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Re:	Sponsor re-circulation Ballot
Abstract	H-ARQ support corrections, for OFDMA PHY mode
Purpose	Adoption of proposed changes into P802.16-REVd/D4-2004
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In page 529, line 47, correct section 8.4.9.2.3.1 as shown below:

8.4.9.2.3.1 CTC encoder

The Convolutional Turbo Code defined in this section is designed to enable support of hybrid ARQ (HARQ). HARQ implementation is optional. The Convolutional Turbo Code encoder, including its constituent encoder, is depicted in Figure 240. It uses a double binary Circular Recursive Systematic Convolutional code. The bits of the data to be encoded are alternately fed to A and B, starting with the MSB of the first byte being fed to A. The encoder is fed by blocks of k bits or N couples $(k = 2*N$ bits). For all the frame sizes k is a multiple of 8 and N is a multiple of 4. Further N shall be limited to: $8 \le N/4 \le 1024$.

The polynomials defining the connections are described in octal and symbol notations as follows:

— For the feedback branch: 0xB, equivalently $1+D+D^3$ (in symbolic notation)

— For the Y parity bit: 0xD, equivalently $1+D^2+D^3$

— For the W parity bit: 0x9, equivalently $1+D^3$

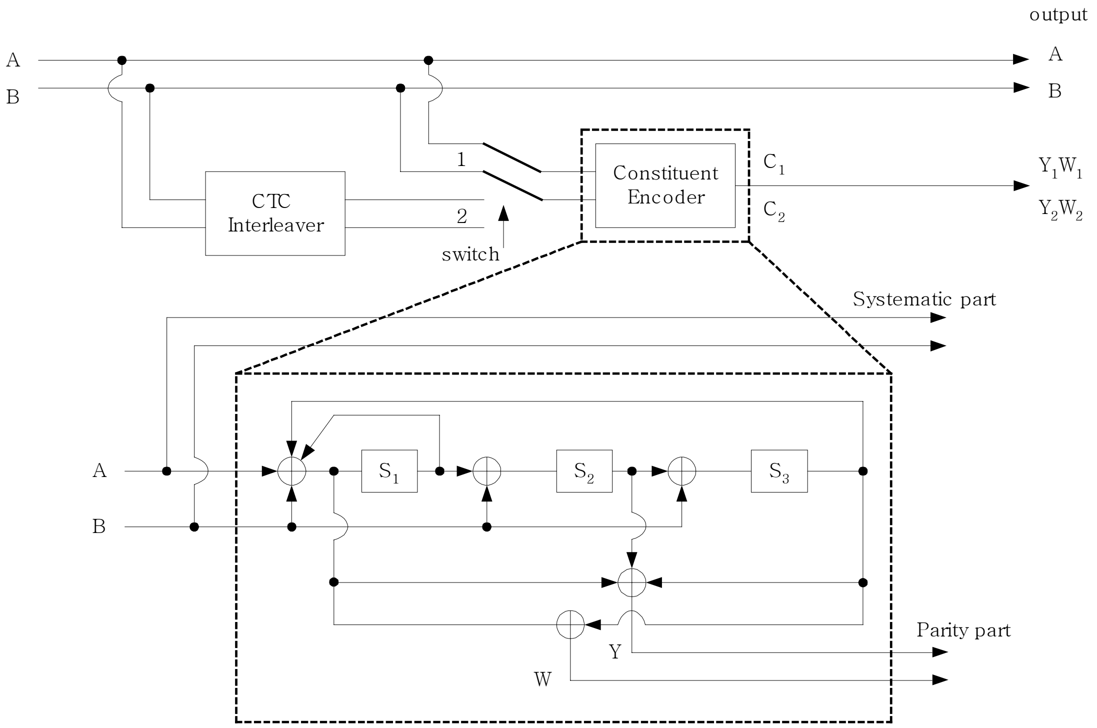


Figure 240—CTC encoder

First, the encoder (after initialization by the circulation state Sc_1, see 8.4.9.2.3.3) is fed the sequence in the natural order (position 1) with the incremental address $i = 0 .. N-1$. This first encoding is called S_{C1} encoding. Then the encoder (after initialization by the circulation state Sc_2, see 8.4.9.2.3.3) is fed by the interleaved sequence (switch in position 2) with incremental address $j = 0, \ldots N-1$. This second encoding is called C_2 encoding.

The order in which the encoded bit shall be fed into the ~~interleaver (8.4.9.3)~~ data modulation block (8.4.9.4.2) is:

$$A,B,Y_1,W_1,Y_2,W_2 = A_1,A_2,\ldots,A_N,B_1,B_2,\ldots,B_N,Y_{11},Y_{12},\ldots,Y_{1N},W_{11},W_{12},\ldots,W_{1N},Y_{21},Y_{22},\ldots,Y_{2N},W_{21},W_{22},\ldots,W_{2N}$$

$$A,B,Y_1,Y_2,W_1,W_2 = A_1,B_1,\ldots,A_N,B_N,Y_{11},Y_{12},\ldots,Y_{1N},Y_{1N},Y_{21},Y_{22},\ldots,Y_{2N},W_{11},W_{12},\ldots,W_{1N},W_{1N},W_{21},W_{22},\ldots,W_{2N}$$

where M is the number of parity bits.

Note that this interleaver (8.4.9.3) shall not be used when using CTC

Table 284 gives the block sizes, code rates, channel efficiency, and code parameters for the different modulation and coding schemes. As 64-QAM is optional, the codes for this modulation shall only be implemented if the modulation is implemented.

The encoding block size shall depend on the number of subchannels allocated and the modulation specified for the current transmission. Concatenation of a number of subchannels shall be performed in order to make larger blocks of coding where it is possible, with the limitation of not passing the largest block under the same coding rate (the block defined by 64-QAM modulation). Table ccc specifies the concatenation of subchannels for different allocations and modulations. The concatenation rule shall not be used when using H-ARQ.

For any modulation and FEC rate, given an allocation of n subchannels, we define the following parameters:

$$\begin{aligned} &j = \text{parameter dependent on the modulation and FEC rate} \\ &n = \text{number of allocated subchannels} \\ &k = \text{floor}(n / j) \\ &m = n \text{ modulo } j \end{aligned} \qquad \text{(aaa)}$$

Table bbb shows the rules used for subchannel concatenation,

Table bbb—Subchannel concatenation rule for CTC

Number of subchannels	**Subchannels concatenated**
$n <= j$ $n \neq 7$	1 block of n subchannels
$n=7$	1 block of 4 subchannels 1 block of 3 subchannels
$n > j$	(k-1) blocks of j subcahnnels 1 block of L_{b1} subchannels 1 block of L_{b2} subchannels Where: L_{b1} = ceil((m+j)/2) L_{b2} = floor((m+j)/2) If (L_{b1} == 7) or (L_{b2} == 7) $L_{b1} = L_{b1} + 1$; $L_{b2} = L_{b2} - 1$;

Table ccc—Encoding Subchannel concatenation for different allocations and modulations in CTC

Modulation and rate	**j**
QPSK 1/2	j = 10
QPSK 3/4	j = 6
QAM16 1/2	j = 5
QAM16 3/4	j = 3
QAM64 1/2	j = 3
QAM64 2/3	j = 2
QAM64 3/4	j = 2
QAM64 5/6	j = 2

Table 284 gives the block sizes, code rates, channel efficiency, and code parameters for the different modulation and coding schemes. As 64-QAM is optional, the codes for this modulation shall only be implemented if the modulation is implemented.

Table 256—Optimal CTC channel coding per modulation

Modulation	Data block size (bytes)	Encoded data block size (bytes)	Code rate	N	P0	P1	P2	P3
QPSK	6	12	1/2	24	5	0	0	0
QPSK	12	24	1/2	48	13	24	0	24
QPSK	18	36	1/2	72	11	6	0	6
QPSK	24	48	1/2	96	7	48	24	72
QPSK	30	60	1/2	120	13	60	0	60
QPSK	36	72	1/2	144	17	74	72	2
QPSK	48	96	1/2	192	11	96	48	144
QPSK	54	108	1/2	216	13	108	0	108
QPSK	60	120	1/2	240	13	120	60	180
QPSK	9	12	3/4	36	11	18	0	18
QPSK	18	24	3/4	72	11	6	0	6
QPSK	27	36	3/4	108	11	54	56	2
QPSK	36	48	3/4	144	17	74	72	2
QPSK	45	60	3/4	180	11	90	0	90
QPSK	54	72	3/4	216	13	108	0	108
QAM16	12	24	1/2	48	13	24	0	24
QAM16	24	48	1/2	96	7	48	24	72
QAM16	36	72	1/2	144	17	74	72	2
QAM16	48	96	1/2	192	11	96	48	144
QAM16	60	120	1/2	240	13	120	60	180
QAM16	18	24	3/4	72	11	6	0	6
QAM16	36	48	3/4	144	17	74	72	2
QAM16	54	108	3/4	216	13	108	0	108
QAM64	18	36	1/2	72	11	6	0	6
QAM64	36	72	1/2	144	17	74	72	2
QAM64	54	108	1/2	216	13	108	0	108
QAM64	24	36	2/3	96	7	48	24	72
QAM64	48	72	2/3	192	11	96	48	144
QAM64	27	36	3/4	108	11	54	56	2
QAM64	54	72	3/4	216	13	108	0	108
QAM64	30	36	5/6	120	13	60	0	60
QAM64	60	72	5/6	240	13	120	60	180

Table hhh—Optimal CTC channel coding per modulation when supporting H-ARQ

Data block size (bytes)	N	P0	P1	P2	P3
6	24	5	0	0	0
12	48	13	24	0	24
18	72	11	6	0	6
24	96	7	48	24	72
36	144	17	74	72	2
48	192	11	96	48	144
60	240	13	120	60	180
120	480	13	240	120	360
240	960	13	480	240	720
360	1440	17	720	360	540
480	1920	17	960	480	1440
600	2400	17	1200	600	1800

In page 532, line 40, correct the text as shown below:

8.4.9.2.3.4 Subpacket generation

Proposed FEC structure punctures the mother codeword to generate subpacket with various coding rates. The subpacket is also used as HARQ packet transmission. Figure ~~bbb~~244 shows block diagram of subpacket generation. 1/3 CTC encoded codeword goes through interleaving block and the puncturing is performed. Figure 245 shows block diagram of the interleaving block. The puncturing is performed to select the consecutive interleaved bit sequence that starts at any point of whole codeword. For the first transmission, the subpacket is generated to select the consecutive interleaved bit sequence that starts from the first bit of the systematic part of the mother codeword. The length of the subpacket is chosen according to the needed coding rate reflecting the channel condition. The first subpacket can also be used as a codeword with the needed coding rate for a burst where HARQ is not applied.

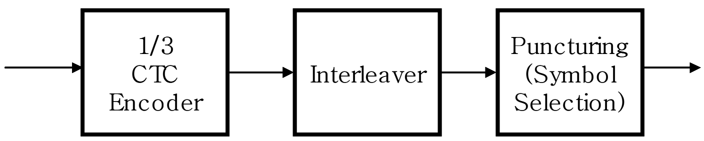


Figure 244— Block diagram of subpacket generation

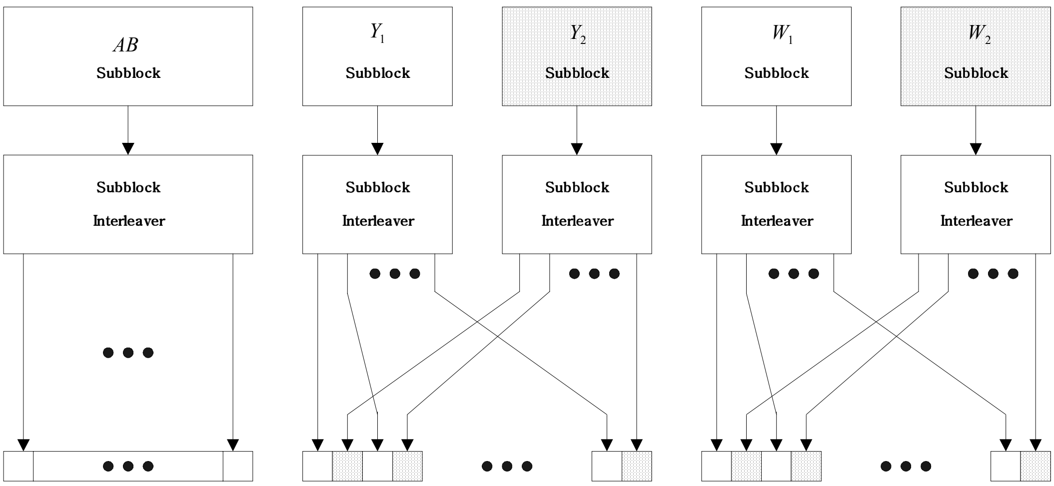


Figure 245— Block diagram of the interleaving scheme

8.4.9.2.3.4.1 Symbol Separation

All of the encoded symbols shall be demultiplexed into 5 subblocks denoted AB, Y_1, Y_2, W_1 and W_2. The encoder output symbols shall be sequentially distributed into 5 subblocks with the first and second encoder output symbols going to the AB subblock, the third to the Y_1 subblock, the fourth to the Y_2 subblock, the fifth to the W_1 subblock, the sixth to the W_2 subblock, etc. The AB subblock is the symbol-by-symbol multiplexed sequence of the input sequence A and B.

$$AB = A_1, B_1, A_2, B_2, \cdots A_N, B_N$$

8.4.9.2.3.4.2 Subblock Interleaving

The five subblocks shall be interleaved separately. For the AB subblock, the interleaving is performed by the unit of pair of two symbols (A_n, B_n). For other subblocks, the interleaving is performed by the unit of symbol. The sequence of interleaver output symbols for each subblock shall be generated by the procedure described below. The entire subblock of symbols (pairs for AB subblock) to be interleaved is written into an array at addresses from 0 to the number of the symbols (pairs for AB subblock) minus one (N-1), and the interleaved symbols (pairs for AB subblock) are read out in a permuted order with the i-th symbol (pair for AB subblock) being read from an address, A_i ($i = 0$ to $N-1$), as follows:

1. Determine the subblock interleaver parameters, m and J. Table ddd gives these parameters.

2. Initialize i and k to 0.

3. Form a tentative output address T_k according to the formula

$$T_k = 2^m (k \bmod J) + BRO_m(\lfloor k / J \rfloor)$$

where $BRO_m(y)$ indicates the bit-reversed m-bit value of y (i.e., BRO3(6) = 3).

4. If T_k is less than N, $A_i = T_k$ and increment i and k by 1. Otherwise, discard T_k and increment k only.

5. Repeat steps 3 and 4 until all N interleaver output addresses are obtained.

The parameters for the subblock interleavers are specified in Table ddd.

Table ddd – The parameters for the subblock interleavers

Data block size (bits) N_{EP}	N	Subblock Interleaver Parameters	
		m	J
48	24	3	3
72	36	4	3
96	48	4	3
144	72	5	3
192	96	5	3
216	108	6	3
240	120	6	2
288	144	6	3
384	192	6	3
432	216	7	2
480	240	7	2

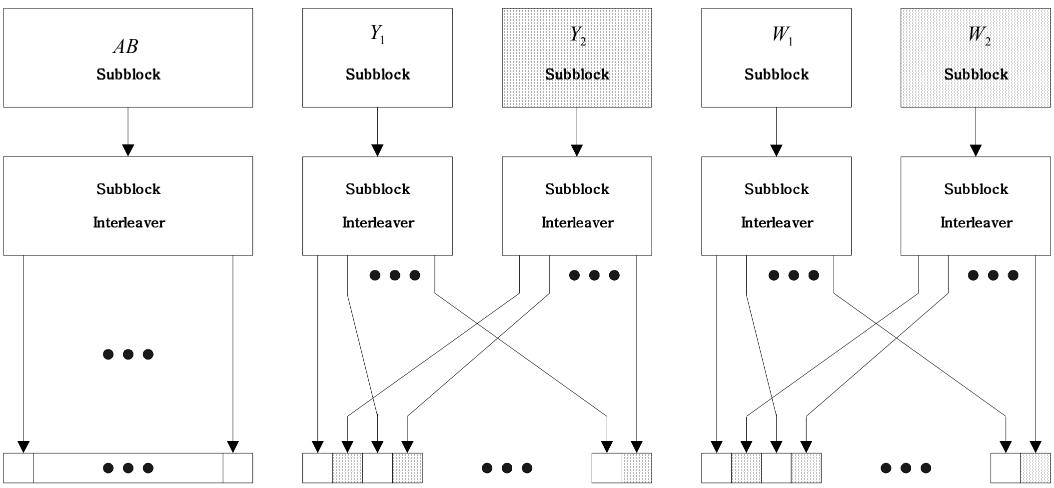
Table eee – The parameters for the subblock interleavers when supporting H-ARQ

Data block size (bits) N_{EP}	N	Subblock Interleaver Parameters	
		m	J
48	24	3	3
96	48	4	3
144	72	5	3
192	96	5	3
288	144	6	3
384	192	6	3
480	240	7	2
960	480	8	2
1920	960	9	2
2880	1440	9	3
3840	1920	10	2
4800	2400	10	3

~~8.4.9.2.3.5~~4.3 ~~Interleaving block~~

~~The puncturing process is very common to generate various coding rates with Turbo code families. However, the puncturing should guarantee the complementary characteristics of the punctured codeword. In other words, the parity bits of the punctured codeword should be chosen uniformly from the parity bits of a constituent encoder. The parity bits of the punctured codeword should have even number of parities from the two constituent encoders. Because the puncturing is just a simple process to select the subpacket, the proposed FEC structure rely such complementary property on the interleaving block.~~

~~Figure eee245 shows block diagram of the interleaving scheme of the proposed FEC structure. At first, the CTC encoder output is separated into a sublock. Then the interleaving is applied for the bit sequence within the sublock. It guarantees the uniformity of the interleaved codeword. Next, Symbol grouping is performed such that the parity bits from the two constituent encoders are interlaced bit by bit. The systematic part of the 1/3 CTC encoder is located at the head of the interleaved codeword. In this way, the proposed FEC structure ensures the quasi complementary characteristics of the interleaved codeword and thus, complementary characteristics of the subpacket. We just say "quasi complementary" for the case of breaking the complementariness of few bits after puncturing.~~



~~Figure 245— Block diagram of the interleaving scheme~~

8.4.9.2.3.~~6.~~4.3 Symbol selection

Lastly, symbol selection is performed to generate the subpacket. We call the puncturing block as the symbol selection in the viewpoint of subpacket generation.

Mother code is transmitted with one of subpackets. The symbols in a subpacket are formed by selecting specific sequences of symbols from the interleaved CTC encoder output sequence. The resulting subpacket sequence is a binary sequence of symbols for the modulator.

Let

k be the subpacket index when HARQ is enabled. k=0 for the first transmission and increases by one for the next subpacket. k = 0 when H-ARQ is not used.

N_{EP} be the number of bits in the encoder packet (before encoding)

N_{SCHk} be the number of subchannel(s) allocated for the k-th subpacket

m_k be the modulation order for the k th subpacket (m_k = 2 for QPSK, 4 for 16QAM, and 6 for 64-QAM); and

$SPID_k$ be the subpacket ID for the k-th subpacket, (for the first subpacket, $SPID_{k=0} = 0$).

Also, let the scrambled and selected symbols be numbered from zero with the 0-th symbol being the first symbol in the sequence. Then, the index of the i-th symbol for the k-th subpacket shall be

$$S_{k,i} = (F_k + i) \bmod (3 * N_{EP})$$

where $i = 0 \; to \; L_K - 1$,

$$L_k = 48 * N_{SCHk} * m_k \text{, and}$$

$$F_k = (SPID_k * L_k) \bmod (3 * N_{EP}) .$$

The N_{EP}, N_{SCHk}, m_k and SPID values are determined by the BS and can be inferred by the SS through the allocation size in the DL-MAP and UL-MAP. ~~The m_k parameter is determined in the next subsection~~. The above symbol selection makes the followings possible.

1. The first transmission includes the systematic part of the mother code. Thus, it can be used as the codeword for a burst where the HARQ is not applied.

2. The location of the subpacket can be determined by the SPID itself without the knowledge of previous subpacket. It is very important property for HARQ retransmission.

In page 535, line 17, Add a new section as shown below:

8.4.9.2.3.~~6.~~5 Optional H-ARQ Support

H-ARQ implementation is optional. The randomization block in 8.4.9.1, the concatenation scheme in 8.4.9.2.3.1 and the interleaving in 8.4.9.3 shall not be applied for the encoding described in this section.

8.4.9.2.3.~~6.~~5.1 Padding

MAC PDU (or concatenated MAC PDUs) is a basic unit processed in this channel coding and modulation blocks. When the size of MAC PDU (or concatenated MAC PDUs) is not the element in the allowed set for H-ARQ, '1's are padded at the end of MAC PDU (or concatenated MAC PDUs). The amount of the padding is the same as the difference between the size of the PDU (or concatenated MAC PDUs) and the smallest element in the allowed set that is not less than the size of the PDU (or concatenated MAC PDUs). The padded packet is input into the Randomization block.

The allowed set is {32, 80, 128, 176, 272, 368, 464, 944, 1904, 2784, 3824, 4784, 9584, 14384, 19184, 23984} bits.

8.4.9.2.3.~~6.~~5.2 Randomization

The randomization is performed on each allocation (burst), which means that for each allocation of a data block the randomizer shall be used independently.

The Pseudo Random Binary Sequence (PRBS) generator shall be $1 + X^{14} + X^{15}$ as shown in Figure eee. Each data byte to be transmitted shall enter sequentially into the randomizer, MSB first. The seed value shall be used to calculate the randomization bits, which are combined in an XOR operation with the serialized bit stream of each burst. The randomizer sequence is applied to the output from the padding block. The bit issued from the randomizer shall be applied to the CRC encoder.

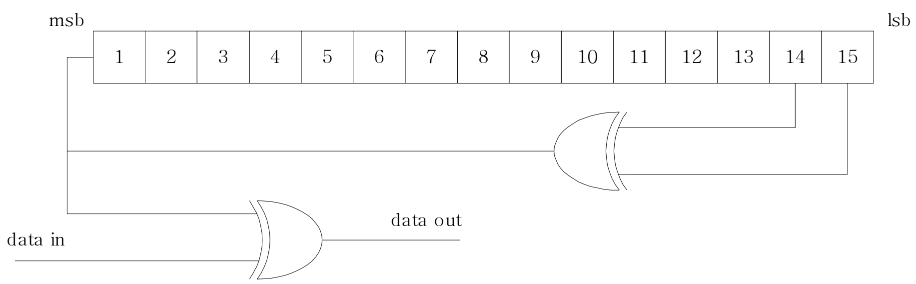


Figure eee – PRBS of the randomizer

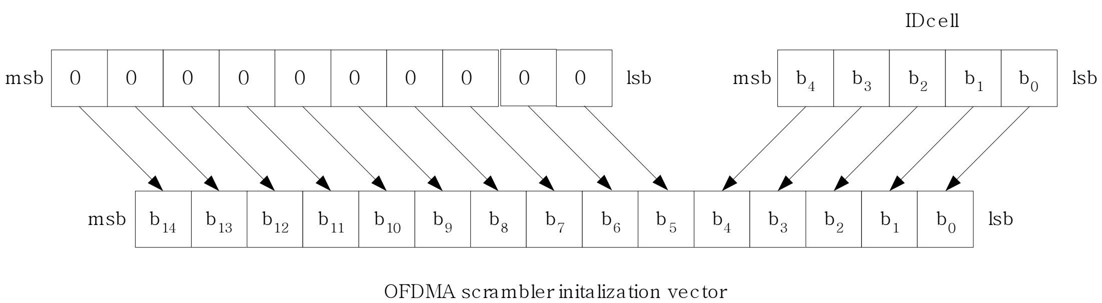


Figure fff – Initialization construction for the PRBS of the randomizer

The scrambler is initialized with the vector created as shown in Figure fff. The lowest 5 bits are ID_{cell} or UL_ID_{cell} and the other bits are set '0'.

8.4.9.2.3.~~6.~~5.3 CRC encoding

When HARQ is applied to a packet, error detection is provided on the padded packet through a Cyclic Redundancy Check (CRC). The size of the CRC is 16 bits. CRC16-CCITT, as defined in ITU-T Recommendation X.25, shall be included at the end of the padded and randomized packet. The CRC covers both the padded bits and the information part of the padded and randomized packet. After the CRC operation, The packet size shall belong to set {48, 96, 144, 192, 288, 384, 480, 960, 1920, 2880, 3840, 4800, 9600, 14400, 19200, 24000}.

8.4.9.2.3.~~6.~~5.4 Fragmentation

When the size after the padding and CRC encoding is n*4800 bits they are separately encoded by the block of 4800 bits and concatenated as the same order of the separation before modulation. No operation is performed for the packet whose size after the padding and CRC encoding is not more than 4800 bits.

The bits output from the fragmentation block are denoted by $r_1, r_2, r_3, \cdots, r_{N_{EP}}$, and this sequence is defined as encoder packet. NEP is the number of the bits in an encoder packet and defined as encoder packet size. The values of N_{EP} are 48, 96, 144, 192, 288, 384, 480, 960, 1920, 2880, 3840, 4800.

8.4.9.2.3.~~6.~~5.5 CTC encoding and subpacket generation

The CTC encoding and subpacket generation is same as the operation described in 8.4.9.2.3.1~8.4.9.2.3.4.

8.4.9.2.3~~.6.4.6.~~5.6 Modulation order of DL traffic burst

For DL, the modulation order (2 for QPSK, 4 for 16-QAM, and 6 for 64-QAM) shall be set for all the allowed transmission formats as shown in table kkk. The transmission format is given by the N_{EP} (Encoding Packet Size) and the N_{SCH} (number of allotted subchannels). N_{EP} per an encoding packet is {144, 192, 288, 384, 480, 960, 1920, 2880, 3840, 4800}. The N_{SCH} per an encoding packet is {1~480}. In the table, the numbers in the first row are N_{EP}'s and the numbers in the remaining rows are N_{SCH}'s and related parameters.

The supportable modulation schemes are QPSK, 16QAM, and 64QAM. When the N_{EP} and the N_{SCH} are given, the modulation order is determined by the value of MPR (Modulation order Product code Rate). The MPR means the effective number of the information bit transmitted per a subcarrier and is defined as follows.

$$MPR = \frac{N_{EP}}{48 \cdot N_{SCH}}$$

Then, the modulation order is specified by the following rule:

i) If $0 < MPR < 1.5$, then a QPSK (modulation order 2) is used

ii) If $1.5 \le MPR < 3.0$, then a 16QAM (modulation order 4) is used

iii) If $3.0 \le MPR < 5.4$, then a 64QAM (modulation order 6) is used

The effective code rate is equal to MPR divided by the modulation order (i.e. 2 for QPSK).

In HARQ_DL allocation_IE{} for DL of DL-UL MAP, N_{EP} is encoded by 4 bit field as shown in Table lll where encoding is presented with decimal value. N_{SCH} can be derived from HARQ_DL allocation_IE{}.

When the values of NEP are n*4800, the actual encoding packet size(NEP)is 4800 and this value is applied for the calculation of subpacket length in 8.4.9.2.3.4.3 Symbol selection subcluase and MPR in this subclause. Let N_{sch_total} be the number of subchannels allocated to the burst divided by n. When the divided number is not the integer, N_{sch_total} is the largest integer smaller than the divided.

N_{SCH} is same as the largest number that is smaller than N_{sch_total} in the column of the actual encoding packet size(NEP) in table kkk.

Table kkk – Transmission format and modulation level for DL

Nep	144	192	288	384	480	960	1920	2880	3840	4800
Sch	1.00	1.00								
MPR	3.00	4.00								
MOD	6.00	6.00								
Rate	1/2	2/3								
Rate	0.50	0.67								
Sch	2.00	2.00	2.00	2.00	2.00					
MPR	1.50	2.00	3.00	4.00	5.00					
MOD	4.00	4.00	6.00	6.00	6.00					
Rate	3/8	1/2	1/2	2/3	5/6					
Rate	0.38	0.50	0.50	0.67	0.83					
Sch	3.00	3.00	3.00	3.00	3.00					
MPR	1.00	1.33	2.00	2.67	3.33					
MOD	2.00	2.00	4.00	4.00	6.00					
Rate	1/2	2/3	1/2	2/3	5/9					
Rate	0.50	0.67	0.50	0.67	0.56					
Sch		4.00	4.00	4.00	4.00	4.00				
MPR		1.00	1.50	2.00	2.50	5.00				
MOD		2.00	4.00	4.00	4.00	6.00				
Rate		1/2	3/8	1/2	5/8	5/6				
Rate		0.50	0.38	0.50	0.63	0.83				
Sch	5.00		5.00	5.00	5.00	5.00				
MPR	0.60		1.20	1.60	2.00	4.00				
MOD	2.00		2.00	4.00	4.00	6.00				
Rate	3/10		3/5	2/5	1/2	2/3				
Rate	0.30		0.60	0.40	0.50	0.67				
Sch	6.00	6.00	6.00	6.00	6.00	6.00				
MPR	0.50	0.67	1.00	1.33	1.67	3.33				
MOD	2.00	2.00	2.00	2.00	4.00	6.00				
Rate	1/4	1/3	1/2	2/3	5/12	5/9				
Rate	0.25	0.33	0.50	0.67	0.42	0.56				
Sch		8.00		8.00	8.00	8.00	8.00			
MPR		0.50		1.00	1.25	2.50	5.00			
MOD		2.00		2.00	2.00	4.00	6.00			
Rate		1/4		1/2	5/8	5/8	5/6			
Rate		0.25		0.50	0.63	0.63	0.83			
Sch	9.00		9.00				9.00			
MPR	0.33		0.67				4.44			
MOD	2.00		2.00				6.00			
Rate	1/6		1/3				20/27			
Rate	0.17		0.33				0.74			
Sch					10.00	10.00	10.00			
MPR					1.00	2.00	4.00			
MOD					2.00	4.00	6.00			
Rate					1/2	1/2	2/3			
Rate					0.50	0.50	0.67			
Sch	12.00	12.00	12.00	12.00				12.00		

MPR	0.25	0.33	0.50	0.67				5.00		
MOD	2.00	2.00	2.00	2.00				6.00		
Rate	1/8	1/6	1/4	1/3				5/6		
Rate	0.13	0.17	0.25	0.33				0.83		
Sch						13.00	13.00	13.00		
MPR						1.54	3.08	4.62		
MOD						4.00	6.00	6.00		
Rate						5/13	20/39	10/13		
Rate						0.38	0.51	0.77		
Sch					15.00	15.00	15.00	15.00		
MPR					0.67	1.33	2.67	4.00		
MOD					2.00	2.00	4.00	6.00		
Rate					1/3	2/3	2/3	2/3		
Rate					0.33	0.67	0.67	0.67		
Sch		16.00		16.00					16.00	
MPR		0.25		0.50					5.00	
MOD		2.00		2.00					6.00	
Rate		1/8		1/4					5/6	
Rate		0.13		0.25					0.83	
Sch	18.00		18.00						18.00	
MPR	0.17		0.33						4.44	
MOD	2.00		2.00						6.00	
Rate	1/12		1/6						20/27	
Rate	0.08		0.17						0.74	
Sch					20.00	20.00	20.00	20.00	20.00	20.00
MPR					0.50	1.00	2.00	3.00	4.00	5.00
MOD					2.00	2.00	4.00	6.00	6.00	6.00
Rate					1/4	1/2	1/2	1/2	2/3	5/6
Rate					0.25	0.50	0.50	0.50	0.67	0.83
Sch								22.00		22.00
MPR								2.73		4.55
MOD								4.00		6.00
Rate								15/22		25/33
Rate								0.68		0.76
Sch		24.00	24.00	24.00						
MPR		0.17	0.25	0.33						
MOD		2.00	2.00	2.00						
Rate		1/12	1/8	1/6						
Rate		0.08	0.13	0.17						
Sch							26.00		26.00	26.00
MPR							1.54		3.08	3.85
MOD							4.00		6.00	6.00
Rate							5/13		20/39	25/39
Rate							0.38		0.51	0.64
Sch					30.00	30.00	30.00	30.00	30.00	
MPR					0.33	0.67	1.33	2.00	2.67	
MOD					2.00	2.00	2.00	4.00	4.00	
Rate					1/6	1/3	2/3	1/2	2/3	

Rate					0.17	0.33	0.67	0.50	0.67	
Sch				32.00						32.00
MPR				0.25						3.13
MOD				2.00						6.00
Rate				1/8						25/48
Rate				0.13						0.52
Sch			36.00							
MPR			0.17							
MOD			2.00							
Rate			1/12							
Rate			0.08							
Sch										38.00
MPR										2.63
MOD										4.00
Rate										25/38
Rate										0.66
Sch					40.00	40.00	40.00	40.00	40.00	
MPR					0.25	0.50	1.00	1.50	2.00	
MOD					2.00	2.00	2.00	4.00	4.00	
Rate					1/8	1/4	1/2	3/8	1/2	
Rate					0.13	0.25	0.50	0.38	0.50	
Sch								44.00		
MPR								1.36		
MOD								2.00		
Rate								15/22		
Rate								0.68		
Sch				48.00						
MPR				0.17						
MOD				2.00						
Rate				1/12						
Rate				0.08						
Sch										50.00
MPR										2.00
MOD										4.00
Rate										1/2
Rate										0.50
Sch									52.00	
MPR									1.54	
MOD									4.00	
Rate									5/13	
Rate									0.38	
Sch					60.00	60.00	60.00	60.00	60.00	
MPR					0.17	0.33	0.67	1.00	1.33	
MOD					2.00	2.00	2.00	2.00	2.00	
Rate					1/12	1/6	1/3	1/2	2/3	
Rate					0.08	0.17	0.33	0.50	0.67	
Sch										64.00
MPR										1.56

MOD Rate Rate										4.00 25/64 0.39
Sch MPR MOD Rate Rate										76.00 1.32 2.00 25/38 0.66
Sch MPR MOD Rate Rate						80.00 0.25 2.00 1/8 0.13	80.00 0.50 2.00 1/4 0.25		80.00 1.00 2.00 1/2 0.50	
Sch MPR MOD Rate Rate								90.00 0.67 2.00 1/3 0.33		
Sch MPR MOD Rate Rate										100.00 1.00 2.00 1/2 0.50
Sch MPR MOD Rate Rate						120.00 0.17 2.00 1/12 0.08	120.00 0.33 2.00 1/6 0.17	120.00 0.50 2.00 1/4 0.25	120.00 0.67 2.00 1/3 0.33	
Sch MPR MOD Rate Rate										150.00 0.67 2.00 1/3 0.33
Sch MPR MOD Rate Rate							160.00 0.25 2.00 1/8 0.13		160.00 0.50 2.00 1/4 0.25	
Sch MPR MOD Rate Rate								180.00 0.33 2.00 1/6 0.17		
Sch MPR MOD Rate Rate										200.00 0.50 2.00 1/4 0.25

Sch MPR MOD Rate Rate							240.00 0.17 2.00 1/12 0.08	240.00 0.25 2.00 1/8 0.13	240.00 0.33 2.00 1/6 0.17	
Sch MPR MOD Rate Rate										300.00 0.33 2.00 1/6 0.17
Sch MPR MOD Rate Rate									320.00 0.25 2.00 1/8 0.13	
Sch MPR MOD Rate Rate								360.00 0.17 2.00 1/12 0.08		
Sch MPR MOD Rate Rate										400.00 0.25 2.00 1/8 0.13
Sch MPR MOD Rate Rate									480.00 0.17 2.00 1/12 0.08	

Table III – N_{EP} Encoding

N_{EP}	48	96	144	192	288	384	480	960	1920	2880	3840	4800	9600	14400	19200	24000
Encoding	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

8.4.9.2.3.~~6.~~~~5.~~5.7 Modulation order of UL traffic burst

For UL, the modulation order (2 for QPSK and 4 for 16-QAM) shall be set for all the allowed transmission formats as shown in Table mmm. The transmission format is given by the N_{EP} (Encoding Packet Size) and the N_{SCH} (number of allotted subchannels). N_{EP} per an encoding packet is {48, 96, 144, 192, 288, 384, 480, 960, 1920, 2880, 3840, 4800}. The N_{SCH} per an encoding packet is {1~288}. In the table, the numbers in the first row are N_{EP}'s and the numbers in the remaining rows are N_{SCH}'s and related parameters.

The supportable modulation schemes are QPSK and 16QAM. When the N_{EP} and the N_{SCH} are given, the modulation order is determined by the value of MPR (Modulation order Product code Rate). The MPR means the effective number of the information bit transmitted per subcarrier and is defined as follows.

$$MPR = \frac{N_{EP}}{48 \cdot N_{SCH}}$$

Then, the modulation order is specified by the following rule:

i) If $0 < MPR < 1.5$, then a QPSK (modulation order 2) is used

ii) If $1.5 \le MPR < 3.4$, then a 16QAM (modulation order 4) is used

The effective code rate is equal to MPR divided by the modulation order (i.e. 2 for QPSK).

In HARQ_UL allocation_IE{} for UL of DL-UL MAP, N_{EP} is encoded by 4 bit field as shown in Table lll where encoding is presented with decimal value. N_{SCH} can be derived from HARQ_UL allocation_IE{}.

When the values of NEP are n*4800, the actual encoding packet size(NEP)is 4800 and this value is applied for the calculation of subpacket length in 8.4.9.2.3.4.3 Symbol selection subcluase and MPR in this subclause. Let N_{sch_total} be the number of subchannels allocated to the burst divided by n. When the divided number is not the integer, N_{sch_total} is the largest integer smaller than the divided.

N_{SCH} is same as the largest number that is smaller than N_{sch_total} in the column of the actual encoding packet size(NEP) in table kkk.

Table mmm – Transmission format and modulation level for UL

Nep	48	96	144	192	288	384	480	960	1920	2880	3840	4800
Sch	1.00	1.00	1.00									
MPR	1.00	2.00	3.00									
MOD	2.00	4.00	4.00									
Rate	1/2	1/2	3/4									
Rate	0.50	0.50	0.75									
Sch	2.00	2.00	2.00	2.00	2.00							
MPR	0.50	1.00	1.50	2.00	3.00							
MOD	2.00	2.00	4.00	4.00	4.00							
Rate	1/4	1/2	3/8	1/2	3/4							
Rate	0.25	0.50	0.38	0.50	0.75							
Sch	3.00	3.00	3.00	3.00	3.00	3.00	3.00					
MPR	0.33	0.67	1.00	1.33	2.00	2.67	3.33					
MOD	2.00	2.00	2.00	2.00	4.00	4.00	4.00					
Rate	1/6	1/3	1/2	2/3	1/2	2/3	5/6					
Rate	0.17	0.33	0.50	0.67	0.50	0.67	0.83					
Sch	4.00	4.00		4.00	4.00	4.00	4.00					
MPR	0.25	0.50		1.00	1.50	2.00	2.50					
MOD	2.00	2.00		2.00	4.00	4.00	4.00					
Rate	1/8	1/4		1/2	3/8	1/2	5/8					
Rate	0.13	0.25		0.50	0.38	0.50	0.63					

Sch			5.00		5.00	5.00	5.00					
MPR			0.60		1.20	1.60	2.00					
MOD			2.00		2.00	4.00	4.00					
Rate			3/10		3/5	2/5	1/2					
Rate			0.30		0.60	0.40	0.50					
Sch	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00				
MPR	0.17	0.33	0.50	0.67	1.00	1.33	1.67	3.33				
MOD	2.00	2.00	2.00	2.00	2.00	2.00	4.00	4.00				
Rate	1/12	1/6	1/4	1/3	1/2	2/3	5/12	5/6				
Rate	0.08	0.17	0.25	0.33	0.50	0.67	0.42	0.83				
Sch								7.00				
MPR								2.86				
MOD								4.00				
Rate								5/7				
Rate								0.714				
Sch		8.00		8.00		8.00	8.00	8.00				
MPR		0.25		0.50		1.00	1.25	2.50				
MOD		2.00		2.00		2.00	2.00	4.00				
Rate		1/8		1/4		1/2	5/8	5/8				
Rate		0.13		0.25		0.50	0.625	0.625				
Sch			9.00		9.00							
MPR			0.33		0.67							
MOD			2.00		2.00							
Rate			1/6		1/3							
Rate			0.17		0.33							
Sch							10.00	10.00				
MPR							1.00	2.00				
MOD							2.00	4.00				
Rate							1/2	1/2				
Rate							0.50	0.50				
Sch		12.00	12.00	12.00	12.00	12.00			12.00			
MPR		0.17	0.25	0.33	0.50	0.67			3.33			
MOD		2.00	2.00	2.00	2.00	2.00			4.00			
Rate		1/12	1/8	1/6	1/4	1/3			5/6			
Rate		0.08	0.13	0.17	0.25	0.33			0.83			
Sch									13.00			
MPR									3.08			
MOD									4.00			
Rate									10/13			
Rate									0.77			
Sch							15.00	15.00	15.00			
MPR							0.67	1.33	2.67			
MOD							2.00	2.00	4.00			
Rate							1/3	2/3	2/3			
Rate							0.33	0.67	0.67			
Sch				16.00		16.00						
MPR				0.25		0.50						
MOD				2.00		2.00						

Rate Rate				1/8 0.13		1/4 0.25						
Sch MPR MOD Rate Rate			18.00 0.17 2.00 1/12 0.08		18.00 0.33 2.00 1/6 0.17					18.00 3.33 4.00 5/6 0.83		
Sch MPR MOD Rate Rate							20.00 0.50 2.00 1/4 0.25	20.00 1.00 2.00 1/2 0.50	20.00 2.00 4.00 1/2 0.50	20.00 3.00 4.00 3/4 0.75		
Sch MPR MOD Rate Rate				24.00 0.17 2.00 1/12 0.08	24.00 0.25 2.00 1/8 0.13	24.00 0.33 2.00 1/6 0.17				24.00 2.50 4.00 5/8 0.63	24.00 3.33 4.00 5/6 0.83	
Sch MPR MOD Rate Rate									26.00 1.54 4.00 5/13 0.385		26.00 3.08 4.00 10/13 0.77	
Sch MPR MOD Rate Rate							30.00 0.33 2.00 1/6 0.17	30.00 0.67 2.00 1/3 0.33	30.00 1.33 2.00 2/3 0.67	30.00 2.00 4.00 1/2 0.50	30.00 2.67 4.00 2/3 0.67	30.00 3.33 4.00 5/6 0.83
Sch MPR MOD Rate Rate						32.00 0.25 2.00 1/8 0.13						
Sch MPR MOD Rate Rate												34.00 2.94 4.00 25/34 0.74
Sch MPR MOD Rate Rate					36.00 0.17 2.00 1/12 0.08							
Sch MPR MOD Rate Rate												38.00 2.63 4.00 25/38 0.66

Sch MPR MOD Rate Rate							40.00 0.25 2.00 1/8 0.13	40.00 0.50 2.00 1/4 0.25	40.00 1.00 2.00 1/2 0.50	40.00 1.50 4.00 3/8 0.38	40.00 2.00 4.00 1/2 0.50	
Sch MPR MOD Rate Rate										45.00 1.33 2.00 2/3 0.67		
Sch MPR MOD Rate Rate						48.00 0.17 2.00 1/12 0.08						
Sch MPR MOD Rate Rate												50.00 2.00 4.00 1/2 0.50
Sch MPR MOD Rate Rate											53.00 1.51 4.00 20/53 0.3774	
Sch MPR MOD Rate Rate							60.00 0.17 2.00 1/12 0.08	60.00 0.33 2.00 1/6 0.17	60.00 0.67 2.00 1/3 0.33	60.00 1.00 2.00 1/2 0.50	60.00 1.33 2.00 2/3 0.67	
Sch MPR MOD Rate Rate												66.00 1.52 4.00 25/66 0.38
Sch MPR MOD Rate Rate												75.00 1.33 2.00 2/3 0.67
Sch MPR MOD Rate Rate								80.00 0.25 2.00 1/8 0.13	80.00 0.50 2.00 1/4 0.25		80.00 1.00 2.00 1/2 0.50	
Sch MPR										90.00 0.67		

MOD Rate Rate										2.00 1/3 0.33		
Sch MPR MOD Rate Rate												100.00 1.00 2.00 1/2 0.50
Sch MPR MOD Rate Rate								120.00 0.17 2.00 1/12 0.08	120.00 0.33 2.00 1/6 0.17	120.00 0.50 2.00 1/4 0.25	120.00 0.67 2.00 1/3 0.33	
Sch MPR MOD Rate Rate												150.00 0.67 2.00 1/3 0.33
Sch MPR MOD Rate Rate									160.00 0.25 2.00 1/8 0.13		160.00 0.50 2.00 1/4 0.25	
Sch MPR MOD Rate Rate										180.00 0.33 2.00 1/6 0.17		
Sch MPR MOD Rate Rate												200.0 0.50 2.00 1/4 0.25
Sch MPR MOD Rate Rate									240.0 0.17 2.00 1/12 0.08	240.0 0.25 2.00 1/8 0.13	240.0 0.33 2.00 1/6 0.17	

In page 480, line 50, Add a new sections as shown below:

8.4.5.3.8 HARQ DL allocation IE

When the H-ARQ feature is applied to a burst, DIUC=15 with HARQ_DL allocation_IE{} shall be used for the physical allocation of the burst.

Table nnn— HARQ DL allocation extended IE

Syntax	Size	Notes
HARQ_DL allocation_IE{		
Extended DIUC	4 bits	HARQ_DL_Allocation = 0x05
Length	4 bits	Length = 0x05
Nep	4 bits	Encoding Packet size (see 8.4.9.2.3.6.4)
OFDMA Symbol offset	8 bits	
Subchannel offset	6 bits	
Boosting	3 bits	000: normal (not boosted); 001: +6dB; 010: -6dB; 011: +9dB; 100: +3dB; 101: -3dB; 110: -9dB; 111: -12dB;
No. OFDMA Symbols	7 bits	
No. Subchannels	6 bits	
SPID	2 bits	Subpacket ID
ACID	3 bits	ARQ channel ID
AI_SN	1 bits	Continuation bit
}		

8.4.5.3.9 HARQ ACK bitmap IE

The HARQ_ACK_Bitmap_IE format is presented in Table ppp. This IE is located in the DL-MAP. A BS may use this IE to transmit acknowledgement for the H-ARQ enabled UL bursts using the one bit in the bitmap. The bit offset in the bitmap is determined by the order of the HARQ enabled UL bursts in a previous UL-MAP according to the HARQ DL ACK delay offset TLV.

Table ppp— HARQ ACK bitmap IE

Syntax	Size	Notes
HARQ-ACK-Bitmap_IE () {		
extended DIUC	4 bits	HARQ ACK bitmap = 0x06
Length	4 bits	Variable length
Bitmap	variable	Bitmap length should be an integer number of bytes, smaller or equal to 15
}		

In the bitmap field, a value of ‘1’ indicates ACK and a value of ‘0’ indicates NACK.

In page 488, line 43, Add a new section as shown below:

8.4.5.4.9 HARQ UL allocation extended IE

When the H-ARQ feature is applied to a burst, DIUC=15 with HARQ_UL allocation_IE{} shall be used for the physical allocation of the burst.

Table ooo— HARQ_UL allocation extended IE

Syntax	Size	Notes
HARQ_UL allocation_IE{		
Extended DIUC	4 bits	HARQ_UL_Allocation = 0x03
Length	4 bits	Length = 0x03
Nep	4 bits	Encoding Packet size (see 8.4.9.2.3.6.5)
Duration	10 bits	In OFDMA slots (see 8.4.3.1)
SPID	2 bits	Subpacket ID
ACID	3 bits	ARQ channel ID
AI_SN	1 bits	Continuation bit
Reserved	4 bits	
}		

In page 589, line 31, Add a new line to the table as shown below:

Table 317—DCD burst profile encodings—WirelessMAN-OFDMA

Name	Type (1 byte)	Length	Value (variable length)
HARQ DL ACK delay offset	154	1	0 = 0 frame offset 1 = 1 frame offset 2 = 2 frame offset

In page 243, line 41, modify the text to read:

6.4.1~~6~~7 MAC support for HARQ

Hybrid automatic repeat request (H-ARQ) scheme is an optional part of the MAC and can be enabled on a per-terminal basis. The per-terminal H-ARQ and associated parameters shall be specified and negotiated during initialization procedure. A terminal cannot have a mixture of H-ARQ and non-H-ARQ traffic.

One or more MAC PDUs can be concatenated and an H-ARQ packet formed by adding a CRC to the PHY burst. Figure 125 shows how the H-ARQ encoder packet is constructed.

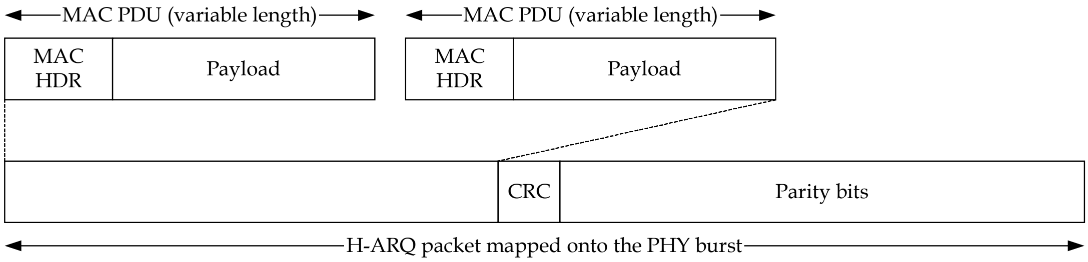


Figure 125—Construction of H-ARQ encoder packet

Each encoder packet is encoded according to the PHY specification, and four subpackets are generated from the encoded result. A subpacket identifier (SPID) is used to distinguish the four subpackets. In case of downlink communication, a BS can send one of the subpackets in a burst transmission. Because of the redundancy among the subpackets, SS can correctly decode the original encoder packet even before it receives all four subpackets. Whenever receiving the first subpacket, the SS attempts to decode the original encoder packet from it. If it succeeds, the SS sends an ACK to the BS, so that the BS stops sending additional subpackets of the encoder packet. Otherwise, the SS sends a NAK, which causes the BS to transmit one subpacket selected from the four. These procedures go on until the SS successfully decodes the encoder packet. When the SS receives more than one subpacket, it tries to decode the encoder packet from ever-received subpackets.

The rule of subpacket transmission is as follows,

1. At the first transmission, BS shall send the subpacket labeled '00'.
2. BS may send one among subpackets labeled '00', '01', '10', or '11' in any order~~, as long as the total number of transmitted subpackets does not exceed the maximum number of H-ARQ retransmission specified in CD message~~
.
3. BS can send more than one copy of any subpacket, and can omit any subpacket except the subpacket labeled '00' .

In order to specify the start of a new transmission, one-bit H-ARQ identifier sequence number (AI_SN) is toggled on every successful transmission of an encoder packet on the same H-ARQ channel. If the AI_SN changes, the receiver treats the corresponding subpacket as a subpacket belongs to a new encoder packet, and discards ever-received subpackets with the same ARQ identifier.

The H-ARQ scheme is basically a stop-and-wait protocol. The ACK is sent by the SS after a fixed delay (synchronous ACK) defined by ~~H-ARQ_ACK_DELAY~~ HARQ DL ACK delay offset which is specified in DCD message. Timing of retransmission is, however, flexible and corresponds to the asynchronous part of the H-ARQ. The ACK/NAK is ~~a differential binary PSK modulated signal sent by the SS~~ sent by the BS using the HARQ Bitmap IE, and sent by a SS using the fast feedback UL subchannel.

The H-ARQ scheme supports multiple H-ARQ channels per a connection, each of which may have an encoder packet transaction pending. The number of H-ARQ channels in use is determined by BS. These ARQ channels are distinguished by an H-ARQ channel identifier (ACID). The ACID for any subpackets can be uniquely identified by the control information carried in the MAPs.

H-ARQ (Hybrid Automatic Repeat reQuest) can be used to mitigate the effect of channel and interference fluctuation. H-ARQ renders performance improvement due to SNR gain and time diversity achieved by combining previously erroneously decoded packet and retransmitted packet, and due to additional coding gain by IR (Incremental Redundancy).

6.4.17.1 Subpacket generation

HARQ operates at the FEC block level. The FEC encoder is responsible for generating the HARQ subpackets, as defined in the relevant PHY section. The subpackets are combined by the receiver FEC decoder as part of the decoding process.

6.4.17.~~1~~2 DL/UL ACK/NAK signaling

For DL/UL H-ARQ, fast ACK/NAK signaling is necessary. For the fast ACK/NAK signaling of DL H-ARQ channel, a dedicated PHY layer ACK/NAK channel is designed in UL. For the fast ACK/NAK signaling of UL ~~H-ARQ channel~~ fast feedback, H-ARQ ACK message is designed.

6.4.17.3 H-ARQ parameter signaling

The parameters for each subpacket should be signaled independent of the subpacket burst itself. The parameters for each subpacket include SPID (Subpacket Identifier. The BS shall set this field to the subpacket identifier for the subpacket transmission.), ACID (ARQ Channel Identifier. The BS shall set this field to the ARQ channel identifier for the subpacket transmission.), and AI_SN (ARQ identifier sequence number. This toggles between '0' and '1' on successfully transmitting each encoder packet with the same ARQ channel.). For the signaling of those parameters, H-ARQ Allocation IE is defined and the IE is to be placed in a DL-MAP or UL-MAP for a burst where H-ARQ is used.