of the Duration field of the MAC Header of the received frame, even though the received frame has been transmitted only on a secondary channel, not on a primary 20-MHz channel.

Electronic Acknowledgement Receipt

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International Application Number:	
Confirmation Number:	3021
Title of Invention:	HEW PPDU PROTECTION MECHANISM
First Named Inventor/Applicant Name:	Yongho SEOK
Customer Number:	83220
Filer:	Soyeon P. Laub/Lori Tillman
Filer Authorized By:	Soyeon P. Laub
Attorney Docket Number:	A303AA-004500PV
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Time Stamp:	20:14:00
Application Type:	Provisional

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		62074514EnglishTranslation.pdf	914574 74f591ac03cf6a2cce2c77213d2e876cf069f4c7	yes	11

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Miscellaneous Incoming Letter	1	2
	Specification	3	11
Warnings:			
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Total Files Size (in bytes):		914574	
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
62/074,514	11/03/2014	Yongho SEOK	A303AA-004500PV

CONFIRMATION NO. 3021

IMPROPER PROVISIONAL LETTER



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Date Mailed: 11/20/2014

Letter re Non-English Language Application Papers in a Provisional Application

The above-identified provisional application was filed in a language other than English. An English-language translation of a non-English provisional application and a statement that the translation is accurate must be filed in the provisional application. See 37 CFR 1.78(a)(5). Applicants are strongly encouraged to file the English-language translation of the provisional application and the statement that the translation is accurate in the provisional application before a nonprovisional application claiming the benefit of the provisional application is filed, or, alternatively, when making a claim for the benefit of the provisional application in a nonprovisional application. If, however, an English translation and a statement that the translation is accurate have not been filed in the above-identified provisional application when a nonprovisional application is filed claiming the benefit of the filing date of the provisional application, the Office should mail a Notice requiring an English translation and the statement to be filed in the provisional application and a confirmation to be filed in the nonprovisional application.

In the event that the Office schedules a nonprovisional application that claims the benefit of a provisional application filed in a language other than English for publication without issuing a Notice requiring the applicant to file an English translation of the non-English provisional application, the applicant should file the English translation of the non-English provisional application and a statement that the translation is accurate as soon as possible in the provisional application.

/mduong/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
62/074,514	11/03/2014		130	A303AA-004500PV		

CONFIRMATION NO. 3021

FILING RECEIPT



83220
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Date Mailed: 11/20/2014

Receipt is acknowledged of this provisional patent application. It will not be examined for patentability and will become abandoned not later than twelve months after its filing date. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

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Applicant(s)

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Power of Attorney:

Steve Cho--44612

Permission to Access - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

If Required, Foreign Filing License Granted: 11/19/2014

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 62/074,514**

Projected Publication Date: None, application is not eligible for pre-grant publication

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

HEW PPDU PROTECTION MECHANISM

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

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Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	A303AA-004500PV
		Application Number	
Title of Invention	HEW PPDU PROTECTION MECHANISM		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2

☐	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
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Inventor 1					Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Yongho		SEOK			
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service						
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Mailing Address of Inventor:						
Address 1		33 Canoe				
Address 2						
City	Irvine	State/Province	CA			
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All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.						
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☐ An Address is being provided for the correspondence Information of this application.			
Customer Number	83220		
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Application Information:

Title of the Invention	HEW PPDU PROTECTION MECHANISM		
Attorney Docket Number	A303AA-004500PV	Small Entity Status Claimed	☒
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)		Suggested Figure for Publication (if any)	

Filing By Reference :

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	A303AA-004500PV
		Application Number	
Title of Invention	HEW PPDU PROTECTION MECHANISM		

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For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

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☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

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When referring to the current application, please leave the application number blank.

Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	A303AA-004500PV
		Application Number	
Title of Invention	HEW PPDU PROTECTION MECHANISM		

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☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013. NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Authorization to Permit Access:

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	A303AA-004500PV
		Application Number	
Title of Invention	HEW PPDU PROTECTION MECHANISM		

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Name of the Deceased or Legally Incapacitated Inventor :			
If the Applicant is an Organization check here. ☒			
Organization Name	NEWRACOM, INC		
Mailing Address Information:			
Address 1	9008 Research Drive		
Address 2			
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Phone Number		Fax Number	

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	A303AA-004500PV
		Application Number	
Title of Invention	HEW PPDU PROTECTION MECHANISM		
Email Address			
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First Name	Steve	Last Name	Cho	Registration Number
				44612
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	A303AA-004500PV
		Application Number	
Title of Invention	HEW PPDU PROTECTION MECHANISM		

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PROVISIONAL PATENT APPLICATION

HEW PPDU PROTECTION MECHANISM

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본 발명은, 2.4GHz, 5GHz 주파수에서 동작하는 IEEE 802.11ax High Efficiency WLAN (HEW) PPDU 전송에 관한 것으로, Orthogonal Frequency Division Multiple Access (OFDMA) 전송을 지원하는 HEW Basic Service Set (BSS) 에서 HEW PPDU Protection Mechanism 을 정의한다.

아래 그림은 본 발명에서 제안하는 HEW PPDU format 을 보여 준다.

L-STF	L-LTF	L-SIG	HEW SIG-A	HEW-STF	HEW-LTF	HEW-SIG-B	HEW-LTF	HEW-SIG-C	PSDU (STA4 to AP)			
				HEW-STF	HEW-LTF	HEW-SIG-B	HEW-LTF	HEW-SIG-C	PSDU (STA3 to AP)			
				HEW-STF	HEW-LTF	HEW-SIG-B	HEW-LTF	HEW-SIG-C	PSDU (STA2 to AP)			
				HEW-STF	HEW-LTF	HEW-SIG-B	HEW-LTF	HEW-SIG-C	HEW-LTF	HEW-SIG-C	HEW-SIG-C	PSDU (STA1 to AP)

L-STF 는 Legacy Short Training Field 에 해당되며, IEEE 802.11a/g/n/ac 와 같은 legacy STA 의 preamble decoding 을 위한 frequency offset estimation, phase offset estimation 을 위한 용도로 사용된다. L-LTF 는 Legacy Long Training Field 에 해당되며, IEEE 802.11a/g/n/ac 와 같은 legacy STA 의 preamble decoding 을 위한 channel estimation 용도로 사용된다. L-SIG 는 Legacy Signal Field 에 해당되며, IEEE 802.11a/g/n/ac 와 같은 legacy STA 의 preamble decoding 및 3rd party PPDU 전송에 대한 protection 기능을 제공한다.

HEW SIG-A 는, High Efficiency WLAN Signal A field 에 해당되며, HEW STA 의 HEW preamble decoding 을 위한 HEW PPDU modulation parameter 등을 제공한다. HEW SIG-A 에 포함되는 parameter 들은, IEEE 802.11ac 단말과 호환을 위해 아래와 같은 IEEE 802.11ac 단말들이 전송하는 VHT PPDU modulation parameter 들을 포함한다.

Two parts of VHT-SIG-A	Bit	Field	Number of bits	Description
VHT-SIG-A1	B6-B1	BW	2	Set to 0 for 20 MHz, 1 for 40 MHz, 2 for 80 MHz, and 3 for 160 MHz and 99+88 MHz
	B2	Reserved	1	Reserved. Set to 1.
	B0	STBC	1	For a VHT SU PPDU: Set to 1 if space-time block coding is used and set to 0 otherwise. For a VHT MU PPDU: Set to 0.
	B4-B8	Group ID	5	Set to the value of the TXVECTOR parameter GROUP_ID. A value of 0 or 03 indicates a VHT SU PPDU; otherwise, indicates a VHT MU PPDU.
	B10-B21	NSTS/Partial AID	12	For a VHT MU PPDU, NSTS is divided into 4 user positions of 3 bits each. User position p , where $0 \leq p \leq 3$, uses bits $B_{(10+3p)}$ to $B_{(11+3p)}$. The number of space-time streams for user n are indicated at user position $p = \text{USER_POSITION}[n]$ where $u = 0, 1, \dots, \text{NUM_USERS} - 1$ and the notation $A[b]$ denotes the value of array A at index b . Zero space-time streams are indicated at positions not listed in the USER_POSITION array. Each user position is set as follows: Set to 0 for 0 space-time streams Set to 1 for 1 space-time stream Set to 2 for 2 space-time streams Set to 3 for 3 space-time streams Set to 4 for 4 space-time streams Values 5-7 are reserved. For a VHT SU PPDU: B10-B11 Set to 0 for 1 space-time stream Set to 1 for 2 space-time streams Set to 2 for 3 space-time streams Set to 3 for 4 space-time streams Set to 4 for 5 space-time streams Set to 5 for 6 space-time streams Set to 6 for 7 space-time streams Set to 7 for 8 space-time streams B15-B21 Partial AID: Set to the value of the TXVECTOR parameter PARTIAL_AID. Partial AID provides an abbreviated indication of the intended recipients of the PSDU (see 9.20 Group ID and partial AID in VHT PPDU).
	B24	TXOP_PS_NOT_ALLOWED	1	Set to 0 by VHT AP if it allows non-AP VHT STAs in TXOP power save mode to enter Doze state during a TXOP. Set to 1 otherwise. The bit is reserved and set to 1 in VHT PPDU transmitted by a non-AP VHT STA.
	B22	Reserved	1	Set to 1.

Two parts of VHT-SIG-A	Bit	Field	Number of bits	Description
VHT-SIG-A2	B0	Short GI	1	Set to 0 if short guard interval is not used in the Data Field. Set to 1 if short guard interval is used in the Data Field.
	B1	Short GI Nym Disambiguation	1	Set to 1 if short guard interval is used and $N_{ym} \neq 0$; otherwise, set to 0. N_{ym} is defined in 22.5.3.4 (TXTIME and PSDU_LENGTH calculation).
	B2	SU/MU [p] Coding	1	For a VHT SU PPDU, B2 is set to 0 for BCC, 1 for LDPC. For a VHT MU PPDU, if the MU[2] NSTS field is nonzero, then B2 indicates the coding used for user n with $\text{USER_POSITION}[n] = 0$; set to 0 for BCC and 1 for LDPC. If the MU[0] NSTS field is 0, then this field is reserved and set to 1.
	B3	LDPC Extra OPDM Symbol	1	Set to 1 if the LDPC PPDU encoding process (if an SU PPDU), or at least one LDPC user's PPDU encoding process (if a VHT MU PPDU), results in an extra OFDM symbol (a symbol as described in 22.5.3.10.5.4 (LDPC coding) and 22.5.3.10.5.5 (Encoding process for VHT MU PPDU)), set to 0 otherwise.
	B4-B7	SU VHT-MU [p] Coding	4	For a VHT SU PPDU: VHT-MU is index. For a VHT MU PPDU: If the MU[1] NSTS field is nonzero, then B4 indicates coding for user n with $\text{USER_POSITION}[n] = 1$; set to 0 for BCC, 1 for LDPC. If the MU[2] NSTS field is 0, then B4 is reserved and set to 1. If the MU[2] NSTS field is nonzero, then B5 indicates coding for user n with $\text{USER_POSITION}[n] = 2$; set to 0 for BCC, 1 for LDPC. If the MU[3] NSTS field is 0, then B5 is reserved and set to 1. If the MU[3] NSTS field is nonzero, then B6 indicates coding for user n with $\text{USER_POSITION}[n] = 3$; set to 0 for BCC, 1 for LDPC. If the MU[4] NSTS field is 0, then B6 is reserved and set to 1. If the MU[4] NSTS field is nonzero, then B7 indicates coding for user n with $\text{USER_POSITION}[n] = 4$; set to 0 for BCC, 1 for LDPC. If the MU[5] NSTS field is 0, then B7 is reserved and set to 1.
	B8	Beamformed	1	For a VHT SU PPDU: Set to 1 if a beamforming steering matrix is applied to the waveform (i.e., an SU transmission) as described in 20.5.11.3.1.2 (Spatial mapping), set to 0 otherwise. For a VHT MU PPDU: Reserved and set to 1. NOTE—If applied to 1, beamforming is not recommended.
	B9	Reserved	1	Reserved and set to 1.
	E10-B17	CRC	8	CRC calculated as in 20.5.9.4.4 (CRC calculation for HT-SS) with $e7$ as B10, B16, B22 of HT-SSGI and bits 6-9 of HT-SSGI are replaced by bits 0-3 of VHT-SIG-A1 and bits 0-9 of VHT-SIG-A2, respectively.
	B18-B23	Tail	6	Used to terminate the tails of the convolutional decoder. Set to 0.

하지만, 본 발명에서 제안하는 HEW PPDU format 은 MU MIMO-OFDMA 을 지원하기 위함이며, 이를 위해 각각의 HEW STA 에게 할당되는 sub-channel 에 대한 정보가 HEW SIG-A 에 포함될 수 있다.

HEW STA 에게 할당되는 sub-channel 정보는, Group ID, N_{BW} 을 HEW SIG-A 에 포함함으로 이루어 진다. HEW STA 이 HEW AP 에 접속하게 되면, HEW AP 는 해당 HEW STA 에게 Group ID 와 각각의 Group ID 별로 해당 HEW STA 의 STA Position 정보를 할당한다.

예를 들어, 아래 테이블의 경우, Group ID 1 은 STA Position 1, Group ID 2 은 STA Position 2, Group ID 61 은 STA Position 4, Group ID 62 은 STA Position 1 이 할당 됨을 의미한다. 이러한 Group ID, STA Position 테이블 정보를 할당받은 HEW STA 은 HEW PPDU 을 수신한 후 다음과 같이 방식으로 자신의 sub-channel 을 결정한다.

Group ID	Group ID 1	Group ID 2	...	Group ID 61	Group ID 62
STA Position	1	2	...	4	1

예를 들어, 수신한 HEW PPDU 에서 HEW SIG-A 의 Group ID 값이 61 이었고, 이어 N_{BW} 값이 b000, b001, b001, b010 였다고 가정한다.

N_{BW} 은 STA Position 1, STA Position 2, STA Position 3, STA Position 4 에 해당하는 HEW STA 들에게 각각 할당된 sub-channel bandwidth 을 알려준다. 만약, 5MHz, 10MHz, 20MHz, 40MHz, 80MHz, 160MHz HEW PPDU 전송이 허용되는 경우, N_{BW} 은 STA Position 1 에 해당하는 HEW STA 의 sub-channel bandwidth 3 bits, STA Position 2 에 해당하는 HEW STA 의 sub-channel bandwidth 3 bits, STA Position 3 에 해당하는 HEW STA 의 sub-channel bandwidth 3 bits, STA Position 4 에 해당하는 HEW STA 의 sub-channel bandwidth 3 bits, 이렇게 총 4 개의 HEW STA 을 지원하기 위해 12 bits 으로 구성 된다.

위의 예제에서 해당 HEW STA 는 Group ID 61 에 대해서 STA Position 으로 4 을 할당 받았다. 따라서, 수신한 HEW PPDU 의 STA Position 4 의 N_{BW} 값 b010 을 통해 자신에게 할당된 sub-channel bandwidth 가 10MHz 임을 알게 된다. 여기서, N_{BW} 의 encoding 은 b000 은 0MHz, b001 은 5MHz, b010 은 10MHz, b011 은 20MHz, b100 은 40MHz, b101 은 80MHz, b110 은 160MHz 임을 가정하였으며, encoding 방식은 구현에 따라 다른 형태로 설정 될 수 있다.

또한, Group ID, N_{BW} 관련해, 위의 예제를 통해 알 수 있는 것은, Group ID 61 에 STA Position 1 을 할당 받은 HEW STA 로 0MHz sub-channel bandwidth 가 할당 되었다는 것이다. 즉, 어떠한 HEW PPDU 전송도 이루어지지 않음을 나타낸다. 그리고, Group ID 61 에 STA Position 2 을 할당 받은 HEW STA 로 5MHz sub-channel bandwidth 가 할당 되었다는 것과 Group ID 61 에 STA Position 3 을 할당 받은 HEW STA 로 5MHz sub-channel bandwidth 가 할당 되었다는 것이다. 아래 그림은 위의 예제에 따른 HEW PPDU 전송을 보여 주고 있다.

L-STF	L-LTF	L-SIG	HEW SIG-A	HEW-STF	HEW-LTF	HEW-LTF	...	HEW-LTF	HEW SIG-B	PSDU (10MHz)
				HEW-STF	HEW-LTF	HEW-LTF	...	HEW-LTF		
				HEW-STF	HEW-LTF	HEW-LTF	...	HEW-LTF	HEW SIG-B	PSDU (5MHz)
				HEW-STF	HEW-LTF	HEW-LTF	...	HEW-LTF	HEW SIG-B	PSDU (5MHz)

이와 같은 HEW PPDU 전송에 있어, 각각의 HEW STA 들에게 할당되는 sub-channel 들은 서로 sequential 해야 하며, 결과적으로 하나의 20MHz channel 안에 할당 되지 않고 중간에 비어 있는 sub-channel 들이 존재 해서는 안된다. 또한, 각각의 HEW STA 들에게 할당되는 sub-channel 들은 20MHz channel 단위로 하나의 channel 안에서만 이루어져야 하며, 결과적으로 복수의 20MHz channel 안에서 부분적으로 겹쳐진 sub-channel 할당은 허용되지 않아야 한다.

본 발명에서 제안하는 HEW PPDU format 은 MU MIMO-OFDMA 을 지원하기 위함이며, 이를 위해 각각의 sub-channel 에 할당된 HEW STA 들로 전송될 spatial steam 수에 대한 정보가 HEW SIG-A 에 포함될 수 있다. 그리고, 전송될 spatial stream 수에 따라, HEW SIG-A 이후에 전송될 fields sequence 가 결정된다. HEW SIG-A 이후에 HEW-STF, HEW-LTF HEW SIG-B, HEW-LTF, HEW-SIG-C 가 각각의 sub-channel 을 통해 전송 된다. HEW-STF 는, 하나의 sub-channel 에 대한 frquency offset estimation, phase off-set estimation 용도로 사용된다. HEW-LTF 는, 하나의 sub-channel 에 대한 channel estimation 용도로 사용된다. 본 발명에서는, 전체 전송되는 spartial stream 수가 총 2 개 일 경우, HEW-LTF 는 총 2 개가 전송되며, 전체 전송되는 spartial stream 수가 총 3 개 일 경우 HEW-LTF 는 총 4 개가 전송되며, 전체 전송되는 spartial stream 수가 총 4 개 일 경우 HEW-LTF 는 총 4 개가 전송되며, 전체 전송되는 spartial stream 수가 총 5 개 일 경우 HEW-LTF 는 총 6 개가 전송되며, 전체 전송되는 spartial stream 수가 총 6 개 일 경우 HEW-LTF 는 총 6 개가 전송되며, 전체 전송되는 spartial stream 수가 총 7 개 일 경우 HEW-LTF 는 총 8 개가 전송되며, 전체 전송되는 spartial stream 수가 총 8 개 일 경우 HEW-LTF 는 총 8 개가 전송되는 것을 제안한다.

Multi-User (MU)-MIMO 을 보다 효과적으로 지원하기 위해서, 각각의 sub-channel 별로 독립된 signaling information 이 전송될 필요가 있다. MU-MIMO 의 경우, MU-MIMO 전송의 수신 단말이 되는 복수의 HEW STA 들에 대해 서로 다른 spatial stream 수가 각각 전송될 수 있다. 이를 위해서, 각각의 HEW STA 들에게 각각 전송될 spatial stream 수가 전달되어야 한다. 만약, 하나의 HEW STA 에게 MU-MIMO 전송을 통해 전달할 수 있는 최대 spartial stream 수가 4 개, MU-MIMO 전송의 수신 단말이 최대 4 개라면, 각각의 sub-channel 별로 총 12 bits 이 요구 된다. 20MHz channel 안에 최대 4 개의 sub-channel 을 구성할 수 있다면, 총 48 bit 의 signaling information 이 요구 된다. 따라서, protocol overhead 을 줄이기 위한 목적으로, 이러한 spartial stream 할당 정보는 각각의 sub-channel 별로 독립적으로 전송하는 것이 바람직하다. 이러한 목적으로, HEW PPDU format 에서 HEW SIG-B 는 각각의 sub-channel 별로 spartial stream 할당 정보를 포함하며, Group ID, N_{STS} 와 같은 형태로 MU-MIMO 의 해당 group (Group ID)에 속하는 STA 들에 대해서 전송될 spatial stream 개수 (N_{STS})를 나타낸다.

마지막으로, HEW-LTF 이후에 전송되는 HEW SIG-C field 는 PSDU 별로 MCS 정보와 PSDU Length 정보를 포함한다.

앞서 제안한 HEW PPDU format 에서, 송신 단말의 구현 복잡에 따라 각각의 sub-channel 별로 전송되는 OFDM symbol 의 timing 을 맞추는 필요가 있다. 이를 위해서, 본 발명에서는 아래 그림과 같이 HEW SIG-B 이후에 전송되는 HEW-LTF 의 개수를 각각의 sub-channel 에 대해서 같은 값을 가지도록 하는 HEW PPDU format 을 제안한다. 이를 통해, 각각의 sub-channel 에서 PSDU 의 전송 시점이 일치되는 장점이 있다.

L-STF	L-LTF	L-SIG	HEW SIG-A	HEW-STF	HEW-LTF	HEW SIG-B	HEW-LTF	HEW-LTF	HEW-LTF	HEW-LTF	HEW SIG-C	PSDU (STA4 to AP)
				HEW-STF	HEW-LTF	HEW SIG-B	HEW-LTF	HEW-LTF	HEW-LTF	HEW-LTF	HEW SIG-C	PSDU (STA3 to AP)
				HEW-STF	HEW-LTF	HEW SIG-B	HEW-LTF	HEW-LTF	HEW-LTF	HEW-LTF	HEW SIG-C	PSDU (STA2 to AP)
				HEW-STF	HEW-LTF	HEW SIG-B	HEW-LTF	HEW-LTF	HEW-LTF	HEW-LTF	HEW SIG-C	PSDU (STA1 to AP)

앞서 제안한 HEW PPDU format 을 사용하게 되면, 복수의 단말이 AP로부터 각각의 sub-channel 을 할당 받아 동시에 PSDU 을 전송하는 것이 가능해 진다. 반대로, AP 가 복수의 단말로 각각의 sub-channel 을 할당하여 동시에 PSDU 을 전송하는 것 또한 가능해 진다.

L-SIG 의 서브 필드 구성과 관련해, HEW PPDU 에 대한 제 3 의 legacy 단말로부터 보호하기 위한 목적으로 L-SIG 의 L_LENGTH, L_DATARATE 서브 필드는 다음과 같이 설정된다.

$$L_LENGTH = \left\lceil \frac{((TXTIME - \text{Signal Extension}) - (aPreambleLength + aPHYHeaderLength))}{aSymbolLength} \right\rceil \times N_{OPS} - \left\lceil \frac{aPHYServiceLength + aPHYConvolutionalTailLength}{8} \right\rceil$$

Signal Extension is 0 μs when TXVECTOR parameter NO_SIG_EXTN is true and is the duration of signal extension as defined by aSignalExtension (6 us for 2.4GHz and 0 us for 5GHz) when TXVECTOR parameter NO_SIG_EXTN is false

aSymbolLength is the duration of a symbol (in microseconds). Normally, aSymbolLength is fixed to 4.

(aPreambleLength + aPHYHeaderLength) is the duration (in microseconds) of the non-HT PHY preamble and L-SIG, defined in 6.5.4 (PLME-CHARACTERISTICS.confirm)

N_{ops} is the number of octets transmitted during a period of aSymbolLength at the rate specified by L_DATARATE. Normally, L_DATARATE is fixed to 6 Mbps and N_{ops} is fixed to 4.

aPHYServiceLength is the number of bits in the PHY SERVICE field

aPHYConvolutionalTailLength is the number of bits in the convolutional code tail bit sequence

HEW PPDU 의 경우, L_LENGTH 는 다음과 같이 변형된다.

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

TXTIME 은 HEW PPDU 의 Duration 을 나타내며 다음과 같다.

TXTIME =

$$T_{L-STF} + T_{L-LTF} + T_{L-SIG} + T_{HEW-SIG-A} + \text{ceiling}((T_{HEW-STF} + N_{HEW-LTF} T_{HEW-LTF} + T_{HEW-SIG-B} + N_{SYM} T_{SYM}) / T_{SYM})$$

T_{L-STF}: Non-HT Short Training field duration (8us)

T_{L-LTF}: Non-HT Long Training field duration (8us)

T_{L-SIG}: Non-HT SIGNAL field duration (4us)

T_{HEW-SIG-A}: HEW Signal A field duration (8us or 12 us)

T_{HEW-SIG-B}: HEW Signal B field duration (16us or 15.6us)

T_{HEW-STF}: HEW Short Training field duration (16us or 15.6us)

T_{HEW-LTF}: HEW Long Training field duration (16us or 15.6us)

N_{HEW-LTF}: Number of HEW-LTF symbols

T_{SYM}: Double GI symbol interval (16us or 15.6us)

T_{SYML}: Long GI symbol interval (4us)

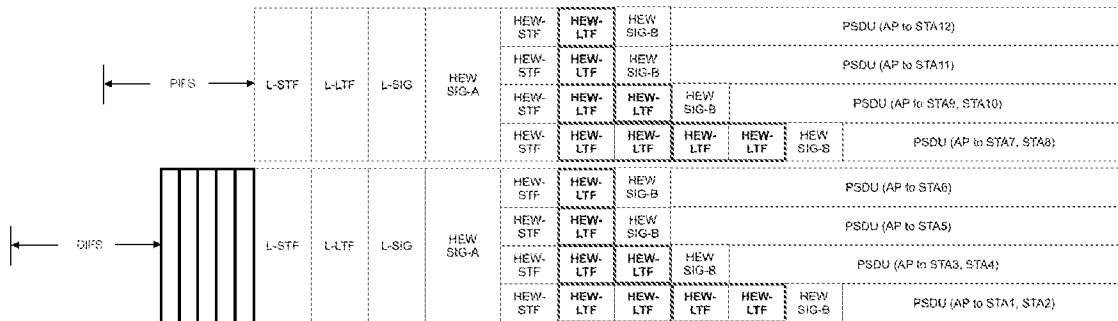
N_{SYM}: Number of symbols in the Data field

복수의 단말이 AP로부터 각각의 sub-channel 을 할당 받거나, AP 가 복수의 단말로 각각의 sub-channel 을 할당하는 경우, EDCA Channel Access mechanism 은 다음과 같다.

If a HEW STA is permitted to begin a TXOP (as shown in the below figure) and the HEW STA has at least one MSDU pending for transmission for the AC of the permitted TXOP, the STA shall perform exactly one of the

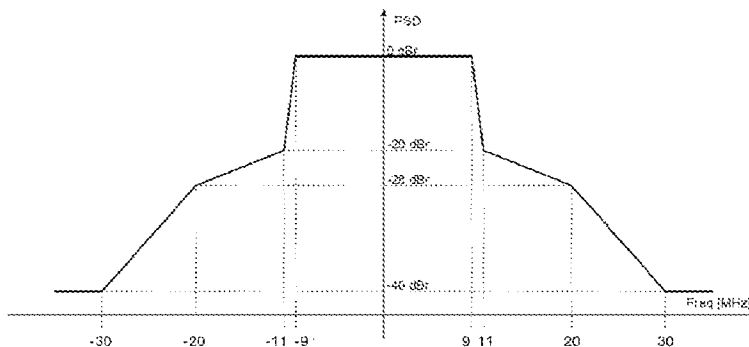
following actions:

- Transmit a 160 MHz or 80+80 MHz mask PPDU if the secondary channel, the secondary 40 MHz channel, and the secondary 80 MHz channel were idle during an interval of PIFS immediately preceding the start of the TXOP.
- Transmit an 80 MHz mask PPDU on the primary 80 MHz channel if both the secondary channel and the secondary 40 MHz channel were idle during an interval of PIFS immediately preceding the start of the TXOP.
- Transmit a 40 MHz mask PPDU on the primary 40 MHz channel if the secondary channel was idle during an interval of PIFS immediately preceding the start of the TXOP.
- Transmit a 20 MHz mask PPDU on the primary 20 MHz channel.
- Restart the channel access attempt by invoking the backoff procedure as though the medium is busy on the primary channel as indicated by either physical or virtual CS and the backoff timer has a value of 0.



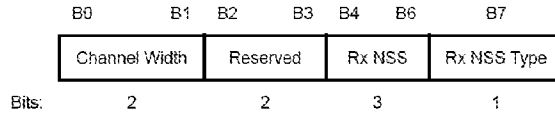
단말이 TXOP 을 획득하기 위해, primary channel 에서 back-off mechanism 을 수행한다. Distributed Inter Frame Space (DIFS) or Arbitrary Inter Frame Space (AIFS) 시간 동안 primary channel 이 idle 한 경우, [0, Contention Window] 간격안에서 임의의 random number 을 선택하고 선택된 random number 에 해당하는 시간 동안 back-off timer 을 동작한다. Back-off timer 는 back-off slot time 동안 primary channel 이 idle 한 경우, back-off timer 을 1 씩 감소해 나가는 방식이다. Back-off timer 가 0 에 도달 하면, 단말은 secondary channel 들의 CCA (idle or busy) 상태를 확인하여 secondary channel 들이 idle 한 경우, 해당 secondary channel 들을 사용해 20MHz/40MHz/80MHz/160MHz/80+80MHz mask PPDU 을 전송하게 된다.

20MHz mask PPDU 는, TXVECTOR parameter CH_BANDWIDTH equal to CBW20 에 해당하는 PPDU 로써 아래 그림과 같은 transmit spectral mask 을 만족하는 PPDU 을 말한다.



단말은 Operating Mode Notificaton frame or element 을 AP 로 전송해, 자신의 Operating Mode 을 AP 에 알릴 수 있다. 아래는 Operating Mode Notification 을 구성하는 field format 을 보여 준다. (Operating Mode

는 (Re-)Association Request/Response frames, Probe Request/Response frames 에 포함 될 수 있다.)



Channel Width -

If the Rx NSS Type subfield is 0, indicates the supported channel width:

Set to 0 for 20 MHz

Set to 1 for 40 MHz

Set to 2 for 80 MHz

Set to 3 for 160 MHz or 80+80 MHz

Reserved if the Rx NSS Type subfield is 1.

Rx NSS -

If the Rx NSS Type subfield is 0, indicates the maximum number of spatial streams that the STA can receive.

If the Rx NSS Type subfield is 1, indicates the maximum number of spatial streams that the STA can receive as a beamformee in an SU PPDU using a beamforming steering matrix derived from a Compressed Beamforming report with Feedback Type subfield indicating MU in the corresponding Compressed Beamforming frame sent by the STA.

Set to 0 for NSS = 1

Set to 1 for NSS = 2

...

Set to 7 for NSS = 8

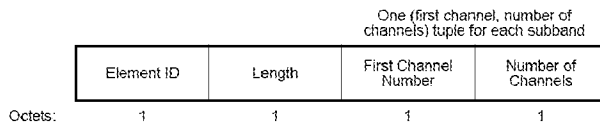
Rx NSS Type -

Set to 0 to indicate that the Rx NSS subfield carries the maximum number of spatial streams that the STA can receive.

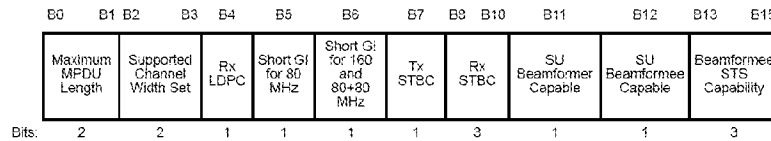
Set to 1 to indicate that the Rx NSS subfield carries the maximum number of spatial streams that the STA can receive in an SU PPDU using a beamforming steering matrix derived from a Compressed Beamforming report with the Feedback Type subfield indicating MU in the corresponding Compressed Beamforming frame sent by the STA.

NOTE—An AP always sets this field to 0.

또한, 단말은 Supported Channel element 을 통해서, 자신이 지원하는 channel list 을 AP 에게 전달 할 수 있다. 아래는 Supported Channel element format 을 보여 준다. (Supported Channel element 는 (Re-)Association Request/Response frames 에 포함 될 수도 있다.)



또한, 단말은 Capabilities element 의 Supported Channel Width Set field 을 통해서, 자신이 지원하는 Supported Channel Width Set 을 AP 에게 전달 할 수 있다. 아래는 Supported Channel Width Set field format 을 보여 준다. (Supported Channel Width Set field 을 포함하는 Capabilities element 는 (Re-)Association Request/Response frames 에 포함 될 수도 있다.)



Supported Channel Width Set -

Indicates the channel widths supported by the STA.

Set to 0 if the STA does not support either 160 or 80+80 MHz.

Set to 1 if the STA supports 160 MHz.

Set to 2 if the STA supports 160 MHz and 80+80 MHz.

The value 3 is reserved.

복수의 단말이 AP로부터 각각의 sub-channel을 할당 받거나, AP가 복수의 단말로 각각의 sub-channel을 할당하는 경우, AP는 단말들의 Operating Channel Width, Supported Channel, Supported Channel Width Set을 고려해 sub-channel 할당을 진행해야 한다.

위의 그림에서, STA1, STA2, STA3, STA4, STA5, STA6이 Operating Mode Notification element의 Channel Width field을 20MHz로 설정하여, 자신들이 secondary 20MHz/secondary 40MHz/secondary 80MHz channel에서 전송되는 PPDU를 수신할 수 없음을 알렸다고 가정한다. 그리고, STA7, STA8, STA9, STA10, STA11, STA12이 Operating Mode Notification element의 Channel Width field을 40MHz로 설정하여, 자신들이 secondary 20MHz까지 전송되는 PPDU를 수신할 수 있지만, secondary 40MHz/secondary 80MHz channel에서 전송되는 PPDU를 수신할 수 없음을 알렸다고 가정한다. 이 경우, AP가 downlink OFDMA 기법으로 STA1, STA2, STA3, STA4, STA5, STA6, STA7, STA8, STA9, STA10, STA11, STA12로 sub-channel을 할당하여 동시 전송을 수행하는 경우, AP는 STA1, STA2, STA3, STA4, STA5, STA6에 대해서 해당 단말이 동작하는 primary 20MHz channel에서만 sub-channel을 할당해 주어야 한다. 이것은, STA1, STA2, STA3, STA4, STA5, STA6이 자신이 선언한 Channel Width, 곧 primary 20MHz channel 외에 secondary 20MHz channel 등으로부터 sub-channel을 할당 받지 않아야 함을 의미한다. 한편, AP는 STA7, STA8, STA9, STA10, STA11, STA12에 대해서 해당 단말이 동작하는 primary 20MHz channel, secondary 20MHz에서 sub-channel을 할당한다.

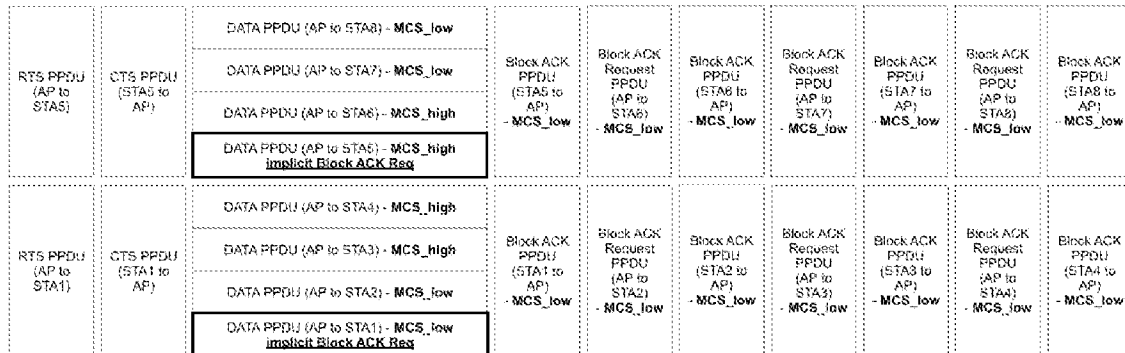
AP가 단말들의 Operating Channel Width, Supported Channel, Supported Channel Width Set을 고려해 sub-channel 할당을 진행하게 되면, 단말들은 AP가 전송하는 OFDMA PPDU를 수신하는데 있어서, 해당 OFDMA PPDU의 전체 Channel Width(e.g., TXVECTOR parameter CH_BANDWIDTH)를 수신하기 위해 자신의 Channel Width 또한 높게 설정해야 하는 이슈를 해결할 수 있다. 이것은, 단말의 전력 소모를 줄일 수 있는 이득을 가지게 한다.

한편, Single-User (SU) PPDU, Multi-User (MU) MIMO PPDU 경우, 해당 PPDU의 Channel Width, 곧 TXVECTOR parameter CH_BANDWIDTH는 목적 단말이 Capabilities element의 Supported Channel Width Set field을 통해서 전달한 수신 가능한 Channel Width Set에 포함되지 않는 Channel Width를 사용할 수 없다. 마찬가지로, 해당 PPDU의 Channel Width, 곧 TXVECTOR parameter CH_BANDWIDTH는 목적 단말이 Operating Mode Notification element의 Channel Width field을 통해서 전달한 수신 가능한 Channel Width를 초과한 Channel Width를 사용할 수 없다. 마찬가지로, 해당 PPDU의 Channel Width, 곧 TXVECTOR parameter CH_BANDWIDTH는 목적 단말이 Supported Channel element을 통해서 전달한 자신이 지원하는 channel list 외에 채널을 포함한 Channel Width를 사용할 수 없다.

하지만, 본 발명에서 제안하는 OFDMA PPDU의 경우, 해당 PPDU의 Channel Width, 곧 TXVECTOR parameter CH_BANDWIDTH는 목적 단말이 Capabilities element의 Supported Channel Width Set field을 통해서 전달한 수신 가능한 Channel Width Set에 포함되지 않는 Channel Width를 사용할 수 있다. 마찬가지로, 해당 PPDU의 Channel Width, 곧 TXVECTOR parameter CH_BANDWIDTH는 목적 단말이 Operating Mode Notification element의 Channel Width field을 통해서 전달한 수신 가능한 Channel Width를 초과한 Channel Width를 사용할 수 있다. 마찬가지로, 해당 PPDU의 Channel Width, 곧 TXVECTOR parameter CH_BANDWIDTH는 목적 단말이 Supported Channel element을 통해서 전달한 자신이 지원하는 channel list 외에 채널을 포함한 Channel Width를 사용할 수 있다. 단, 이를 위한 요구 사항으로, 앞서 설명하였듯이 AP가 단말들의 Operating Channel Width, Supported Channel, Supported Channel Width Set을 고려해 sub-channel 할당을 진행하는 것이다. AP가 OFDMA PPDU를 전송할 때, 단말들에게 할당한 sub-channel의 Channel Width를 TXVECTOR parameter SUBCH_BANDWIDTH라고 하면, TXVECTOR parameter SUBCH_BANDWIDTH는 목적 단말이 Capabilities element의 Supported Channel Width Set field을 통해서 전달한 수신 가능한 Channel Width Set에 포함되지 않는 Channel Width를 사용할 수 없다. 마찬가지로, 단말들에게 할당한 sub-channel의 Channel Width, 곧 TXVECTOR param-

eter SUBCH_BANDWIDTH 은 목적 단말이 Operating Mode Notification element 의 Channel Width field 을 통해서 전달한 수신 가능한 Channel Width 을 초과한 Channel Width 을 사용할 수 없다. 마찬가지로, 단말들에게 할당한 sub-channel 의 Channel Width, 곧 TXVECTOR parameter SUBCH_BANDWIDTH 은 목적 단말이 Supported Channel element 을 통해서 전달한 자신이 지원하는 channel list 외에 채널을 포함한 Channel Width 을 사용할 수 없다.

OFDMA DATA PPDU 을 수신한 단말들은 다음과 같은 Block ACK mechansim 을 수행한다.



위의 그림에서 AP 는 40MHz channel 을 사용해 STA1, STA2, STA3, STA4, STA5, STA6, STA7, STA8 로 총 8 개의 5MHz sub-channel 들을 구성해 복수의 DATA PPDU 을 동시 전송하였다. 또한, 복수의 DATA PPDU 을 동시 전송하기 전에 RTS PPDU 을 20MHz channel 각각을 사용해 STA1, STA5 로 동시 전송하고, STA1, STA5 로부터 20MHz channel 각각을 사용해 CTS PPDU 을 수신 받았다.

40MHz channel 을 사용해 STA1, STA2, STA3, STA4, STA5, STA6, STA7, STA8 로 각각 5MHz sub-channel 을 구성해 복수의 DATA PPDU 을 동시 전송할 때, DATA PPDU 들의 ACK Policy 을 살펴 보면 20MHz channel 단위로 오직 하나의 목적 단말에 대해 implicit Block ACK Request 가 설정 될 수 있음을 알 수 있다. 이것은, 복수의 목적 단말이 동시에 Block ACK PPDU 을 전송해 collision 이 발생하는 것을 방지하기 위함이다.

위의 그림과 같이 목적 단말들이 Block ACK PPDU 와 같은 Control Response frame 을 동시 전송할 때, Transmit Spectrum Mask 는 서로 동일한 것을 사용해야 한다. 이것은 수신 단말의 구현 복잡도를 줄이기 위함이며, 만약 복수의 목적 단말이 서로 다른 Transmit Spectrum Mask 을 사용해 Control Response frame 을 동시 전송하는 경우, 수신 단말은 복수의 Spectrum Mask 에 대한 동시 수신 기능을 가져야 한다. Control Response frame 을 동시 전송할 때, Transmit Spectrum Mask 을 서로 동일하게 하기 위한 방법으로, 목적 단말은 수신한 OFDMA PPDU 의 전체 Channel Width (RXVECTOR parameter CH_BANDWIDTH) 을 기반으로 Control Response frame 전송에 사용될 Spectrum Mask 을 결정하는 것이다.

예를 들어, 위의 예제와 같이 40MHz OFDMA PPDU 을 수신한 경우 (RXVECTOR parameter CH_BANDWIDTH equal to CBW40), Control Response frame 은 항상 40MHz Channel Width 전송에 적합한 40MHz Transmit Spectrum Mask 을 사용하는 것이다. 위의 예제에서 OFDMA PPDU 을 수신하고 SIFS 시간 후에 Block ACK PPDU 을 응답하는 STA1, STA5 는, 자신이 전송하는 Block ACK PPDU 의 Channel Width 가 20MHz 임에도 불구하고 Transmit Spectrum Mask 는 40MHz Transmit Spectrum Mask 을 각각 동일하게 사용하는 것이다. 이러한 규칙은 또한 다음과 같은 실시예를 포함하는 것은 자명하다. 만약 80MHz OFDMA PPDU 을 수신한 경우 (RXVECTOR parameter CH_BANDWIDTH equal to CBW80), Control Response frame 은 항상 80MHz Channel Width 전송에 적합한 80MHz Transmit Spectrum Mask 을 사용하는 것이다. 만약 160MHz OFDMA PPDU 을 수신한 경우 (RXVECTOR parameter CH_BANDWIDTH equal to CBW160), Control Response frame 은 항상 160MHz Channel Width 전송에

적합한 160MHz Transmit Spectrum Mask 을 사용하는 것이다. 만약 20MHz OFDMA PPDU 을 수신한 경우 (RXVECTOR parameter CH_BANDWIDTH equal to CBW20), Control Response frame 은 항상 20MHz Channel Width 전송에 적합한 20MHz Transmit Spectrum Mask 을 사용하는 것이다.

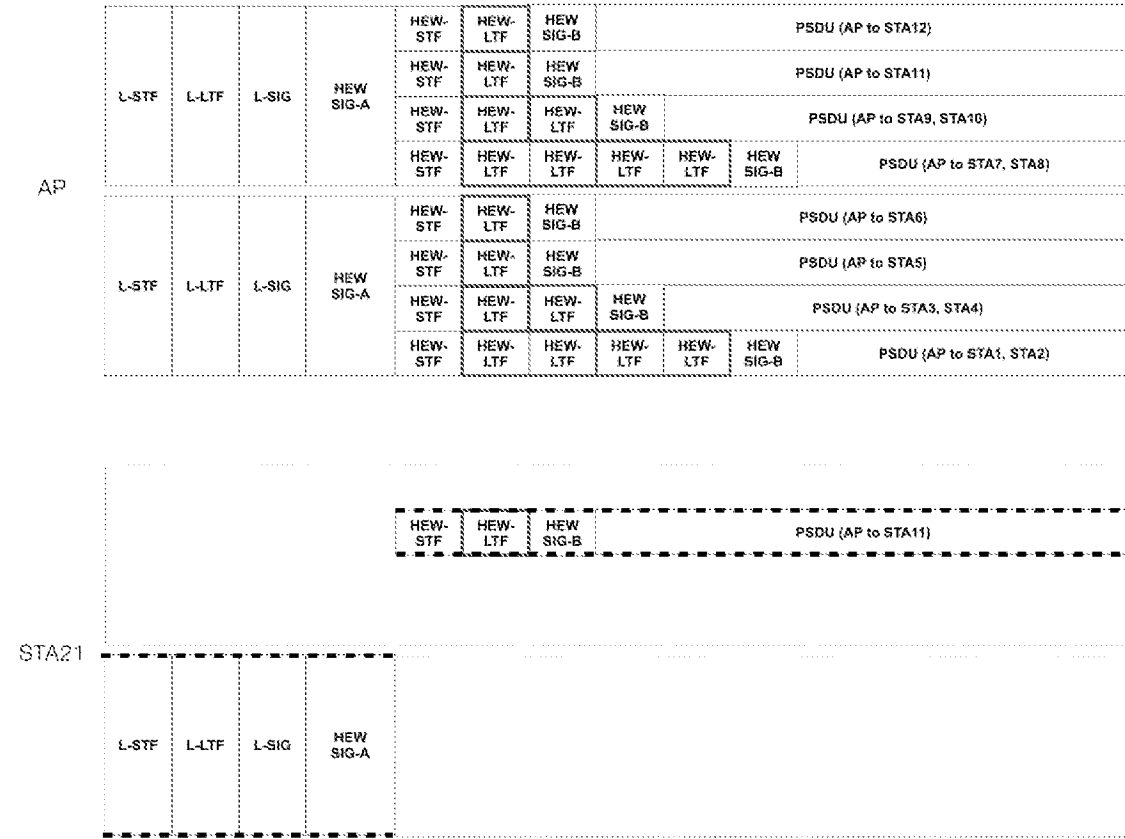
HEW PPDU 전송을 제 3 의 HEW STA 로부터 보호하기 위한 목적으로, HEW PPDU 에 포함되는 PSDU 의 MAC Header 안에 Duration field 을 활용할 수 있다. MAC Header 안에 Duration field 는 제 3 의 HEW STA 들로 하여금 Network Allocation Vector (NAV) 을 Duration field 값만큼 설정하여 해당 시간 동안 채널을 Busy 한것으로 간주하게 한다. 이를 통해, 제 3 의 HEW STA 들이 물리적으로 채널이 Idle 할지라도, 해당 시간 동안 채널 액세스를 하지 못하게 한다.

HEW PPDU 의 경우, MAC Header 가 포함된 PSDU 의 channel bandwidth 가 HEW PPDU 의 channel bandwidth 보다 작을 수 있다. 만약, HEW PPDU 의 channel bandwidth 와 PSDU 의 channel bandwidth 가 같다면, 단말의 NAV 설정은 다음과 같이 정의 할 수 있다.

A HEW STA shall update its NAV using the Duration/ID field value in any frame that does not have an RA matching the STA's MAC address and that was received in a 20 MHz PPDU in the primary 20 MHz channel or received in a 40 MHz PPDU in the primary 40 MHz channel or received in an 80 MHz PPDU in the primary 80 MHz channel or received in a 160 MHz or 80+80 MHz PPDU.

하지만, PSDU 의 channel bandwidth 가 HEW PPDU 의 channel bandwidth 보다 작은 경우, 곧 OFDMA 가 사용된 경우, 단말의 NAV 설정은 다음과 같이 정의 할 수 있다.

A HEW STA shall update its NAV using the Duration/ID field value in any frame that does not have an RA matching the STA's MAC address and that was received in any sub-channel of a 20 MHz OFDMA PPDU in the primary 20 MHz channel or received in any sub-channel of a 40 MHz OFDMA PPDU in the primary 40 MHz channel or received in any sub-channel of an 80 MHz OFDMA PPDU in the primary 80 MHz channel or received in any sub-channel of a 160 MHz or 80+80 MHz OFDMA PPDU.



위의 그림은 Downlink OFDMA PPDU 가 STA1, STA2, STA3, STA4, STA5, STA6, STA7, STA8, STA9, STA10, STA11, STA12 로 전송 될때, 제 3 의 HEW STA 에 해당하는 STA21 의 동작을 보여 준다.

Downlink OFDMA PPDU 에서 복수의 목적 단말들은 자신이 할당된 sub-channel 정보를 HEW SIG-A 을 통해 확인할 수 있다. 하지만, HEW SIG-A 에서 사용 가능한 bits 수가 제한되어 있어, sub-channel 이 할당된 목적 단말이 하나의 단말로만 특정되지 않을 수 있다. 즉, Downlink OFDMA PPDU 을 수신한 복수의 단말들중에 HEW SIG-A 을 통해 자신이 목적 단말이라고 간주 할 수 있지만, 실제 해당 단말로는 sub-channel 이 할당되지 않을 수 있다. 위의 그림에서 STA21 이 이러한 단말에 해당되며, HEW SIG-A 에서 STA11 과 STA21 의 sub-channel 할당 정보가 서로 공유된 것을 보여 준다. 다르게 말해, Downlink OFDMA PPDU 에서 STA11, STA21 은 동시에 서비스 될 수 없다는 것을 의미한다.

STA21 은 HEW SIG-A 을 통해 자신에 할당된 sub-channel 이, secondary 20MHz (above 20MHz channel) 중에 아래에서 세번째 5MHz channel 에 해당한 것으로 간주하였다. 따라서, HEW SIG-A 이후에 해당 sub-channel 로 이동하여 HEW-STF, HEW-LTF, HEW SIG-B, PSDU 을 수신하기 시작한다. 하지만, STA21 이 PSDU 을 수신한 후에 해당 PSDU 의 목적 단말은 자신이 아니고 STA11 이라는 사실을 MAC Header 의 Receiver Address field 을 통해 확인 할 수 있다. 이 경우, STA21 은 앞서 언급한 OFDMA PPDU 의 NAV 설정 규칙, 즉 수신한 frame 이 primary 40MHz channel 에서 40MHz OFDMA PPDU 의 임의의 sub-channel 에서 전송되었고 RA field 가 일치하지 않은 경우에 해당되어, 수신한 frame 의 MAC Header 의 Duration field 값으로 NAV 값이 설정되게 된다.

결론적으로, OFDMA PPDU 을 수신한 제 3 의 HEW STA 들은 자신이 수신한 frame 이 primary 20MHz 채널을 사용해 전송되지 않았고 secondary channel 만을 통해서 전송된 경우일지라도, 해당하는 제 3 의 HEW STA 단말들은 자신이 수신한 frame 에서 MAC Header 의 Duration field 값으로 NAV 값을 설정하는 것을 의미한다.

Electronic Patent Application Fee Transmittal

Application Number:

Filing Date:

Title of Invention:

HEW PPDU PROTECTION MECHANISM

First Named Inventor/Applicant Name:

Yongho SEOK

Filer:

Steve Yong Soo Cho

Attorney Docket Number:

A303AA-004500PV

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Provisional Filing Fees

Description

Fee Code

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Basic Filing:

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Claims:

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Petition:

Patent-Appeals-and-Interference:

Post-Allowance-and-Post-Issuance:

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Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
Total in USD (\$)				130

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Application Number:	62074514
International Application Number:	
Confirmation Number:	3021
Title of Invention:	HEW PPDU PROTECTION MECHANISM
First Named Inventor/Applicant Name:	Yongho SEOK
Customer Number:	83220
Filer:	Steve Yong Soo Cho
Filer Authorized By:	
Attorney Docket Number:	A303AA-004500PV
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	2014_11_03_ADS_A303AA-004500PV.pdf	1560833 4f091c97c3f8829175ef8ba73fe4c80804818f96	no	7

Warnings:**Information:**

2	Specification - Not in English	2014_11_03_SPEC_A303AA-004500PV.pdf	1155079 779eb204d9a8262e08b39663d08fd1ba09c2957	no	11
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Warnings:**Information:**

3	Fee Worksheet (SB06)	fee-info.pdf	29371 e58a64f37d7a15f126e559ea5d89012430dc9be8	no	2
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Warnings:**Information:**

Total Files Size (in bytes):			2745283		
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.