

and the subchannel allocation scheme.) In this scheme, transmission on regular subchannels and STC subchannels is possible and is determined by the MAC layer (the allocation is performed by allocating major groups of subchannels for regular or STC transmission). The transmission of the data shall be performed in pairs of symbols as illustrated in Figure 246.

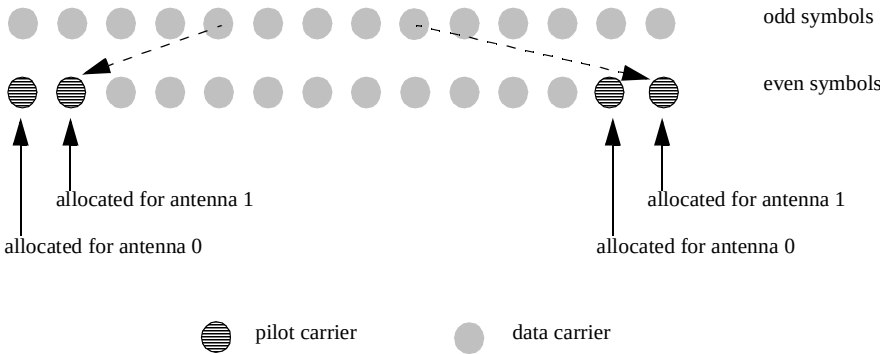


Figure 245—Cluster structure

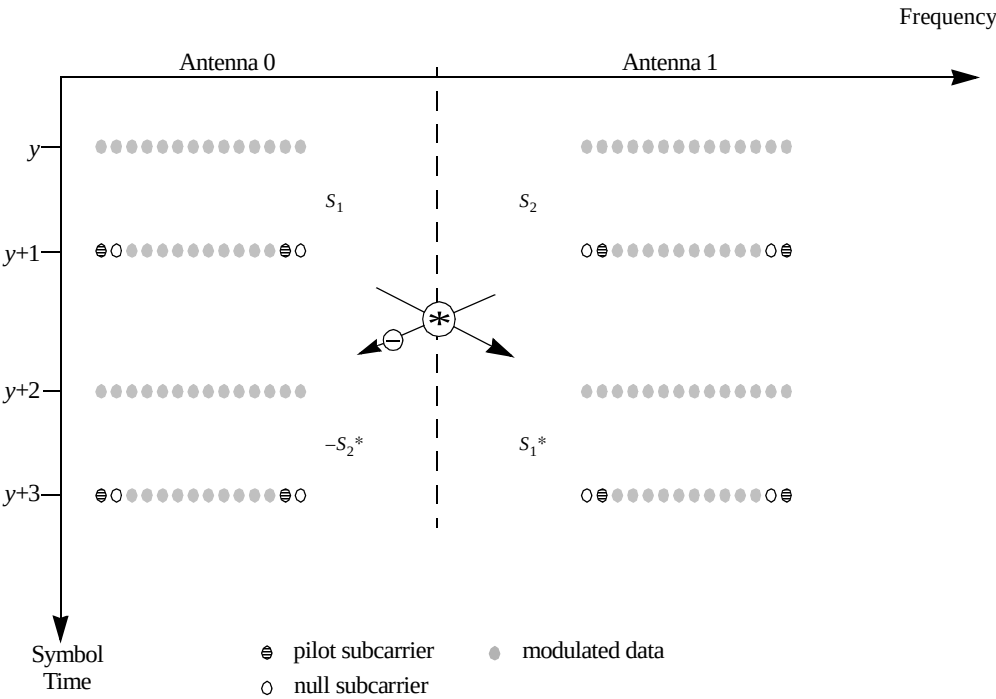


Figure 246—STC usage with PUSC

8.4.8.1.2.1.2 STC using using 2 antennas in FUSC

In FUSC, all subchannels shall be used for STC transmission. The pilots within the symbols shall be divided between the antennas—antenna 0 uses VariableSet#0 and ConstantSet#0 for even symbols while antenna 1 uses VariableSet#1 and ConstantSet#1 for even symbols, antenna 0 uses VariableSet#1 and ConstantSet#0 for odd symbols while antenna 1 uses VariableSet#0 and ConstantSet#1 for odd symbols (symbol counting starts at the starting point of the relevant STC zone), defined in 8.4.6.1.2.2. The transmission of the data shall be performed in pairs of symbols as illustrated in Figure 247.

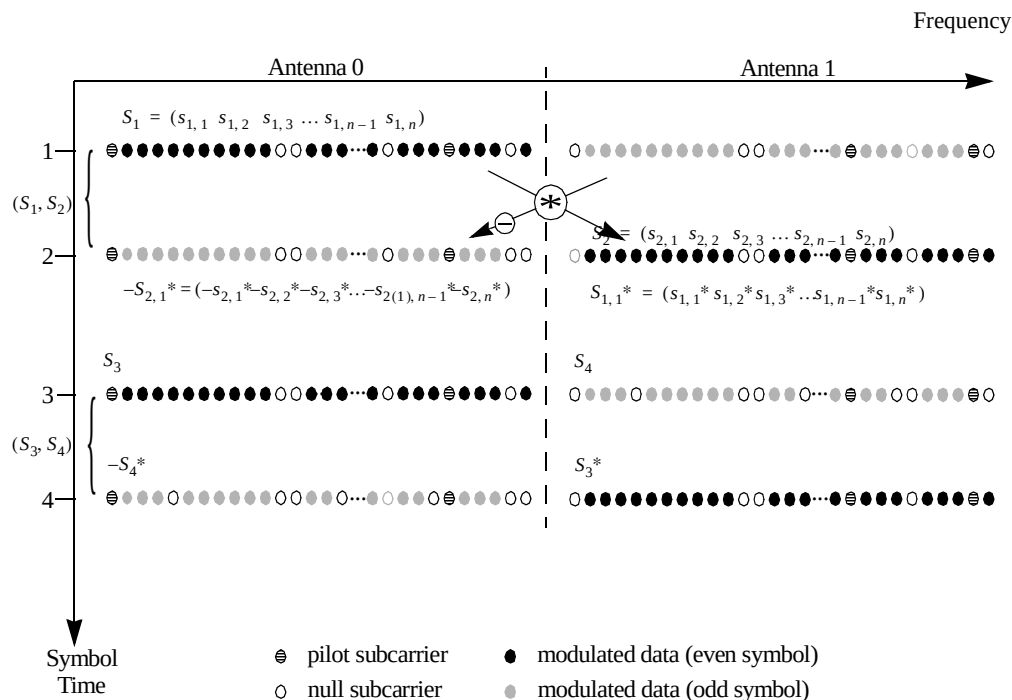


Figure 247—STC usage with FUSC

8.4.8.1.2.2 STC decoding

The receiver waits for two symbols, and combines them on a subcarrier basis according to Equation (117) and Equation (118) in 8.4.8.1.2.1.

8.4.8.1.3 Frequency hopping diversity coding (FHDC)

This scheme (as for STC) transmits two complex symbols, s_1 and s_2 , using the multiple input single output channel (two Tx, one Rx). Allocation of subchannels for FHDC transmission shall be even numbered in the same OFDMA symbol, and the first subchannel shall have an even logical index.

The transmission is based on transmitting the FHDC allocated subchannels from both antennas in the following format:

- Antenna 0 transmits mapped carriers for subchannel X (S_1) onto subchannel X and mapped carriers for subchannel $X + 1$ (S_2) onto subchannel $X + 1$
- Antenna 1 transmits $(-S_2^*)$ onto subchannel X and (S_1^*) onto subchannel $X + 1$

Receiver gets r_0 (reception of subchannel X) and r_1 (reception of subchannel $X + 1$), and the user shall extract signals S_1, S_2 :

$$\begin{aligned} r_0 &= h_{x,0} \cdot S_1 - h_{x+1,0} \cdot S_2^* \\ r_1 &= h_{x+1,1} \cdot S_2 + h_{x,1} \cdot S_1^* \end{aligned} \quad (119)$$

These estimates benefit from second order diversity as in the 1Tx-2Rx Maximum Ratio Combining scheme. The downlink preamble will be transmitted for the duration of one OFDMA symbol from both antennas, and subchannels used for FHDC are transmitted in adjunct pairs of subchannels.

The same data/pilot subcarrier structure as defined for the STC mode shall be used in the FHDC mode.

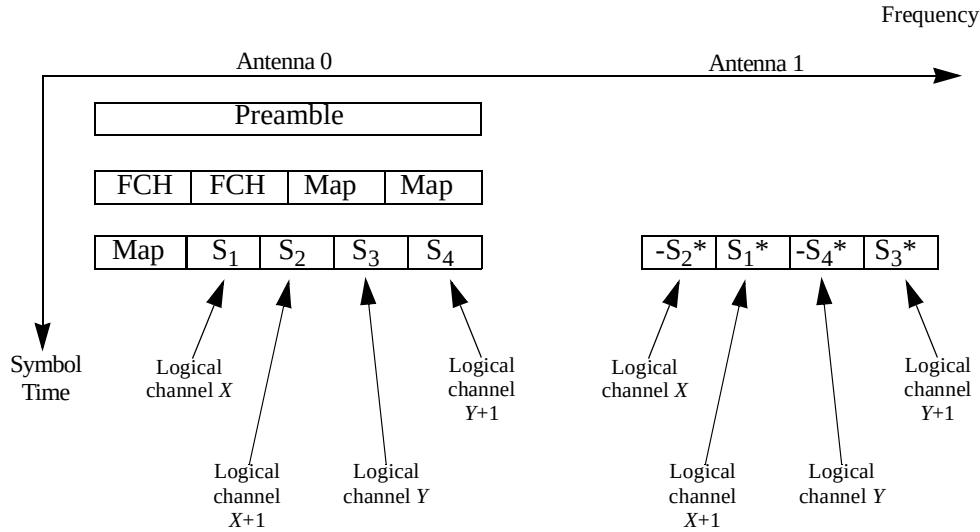


Figure 248— Example of using FHDC in PUSC

8.4.8.1.4 STC/FHDC configurations

Two transmission formats are allowed for the two antenna configuration, each format has its own capacity/diversity tradeoffs. The following matrices define the transmission format with the row index indicating the antenna number and column index indicating the subchannel symbol time (two symbols per entry). The entries define the transmission from a subchannel used for this transmission configuration (the same operation is repeated for all subchannels used in this format).

Transmission format A uses Matrix A (space time coding rate = 1, as explained in 8.4.8.1.2 and 8.4.8.1.3):

$$A = \begin{bmatrix} S_1 & -(S_2)^* \\ S_2 & (S_1)^* \end{bmatrix} \quad (120)$$

Transmission format B uses Matrix B (space time coding rate = 2):

$$B = \begin{matrix} S_1 \\ S_2 \end{matrix}$$

(121)

8.4.8.1.5 Uplink using STC

A user-supporting transmission using STC configuration in the uplink, shall use a modified uplink tile, 2-transmit diversity data, or 2-transmit spatial multiplexing data that can be mapped onto each subcarrier. The mandatory tile shall be modified to accommodate those configurations. Figure 249 depicts the UL tile for STC transmission.

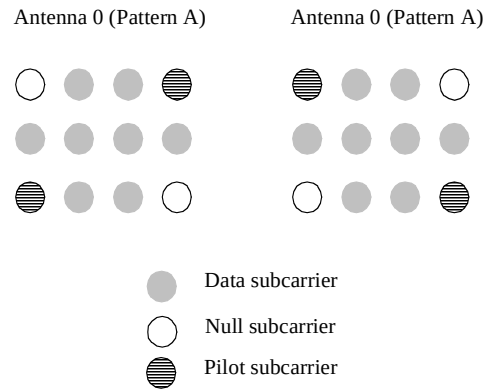


Figure 249—UL STC tile

Two single transmit antenna SS's can perform collaborative spatial multiplexing onto the same subcarrier. In this case, the one SS should use the uplink tile with pattern-A, and the other SS should use the uplink tile with pattern-B.

8.4.8.1.6 STC of two antennas using directivity through four antennas

The STC scheme for two antennas may be enhanced by using four antennas at the transmission site. Two antennas are now being used in order to transmit each symbol (the first antenna transmits the signal as defined in 8.4.8.1.2 and 8.4.8.1.3, and the second transmits the same signal with a complex multiplication factor). The BS may change the antenna weights using feedback from the user as described in 8.4.5.4.10.2. This scheme is presented in Figure 250.

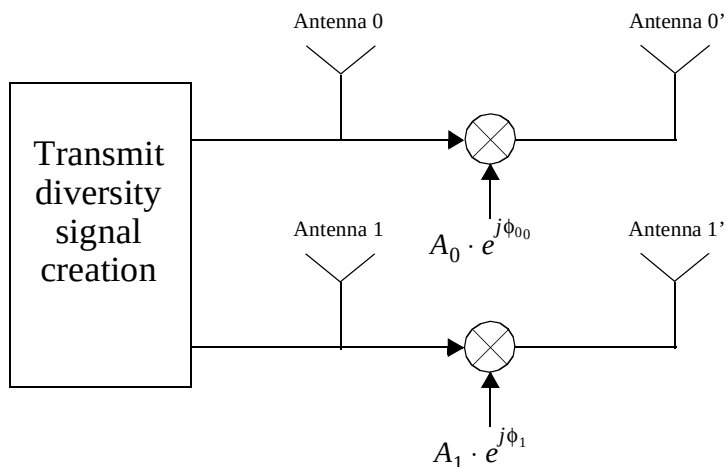


Figure 250—Illustration of Transmit diversity using four antennas

This method does not change the channel estimation process of the user; therefore, this scheme could be implemented without any changes made to the Transmit diversity user.

8.4.8.2 Transmit diversity for four antennas

The Transmit diversity schemes could be further enhanced by using four antennas at the transmission site. This configuration could be only used using STC encoding with PUSC or FUSC scheme.

8.4.8.2.1 STC for four antennas using PUSC

For this configuration, the basic cluster structure is changed (as indicated in Figure 251) to accommodate the transmission from four antennas. (Pilots for antennas 2/3 override data subcarriers in the even symbols. Switching and erasing of the data subcarriers shall be performed after constellation mapping; therefore, maintaining all the encoding scheme and the subchannel allocation scheme).

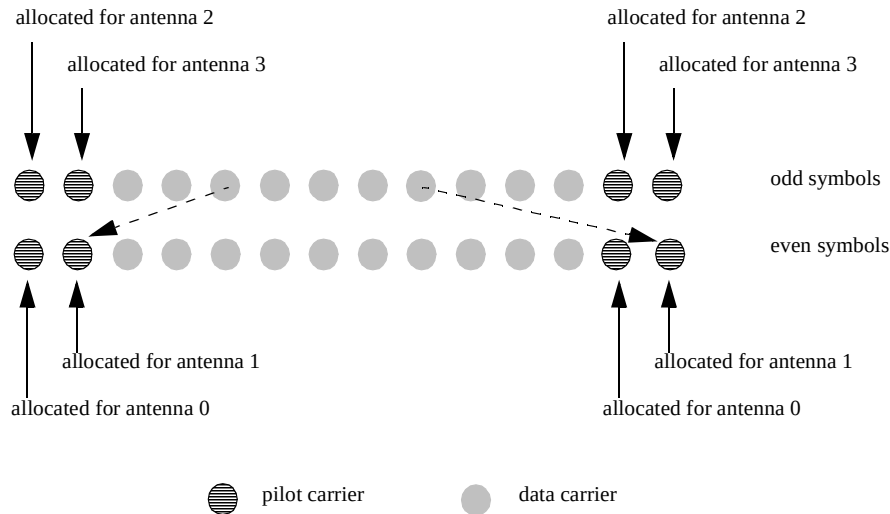


Figure 251—Cluster structure

8.4.8.2.2 STC for four antennas using FUSC

For the FUSC configuration, the pilots embedded within the symbol shall be further divided. The pilots shall be transmitted with a structure including four time symbols (repeating itself every four symbols) as follows:

- Symbol 0: antenna 0 uses VariableSet#0 and ConstantSet#0, antenna 1 uses VariableSet#1 and ConstantSet#1
- Symbol 1: antenna 2 uses VariableSet#0 and ConstantSet#0, antenna 3 uses VariableSet#1 and ConstantSet#1
- Symbol 2: antenna 0 uses VariableSet#1 and ConstantSet#0, antenna 1 uses VariableSet#0 and ConstantSet#1
- Symbol 3: antenna 2 uses VariableSet#1 and ConstantSet#0, antenna 3 uses VariableSet#0 and ConstantSet#1

8.4.8.2.3 STC configurations

Several transmission formats are allowed for this configuration. Each format has its own capacity/diversity tradeoffs.

The following matrices define the transmission format with the row index indicating the antenna number and column index indicating the subchannel symbol time (two symbols per entry). The entries define the transmission from a subchannel used for this transmission configuration (the same operation is repeated for all subchannels used in this format).

Transmission format A uses Matrix A (space time coding rate = 1):

$$A = \begin{bmatrix} S_1 & -(S_2)^* & 0 & 0 \\ S_2 & (S_1)^* & 0 & 0 \\ 0 & 0 & S_3 & -(S_4)^* \\ 0 & 0 & S_4 & (S_3)^* \end{bmatrix} \quad (122)$$

Transmission format B uses Matrix B (space time coding rate = 2):

$$B = \begin{bmatrix} S_1 & -(S_2)^* & S_5 & -(S_7)^* \\ S_2 & (S_1)^* & S_6 & -(S_8)^* \\ S_3 & -(S_4)^* & S_7 & (S_5)^* \\ S_4 & (S_3)^* & S_8 & (S_6)^* \end{bmatrix} \quad (123)$$

Transmission format C uses Matrix C (space time coding rate = 4):

$$C = \begin{bmatrix} S_1 \\ S_2 \\ S_3 \\ S_4 \end{bmatrix} \quad (124)$$

8.4.9 Channel coding

Channel coding procedures include randomization (see 8.4.9.1), FEC encoding (see 8.4.9.2), bit interleaving (see 8.4.9.3), and modulation (see 8.4.9.4). When repetition code is used, allocation for the transmission shall always include an even number of adjacent subchannels. The basic block shall pass the regular coding chain where the first subchannel shall set the randomization seed used in 8.4.9.1, and the data shall follow the coding chain up to the mapping. The data outputted from the modulation (8.4.9.4) shall be mapped onto the block of subchannels allocated for the basic block and then it will be also mapped on the following consecutive allocated subchannels (for repetition coding of 2, another block of subchannels of the same size is used; for repetition coding of 4, another 3 blocks of subchannels of the same size are used; and for repetition of 6, another 5 blocks of subchannels of the same size are used), the process of regular encoding and repetition encoding is shown in Figure 252.

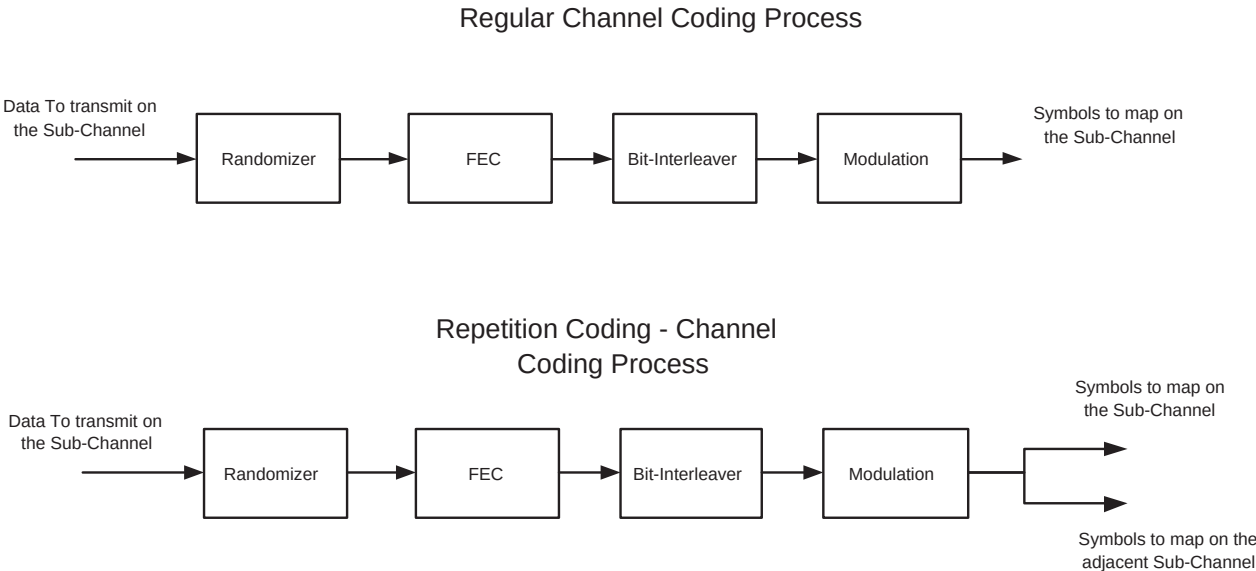


Figure 252—Channel coding process for regular and repetition coding transmission

8.4.9.1 Randomization

Data randomization is performed on data transmitted on the downlink and uplink. The randomization is initialized on each FEC block (using the first Subchannel offset and OFDMA symbol offset on which the FEC block is mapped. Symbol offset, for both UL and DL, shall be counted from the start of the frame, where the DL preamble shall be count 0). If the amount of data to transmit does not fit exactly the amount of data allocated, padding of 0xFF (“1” only) shall be added to the end of the transmission block, up to the amount of data allocated.

The PRBS generator shall be $1 + x^{14} + x^{15}$, as shown in Figure 253. Each data byte to be transmitted shall enter sequentially into the randomizer, MSB first. Preambles are not randomized. 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 FEC block. The randomizer sequence is applied only to information bits.

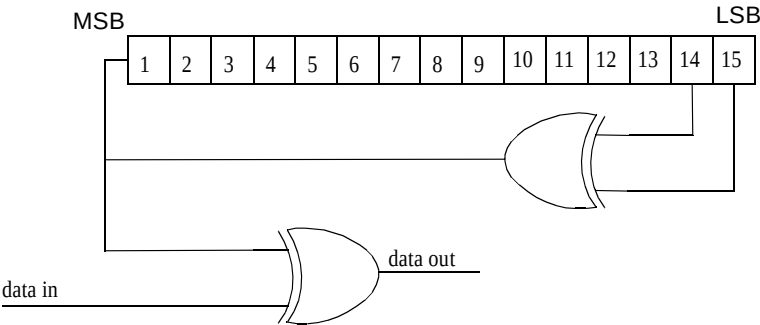


Figure 253—PRBS for data randomization

The bit issued from the randomizer shall be applied to the encoder.

The randomizer is initialized with the vector created as shown in Figure 254.

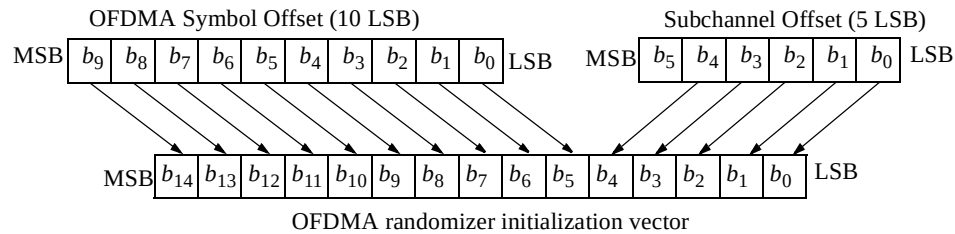


Figure 254—Creation of OFDMA randomizer initialization vector

8.4.9.2 Encoding

The coding method used as the mandatory scheme will be the tail-biting convolutional encoding specified in 8.4.9.2.1, and the optional modes of encoding in 8.4.9.2.2 and 8.4.9.2.3 shall be also supported.

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 318 specifies the concatenation of subchannels for different allocations and modulations. The parameters in Table 317 and Table 318 shall apply to the CC encoding scheme (see 8.4.9.2.1) and the BTC encoding scheme (see 8.4.9.2.2); for the CTC encoding scheme (see 8.4.9.2.3), the concatenation rule is defined in 8.4.9.2.3.3.

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

- j : parameter dependent on the modulation and FEC rate
- n : number of allocated subchannels
- k : floor (n/j)
- m : n modulo j

Table 317 shows the rules used for subchannel concatenation.

Table 317—Subchannel concatenation rule

Number of subchannels	Subchannels concatenated
$n \leq j$	1 block of n subchannels
$n > j$	$(k-1)$ blocks of j subchannels 1 block of $\text{ceil}((m+j)/2)$ subchannels 1 block of $\text{floor}((m+j)/2)$ subchannels

Table 318—Encoding Subchannel concatenation for different allocations and modulations

Modulation and rate	<i>j</i>
QPSK 1/2	<i>j</i> = 6
QPSK 3/4	<i>j</i> = 4
16-QAM 1/2	<i>j</i> = 3
16-QAM 3/4	<i>j</i> = 2
64-QAM 1/2	<i>j</i> = 2
64-QAM 2/3	<i>j</i> = 1
64-QAM 3/4	<i>j</i> = 1

8.4.9.2.1 Convolutional coding (CC)

Each FEC block is encoded by the binary convolutional encoder, which shall have native rate of 1/2, a constraint length equal to $K = 7$, and shall use the following generator polynomials codes to derive its two code bits:

$$\begin{aligned} G_1 &= 171_{OCT} && \text{FOR } X \\ G_2 &= 133_{OCT} && \text{FOR } Y \end{aligned} \tag{125}$$

The generator is depicted in Figure 255.

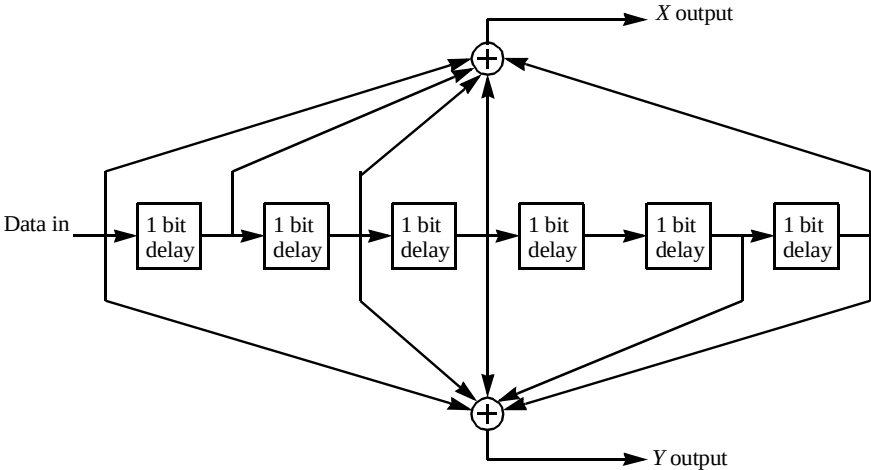


Figure 255—Convolutional encoder of rate 1/2

The puncturing patterns and serialization order that shall be used to realize different code rates are defined in Table 319. In the table, “1” means a transmitted bit and “0” denotes a removed bit, whereas X and Y are in reference to Figure 255.

Table 319—The inner convolutional code with puncturing configuration

	Code Rates			
Rate	1/2	2/3	3/4	5/6
d_{free}	10	6	5	4
X	1	10	101	10101
Y	1	11	110	11010
XY	X_1Y_1	$X_1Y_1Y_2$	$X_1Y_1Y_2X_3$	$X_1Y_1Y_2X_3Y_4X_5$

Each FEC block is encoded by a tail-biting convolutional encoder, which is achieved by initializing the encoders memory with the last data bits of the FEC block being encoded (the packet data bits numbered $b_{n-5} \dots b_n$).

Table 320 defines the basic sizes of the useful data payloads to be encoded in relation with the selected modulation type and encoding rate and concatenation rule.

Table 320—Useful data payload for a subchannel

	QPSK		16 QAM		64 QAM		
Encoding rate	R=1/2	R=3/4	R=1/2	R=3/4	R=1/2	R=2/3	R=3/4
Data payload (bytes)	6						
		9					
	12		12				
	18	18		18	18		
	24		24			24	
		27					27
	30						
	36	36	36	36	36		

8.4.9.2.2 Block Turbo Coding (optional)

The BTC is based on the product of two simple component codes, which are binary extended Hamming codes or parity check codes from the set depicted in Table 321.

Table 321 specifies the generator polynomials for the Hamming codes. To create extended Hamming codes, an overall even parity check bit is added at the end of each code word.

Table 321—OFDMA Hamming code generator polynomials

n'	k'	Generator polynomial
15	11	X^4+X^1+1
31	26	X^5+X^2+1
63	57	X^6+X+1

The component codes are used in a two-dimensional matrix form, which is depicted in Figure 256. The k_x information bits in the rows are encoded into n_x bits by using the component block (n_x, k_x) code specified for the respective composite code. After encoding the rows, the columns are encoded using a block code (n_y, k_y) , where the check bits of the first code are also encoded. The overall block size of such a product code is $n = n_x \times n_y$, the total number of information bits $k = k_x \times k_y$, and the code rate is $R = R_x \times R_y$, where $R_i = k_i/n_i$, $i = x, y$. The Hamming distance of the product code is $d = d_x \times d_y$. Data bit ordering for the composite BTC matrix is the first bit in the first row is the LSB and the last data bit in the last data row is the MSB.

Transmission of the block over the channel shall occur in a linear fashion, with all bits of the first row transmitted left to right followed by the second row, etc.

To match a required packet size, BTCs may be shortened by removing symbols from the BTC array. In the two-dimensional case, rows, columns, or parts thereof can be removed until the appropriate size is reached. There are three steps in the process of shortening product codes:

- Step 1) Remove I_x rows and I_y columns from the two-dimensional code. This is equivalent to shortening the constituent codes that make up the product code.
- Step 2) Remove B individual bits from the first row of the two-dimensional code starting with the LSB.
- Step 3) Use if the product code specified from Step 1) and Step 2) of this subclause has a non-integral number of data bytes. In this case, the Q leftover LSB are zero-filled by the encoder. After decoding at the receive end, the decoder shall strip off these unused bits and only the specified data payload is passed to the next higher level in the PHY. The same general method is used for shortening the last code word in a message where the available data bytes do not fill the available data bytes in a code block.

These three processes of code shortening are depicted in Figure 256. In the first two-dimensional BTC, a nonshortened product code is shown. By comparison, a shortened BTC is shown in the adjacent two-dimensional array. The new coded block length of the code is $(n_x - I_x)(n_y - I_y) - B$. The corresponding information length is given as $(k_x - I_x)(k_y - I_y) - B - Q$. Consequently, the code rate is given by Equation (126).

$$R = \frac{(k_x - I_x)(k_y - I_y) - B - Q}{(n_x - I_x)(n_y - I_y) - B} \quad (126)$$

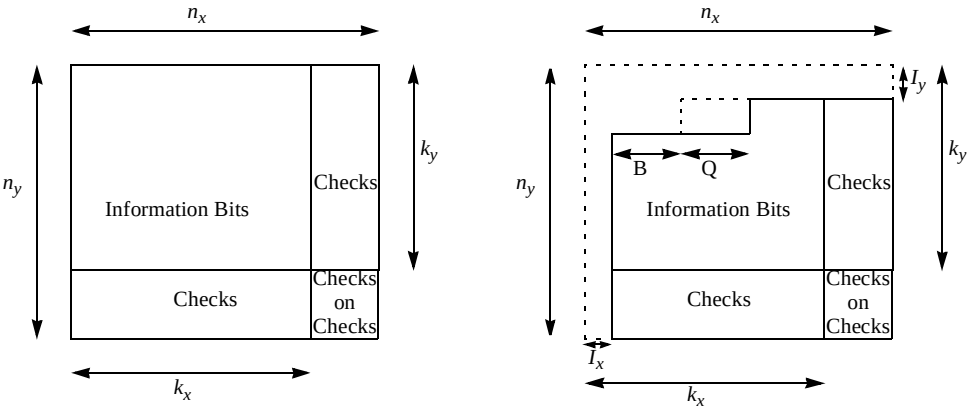


Figure 256—BTC and shortened BTC structure

Table 322 gives the block sizes for the optional modulation and coding schemes using BTC. Table 323 gives the code parameters for each of the possible data and coded block sizes.

Table 322—Useful data payload for a subchannel

Encoding Rate	QPSK		16-QAM		64-QAM		Coded Bytes
	R=1/2	R=3/4	R=1/2	R=3/4	R=1/2	R=3/4	
Allowed Data (Bytes)	6	9					12
	16	20	16	20			24
	16	25			16	25	36
	23	35	23	35			48
	31						60
	40		40		40		72

Table 323—Optional channel coding per modulation

Data Bytes	Coded Bytes	Constituent	Code parameters
6	12	(8,7)(32,26)	$I_x=4, I_y=8, B=0, Q=6$
9	12	(16,15)(16,15)	$I_x=6, I_y=6, B=4, Q=5$
16	24	(8,7)(32,26)	$I_x=2, I_y=0, B=0, Q=2$
20	24	(16,15)(16,15)	$I_x=2, I_y=2, B=4, Q=5$
16	36	(32,26)(16,11)	$I_x=11, I_y=2, B=6, Q=7$

Table 323—Optional channel coding per modulation (*continued*)

Data Bytes	Coded Bytes	Constituent	Code parameters
25	36	(8,7)(64,57)	$I_x=2, I_y=16, B=0, Q=5$
23	48	(32,26)(16,11)	$I_x=4, I_y=2, B=8, Q=6$
35	48	(32,26)(16,15)	$I_x=0, I_y=4, B=0, Q=6$
31	60	(32,26)(32,26)	$I_x=10, I_y=10, B=4, Q=4$
40	72	(32,26)(32,26)	$I_x=8, I_y=8, B=0, Q=4$

8.4.9.2.3 Convolutional turbo codes (optional)

8.4.9.2.3.1 CTC encoder

The Convolutional Turbo Code (CTC) defined in this subclause is designed to enable support of hybrid ARQ (HARQ). HARQ implementation is optional. The CTC encoder, including its constituent encoder, is depicted in Figure 257. 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 ($k = 2 \cdot N$ 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: $8 \leq N/4 \leq 1024$.

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 $1 + D^3$

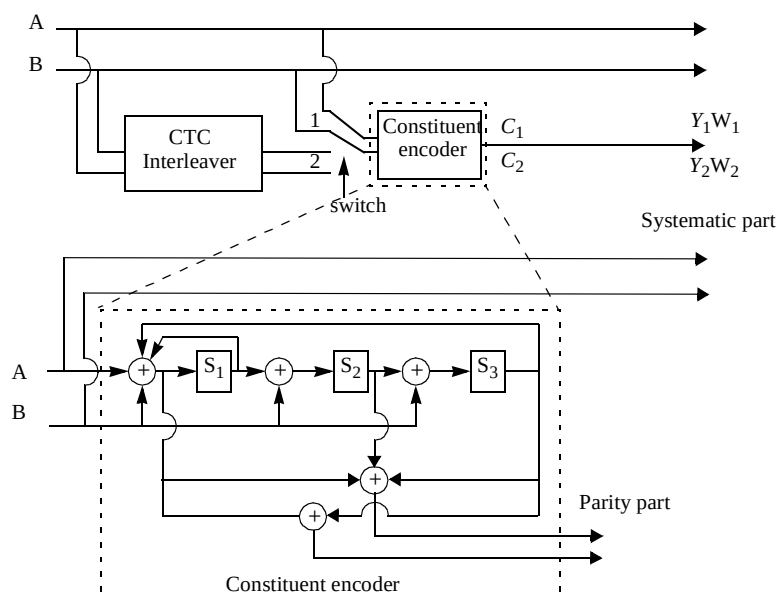


Figure 257—CTC encoder

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 $i = 0 \dots N-1$. This first encoding is called C_1 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 $j = 0, \dots, N-1$. This second encoding is called C_2 encoding.

The order in which the encoded bit shall be fed into the subpacket generation block (8.4.9.2.3.4) is:

$$A, B, Y_1, Y_2, W_1, W_2 =$$

$$A_0, B_0, \dots, A_{N-1}, B_{N-1}, Y_{1,0}, Y_{1,1}, \dots, Y_{1,N-1}, Y_{2,0}, Y_{2,1}, \dots, Y_{2,N-1}, W_{1,0}, W_{1,1}, \dots, W_{1,N-1}, W_{2,0}, W_{2,1}, \dots, W_{2,N-1}$$

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

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 325 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, the following parameters are defined:

j	parameter dependent on the modulation and FEC rate
n	number of allocated subchannels
k	$= \text{floor}(n/j)$
m	$= n \bmod j$

Table 324 shows the rules used for subchannel concatenation:

Table 324—Subchannel concatenation rule for CTC

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

Table 325—Encoding subchannel concatenation for different rates in CTC

Modulation and rate	<i>j</i>
QPSK 1/2	10
QPSK 3/4	6
16-QAM 1/2	5
16-QAM 3/4	3
64-QAM 1/2	3
64-QAM 2/3	2
64-QAM 3/4	2
64-QAM 5/6	2

Table 326 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 327 shows code parameters for HARQ.

Table 326—Optimal CTC channel coding per modulation

Modulation	Data block size (bytes)	Encoded data block size (bytes)	Code rate	N	P ₀	P ₁	P ₂	P ₃
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
16-QAM	12	24	1/2	48	13	24	0	24
16-QAM	24	48	1/2	96	7	48	24	72
16-QAM	36	72	1/2	144	17	74	72	2
16-QAM	48	96	1/2	192	11	96	48	144
16-QAM	60	120	1/2	240	13	120	60	180
16-QAM	18	24	3/4	72	11	6	0	6
16-QAM	36	48	3/4	144	17	74	72	2
16-QAM	54	108	3/4	216	13	108	0	108
64-QAM	18	24	1/2	72	11	6	0	6
64-QAM	36	72	1/2	144	17	74	72	2
64-QAM	54	108	1/2	216	13	108	0	108
64-QAM	24	36	2/3	96	7	48	24	72
64-QAM	48	72	2/3	192	11	96	48	144
64-QAM	27	36	3/4	108	11	54	56	2

Table 326—Optimal CTC channel coding per modulation (*continued*)

Modulation	Data block size (bytes)	Encoded data block size (bytes)	Code rate	N	P ₀	P ₁	P ₂	P ₃
64-QAM	54	72	3/4	216	13	108	0	108
64-QAM	30	36	5/6	120	13	60	0	60
64-QAM	60	72	5/6	240	13	120	60	180

Table 327—Optimal CTC channel coding per modulation when supporting H-ARQ

Data block size (bytes)	N	P ₀	P ₁	P ₂	P ₃
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

8.4.9.2.3.2 CTC interleaver

The interleaver requires the parameters P_0 and P_1 , shown in Table 326.

The two-step interleaver shall be performed by:

Step 1: Switch alternate couples

for $j = 0 \dots N - 1$

if $(j_{\text{mod}_2} == 0)$ let $(B, A) = (A, B)$ (i.e., switch the couple)

Step 2: $P_i(j)$

The function $P_i(j)$ provides the interleaved address i of the consider couple j .

for $j = 0 \dots N - 1$

switch j_{mod_4} :

case 0: $i = (P_0 \cdot j + 1)_{\text{mod}_N}$

$$\begin{aligned} \text{case 1: } i &= (P_0 \cdot j + 1 + N/2 + P_1)_{\text{mod}_N} \\ \text{case 2: } i &= (P_0 \cdot j + 1 + P_2)_{\text{mod}_N} \\ \text{case 3: } i &= (P_0 \cdot j + 1 + N/2 + P_3)_{\text{mod}_N} \end{aligned}$$

8.4.9.2.3.3 Determination of CTC circulation states

The state of the encoder is denoted S ($0 \leq S \leq 7$) with S the value read binary (left to right) out of the constituent encoder memory (see Figure 257). The circulation states Sc_1 and Sc_2 are determined by the following operations:

- 1) Initialize the encoder with state 0. Encode the sequence in the natural order for the determination of Sc_1 or in the interleaved order for determination of Sc_2 . In both cases the final state of the encoder is $S0_{N-1}$;
- 2) According to the length N of the sequence, use Table 328 to find Sc_1 or Sc_2 .

Table 328—Circulation state lookup table (Sc)

N_{mod_7}	$S0_{N-1}$							
	0	1	2	3	4	5	6	7
1	0	6	4	2	7	1	3	5
2	0	3	7	4	5	6	2	1
3	0	5	3	6	2	7	1	4
4	0	4	1	5	6	2	7	3
5	0	2	5	7	1	3	4	6
6	0	7	6	1	3	4	5	2

8.4.9.2.3.4 Subpacket generation

Proposed FEC structure punctures the mother codeword to generate a subpacket with various coding rates. The subpacket is also used as HARQ packet transmission. Figure 258 shows a block diagram of subpacket generation. 1/3 CTC encoded codeword goes through interleaving block and the puncturing is performed. Figure 259 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.

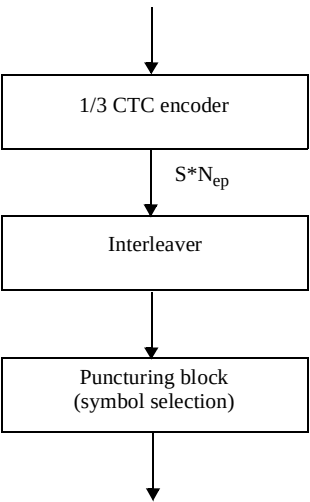


Figure 258—Block diagram of subpacket generation

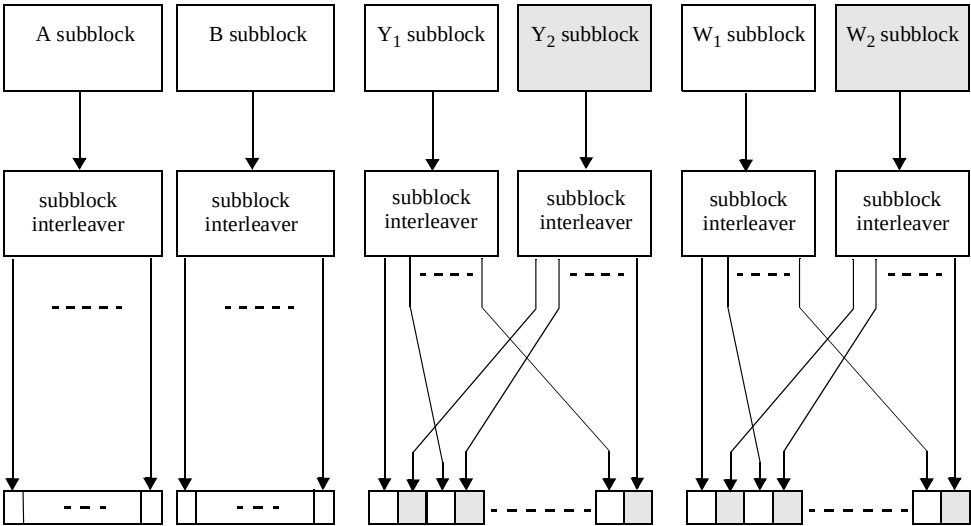


Figure 259—Block diagram of the interleaving scheme

8.4.9.2.3.4.1 Symbol separation

All of the encoded symbols shall be demultiplexed into six subblocks denoted A , B , Y_1 , Y_2 , W_1 , and W_2 . The encoder output symbols shall be sequentially distributed into six subblocks with the first encoder output

symbols going to the A subblock, the second encoder output going to the B 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.

8.4.9.2.3.4.2 Subblock interleaving

The six subblocks shall be interleaved separately. 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 to be interleaved is written into an array at addresses from 0 to the number of the symbols minus one ($N-1$), and the interleaved symbols are read out in a permuted order with the i -th symbol being read from an address, AD_i ($i = 0 \dots N-1$), as follows:

3. Determine the subblock interleaver parameters, m and J . Table 329 gives these parameters.
4. Initialize i and k to 0.
5. 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., $BRO_3(6) = 3$).
6. If T_k is less than N $AD_i = T_k$ and increment i and k by 1. Otherwise, discard T_k and increment k only.
7. Repeat steps 3) and 4) until all N interleaver output addresses are obtained.

The parameters for the subblock interleavers are specified in Table 329.

Table 329—Parameters for the subblock interleavers

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	6	4
480	240	7	2

Table 330—Parameters for the subblock interleavers when supporting H-ARQ

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

8.4.9.2.3.4.3 Symbol grouping

The channel interleaver output sequence shall consist of the interleaved A and B subblock sequence, followed by a symbol-by-symbol multiplexed sequence of the interleaved Y_1 and Y_2 subblock sequences, followed by a symbol-by-symbol multiplexed sequence of the interleaved W_1 and W_2 subblock sequences. The symbol-by-symbol multiplexed sequence of interleaved Y_1 and Y_2 subblock sequences shall consist of the first output bit from the Y_1 subblock interleaver, the first output bit from the Y_2 subblock interleaver, the second output bit from the Y_1 subblock interleaver, the second output bit from the Y_2 subblock interleaver, etc. The symbol-by-symbol multiplexed sequence of interleaved W_1 and W_2 subblock sequences shall consist of the first output bit from the W_1 subblock interleaver, the first output bit from the W_2 subblock interleaver, the second output bit from the W_1 subblock interleaver, the second output bit from the W_2 subblock interleaver, etc. Figure 259 shows the interleaving scheme.

8.4.9.2.3.4.4 Symbol selection

Lastly, symbol selection is performed to generate the subpacket. The puncturing block is referred as symbols 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 16-QAM, and 6 for 64-QAM).
 $SPID_k$ 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:

$$S_{k,i} = (F_k + i) \bmod (3 \cdot N_{EP}) \quad (127)$$

where:

$$\begin{aligned} i &= 0 \dots L_k - 1, \\ L_k &= 48 \cdot N_{SCHk} \cdot m_k, \\ F_k &= (SPID_k \cdot L_k) \bmod (3 \cdot N_{EP}). \end{aligned}$$

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 above symbol selection makes the following 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.

8.4.9.2.3.5 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 subclause.

8.4.9.2.3.5.1 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, 2864, 3824, 4784, 9584, 14384, 19184, 23984} bits.

8.4.9.2.3.5.2 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 PRBS generator shall be $1 + x^{14} + x^{15}$ as shown in Figure 260. Each data byte to be transmitted shall enter sequentially into the randomizer, MSB first. Preambles are not randomized. 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 FEC block. 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.

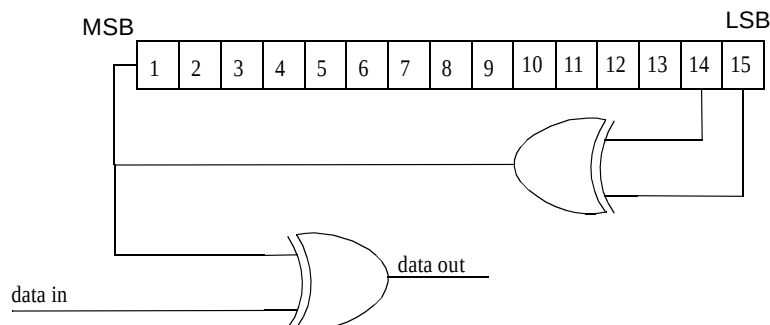


Figure 260—PRBS of the randomization

The bit issued from the randomizer shall be applied to the encoder.

The scrambler is initialized with the vector created as shown in Figure 261. The lowest 5 bits are IDcell or UL_IDcell and the other bits are set “0.”

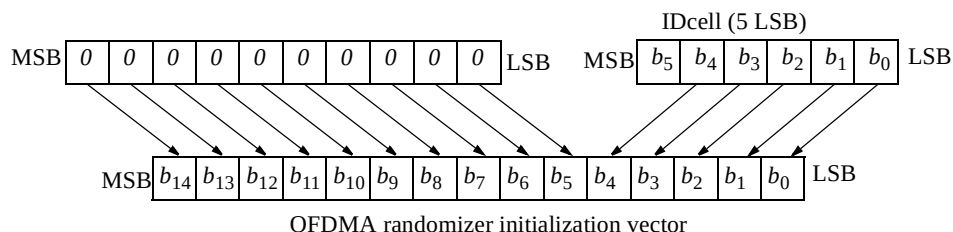


Figure 261—Initialization construction for the PRBS of the randomizer

8.4.9.2.3.5.3 CRC encoding

When H-ARQ 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}.

8.4.9.2.3.5.4 Fragmentation

When the size after the padding and CRC encoding is $n \cdot 4800$ 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 $r_1, r_2, \dots, r_{N_{EP}}$, and this sequence is defined as encoder packet. N_{EP} 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.

8.4.9.2.3.5.5 CTC encoding and subpacket generation

The CTC encoding and subpacket generation is the same as the operation described in 8.4.9.2.3.1, 8.4.9.2.3.2, 8.4.9.2.3.3, and 8.4.9.2.3.4.

8.4.9.2.3.5.6 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 331. 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 Table 331, 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, 16-QAM, and 64-QAM. 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 by Equation (128).

$$MPR = \frac{N_{EP}}{48 \cdot N_{SCH}} \quad (128)$$

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

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

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

If $3.0 \leq MPR < 5.4$, 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).

The information of N_{EP} and N_{SCH} shall be signaled in UL MAP. Instead of the actual values of N_{EP} and N_{SCH} , the encoded value of N_{EP} (N_{EP} code) and N_{SCH} (N_{SCH} code) shall be used for the signaling. They are encoded by 4 bits, respectively. The encoding of N_{EP} (N_{EP} code) is shown in Table 332. The encoding of N_{SCH} (N_{SCH} code) is performed per N_{EP} value. For each N_{EP} , there are less than 16 kinds of N_{SCH} values and they are encoded from "0" (the smallest number of subchannels) to "15" in increasing order. When the number of N_{SCH} values for a N_{EP} is smaller than 16, the smallest number of the smallest codes are used. When the fragmentation is applied and the number of the subpackets for an allocation is n , $n \cdot N_{EP}$ and N_{SCH} (the number of subchannels allocated for a subpacket) should be signaled.

The encoding for $n \cdot N_{EP}$ (N_{EP} code) is also shown in Table 332. The encoded value of N_{SCH} (N_{SCH} code) should be interpreted as N_{SCH} for a subpacket, and $n \cdot N_{SCH}$ for the whole allocation.

Table 331—Transmission format and modulation level for DL

<i>N_{EP}</i>	144	192	288	384	480	960	1920	2880	3840	4800
<i>Sch</i>	1.00	1.00								
<i>MPR</i>	3.00	4.00								
<i>MOD</i>	6.00	6.00								
Rate	1/2	2/3								
Rate	0.50	0.67								
<i>Sch</i>	2.00	2.00	2.00	2.00	2.00					
<i>MPR</i>	1.50	2.00	3.00	4.00	5.00					
<i>MOD</i>	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					
<i>Sch</i>	3.00	3.00	3.00	3.00	3.00					
<i>MPR</i>	1.00	1.33	2.00	2.67	3.33					
<i>MOD</i>	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					
<i>Sch</i>		4.00	4.00	4.00	4.00	4.00				
<i>MPR</i>		1.00	1.50	2.00	2.50	5.00				
<i>MOD</i>		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				
<i>Sch</i>	5.00		5.00	5.00	5.00	5.00				
<i>MPR</i>	0.60		1.20	1.60	2.00	4.00				
<i>MOD</i>	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				
<i>Sch</i>	6.00	6.00	6.00	6.00	6.00	6.00				
<i>MPR</i>	0.50	0.67	1.00	1.33	1.67	3.33				
<i>MOD</i>	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				
<i>Sch</i>		8.00		8.00	8.00	8.00	8.00			
<i>MPR</i>		0.50		1.00	1.25	2.50	5.00			
<i>MOD</i>		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			
<i>Sch</i>	9.00		9.00				9.00			
<i>MPR</i>	0.33		0.67				4.44			
<i>MOD</i>	2.00		2.00				6.00			
Rate	1/6		1/3				20/27			
Rate	0.17		0.33				0.74			
<i>Sch</i>					10.00	10.00	10.00			
<i>MPR</i>					1.00	2.00	4.00			
<i>MOD</i>					2.00	4.00	6.00			
Rate					1/2	1/2	2/3			
Rate					0.50	0.50	0.67			

Table 331—Transmission format and modulation level for DL (continued)

N_{EP}	144	192	288	384	480	960	1920	2880	3840	4800
<i>Sch</i>	12.00	12.00	12.00	12.00				12.00		
<i>MPR</i>	0.25	0.33	0.50	0.67				5.00		
<i>MOD</i>	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		
<i>Sch</i>						13.00	13.00	13.00		
<i>MPR</i>						1.54	3.08	4.62		
<i>MOD</i>						4.00	6.00	6.00		
Rate						5/13	20/39	10/13		
Rate						0.38	0.51	0.77		
<i>Sch</i>					15.00	15.00	15.00	15.00		
<i>MPR</i>					0.67	1.33	2.67	4.00		
<i>MOD</i>					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		
<i>Sch</i>		16.00		16.00					16.00	
<i>MPR</i>		0.25		0.50					5.00	
<i>MOD</i>		2.00		2.00					6.00	
Rate		1/8		1/4					5/6	
Rate		0.13		0.25					0.83	
<i>Sch</i>	18.00		18.00						18.00	
<i>MPR</i>	0.17		0.33						4.44	
<i>MOD</i>	2.00		2.00						6.00	
Rate	1/12		1/6						20/27	
Rate	0.08		0.17						0.74	
<i>Sch</i>						20.00	20.00	20.00	20.00	20.00
<i>MPR</i>						0.50	1.00	2.00	3.00	5.00
<i>MOD</i>						2.00	2.00	4.00	6.00	6.00
Rate						1/4	1/2	1/2	1/2	5/6
Rate						0.25	0.50	0.50	0.50	0.83
<i>Sch</i>								22.00		22.00
<i>MPR</i>								2.73		4.55
<i>MOD</i>								4.00		6.00
Rate								15/22		25/33
Rate								0.68		0.76
<i>Sch</i>		24.00	24.00	24.00						
<i>MPR</i>		0.17	0.25	0.33						
<i>MOD</i>		2.00	2.00	2.00						
Rate		1/12	1/8	1/6						
Rate		0.08	0.13	0.17						
<i>Sch</i>							26.00		26.00	26.00
<i>MPR</i>							1.54		3.08	3.85
<i>MOD</i>							4.00		6.00	6.00
Rate							5/13		20/39	25/39
Rate							0.38		0.51	0.64
<i>Sch</i>					30.00	30.00	30.00	30.00	30.00	
<i>MPR</i>					0.33	0.67	1.33	2.00	2.67	
<i>MOD</i>					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	

Table 331—Transmission format and modulation level for DL (continued)

N_{EP}	144	192	288	384	480	960	1920	2880	3840	4800
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate				32.00 0.25 2.00 1/8 0.13						32.00 3.13 6.00 25/48 0.52
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate										38.00 2.63 4.00 25/38 0.66
<i>Sch</i> <i>MPR</i> <i>MOD</i> 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	
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate								44.00 1.36 2.00 15/22 0.68		
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate				48.00 0.17 2.00 1/12 0.08						
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate										50.00 2.00 4.00 1/2 0.50
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate									52.00 1.54 4.00 5/13 0.38	
<i>Sch</i> <i>MPR</i> <i>MOD</i> 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	
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate										64.00 1.56 4.00 25/64 0.39
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate										76.00 1.32 2.00 25/38 0.66

Table 331—Transmission format and modulation level for DL (continued)

N_{EP}	144	192	288	384	480	960	1920	2880	3840	4800
<i>Sch</i> <i>MPR</i> <i>MOD</i> 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	
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate								90.00 0.67 2.00 1/3 0.33		
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate										100.00 1.00 2.00 1/2 0.50
<i>Sch</i> <i>MPR</i> <i>MOD</i> 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	
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate										150.00 0.67 2.00 1/3 0.33
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate							160.00 0.25 2.00 1/8 0.13		160.00 0.50 2.00 1/4 0.25	
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate								180.00 0.33 2.00 1/6 0.17		
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate										200.00 0.50 2.00 1/4 0.25
<i>Sch</i> <i>MPR</i> <i>MOD</i> 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	
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate										300.00 0.33 2.00 1/6 0.17

Table 331—Transmission format and modulation level for DL (continued)

N_{EP}	144	192	288	384	480	960	1920	2880	3840	4800
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate									320.00 0.25 2.00 1/8 0.13	
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate								360.00 0.17 2.00 1/12 0.08		
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate										400.00 0.25 2.00 1/8 0.13
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate									480.00 0.17 2.00 1/12 0.08	

Table 332— N_{EP} encoding

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

8.4.9.2.3.5.7 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 333. 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 Table 333, 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 16-QAM. When the N_{EP} and the N_{SCH} are given, the modulation order is determined by the value of MPR . The MPR means the effective number of the information bit transmitted per subcarrier and is defined by Equation (129).

$$MPR = \frac{N_{EP}}{48 \cdot N_{SCH}} \quad (129)$$

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

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

If $1.5 \leq MPR < 3.4$, then a 16-QAM (modulation order 4) is used.

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

The information of N_{EP} and N_{SCH} shall be signaled in UL MAP. Instead of the actual values of N_{EP} and N_{SCH} , the encoded value of N_{EP} (N_{EP} code) and N_{SCH} (N_{SCH} code) shall be used for the signaling. They are encoded by 4 bits, respectively. The encoding of N_{EP} (N_{EP} code) is shown in Table 332. The encoding of N_{SCH} (N_{SCH} code) is performed per N_{EP} value. For each N_{EP} , there are less than 16 kinds of N_{SCH} values and they are encoded from “0” (the smallest number of subchannels) to “15” in increasing order. When the number of N_{SCH} values for a N_{EP} is smaller than 16, then the corresponding number of codes is used. When the fragmentation is applied and the number of the subpackets for an allocation is n , $n \cdot N_{EP}$ and N_{SCH} (the number of subchannels allocated for a subpacket) should be signaled.

The encoding for $n \cdot N_{EP}$ (N_{EP} code) is also shown in Table 332. The encoded value of N_{SCH} (N_{SCH} code) should be interpreted as N_{SCH} for a subpacket, and $n \cdot N_{SCH}$ for the whole allocation.

Table 333—Transmission format and modulation level for UL

N_{EP}	48	96	144	192	288	384	480	960	1920	2880	3840	4800
<i>Sch</i>	1.00	1.00	1.00									
<i>MPR</i>	1.00	2.00	3.00									
<i>MOD</i>	2.00	4.00	4.00									
Rate	1/2	1/2	3/4									
Rate	0.50	0.50	0.75									
<i>Sch</i>	2.00	2.00	2.00	2.00	2.00							
<i>MPR</i>	0.50	1.00	1.50	2.00	3.00							
<i>MOD</i>	2.00	2.00	4.00	4.00	4.00							
Rate	1/4	1/2	3/8	1/2	3/4							
Rate	0.25	0.5	0.38	0.50	0.75							
<i>Sch</i>	3.00	3.00	3.00	3.00	3.00	3.00	3.00					
<i>MPR</i>	0.33	0.67	1.00	1.33	2.00	2.67	3.33					
<i>MOD</i>	2.00	2.00	2.00	2.00	4.00	4.00	4.00					
Rate	1/6	1/3	1/5	2/3	1/2	2/3	5/6					
Rate	0.17	0.33	0.50	0.67	0.5	0.67	0.83					
<i>Sch</i>	4.00	4.00		4.00	4.00	4.00	4.00					
<i>MPR</i>	0.25	0.50		1.00	1.50	2.00	2.50					
<i>MOD</i>	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					
<i>Sch</i>			5.00		5.00	5.00	5.00					
<i>MPR</i>			0.60		1.20	1.60	2.00					
<i>MOD</i>			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					
<i>Sch</i>	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00				
<i>MPR</i>	0.17	0.33	0.50	0.67	1.00	1.33	1.67	3.33				
<i>MOD</i>	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				

Table 333—Transmission format and modulation level for UL (continued)

N_{EP}	48	96	144	192	288	384	480	960	1920	2880	3840	4800
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate								7.00 2.86 4.00 5/7 0.714				
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate		8.00 0.25 2.00 1/8 0.13		8.00 0.50 2.00 1/4 0.25		8.00 1.00 2.00 1/2 0.50	8.00 1.25 2.00 5/8 0.63	8.00 2.50 4.00 5/8 0.63				
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate			9.00 0.33 2.00 1/6 0.17		9.00 0.67 2.00 1/3 0.33							
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate							10.00 1.00 2.00 1/2 0.50	10.00 2.00 4.00 1/2 0.50				
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate		12.0 0.17 2.0 1/12 0.08	12.00 0.25 2.00 1/8 0.13	12.0 0.33 2.00 1/6 0.17	12.0 0.50 2.00 1/4 0.25	12.0 0.67 2.00 1/3 0.33			12.0 3.33 4.00 5/6 0.83			
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate									13.00 3.08 3.00 10/13 0.77			
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate							15.00 0.67 2.00 1/3 0.33	15.00 1.33 2.00 2/3 0.67	15.00 2.67 4.00 2/3 0.67			
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate				16.0 0 0.25 2.00 1/8 0.13		16.0 0 0.50 2.00 1/4 0.25						
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate			18.00 0.17 2.00 1/12 0.08		18.0 0.33 2.00 1/6 0.17						18.00 3.33 4.00 5/6 0.83	
<i>Sch</i> <i>MPR</i> <i>MOD</i> 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	20.0 3.00 4.00 3/4 0.75	

Table 333—Transmission format and modulation level for UL (continued)

N_{EP}	48	96	144	192	288	384	480	960	1920	2880	3840	4800
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate				24.0 0.17 2.00 1/12 0.08	24.0 0.25 2.00 1/8 0.13	24.0 0.33 2.00 1/6 0.17				24.0 2.50 4.00 5/8 0.63	24.0 3.33 4.0 5/6 0.83	
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate									26.00 1.54 4.00 5/13 0.38		26.0 3.08 4.00 10/13 0.77	
<i>Sch</i> <i>MPR</i> <i>MOD</i> 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	30.0 3.33 3.00 5/6 0.83
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate						32.0 0.25 2.00 1/8 0.13						
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate												34.0 2.94 4.00 25/34 0.74
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate					36.0 0.17 2.00 1/12 0.08							
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate												38.00 2.63 4.00 25/38 0.66
<i>Sch</i> <i>MPR</i> <i>MOD</i> 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	
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate										45.0 1.33 2.00 2/3 0.67		
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate						48.0 0.17 2.00 1/12 0.08						

Table 333—Transmission format and modulation level for UL (continued)

N_{EP}	48	96	144	192	288	384	480	960	1920	2880	3840	4800
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate												50.00 2.00 4.00 1/2 0.50
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate											52.00 1.54 4.00 5/13 0.38	
<i>Sch</i> <i>MPR</i> <i>MOD</i> 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	
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate												66.0 1.52 4.00 25/66 0.38
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate												76.00 1.32 2.00 25/38 0.66
<i>Sch</i> <i>MPR</i> <i>MOD</i> 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	
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate										90.00 0.67 2.00 1/3 0.33		
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate												100.00 1.00 2.00 1/2 0.50
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate								120.0 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	
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate												150.00 0.67 2.00 1/3 0.33

Table 333—Transmission format and modulation level for UL (continued)

N_{EP}	48	96	144	192	288	384	480	960	1920	2880	3840	4800
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate									160.00 0.25 2.00 1/8 0.13		160.00 0.50 2.00 1/4 0.25	
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate										180.00 0.33 2.00 1/6 0.17		
<i>Sch</i> <i>MPR</i> <i>MOD</i> Rate Rate												200.00 0.50 2.00 1/4 0.25
<i>Sch</i> <i>MPR</i> <i>MOD</i> 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	

8.4.9.2.4 Zero tailed convolutional coding (optional)

The convolutional encoder (as described in 8.4.9.2.1) may employ the Zero Tailing technique. In this case, a single 0x00 tail byte is appended at the end of each burst. This tail byte shall be appended after randomization. The convolutional code and the puncturing shall be applied to the whole burst without partitioning it into blocks. The interleaving shall be applied to the coded bits in blocks of size described in 8.4.9.2.

8.4.9.3 Interleaving

All encoded data bits shall be interleaved by a block interleaver with a block size corresponding to the number of coded bits per the encoded block size N_{cbps} as set in 8.4.9.2. The interleaver is defined by a two-step permutation. The first ensures that adjacent coded bits are mapped onto nonadjacent subcarriers. The second permutation insures that adjacent coded bits are mapped alternately onto less or more significant bits of the constellation, thus avoiding long runs of lowly reliable bits.

Let N_{cpc} be the number of coded bits per subcarrier, i.e., 2, 4, or 6 for QPSK, 16-QAM or 64-QAM, respectively. Let $s = N_{cpc}/2$. Within a block of N_{cbps} bits at transmission, let k be the index of the coded bit before the first permutation, m_k be the index of that coded bit after the first and before the second permutation and let j_k be the index after the second permutation, just prior to modulation mapping, and d be the modulo used for the permutation.

The first permutation is defined by Equation (130): $k = 0, 1, \dots, N_{cbps} - 1$, $d = 16$

$$m_k = (N_{cbps}/d) \cdot k_{mod(d)} + floor(k/d) \quad k = 0, 1, \dots, N_{cbps} - 1 \quad d = 16 \quad (130)$$

The second permutation is defined by Equation (131):

$$j_k = s \cdot floor(m_k/s) + (m_k + N_{cbps} - floor(d \cdot m_k/N_{cbps}))_{mod(s)} \quad k = 0, 1, \dots, N_{cbps} - 1 \quad d = 16 \quad (131)$$

The de-interleaver, which performs the inverse operation, is also defined by two permutations. Within a received block of N_{cbps} bits, let j be the index of a received bit before the first permutation; m_j be the index of that bit after the first and before the second permutation; and let k_j be the index of that bit after the second permutation, just prior to delivering the block to the decoder.

The first permutation is defined by Equation (132):

$$m_j = s \cdot \text{floor}(j/s) + (j + \text{floor}(d \cdot j/N_{\text{cbps}}))_{\text{mod}(s)} \quad j = 0, 1, \dots, N_{\text{cbps}} - 1 \quad d = 16 \quad (132)$$

The second permutation is defined by Equation (133):

$$k_j = d \cdot m_j - (N_{\text{cbps}} - 1) \cdot \text{floor}(d \cdot m_j/N_{\text{cbps}}) \quad j = 0, 1, \dots, N_{\text{cbps}} - 1 \quad d = 16 \quad (133)$$

The first permutation in the de-interleaver is the inverse of the second permutation in the interleaver, and conversely.

8.4.9.4 Modulation

8.4.9.4.1 Permutation definition

The PRBS generator depicted hereafter shall be used to produce a sequence, w_k (see Figure 262). The polynomial for the PRBS generator shall be $X^{11} + X^9 + 1$.

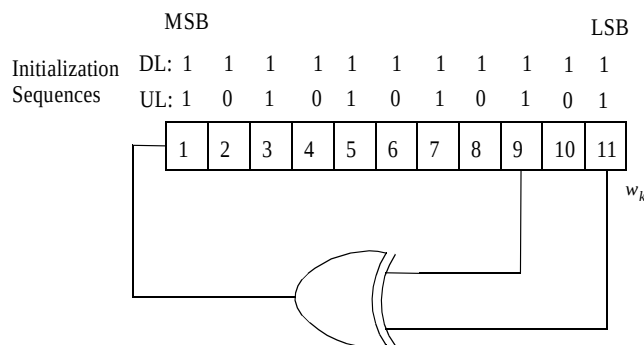


Figure 262—PRBS for pilot modulation

The value of the pilot modulation, on subcarrier k , shall be derived from w_k .

The initialization vector of the PRBS for both uplink and downlink shall be designated b10..b0, such that:

- b10..b6 = Five least significant bits of IDcell as indicated by the frame preamble, except for zones marked by “Use all SC indicator = 1,” where these bits shall be set to 1, in the downlink. Five least significant bits of UL_IDcell in the uplink
- b5..b4 = Set to the segment number + 1 as indicated by the frame preamble, except for zones marked by “Use all SC indicator = 1,” where these bits shall be set to 1
- b3..b0 = Four least significant bits of symbol offset from the first data symbol in the frame (i.e., the symbol in the frame in which the DL-MAP starts)

For example, should the initialization vector of the PRBS be b10..b0 = 101010101, the initializations result in the sequence $w_k = 101010101000000000\dots$ in the uplink. The PRBS shall be initialized so that its first output bit coincides with the first usable subcarrier (as defined in Table 313). A new value shall be generated by the PRBS for every subcarrier up to the highest numbered usable subcarrier, including the DC subcarrier.

8.4.9.4.2 Data modulation

After bit interleaving, the data bits are entered serially to the constellation mapper. Gray-mapped QPSK and 16-QAM (as shown in Figure 263) shall be supported, whereas the support of 64-QAM is optional. The constellations (as shown in Figure 263) shall be normalized by multiplying the constellation point with the indicated factor c to achieve equal average power.

Per-allocation adaptive modulation and coding shall be supported in the downlink. The uplink shall support different modulation schemes for each SS based on the MAC burst configuration messages coming from the BS. Complete description of the MAC/PHY support of adaptive modulation and coding is provided in 6.3.7.

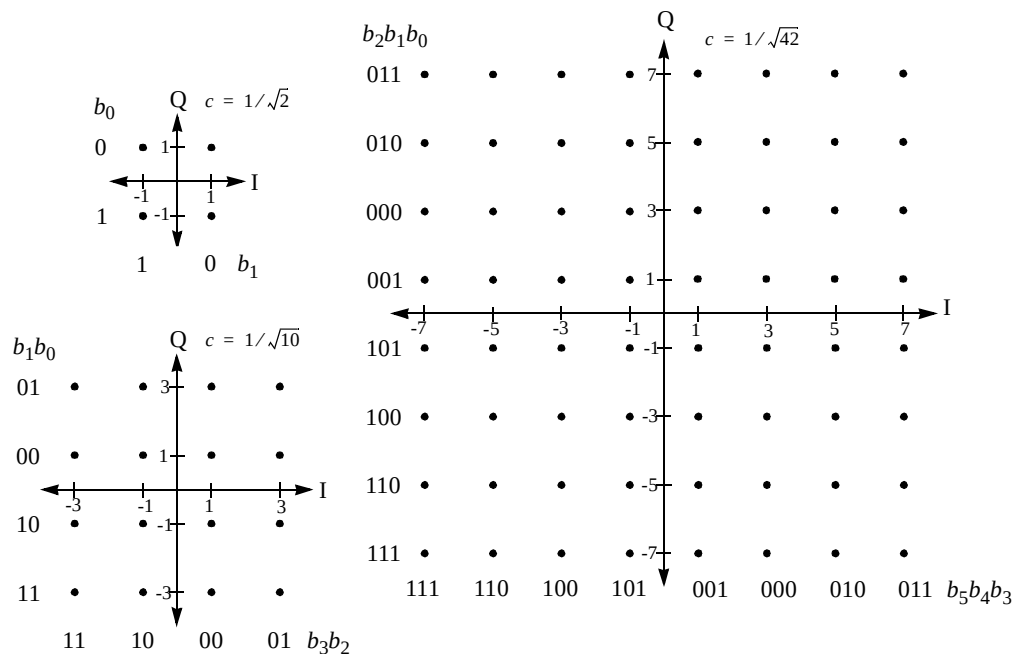


Figure 263—QPSK, 16-QAM, and 64-QAM constellations

The constellation-mapped data shall be subsequently modulated onto the allocated data subcarriers and each subcarrier multiplied by the factor $2^{*(1/2 - w_k)}$ according to the subcarrier index, k .

8.4.9.4.3 Pilot modulation

For the mandatory tile structure in the uplink, pilot subcarriers shall be inserted into each data burst in order to constitute the Symbol and they shall be modulated according to their subcarrier location within the OFDMA symbol.

The Pilot subcarriers shall be modulated according to Equation (134):

$$\begin{aligned} \text{Re}\{c_k\} &= 2\left(\frac{1}{2} - w_k\right) \\ \text{Im}\{c_k\} &= 0 \end{aligned} \quad (134)$$

In the downlink and for the optional uplink tile structure each pilot shall be transmitted with a boosting of 2.5 dB over the average power of each data tone. The Pilot subcarriers shall be modulated according to Equation (135):

$$\begin{aligned}\operatorname{Re}\{c_k\} &= \frac{8}{3}\left(\frac{1}{2} - w_k\right) \\ \operatorname{Im}\{c_k\} &= 0\end{aligned}\tag{135}$$

8.4.9.4.3.1 Preambles/midambles pilot modulation

The pilots in the downlink preamble shall follow the instructions in 8.4.6.1.1, and shall be modulated according to Equation (136):

$$\begin{aligned}\operatorname{Re}\{PreamblePilotsModulated\} &= 4 \cdot \sqrt{2} \cdot \left(\frac{1}{2} - w_k\right) \\ \operatorname{Im}\{PreamblePilotsModulated\} &= 0\end{aligned}\tag{136}$$

8.4.9.4.3.2 Ranging pilot modulation

The BPSK modulation on the ranging transmissions, real and imaginary parts, is defined by Equation (137):

$$\begin{aligned}\operatorname{Re}\{c_k\} &= 2 \cdot (1/2 - C_k) \\ \operatorname{Im}\{c_k\} &= 0\end{aligned}\tag{137}$$

where c_k is the k -th subcarrier of the Ranging Channel, and C_k is the k -th bit of the code generated according to 8.4.7.3

8.4.9.4.4 Example of OFDMA uplink CC encoding

An example of one burst of OFDMA uplink using mandatory structure is provided, illustrating each process from randomization through subcarrier modulation. The scenario parameters are as follows:

- 1) OFDM symbol number start = 35
- 2) Number of time slots in UL allocation = 2
- 3) Starting Logical Slot = 6 (mapped onto physical subchannel 16 in the first time slot and physical subchannel 17 in the second time slot due to subchannel rotation)
- 4) IDcell = 5
- 5) Segment = 0
- 6) Modulation = QPSK
- 7) Coding scheme = Convolutional coding
- 8) Coding rate = 1/2

Input Data (Hex)

AC BC D2 11 4D AE 15 77 C6 DB F4 C9

Randomized Data (Hex)

06 DF 2F 59 42 1E 34 D7 03 19 68 46

Convolutional encoded Data (Hex)

36 F5 E1 7E E8 98 6E 27 EB B9 F2 A6 57 B6 A0 51 FA BD 4E E0 E5 A9 E7 F2

Interleaved Data (Hex)

6D BB DF FD B4 94 38 C6 1B 9E D8 53 AE FC 2A DE FD 76 68 AE 94 56 16 65

Constellation Mapping (data shall be transformed to constellation values: I value/Q value. The value 0.707 represents $\sqrt{2}/2$),:

+0.707/-0.707, -0.707/+0.707, -0.707/-0.707, +0.707/-0.707, -0.707/+0.707, -0.707/-0.707, -0.707/
 +0.707, -0.707/-0.707, -0.707/-0.707, +0.707/-0.707, -0.707/-0.707, -0.707/-0.707, -0.707/-0.707, -
 0.707/-0.707, -0.707/-0.707, +0.707/-0.707, -0.707/+0.707, -0.707/-0.707, +0.707/-0.707, +0.707/
 +0.707, -0.707/+0.707, +0.707/-0.707, +0.707/-0.707, +0.707/+0.707, +0.707/+0.707, -0.707/-
 0.707, -0.707/+0.707, +0.707/+0.707, -0.707/-0.707, +0.707/+0.707, +0.707/-0.707, -0.707/+0.707,
 +0.707/+0.707, +0.707/-0.707, -0.707/+0.707, -0.707/-0.707, -0.707/+0.707, +0.707/+0.707, +0.707/-0.707,
 -0.707, -0.707/+0.707, -0.707/-0.707, +0.707/-0.707, +0.707/-0.707, +0.707/+0.707, +0.707/+0.707,
 -0.707/+0.707, -0.707/+0.707, -0.707/-0.707, -0.707/-0.707, +0.707/+0.707, +0.707/+0.707, -0.707/+0.707,
 -0.707/+0.707, -0.707/+0.707, -0.707/-0.707, +0.707/-0.707, -0.707/-0.707, -0.707/+0.707, -0.707/-
 0.707, -0.707/-0.707, -0.707/-0.707, +0.707/-0.707, +0.707/-0.707, -0.707/-0.707, +0.707/-0.707, -
 0.707/+0.707, +0.707/-0.707, -0.707/+0.707, -0.707/+0.707, +0.707/+0.707, -0.707/+0.707, -0.707/
 +0.707, -0.707/-0.707, -0.707/+0.707, -0.707/+0.707, +0.707/-0.707, +0.707/-0.707, +0.707/+0.707,
 +0.707/-0.707, +0.707/-0.707, +0.707/-0.707, +0.707/-0.707, -0.707/+0.707, +0.707/+0.707, +0.707/-0.707,
 +0.707/-0.707, -0.707/+0.707, +0.707/-0.707, -0.707/+0.707, +0.707/-0.707, +0.707/-0.707

Mapping onto subcarriers and multiplying by PN [assuming the use of logical data subchannel 6, mapped onto physical subchannel 16 in the first time slot and to physical subchannel 17 at the second time slot, structure includes pilots and is in the structure of (Symbol Number, Subcarrier Index, I value / Q Value)]:

(35,448,+1/0), (35,449,-0.707/+0.707), (35,450,-0.707/-0.707), (35,451,+1/0), (35,512,+1/0), (35,513,-0.707/+0.707), (35,514,-0.707/-0.707), (35,515,-1/0), (35,984,+1/0), (35,985,-0.707/-0.707), (35,986,+0.707/-0.707), (35,987,+1/0), (35,1189,-1/0), (35,1190,-0.707/-0.707), (35,1191,-0.707/-0.707), (35,1192,+1/0), (35,1505,+1/0), (35,1506,+0.707/-0.707), (35,1507,-0.707/+0.707), (35,1508,+1/0), (35,1753,-1/0), (35,1754,-0.707/-0.707), (35,1755,+0.707/-0.707), (35,1756,+1/0), (36,448,-0.707/+0.707), (36,449,+0.707/-0.707), (36,450,+0.707/-0.707), (36,451,+0.707/+0.707), (36,512,+0.707/+0.707), (36,513,-0.707/-0.707), (36,514,-0.707/+0.707), (36,515,+0.707/+0.707), (36,984,-0.707/-0.707), (36,985,+0.707/+0.707), (36,986,+0.707/-0.707), (36,987,-0.707/+0.707), (36,1189,+0.707/+0.707), (36,1190,+0.707/-0.707), (36,1191,-0.707/+0.707), (36,1192,-0.707/-0.707), (36,1505,-0.707/-0.707), (36,1506,-0.707/-0.707), (36,1507,-0.707/-0.707), (36,1508,+0.707/-0.707), (36,1753,-0.707/+0.707), (36,1754,-0.707/-0.707), (36,1755,+0.707/-0.707), (36,1756,+0.707/+0.707), (37,448,+1/0), (37,449,-0.707/-0.707), (37,450,+0.707/-0.707), (37,451,-1/0), (37,512,+1/0), (37,513,-0.707/+0.707), (37,514,+0.707/+0.707), (37,515,+1/0), (37,984,+1/0), (37,985,+0.707/-0.707), (37,986,+0.707/-0.707), (37,987,+1/0), (37,1189,+1/0), (37,1190,+0.707/+0.707), (37,1191,-0.707/-0.707), (37,1192,+1/0), (37,1505,-1/0), (37,1506,-0.707/+0.707), (37,1507,+0.707/-0.707), (37,1508,-1/0), (37,1753,+1/0), (37,1754,-0.707/-0.707), (37,1755,-0.707/+0.707), (37,1756,-1/0), (38,232,+1/0), (38,233,+1/0), (38,234,-0.707/+0.707), (38,235,-0.707/+0.707), (38,704,+1/0), (38,705,+1/0), (38,706,-0.707/+0.707), (38,707,-0.707/+0.707), (38,908,+1/0), (38,909,+1/0), (38,910,-0.707/-0.707), (38,911,-0.707/+0.707), (38,1225,+1/0), (38,1226,+1/0), (38,1227,-0.707/-0.707), (38,1228,-0.707/-0.707), (38,1473,+1/0), (38,1474,+1/0), (38,1475,-0.707/-0.707), (38,1476,+0.707/+0.707), (38,1813,+1/0), (38,1814,+1/0), (38,1815,+0.707/+0.707), (38,1816,-0.707/+0.707), (39,232,-0.707/+0.707), (39,233,-0.707/+0.707), (39,234,+0.707/-0.707), (39,235,+0.707/-0.707), (39,704,+0.707/+0.707), (39,705,-0.707/-0.707), (39,706,+0.707/-0.707), (39,707,-0.707/-0.707), (39,908,-0.707/+0.707), (39,909,-0.707/-0.707), (39,910,-0.707/-0.707), (39,911,-0.707/-0.707), (39,1225,+0.707/-0.707), (39,1226,+0.707/-0.707), (39,1227,-0.707/-0.707), (39,1228,+0.707/-0.707), (39,1473,-0.707/+0.707), (39,1474,+0.707/-0.707), (39,1475,-0.707/+0.707), (39,1476,-0.707/+0.707), (39,1813,+0.707/+0.707), (39,1814,-0.707/+0.707), (39,1815,-0.707/+0.707), (39,1816,+0.707/+0.707), (39,1817,-0.707/+0.707), (39,1818,+0.707/+0.707), (39,1819,-0.707/+0.707), (39,1820,+0.707/+0.707), (39,1821,-0.707/+0.707), (39,1822,+0.707/+0.707), (39,1823,-0.707/+0.707), (39,1824,+0.707/+0.707), (39,1825,-0.707/+0.707), (39,1826,+0.707/+0.707), (39,1827,-0.707/+0.707), (39,1828,+0.707/+0.707), (39,1829,-0.707/+0.707), (39,1830,+0.707/+0.707), (39,1831,-0.707/+0.707), (39,1832,+0.707/+0.707), (39,1833,-0.707/+0.707), (39,1834,+0.707/+0.707), (39,1835,-0.707/+0.707), (39,1836,+0.707/+0.707), (39,1837,-0.707/+0.707), (39,1838,+0.707/+0.707), (39,1839,-0.707/+0.707), (39,1840,+0.707/+0.707), (39,1841,-0.707/+0.707), (39,1842,+0.707/+0.707), (39,1843,-0.707/+0.707), (39,1844,+0.707/+0.707), (39,1845,-0.707/+0.707), (39,1846,+0.707/+0.707), (39,1847,-0.707/+0.707), (39,1848,+0.707/+0.707), (39,1849,-0.707/+0.707), (39,1850,+0.707/+0.707), (39,1851,-0.707/+0.707), (39,1852,+0.707/+0.707), (39,1853,-0.707/+0.707), (39,1854,+0.707/+0.707), (39,1855,-0.707/+0.707), (39,1856,+0.707/+0.707), (39,1857,-0.707/+0.707), (39,1858,+0.707/+0.707), (39,1859,-0.707/+0.707), (39,1860,+0.707/+0.707), (39,1861,-0.707/+0.707), (39,1862,+0.707/+0.707), (39,1863,-0.707/+0.707), (39,1864,+0.707/+0.707), (39,1865,-0.707/+0.707), (39,1866,+0.707/+0.707), (39,1867,-0.707/+0.707), (39,1868,+0.707/+0.707), (39,1869,-0.707/+0.707), (39,1870,+0.707/+0.707), (39,1871,-0.707/+0.707), (39,1872,+0.707/+0.707), (39,1873,-0.707/+0.707), (39,1874,+0.707/+0.707), (39,1875,-0.707/+0.707), (39,1876,+0.707/+0.707), (39,1877,-0.707/+0.707), (39,1878,+0.707/+0.707), (39,1879,-0.707/+0.707), (39,1880,+0.707/+0.707), (39,1881,-0.707/+0.707), (39,1882,+0.707/+0.707), (39,1883,-0.707/+0.707), (39,1884,+0.707/+0.707), (39,1885,-0.707/+0.707), (39,1886,+0.707/+0.707), (39,1887,-0.707/+0.707), (39,1888,+0.707/+0.707), (39,1889,-0.707/+0.707), (39,1890,+0.707/+0.707), (39,1891,-0.707/+0.707), (39,1892,+0.707/+0.707), (39,1893,-0.707/+0.707), (39,1894,+0.707/+0.707), (39,1895,-0.707/+0.707), (39,1896,+0.707/+0.707), (39,1897,-0.707/+0.707), (39,1898,+0.707/+0.707), (39,1899,-0.707/+0.707), (39,1900,+0.707/+0.707), (39,1901,-0.707/+0.707), (39,1902,+0.707/+0.707), (39,1903,-0.707/+0.707), (39,1904,+0.707/+0.707), (39,1905,-0.707/+0.707), (39,1906,+0.707/+0.707), (39,1907,-0.707/+0.707), (39,1908,+0.7

+0.707), (39,1814,-0.707/+0.707), (39,1815,-0.707/+0.707), (39,1816,-0.707/-0.707), (40,232,+1/0), (40,233,+1/0), (40,234,+0.707/-0.707), (40,235,+0.707/-0.707), (40,704,+1/0), (40,705,+1/0), (40,706,+0.707/-0.707), (40,707,+0.707/-0.707), (40,908,+1/0), (40,909,+1/0), (40,910,+0.707/-0.707), (40,911,-0.707/+0.707), (40,1225,+1/0), (40,1226,+1/0), (40,1227,+0.707/+0.707), (40,1228,+0.707/-0.707), (40,1473,+1/0), (40,1474,+1/0), (40,1475,+0.707/-0.707), (40,1476,-0.707/+0.707), (40,1813,+1/0), (40,1814,+1/0), (40,1815,+0.707/-0.707), (40,1816,-0.707/+0.707),

8.4.10 Control mechanisms

8.4.10.1 Synchronization

8.4.10.1.1 Network synchronization

For TDD and FDD realizations, it is recommended (but not required) that all BSs be time synchronized to a common timing signal. In the event of the loss of the network timing signal, BSs shall continue to operate and shall automatically resynchronize to the network timing signal when it is recovered. The synchronizing reference shall be a 1 pps timing pulse and a 10 MHz frequency reference. These signals are typically provided by a GPS receiver.

For both FDD and TDD realizations, frequency references derived from the timing reference may be used to control the frequency accuracy of Base-Stations provided that they meet the frequency accuracy requirements of 8.4.14. This applies during normal operation and during loss of timing reference.

8.4.10.1.2 SS synchronization

For any duplexing, all SSs shall acquire and adjust their timing such that all uplink OFDMA symbols arrive time coincident at the BS to a accuracy of $\pm 25\%$ of the minimum guard-interval or better.

8.4.10.2 Ranging

Ranging for time (coarse synchronization) and power is performed during two phases of operation: during (re)registration and when synchronization is lost; and second, during FDD or TDD transmission on a periodic basis.

During registration, a new subscriber registers using the random access channel, and if successful, is entered into a ranging process under control of the BS. The ranging process is cyclic in nature where default time and power parameters are used to initiate the process followed by cycles where (re)calculated parameters are used in succession until parameters meet acceptance criteria for the new subscriber. These parameters are monitored, measured, and stored at the BS, and transmitted to the subscriber unit for use during normal exchange of data. During normal exchange of data, the stored parameters are updated in a periodic manner based on configurable update intervals to ensure changes in the channel can be accommodated. The update intervals shall vary in a controlled manner on a subscriber unit by subscriber unit basis.

Ranging on re-registration follows the same process as new registration.

8.4.10.3 Power control

A power control algorithm shall be supported for the uplink channel with both an initial calibration and periodic adjustment procedure without loss of data. The BS should be capable of providing accurate power measurements of the received burst signal. This value can then be compared against a reference level, and the resulting error can be fed back to the SS in a calibration message coming from the MAC. The power control algorithm shall be designed to support power attenuation due to distance loss or power fluctuations at rates of at most 30 dB/s with depths of at least 10 dB for fixed deployment. The exact algorithm implementation is vendor-specific. The total power control range consists of both a fixed portion and a

portion that is automatically controlled by feedback. The power control algorithm shall take into account the interaction of the RF power amplifier with different burst profiles. For example, when changing from one burst profile to another, margins should be maintained to prevent saturation of the amplifier and to prevent violation of emissions masks.

A transmitting SS shall maintain the same transmitted power density regardless of the number of subchannels assigned, unless the maximum power level is reached. That is, when the number of active subchannels allocated to a user is reduced, the total transmitted power shall be reduced proportionally by the SS, without additional power control messages. When the number of subchannels is increased, the total transmitted power shall also be increased proportionally. However, the transmitted power level shall not exceed the maximum levels dictated by signal integrity considerations and regulatory requirements. The SS shall interpret power control messages as the required changes to the transmitted power density.

To maintain at the BS a power density consistent with the modulation and FEC rate used by each SS, the BS may change the SS TX power as well as the SS assigned modulation and FEC rate. There are, however, situations where the SS should automatically update its TX power, without being explicitly instructed by the BS. This happens when the SS transmits in region marked by UIUC = 0, UIUC = 12, or UIUC = 14. In all these situations, the SS shall use a temporary TX power value set according to Equation (138) (in dB),

$$P_{new} = P_{last} + (C/N_{new} - C/N_{last}) - (\log_{10}(R_{new}) - \log_{10}(R_{last})) \quad (138)$$

where,

- P_{new} is the temporary TX Power,
- P_{last} is the last used TX Power,
- C/N_{new} is the normalized C/N of new modulation/FEC rate instructed by the UIUC,
- C/N_{last} is the normalized C/N of the last used modulation/FEC rate,
- R_{new} is the number of repetitions for the new modulation/FEC rate instructed by the UIUC,
- R_{last} is the number of repetitions on the last used modulation/FEC rate.

The default normalized C/N values per modulation are given by Table 334. These values may be overridden by the BS by using a dedicated UCD message TLV.

Table 334—Normalized C/N per modulation

Modulation/ FEC rate	Normalized C/N
Fast_feedback IE	0
CDMA code	3
QPSK 1/2	6
QPSK 3/4	9
16-QAM 1/2	12
16-QAM 3/4	15
64-QAM 1/2	18

Table 334—Normalized C/N per modulation (continued)

Modulation/ FEC rate	Normalized C/N
64-QAM 2/3	20
64QAM 3/4	21
64QAM 5/6	23

To maintain at the BS a power density consistent with the modulation used by each SS, the BS may change the SS TX power as well as the SS assigned modulation and FEC rate. There are, however, situations where the SS should automatically update its TX power, without being explicitly instructed by the BS. This happens when the SS transmits in region marked by UIUC = 0, UIUC = 12, or UIUC = 14. In all these situations, the SS shall use a temporary TX power value set according to the formula $\text{Temporary_TX_Power} = \text{Last_TX_Power_Normalized_C/N_of_last_modulation} + \text{Normalized_C/N_of_QPSK_1/2_modulation}$.

The SS shall report the maximum available power and the normalized transmitted power. These parameters may be used by the base station for optimal assignment of coding schemes and modulations and also for optimal allocation of subchannels. The algorithm is vendor-specific. These parameters are reported in the REG-RSP message. The current transmitted power shall also be reported in the RNG-RSP message if the relevant flag in the REP-REQ message has been set.

The current transmitted power is the power of the burst that carries the message. The maximum available power is reported for QPSK QAM16 and QAM64 constellations. The current transmitted power and the maximum power parameters are reported in dBm. The parameters are quantized in 0.5dBm steps ranging from -64dBm (encoded 0x00) to 63.5dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme. SSs that do not support QAM64 shall report the value of 0x00 in the maximum QAM64 power field.

8.4.11 Channel quality measurements

8.4.11.1 Introduction

RSSI and CINR signal quality measurements and associated statistics can aid in such processes as BS selection/assignment and burst adaptive profile selection. As channel behavior is time-variant, both mean and standard deviation are defined. Implementation of the RSSI and CINR statistics and their reports is mandatory.

The process by which RSSI measurements are taken does not necessarily require receiver demodulation lock; for this reason, RSSI measurements offer reasonably reliable channel strength assessments even at low signal levels. On the other hand, although CINR measurements require receiver lock, they provide information on the actual operating condition of the receiver, including interference and noise levels, and signal strength.

8.4.11.2 RSSI mean and standard deviation

When collection of RSSI measurements is mandated by the BS, an SS shall obtain an RSSI measurement (implementation-specific). From a succession of RSSI measurements, the SS shall derive and update estimates of the mean and the standard deviation of the RSSI, and report them via REP-RSP messages.

Mean and standard deviation statistics shall be reported in units of dBm. To prepare such reports, statistics shall be quantized in 1 dB increments, ranging from –40 dBm (encoded 0x53) to –123 dBm (encoded 0x00). Values outside this range shall be assigned the closest extreme value within the scale.

The method used to estimate the RSSI of a single message is left to individual implementation, but the relative accuracy of a single signal strength measurement, taken from a single message, shall be ± 2 dB, with an absolute accuracy of ± 4 dB. This shall be the case over the entire range of input RSSIs. In addition, the range over which these single-message measurements are measured should extend 3 dB on each side beyond the –40 dBm to –123 dBm limits for the final averaged statistics that are reported.

One possible method to estimate the RSSI of a signal of interest at the antenna connector is given by Equation (139):

$$RSSI = 10^{-\frac{G_{rt}}{10}} \frac{1.2567 \times 10^4 V_c^2}{(2^{2B})R} \left(\frac{1}{N} \sum_{n=0}^{N-1} |Y_{I \text{ or } Q}[k, n]| \right)^2 \text{ mW} \quad (139)$$

where

- B is ADC precision, number of bits of ADC,
- R is ADC input resistance [Ohm],
- V_c is ADC input clip level [Volts],
- G_{rt} is analog gain from antenna connector to ADC input,
- $Y_{I \text{ or } Q}[k, n]$ is n -th sample at the ADC output of I or Q -branch within signal k ,
- N is number of samples.

The (linear) mean RSSI statistics (in mW), derived from a multiplicity of single messages, shall be updated using Equation (140).

$$\hat{\mu}_{RSSI}[k] = \begin{cases} R[0] & k = 0 \\ (1 - \alpha_{avg})\hat{\mu}_{RSSI}[k-1] + \alpha_{avg}R[k] & k > 0 \end{cases} \quad \text{mW} \quad (140)$$

where

- k is the time index for the message (with the initial message being indexed by $k = 0$, the next message by $k = 1$, etc.),
- $R[k]$ is the RSSI in mW measured during message k , and α_{avg} is an averaging parameter specified by the BS.

The mean estimate in dBm shall then be derived from Equation (141).

$$\hat{\mu}_{RSSI \text{ dBm}}[k] = 10 \log(\hat{\mu}_{RSSI}[k]) \quad \text{dBm} \quad (141)$$

To solve for the standard deviation in dB, the expectation-squared statistic shall be updated using Equation (142),

$$\hat{x}_{RSSI}^2[k] = \begin{cases} |R[0]|^2 & k = 0 \\ (1 - \alpha_{avg})\hat{x}_{RSSI}^2[k-1] + \alpha_{avg}|R[k]|^2 & k > 0 \end{cases} \quad (142)$$

and the result applied to Equation (143).

$$\hat{\sigma}_{RSSI \text{ dB}} = 5 \log \left(\left| x_{RSSI}^2[k] - (\hat{\mu}_{RSSI}[k])^2 \right| \right) \text{ dB} \quad (143)$$

8.4.11.3 CINR mean and standard deviation

When CINR measurements are mandated by the BS, an SS shall obtain a CINR measurement (implementation-specific). From a succession of these measurements, the SS shall derive and update estimates of the mean and the standard deviation of the CINR, and report them via REP-RSP messages.

Mean and standard deviation statistics for CINR shall be reported in units of dB. To prepare such reports, statistics shall be quantized in 1 dB increments, ranging from a minimum of −10 dB (encoded 0x00) to a maximum of 53 dB (encoded 0x3F). Values outside this range shall be assigned the closest extreme value within the scale.

The method used to estimate the CINR of a single message is left to individual implementation, but the relative and absolute accuracy of a CINR measurement derived from a single message shall be ± 1 dB and ± 2 dB, respectively. The specified accuracy shall apply to the range of CINR values starting from 3 dB below SNR of the most robust rate, to 10 dB above the SNR of the least robust rate. See Table 338. In addition, the range over which these single-packet measurements are measured should extend 3 dB on each side beyond the −10 dB to 53 dB limits for the final reported, averaged statistics.

One possible method to estimate the CINR of a single message is to compute the ratio of the sum of signal power and the sum of residual error for each data sample, using Equation (144).

$$\text{CINR}[k] = \frac{\sum_{n=0}^{N-1} |s[k, n]|^2}{\sum_{n=0}^{N-1} |r[k, n] - s[k, n]|^2} \quad (144)$$

where $r[k, n]$ received sample n within message k ; $s[k, n]$ the corresponding detected or pilot sample (with channel state weighting) corresponding to received symbol n .

The mean CINR statistic (in dB) shall be derived from a multiplicity of single messages using Equation (145).

$$\hat{\mu}_{\text{CINR dB}}[k] = 10 \log(\hat{\mu}_{\text{CINR}}[k]) \quad (145)$$

where

$$\hat{\mu}_{\text{CINR}}[k] = \begin{cases} \text{CINR}[0] & k = 0 \\ (1 - \alpha_{\text{avg}}) \hat{\mu}_{\text{CINR}}[k-1] + \alpha_{\text{avg}} \text{CINR}[k] & k > 0 \end{cases} \quad (146)$$

k is the time index for the message (with the initial message being indexed by $k = 0$, the next message by $k = 1$, etc.); $\text{CINR}[k]$ is a linear measurement of CINR (derived by any mechanism which delivers the prescribed accuracy) for message k ; and α_{avg} is an averaging parameter specified by the BS.

To solve for the standard deviation, the expectation-squared statistic shall be updated using Equation (147).

$$\hat{x}_{\text{CINR}}^2[k] = \begin{cases} |\text{CINR}[0]|^2 & k = 0 \\ (1 - \alpha_{\text{avg}})\hat{x}_{\text{CINR}}^2[k-1] + \alpha_{\text{avg}}|\text{CINR}[k]|^2 & k > 0 \end{cases} \quad (147)$$

and the result applied to

$$\hat{\sigma}_{\text{CINR dB}} = 5 \log(|\hat{x}_{\text{CINR}}^2[k] - (\hat{\mu}_{\text{CINR}}[k])^2|) \quad \text{dB} \quad (148)$$

8.4.12 Transmitter requirements

8.4.12.1 Transmit power level control

The transmitter shall support monotonic power level control of 45 dB (30 dB for license-exempt bands) minimum with a minimum step size of 1 dB and a relative accuracy of ± 0.5 dB.

8.4.12.2 Transmitter spectral flatness

The average energy of the constellations in each of the n spectral lines shall deviate no more than indicated in Table 335. The absolute difference between adjacent subcarriers shall not exceed 0.1 dB, excluding intentional boosting or suppression of subcarriers and PAPR reduction subchannels are not allocated.

Table 335—Spectral flatness

Spectral lines	Spectral flatness
Spectral lines from $-N_{\text{used}}/4$ to -1 and $+1$ to $N_{\text{used}}/4$	± 2 dB from the measured energy averaged over all N_{used} active tones
Spectral lines from $-N_{\text{used}}/2$ to $-N_{\text{used}}/4$ and $+N_{\text{used}}/4$ to $N_{\text{used}}/2$	$+2/-4$ dB from the measured energy averaged over all N_{used} active tones

This data shall be taken from the channel estimation step.

8.4.12.3 Transmitter constellation error and test method

To ensure that the receiver SNR does not degrade more than 0.5 dB due to the transmitter SNR, the relative constellation RMS error, averaged over subcarriers, OFDMA frames, and packets, shall not exceed a burst profile dependent value according to Table 336.

Table 336—Allowed relative constellation error versus data rate

Burst type	Relative constellation error (dB)
QPSK-1/2	16.4
QPSK-3/4	18.2
16-QAM-1/2	23.4

Table 336—Allowed relative constellation error versus data rate

Burst type	Relative constellation error (dB)
16-QAM-3/4	25.2
64-QAM-2/3	29.7
64-QAM-3/4	31.4

All measurement errors taken together shall be 10 dB less than the required noise level, i.e., if a specification is TX S/N = 10 dB, the measurement S/N should be at least 20 dB. For all PHY modes, measurements shall be taken with all nonguard subcarriers active and no PAPR reduction subchannels used.

The sampled signal shall be processed in a manner similar to an actual receiver, according to the following steps, or an equivalent procedure (IEEE Std 802.11a-1999 [B29]):

- Start of frame shall be detected.
- Transition from short sequences to channel estimation sequences shall be detected, and fine timing (with one sample resolution) shall be established.
- Coarse and fine frequency offsets shall be estimated.
- The packet shall be de-rotated according to estimated frequency offset.
- The complex channel response coefficients shall be estimated for each of the subcarriers.
- For each of the data OFDMA symbols: transform the symbol into subcarrier received values, estimate the phase from the pilot subcarriers, de-rotate the subcarrier values according to estimated phase, and divide each subcarrier value with a complex estimated channel response coefficient.
- For each data-carrying subcarrier, find the closest constellation point and compute the Euclidean distance from it.
- Compute the RMS average of all errors in a packet, given by Equation (149).

$$\text{Error}_{\text{RMS}} = \frac{\sum_{i=1}^{N_f} \sum_{j=1}^{L_P} \left[\sum_{k=1}^{N_{FFT}} \left\{ (I(i,j,k) - I_0(i,j,k))^2 + (Q(i,j,k) - Q_0(i,j,k))^2 \right\} \right]}{P_0 \cdot L_P \cdot N_{FFT} \cdot N_f} \quad (149)$$

where

- L_P is the length of the packet,
- N_f is the number of frames for the measurement,
- $(I_0(i,j,k), Q_0(i,j,k))$ denotes the ideal symbol point of the i -th frame, j -th OFDMA symbol of the frame, k -th subcarrier of the OFDMA symbol in the complex plane,
- $(I(i,j,k), Q(i,j,k))$ denotes the observed point of the i -th frame, j -th OFDMA symbol of the frame, k -th subcarrier of the OFDMA symbol in the complex plane,
- P_0 is the average power of the constellation.

8.4.13 Receiver requirements

8.4.13.1 Receiver sensitivity

The BER shall be less than 10^{-6} at the power levels shown in Table 337 for standard message and test conditions. If the implemented bandwidth is not listed, then the values for the nearest smaller listed bandwidth shall apply. The minimum input levels are measured as follows:

- At the antenna connector or through a calibrated radiated test environment.
- Using the defined standardized message packet formats.
- Using an AWGN channel.

Table 337—Receiver minimum input level sensitivity (dBm)

Bandwidth (MHz)	QPSK		16-QAM		64-QAM	
	1/2	3/4	1/2	3/4	2/3	3/4
1.5	−91	−89	−84	−82	−78	−76
1.75	−90	−87	−83	−81	−77	−75
3	−88	−86	−81	−79	−75	−73
3.5	−87	−85	−80	−78	−74	−72
5	−86	−84	−79	−77	−72	−71
6	−85	−83	−78	−76	−72	−70
7	−84	−82	−77	−75	−71	−69
10	−83	−81	−76	−74	−69	−68
12	−82	−80	−75	−73	−69	−67
14	−81	−79	−74	−72	−68	−66
20	−80	−78	−73	−71	−66	−65

Table 337 (as well as Table 336) are derived assuming 5 dB implementation loss, a Noise Figure of 7 dB, and receiver SNR and E_b/N_0 values as listed in Table 338.

Table 338—Receiver SNR and E_b/N_0 assumptions

Modulation	E_b/N_0 (dB)	Coding rate	Receiver SNR (dB)
QPSK	10.5	1/2	9.4
		3/4	11.2

Table 338—Receiver SNR and E_b/N_0 assumptions

Modulation	E_b/N_0 (dB)	Coding rate	Receiver SNR (dB)
16-QAM	14.5	1/2	16.4
		3/4	18.2
64-QAM	19.0	2/3	22.7
		3/4	24.4

Test messages for measuring Receiver Sensitivity shall be based on a continuous stream of MAC PDUs, each with a payload consisting of a R times repeated sequence $S_{\text{modulation}}$. For each modulation, a different sequence applies:

$$S_{QPSK} = [0xE4, 0xB1, 0xE1, 0xB4]$$

$$S_{16QAM} = [0xA8, 0x20, 0xB9, 0x31, 0xEC, 0x64, 0xFD, 0x75] \quad (150)$$

$$S_{64QAM} = [0xB6, 0x93, 0x49, 0xB2, 0x83, 0x08, 0x96, 0x11, 0x41, 0x92, 0x01, 0x00, 0xBA, 0xA3, 0x8A, 0x9A, 0x21, 0x82, 0xD7, 0x15, 0x51, 0xD3, 0x05, 0x10, 0xDB, 0x25, 0x92, 0xF7, 0x97, 0x59, 0xF3, 0x87, 0x18, 0xBE, 0xB3, 0xCB, 0x9E, 0x31, 0xC3, 0xDF, 0x35, 0xD3, 0xFB, 0xA7, 0x9A, 0xFF, 0xB7, 0xDB]$$

For each mandatory test message, the $(R, S_{\text{modulation}})$ tuples that shall apply are:

Short length test message payload (288 data bytes): $(72, S_{QPSK})$, $(36, S_{16-QAM})$, $(6, S_{64-QAM})$

Mid length test message payload (864 data bytes): $(216, S_{QPSK})$, $(108, S_{16-QAM})$, $(18, S_{64-QAM})$

Long length test message payload (1536 data bytes): $(384, S_{QPSK})$, $(192, S_{16-QAM})$, $(32, S_{64-QAM})$

The test condition requirements are as follows:

- Ambient room temperature
- Shielded room
- Conducted measurement at the RF port if available
- Radiated measurement in a calibrated test environment if the antenna is integrated
- CC FEC is enabled

The test shall be repeated for each test message length and for each $(R, S_{\text{modulation}})$ tuple as identified above, using the mandatory FEC scheme. The results shall meet or exceed the sensitivity requirements set out in Table 337.

8.4.13.2 Receiver adjacent and alternate channel rejection

The adjacent channel rejection and alternate channel rejection shall be measured by setting the desired signal's strength 3 dB above the rate dependent receiver sensitivity (see Table 337) and raising the power level of the interfering signal until the specified error rate is obtained. The power difference between the interfering signal and the desired channel is the corresponding adjacent channel rejection. The interfering signal in the adjacent channel shall be a conforming OFDMA signal, not synchronized with the signal in the channel under test. For nonadjacent channel testing the test method is identical except the interfering channel shall be any channel other than the adjacent channel or the co-channel.

For the PHY to be compliant, the minimum rejection shall exceed the following:

Table 339—Adjacent and nonadjacent channel rejection

Modulation/coding	Adjacent channel rejection (dB)	Nonadjacent channel rejection (dB)
16-QAM-3/4	11	30
64-QAM-2/3	4	23

8.4.13.3 Receiver maximum input signal

The receiver shall be capable of decoding a maximum on-channel signal of -30 dBm.

8.4.13.4 Receiver maximum tolerable signal

The receiver shall tolerate a maximum signal of 0 dBm without damage.

8.4.14 Frequency control requirements

8.4.14.1 Center frequency and symbol clock frequency tolerance

At the BS, the transmitted center frequency, receive center frequency, and the symbol clock frequency shall be derived from the same reference oscillator. At the BS, the reference frequency accuracy shall be better than $\pm 2 \times 10^{-6}$.

At the SS, both the transmitted center frequency and the symbol clock frequency shall be synchronized to the BS with a tolerance of maximum 2% of the subcarrier spacing.

For Mesh capable devices, all device frequencies shall be accurate to within $\pm 20 \times 10^{-6}$ and achieve synchronization to its neighboring nodes with a tolerance of maximum 3% of the subcarrier spacing.

During the synchronization period, the SS shall acquire frequency synchronization within the specified tolerance before attempting any uplink transmission. During normal operation, the SS shall track the frequency changes and shall defer any transmission if synchronization is lost.

8.5 WirelessHUMAN specific components

8.5.1 Channelization

The channel center frequency shall follow Equation (151):

$$\text{Channel center frequency (MHz)} = 5000 + 5 n_{ch} \quad (151)$$

where $n_{ch} = 0, 1, \dots, 199$ is the Channel Nr. This definition provides an 8-bit unique numbering system for all channels, with 5 MHz spacing, from 5 GHz to 6 GHz. This provides flexibility to define channelization sets for current and future regulatory domains. The set of allowed channel numbers is shown in Table 340 for two regulatory domains. The support of any individual band in the table is not mandatory, but all channels within a band shall be supported.

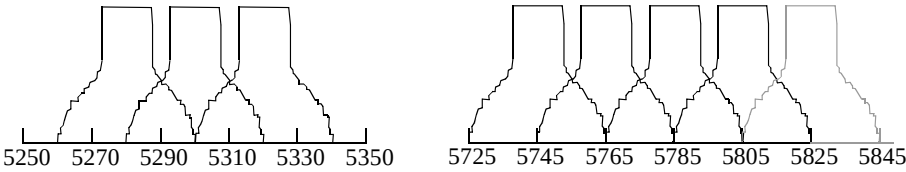
Figure 264 depicts the 20 MHz channelization scheme listed in Table 340. Channelization has been defined to be compatible with IEEE Std 802.11a-1999 for interference mitigation purposes, even though this results in less efficient spectrum usage in the middle Unlicensed National Information Infrastructure (U-NII) band.

Table 340—Channelizations

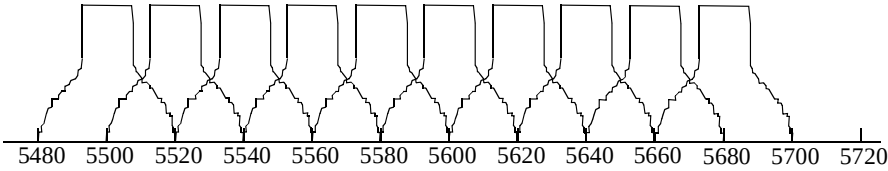
Regulatory domain	Band (GHz)	Channelization (MHz)	
		20	10
USA	U-NII middle 5.25–5.35	56, 60, 64	55, 57, 59, 61, 63, 65, 67
	U-NII upper 5.725–5.825	149, 153, 157, 161, 165 ^a	148, 150, 152, 154, 156, 158, 160, 162, 164 ^a , 166 ^a
Europe	CEPT band B ^b 5.47–5.725	100, 104, 108, 112, 116, 120, 124, 128, 132, 136	99, 101, 103, 105, 107, 109, 111, 113, 115, 117, 119, 121, 123, 125, 127, 129, 131, 133, 135, 137
	CEPT band C ^b 5.725–5.875	148, 152, 156, 160, 164, 168	147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169

^aSee CFR 47 Part 15.247.

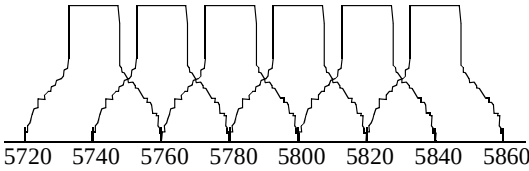
^bCurrent applicable regulations do not allow this standard to be operated in the indicated band.



U-NII middle and upper band



CEPT, 5 GHz, band B



CEPT, 5 GHz, band C

Figure 264—Channelization, 20 MHz

8.5.2 Transmit spectral mask

The transmitted spectral density of the transmitted signal shall fall within the spectral mask as shown Figure 265 and Table 341. The measurements shall be made using 100 kHz resolution bandwidth and a 30 kHz video bandwidth. The 0 dB_r level is the maximum power allowed by the relevant regulatory body.

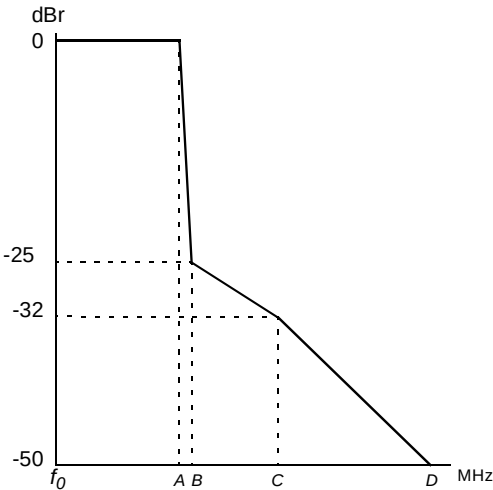


Figure 265—Transmit spectral mask (see Table 341)

Table 341—Transmit spectral mask parameters

Channelization (MHz)	A	B	C	D
20	9.5	10.9	19.5	29.5
10	4.75	5.45	9.75	14.75

9. Configuration

9.1 SS IP addressing

9.1.1 DHCP fields used by the SS

The following fields shall be present in the DHCP request from the SS and shall be set as described below and encoded as per IETF RFC 2131:

- a) The hardware type (htype) shall be set to 1 (Ethernet).
- b) The hardware length (hlen) shall be set to 6.
- c) The client hardware address (chaddr) shall be set to the 48-bit MAC address associated with the RF interface of the SS.
- d) The “client identifier” option shall be included, with the hardware type set to 1, and the value set to the same MAC address as the chaddr field.
- e) The “parameter request list” option shall be included. The option codes that shall be included in the list are:
 - 1) Option code 1 (Subnet Mask)
 - 2) Option code 2 (Time Offset)
 - 3) Option code 3 (Router Option)
 - 4) Option code 4 (Time Server Option)
 - 5) Option code 7 (Log Server Option)
 - 6) Option code 60 (Vendor Class Identifier)—A compliant SS shall send the following ASCII coded string in Option code 60: “802.16.”

The following fields are expected in the DHCP response returned to the SS. The SS shall configure itself based on the DHCP response.

- a) The IP address to be used by the SS (yiaddr).
- b) The IP address of the TFTP server for use in the next phase of the bootstrap process (siaddr).
- c) If the DHCP server is on a different network (requiring a relay agent), then the IP address of the relay agent (giaddr).
NOTE—This may differ from the IP address of the first hop router.
- d) The name of the SS configuration file to be read from the TFTP server by the SS (file).
- e) The subnet mask to be used by the SS (Subnet Mask, option 1).
- f) The time offset of the SS from UTC (Time Offset, option 2). This is used by the SS to calculate the local time for use in time-stamping error logs.
- g) A list of addresses of one or more routers to be used for forwarding SS-originated IP traffic (Router Option, option 3). The SS is not required to use more than one router IP address for forwarding.
- h) A list of time servers (IETF RFC 868) from which the current time may be obtained (Time Server Option, option 4).
- i) A list of SYSLOG servers to which logging information may be sent (Log Server Option, option 7).

9.2 SS Configuration file

9.2.1 SS binary configuration file format

The SS-specific configuration data shall be contained in the SS configuration file that is downloaded to the SS via TFTP. It shall consist of a number of configuration settings (1 per parameter), each in a TLV encoded form (see Clause 11). Note that SSs are not required to need a configuration file. In this case, the configuration file name will not be present in the DHCP response.

Configuration settings are divided into three types as follows:

- Standard configuration settings that shall be present
- Standard configuration settings that may be present
- Vendor-specific configuration settings

SSs shall be capable of processing all standard configuration settings. SSs shall ignore any configuration setting in the configuration file that it cannot interpret. To allow uniform management of SSs conformant to this specification, conformant SSs shall support a 8192 byte configuration file at a minimum.

Integrity of the configuration file information is provided by the SS message integrity check (MIC). The SS MIC is a digest that ensures the data sent from the provisioning server were not modified en route. This is not an authenticated digest (i.e., it does not include any shared secret).

The SS MIC shall immediately be followed by the End of Data marker equal to 0xFF.

In case the file is a non-integer number of 32-bit words, the file shall be padded with zeros until the next 32-bit boundary.

The file structure is shown in Figure 266:

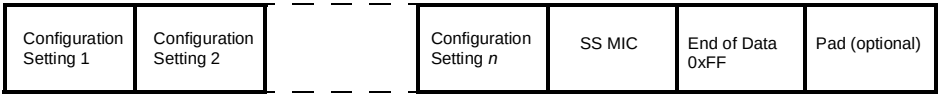


Figure 266—Configuration file structure

9.2.2 Configuration file settings

The following configuration settings shall be included in the configuration file and shall be supported by all SSs:

- a) SS MIC Configuration Setting
- b) TFTP Server Timestamp

The following configuration settings may be included in the configuration file and if present shall be supported by all SSs:

- a) Software Upgrade Filename Configuration Setting (see 11.2.2)
- b) Software Server IP Address (see 11.2.3)
- c) Authorization Node IP Address (11.2.5, Mesh only)
- d) Registration Node IP Address (11.2.6, Mesh only)
- e) Provisioning Node IP Address (11.2.7, Mesh only)
- f) Vendor-specific configuration settings

9.2.3 Configuration file creation

The sequence of operations required to create the configuration file is as shown in Figure 267, Figure 268, and Figure 269.

- a) Create the TLV entries for all the parameters required by the SS.

type, length, value for parameter 1
type, length, value for parameter 2
type, length, value for parameter <i>n</i>

Figure 267—Create TLV entries for parameters required by the SS

- b) Calculate the SS MIC configuration setting as defined in 9.2.3.1 and add to the file following the last parameter using code and length values defined for this field.

type, length, value for parameter 1
type, length, value for parameter 2
type, length, value for parameter <i>n</i>
type, length, value for SS MIC

Figure 268—Add SS MIC

- c) Add the end of data marker and pad with zeros to next 32-bit boundary if necessary.

type, length, value for parameter 1	
type, length, value for parameter 2	
type, length, value for parameter n	
type, length, value for SS MIC	
end of data marker	pad (optional)

Figure 269—Add end of data marker and pad

9.2.3.1 SS MIC calculation

The SS MIC configuration setting shall be calculated by performing a SHA-1 digest over the bytes of the configuration setting fields. It is calculated over the bytes of these settings as they appear in the TFTPed image, without regard to TLV ordering or contents. There are two exceptions to this disregard of the contents of the TFTPed image:

- The bytes of the SS MIC TLV itself are omitted from the calculation. This includes the type, length, and value fields.
- On receipt of a configuration file, the SS shall recompute the digest and compare it to the SS MIC configuration setting in the file. If the digests do not match, then the configuration file shall be discarded.

10. Parameters and constants

10.1 Global values

The BS and SS shall meet the timing requirements contained in Table 342.

Table 342—Parameters and constants

System	Name	Time reference	Minimum value	Default value	Maximum value
BS	DCD Interval	Time between transmission of DCD messages			10 s
BS	UCD Interval	Time between transmission of UCD messages			10 s
BS	UCD Transition	The time the BS shall wait after repeating a UCD message with an incremented Configuration Change Count before issuing a UL-MAP message referring to Uplink_Burst_Profiles defined in that UCD message	2 MAC frames		
BS	DCD Transition	The time the BS shall wait after repeating a DCD message with an incremented Configuration Change Count before issuing a DL-MAP message referring to Downlink_Burst_Profiles defined in that DCD message	2 MAC frames		
BS	Max MAP Pending	Maximum validity of map			End of next frame
BS	Initial Ranging Interval	Time between Initial Ranging regions assigned by the BS			2 s
BS	CLK-CMP Interval	Time between the clock compare measurements used for the generation of CLK-CMP messages.	50 ms	50 ms	50 ms
SS	Lost DL-MAP Interval	Time since last received DL-MAP message before downlink synchronization is considered lost			600 ms
SS	Lost UL-MAP Interval	Time since last received UL-MAP message before uplink synchronization is considered lost			600 ms
SS	Contention Ranging Retries	Number of retries on contention Ranging Requests	16		
SS, BS	Invited Ranging Retries	Number of retries on inviting Ranging Requests	16		
SS	Request Retries	Number of retries on bandwidth allocation requests	16		

Table 342—Parameters and constants (continued)

System	Name	Time reference	Minimum value	Default value	Maximum value
SS	Registration Request Retries	Number of retries on registration requests	3		
BS	T_{proc}	Time provided between arrival of the last bit of a UL-MAP at an SS and effectiveness of that map	SC: 200 μ s OFDM: 1 ms OFDMA: 10 OFDMA symbols		
BS	SS Ranging Response Processing Time	Time allowed for an SS following receipt of a ranging response before it is expected to reply to an invited ranging request	10 ms		
SS, BS	Minislot size (SC/SCa only)	Size of minislot for uplink transmission. Shall be a power of 2 (in units of PS)	1 PS		
SS, BS	DSx Request Retries	Number of Timeout Retries on DSA/DSC/DSD Requests		3	
SS, BS	DSx Response Retries	Number of Timeout Retries on DSA/DSC/DSD Responses		3	
SS	TFTP Backoff Start	Initial value for TFTP backoff	1 s		
SS	TFTP Backoff End	Last value for TFTP backoff	16 s		
SS	TFTP Request Retries	Number of retries on TFTP request	16		
SS	TFTP Download Retries	Number of retries on entire TFTP downloads	3		
SS	TFTP Wait	The duration between two consecutive TFTP retries	2 min		
SS	Time of Day Retries	Number of Retries per Time of Day Retry Period	3		
SS	Time of Day Retry Period	Time period for Time of Day retries	5 min		
SS	T1	Wait for DCD timeout			5 * DCD interval maximum value
SS	T2	Wait for broadcast ranging timeout			5 * ranging interval
SS	T3	Ranging Response reception timeout following the transmission of a Ranging Request		200 ms	200 ms

Table 342—Parameters and constants (continued)

System	Name	Time reference	Minimum value	Default value	Maximum value
SS	T4	Wait for unicast ranging opportunity. If the pending-until-complete field was used earlier by this SS, then the value of that field shall be added to this interval.	30 s		35 s
BS	T5	Wait for Uplink Channel Change response			2 s
SS	T6	Wait for registration response			3 s
SS, BS	T7	Wait for DSA/DSC/DSD Response timeout			1 s
SS, BS	T8	Wait for DSA/DSC Acknowledge timeout			300 ms
BS	T9	Registration Timeout, the time allowed between the BS sending a RNG-RSP (success) to an SS, and receiving a SBC-REQ from that same SS	300 ms	300 ms	
SS, BS	T10	Wait for Transaction End timeout			3 s
SS	T12	Wait for UCD descriptor			5 * UCD Interval maximum value
BS	T13	The time allowed for an SS, following receipt of a REG-RSP message to send a TFTP-CPLT message to the BS	15 min	15 min	
SS	T14	Wait for DSX-RVD Timeout			200 ms
BS	T15	Wait for MCA-RSP	20 ms	20 ms	
SS	T16	Wait for bandwidth request grant	10 ms		service QoS dependent
BS	T17	Time allowed for SS to complete SS Authorization and Key Exchange	5 min	5 min	
SS	T18	Wait for SBC-RSP timeout		50 ms	<< T9
SS	T19	Time DL-channel remains unusable			
SS	T20	Time the SS searches for preambles on a given channel	2 MAC frames		
SS	T21	Time the SS searches for DL-MAP on a given channel			10 s
SS, BS	T22	Wait for ARQ-Reset			0.5 s

Table 342—Parameters and constants (continued)

System	Name	Time reference	Minimum value	Default value	Maximum value
Mesh node	T23	Network Entry: Detect network	1 s		
Mesh node	T24	Network Entry: Accumulate MSH-NCFG messages		120 s	
Mesh node	T25	Network Entry: Wait for MSH-NENT/MSH-NCFG		1 s	
SS	SBC Request Retries	Number of retries on SBC Request	3	3	16
SS	TFTP-CPLT Retries	Number of retries on TFTP-CPLT	3	3	16
SS	T26	Wait for TFTP-RSP	10 ms	200 ms	200 ms
BS	T27 as Idle Timer	Maximum time between unicast grants to SS when BS believes SS uplink transmission quality is <i>good enough</i>	SS Ranging Response Processing Time		
BS	T27 as Active Timer	Maximum time between unicast grants to SS when BS believes SS uplink transmission quality is <i>not good enough</i>	SS Ranging Response Processing Time		
SS	SS downlink management message processing time	Max. time between reception of Fast Power Control management message and compliance to its instructions by SS			200 μ s (OFDM only)

10.2 PKM parameter values

Table 343 defines the ranges and default values for the PKM configuration and operational parameters.

For the purposes of protocol testing, it is useful to run the privacy protocol with timer values well below the low end of the operational ranges. The shorter timer values “speed up” privacy’s clock, causing privacy protocol state machine events to occur far more rapidly than they would under an “operational” configuration. While privacy implementations need not be designed to operate efficiently at this accelerated privacy pace, the protocol implementation should operate correctly under these shorter timer values. Table 344 provides a list of shortened parameter values that are likely to be employed in protocol conformance and certification testing.

The TEK Grace Time shall be less than half the TEK lifetime.

Table 343—Operational ranges for privacy configuration settings

System	Name	Description	Minimum value	Default value	Maximum value
BS	AK Lifetime	Lifetime, in seconds, BS assigns to new AK	1 day (86 400 s)	7 days (604 800 s)	70 days (6 048 000 s)
BS	TEK Lifetime	Lifetime, in seconds, BS assigns to new TEK	30 min (1800 s)	12 h (43 200 s)	7 days (604 800 s)
SS	Authorize Wait Timeout	Auth Req retransmission interval from Auth Wait state	2 s	10 s	30 s
SS	Reauthorize Wait Timeout	Auth Req retransmission interval from Reauth Wait state	2 s	10 s	30 s
SS	Authorization Grace Time	Time prior to Authorization expiration SS begins reauthorization	5 min (300 s)	10 min (600 s)	35 days (3 024 000 s).
SS	Operational Wait Timeout	Key Req retransmission interval from Op Wait state	1 s	1 s	10 s
SS	Rekey Wait Timeout	Key Req retransmission interval from Rekey Wait state	1 s	1 s	10 s
SS	TEK Grace Time	Time prior to TEK expiration SS begins rekeying	5 min (300 s)	1 h (3600 s)	3.5 days (302 399 s)
SS	Authorize Reject Wait Timeout	Delay before resending Auth Request after receiving Auth Reject	10 s	60 s	10 min (600 s)

Table 344—Values for privacy configuration setting for protocol testing

Parameter	Shortened value
AK Lifetime	5 min (300 s)
TEK Lifetime	3 min (180 s)
Authorization Grace Time	1 min (60 s)
TEK Grace time	1 min (60 s)

10.3 PHY-specific values

10.3.1 WirelessMAN-SC parameter and constant definitions

10.3.1.1 PS

For the WirelessMAN-SC PHY, a PS is the duration of four modulation symbols at the symbol rate of the downlink transmission.

10.3.1.2 Symbol rate

The symbol rate shall be in the range 10–44.8 MBd, in increments of 100 kBd.

10.3.1.3 Uplink center frequency

The uplink center frequency shall be a multiple of 250 kHz.

10.3.1.4 Downlink center frequency

The downlink center frequency shall be a multiple of 250 kHz.

10.3.1.5 Tolerated poll jitter

For the 10–66 GHz PHY, the minimum value of the Tolerated Poll Jitter (see 11.13.13) shall be 3000 μ s.

10.3.1.6 Allocation Start Time

Unit of Allocation Start Time shall be minislots from the start of the downlink frame in which the UL-MAP message occurred.

10.3.1.7 Timing Adjust Units

The timing adjust units shall be 1/4 modulation symbols. During periodic ranging, the range of the value of this parameter shall be limited to ± 2 modulation symbols.

10.3.2 WirelessMAN-SCa parameters and constant definitions**10.3.2.1 Uplink Allocation Start Time**

Unit of Allocation Start Time shall be PSs from the start of the downlink frame in which the UL-MAP message occurred. The minimum value specified for this parameter shall correspond to one frame duration.

10.3.2.2 PS

PSs are defined as in Equation (152):

$$PS = 4 \times \text{Symbol duration} \quad (152)$$

10.3.2.3 Timing adjust units

The timing adjust units shall be 1/32 modulation symbols.

10.3.3 WirelessMAN-OFDM parameters and constant definitions**10.3.3.1 Uplink Allocation Start Time**

Unit of Allocation Start Time shall be PSs from the start of the downlink frame in which the UL-MAP message occurred. The minimum value specified for this parameter shall correspond to a point in the frame 1 ms after the last symbol of the UL-MAP.

10.3.3.2 PS

PSs are defined as in Equation (153):

$$PS = 4/F_s \quad (153)$$

10.3.3.3 Timing adjust units

The timing adjust units shall be $1/F_s$.

10.3.4 WirelessMAN-OFDMA parameters and constant definitions

10.3.4.1 Uplink Allocation Start Time

Unit of Allocation Start Time shall be PSs from the start of the downlink frame in which the UL-MAP message occurred. The minimum value specified for this parameter shall correspond to 10 OFDMA symbols.

10.3.4.2 PS

PSs are defined as Equation (154):

$$PS = 4/F_s \tag{154}$$

10.3.4.3 Timing adjust units

The timing adjust units shall be $1/F_s$.

10.4 Well-known addresses and identifiers

There are several CIDs defined in Table 345 that have specific meaning. These identifiers shall not be used for any other purposes.

Table 345—CIDs

CID	Value	Description
Initial ranging	0x0000	Used by SS and BS during initial ranging process.
Basic CID	0x0001– <i>m</i>	The same value is assigned to both the DL and UL connection.
Primary management	<i>m</i> +1 – 2 <i>m</i>	The same value is assigned to both the DL and UL connection.
Transport CIDs and secondary Mgt CIDs	2 <i>m</i> +1–0xFEFE	For the secondary management connection, the same value is assigned to both the DL and UL connection.
AAS initial ranging CID	0xFEFF	A BS supporting AAS shall use this CID when allocating a Initial Ranging period for AAS devices.
Multicast polling CIDs	0xFF00–0xFFFD	An SS may be included in one or more multicast polling groups for the purposes of obtaining bandwidth via polling. These connections have no associated service flow.
Padding CID	0xFFFE	Used for transmission of padding information by SS and BS.
Broadcast CID	0xFFFF	Used for broadcast information that is transmitted on a downlink to all SS.

11. TLV encodings

The following TLV encodings shall be used for parameters in both the configuration file (Clause 9) and MAC Management messages (6.3.2.3). TLV tuples with Type values not specified in this standard or specified as “*reserved*” should be silently discarded. The length of the Type field shall be one byte.

The format of the Length field shall be per the “definite form” of ITU-T X.690. Specifically, if the actual length of the Value field is less than or equal to 127 bytes, then

- The length of the Length field shall be one byte,
- The MSB of the Length field shall be set to 0, and
- The other 7 bits of the Length field shall be used to indicate the actual length of the value field in bytes.

If the length of the Value field is more than 127 bytes, then:

- The length of the length field shall be one byte more than what is actually used to indicate the length of the value field in bytes,
- The MSB of the first byte of the length field shall be set to 1,
- The other 7 bits of the first byte of the length field shall be used to indicate the number of additional bytes of the length field (i.e., excluding the first byte), and
- The remaining bytes (i.e., excluding the first byte) of the length field shall be used to indicate the actual length of the value field.

NOTE—Uniqueness of TLV Type values is assured by identifying the groups of IEEE 802.16 entities (configuration file and/or MAC Management messages) that share references to specific TLV encodings. Disjoint collections of TLVs are formed that correspond to each such functional grouping. Each set of TLVs that are explicitly defined to be members of a compound TLV structure form additional collections. Unique Type values are assigned to the member TLV encodings of each collection.

An additional collection, the Common encodings, is defined that consists of TLV encodings that are referenced by more than one of the functional groups. The Type values of the TLV members of this collection are assigned to assure uniqueness across all collections. This is the only collection for which global uniqueness is guaranteed.

In cases where a collection contains TLV encodings that are PHY specification specific, subcollections are formed that contain these TLV encodings. Type values assigned to members of each subcollection are assigned such that the values are unique within the subcollection and with non-PHY specification specific members of the collection. Type values are not unique across PHY-specific subcollections.

TLV Type values are assigned in accordance with the following rules:

- Common encodings start at 149, subsequent values are assigned in descending order.
- For individual collections, non-PHY specification specific encodings start at 1, subsequent values are assigned in ascending order.
- For individual collections, PHY specification specific encodings start at 150, subsequent values are assigned in ascending order.

11.1 Common encodings

Common TLV fields and their associated type codes are presented in Table 346.

Table 346—Type values for common TLV encodings

Type	Name
149	HMAC tuple
148	MAC version encoding
147	Current transmit power
146	Downlink service flow
145	Uplink service flow
144	Vendor ID encoding
143	Vendor-specific information

11.1.1 Current transmit power

The parameter indicates the transmitted power used for the burst which carried the message. The parameter is reported in dBm and is quantized in 0.5 dBm steps ranging from −64 dBm (encoded 0x00) to 63.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme. The parameter is only applicable to systems supporting the SCa, OFDM, or OFDMA PHY specifications.

Type	Length	Value	Scope
147	1	Current transmitted power	SBC-REQ, REP-RSP

When included in an SBC-REQ message, the TLV is encapsulated in the Physical supported parameters compound TLV

11.1.2 HMAC tuple

This parameter contains the HMAC Key Sequence Number concatenated with an HMAC-Digest used for message authentication. The HMAC Key Sequence Number is stored in the four least significant bits of the first byte of the HMAC Tuple, and the most significant four bits are reserved. The HMAC-Tuple attribute format is shown in Table 347 and Table 348.

Table 347—HMAC Tuple definition

Type	Length	Value	Scope
149	21	See Table 348	DSx-REQ, DSx-RSP, DSx-ACK, REG-REQ, REG-RSP, RES-CMD, DREG-CMD, TFTP-CPLT

Table 348—HMAC Tuple value field

Field	Length	Notes
<i>reserved</i>	4 bits	
HMAC Key Sequence Number	4 bits	
HMAC-Digest	160 bits	HMAC with SHA-1

11.1.3 MAC version encoding

This parameter specifies the version of IEEE 802.16 to which the message originator conforms. If the MAC version values exchanged between a BS and SS during network entry and initialization differ, one of the following actions are taken:

- BS version > SS version ==> SS performs normal operations, but BS communicates with the SS per the version level specified by the SS.
- BS version < SS version ==> SS performs normal operations, but does so in conformance with the version level specified by BS. If backward-compatibility is not supported, SS disables any attempt for uplink transmission to BS.

Type	Length	Value	Scope
148	1	Version number of 802.16 supported on this channel. 1: Indicates conformance with IEEE Std 802.16-2001 2: Indicates conformance with IEEE Std 802.16c-2002 and its predecessors 3: Indicates conformance with IEEE Std 802.16a-2003 and its predecessors 4: Indicates conformance with IEEE Std 802.16-2004 5–255: <i>reserved</i>	PMP: DCD, RNG-REQ MESH: REG-REQ, REG-RSP

11.1.4 Service flow descriptors

Information regarding the attributes of an uplink or downlink service flow shall be encapsulated in a compound structure identified by the appropriate TLV Type value. The contents of the compound structure are defined in 11.13.

Type	Length	Value	Scope
146	<i>variable</i>	Compound: Downlink service flow	DSx-REQ, DSx-RSP, DSx-ACK
145	<i>variable</i>	Compound: Uplink service flow	DSx-REQ, DSx-RSP, DSx-ACK

11.1.5 Vendor ID encoding

The value field contains the vendor identification specified by the 3-byte, vendor-specific organizationally unique identifier of the SS or BS MAC address.

When used as a subfield of the TLVs Vendor-specific information, Vendor-specific QoS parameters, Vendor-specific classifier parameters, Vendor-specific PHS parameters, or Software upgrade descriptors, the Vendor ID encoding identifies the Vendor ID of the SSs that are intended to use this information. A vendor ID used in a Registration Request shall be the Vendor ID of the SS sending the request. A vendor ID used in a Registration Response shall be the Vendor ID of the BS sending the response.

Type	Length	Value	Scope
144	3	v1, v2, v3	REG-REQ (see 6.3.2.3.7), REG-RSP (see 6.3.2.3.8) DSx-REQ, DSx-RSP, DSx-ACK, Configuration File

11.1.6 Vendor-specific information

Vendor-specific information for SSs, if present, shall be encoded in the vendor-specific information field (VSIF) (type 143) using the Vendor ID field (11.1.5) to specify which tuples apply to which vendor’s products. The Vendor ID shall be the first TLV embedded inside VSIF. If the first TLV inside VSIF is not a Vendor ID, then the TLV shall be discarded.

This configuration setting may appear multiple times. The same Vendor ID may appear multiple times. This configuration setting may be nested inside a Packet Classification Configuration Setting, a Service Flow Configuration Setting, or a Service Flow Response. However, there shall not be more than one Vendor ID TLV inside a single VSIF.

Type	Length	Value
143	<i>variable</i>	Per vendor definition

Example:

Configuration with vendor A specific fields and vendor B specific fields:

VSIF (143) + *n* (number of bytes inside this VSIF)
 8 (Vendor ID Type) + 3 (length field) + Vendor ID of Vendor A
 Vendor A Specific Type #1 + length of the field + Value #1
 Vendor A Specific Type #2 + length of the field + Value #2

VSIF (143) + *n* (number of bytes inside this VSIF)
 8 (Vendor ID Type) + 3 (length field) + Vendor ID of Vendor B
 Vendor B Specific Type + length of the field + Value

11.2 Configuration file encodings

These settings are found only in the configuration file. They shall not be forwarded to the BS in the Registration Request.

11.2.1 SS MIC configuration setting

This value field contains the SS MIC code. This is used to detect unauthorized modification or corruption of the configuration file.

Type	Length	Value
1	20	d1 d2..... d20

11.2.2 Software upgrade descriptors

This field defines the parameters associated with software upgrades. It is composed of one or more upgrade descriptors. An upgrade descriptor is defined by the set of all encapsulated tags defined in 11.2.2.1 through 11.2.2.4, occurring in order in the TFTP file. A new upgrade descriptor begins with the occurrence of the Vendor ID TLV.

Type	Length	Value
2	<i>variable</i>	Compound

When a managed SS decodes a descriptor with a matching Vendor ID, Hardware ID, and Software version different than the one currently running, it may initiate a TFTP transfer to upgrade its software.

11.2.2.1 Vendor ID

This value identifies the managed SS vendor to which the software upgrade is to be applied. Its format and value is described in 11.1.5.

Type	Length	Value
2.144	3	v1, v2, v3

11.2.2.2 Hardware ID

This value identifies the hardware version to which the software upgrade is to be applied. This value is administered by the vendor identified by the Vendor ID field.

Type	Length	Value
2.1	<i>n</i>	Hardware ID (string)

11.2.2.3 Software version

This value identifies the software version of the software upgrade file. The value is administered by the vendor identified in the Vendor ID field. It should be defined by the vendor to be unique with respect to a given Hardware ID.

Type	Length	Value
2.2	<i>n</i>	Software version (string)

11.2.2.4 Upgrade filename

The filename of the software upgrade file for the managed SS. The filename is a fully qualified directory-path name that is in a format appropriate to the server. There is no requirement that the character string be null-terminated; the length field always identifies the end of the string. The file is expected to reside on a TFTP server identified in a configuration setting option defined in 11.2.3.

Type	Length	Value
2.3	<i>n</i>	Filename

11.2.3 Software upgrade TFTP server

This object is the IP address of the TFTP server on which the software upgrade file for the SS resides.

Type	Length	Value
3	4 or 16	IP Address

11.2.4 TFTP Server Timestamp

This is the sending time of the configuration file in seconds. The definition of time is as in IETF RFC 868.

Type	Length	Value
4	4	Number of seconds since 00:00 1 January 1900

NOTE—The purpose of this parameter is to prevent replay attacks with old configuration files.

11.2.5 Authorization Node

The Authorization Node parameter contains the IP address of the Authorization Node.
Applicable only to Mesh mode.

Type	Length	Value
5	4 or 16	IP Address

11.2.6 Registration Node

The Registration Node parameter contains the IP address of the Registration Node.
Applicable only to Mesh mode.

Type	Length	Value
6	4 or 16	IP Address

11.2.7 Provisioning Node

The Provisioning Node parameter contains the IP address of the Provisioning Node.
Applicable only to Mesh mode.

Type	Length	Value
7	4 or 16	IP Address

11.3 UCD management message encodings

The UCD message encodings are specific to the UCD message (see 6.3.2.3.3).

11.3.1 UCD channel encodings

UCD channel encodings shared across PHY specifications are provided in Table 349.

Table 349—UCD common channel encodings

Name	Type (1 byte)	Length	Value
Uplink_Burst_Profile	1		May appear more than once (see 6.3.2.3.3). The length is the number of bytes in the overall object, including embedded TLV items.
Contention-based reservation timeout	2	1	Number of UL-MAPs to receive before contention-based reservation is attempted again for the same connection.

Table 349—UCD common channel encodings (*continued*)

Name	Type (1 byte)	Length	Value
Bandwidth request opportunity size	3	2	Size (in units of PS) of PHY payload that SS may use to format and transmit a bandwidth request message in a contention request opportunity. The value includes all PHY overhead as well as allowance for the MAC data the message may hold.
Ranging request opportunity size	4	2	Size (in units of PS) of PHY bursts that an SS may use to transmit a RNG-REQ message in a contention ranging request opportunity. The value includes all PHY overhead as well as the maximum SS/BS round trip propagation delay.
Frequency	5	4	Uplink center frequency (kHz).

The UCD channel encodings unique to each PHY specifications are provided in Table 350, Table 351, Table 352, and Table 353.

Table 350—UCD PHY-specific channel encodings — WirelessMAN-SC

Name	Type (1 byte)	Length	Value
Symbol rate	150	2	Symbol rate, in increments of 10 kBd.
SSTG	151	1	The time, as measured at the BS and expressed in PSs, between the end of an SS burst and the beginning of the subsequent SS burst. The SS shall take this into account when determining the length of the burst. The SSTG consumes the last n PS of the intervals allocated in the UL-MAP. That is, UL-MAP entries include the time for a burst's ramp down.
Roll-off factor	152	1	2 = 0.25 0, 1, 3–255 <i>Reserved</i>
Power adjustment rule	153	1	0 = Preserve Peak Power 1 = Preserve Mean Power Describes the power adjustment rule when performing a transition from one burst profile to another.
Minislot Size	154	1	The size n of the minislot for this uplink channel in units of physical slots (PSs). Allowable values are $n = 2^m$, where m is an integer ranging from 0 through 7.
UL channel ID	155	1	The identifier of the uplink channel to which this message refers. This identifier is arbitrarily chosen by the BS and is only unique within the MAC domain.

Table 351—UCD PHY-specific channel encodings — WirelessMAN-SCa

Name	Type (1 byte)	Length	Value
Symbol rate	150	2	Symbol rate, in increments of 10 kBd.
SSTG	151	1	The time, as measured at the BS and expressed in PSs, between the end of an SS burst and the beginning of the subsequent SS burst. The SS shall take this into account when determining the length of the burst. The SSTG consumes the last n PS of the intervals allocated in the UL-MAP. That is, UL-MAP entries accommodate the RxDS burst element, which includes time for both ramp down and delay spread to clear the receiver.
Roll-off factor	152	1	0 = 0.15 1 = 0.18 2 = 0.25 (default) 3–255 = <i>Reserved</i>
Power adjustment rule	153	1	0 = Preserve Peak Power 1 = Preserve Mean Power Describes the power adjustment rule when performing a transition from one burst profile to another.
Initial Ranging SSTG	154	1	The time, as measured at the BS and expressed in PSs, between the end of an SS burst and the beginning of a subsequent burst residing in an Initial Ranging slot. Or, the time, as measured at the BS and expressed in PSs, between the end of burst in an Initial Ranging slot and beginning of a subsequent SS burst. An SS shall take this into account when determining the length of a burst in an Initial Ranging slot. The Initial Ranging SSTG consumes the last n PS of the intervals allocated in the UL-MAP. That is, UL-MAP entries accommodate the RxDS burst element, which includes time for both ramp down and delay spread to clear the receiver.
Minislot Size	155	1	The size n of the minislot for this uplink channel in units of physical slots (PSs). Allowable values are $n = 2^m$, where m is an integer ranging from 0 through 7.
UL channel ID	156	1	The identifier of the uplink channel to which this message refers. This identifier is arbitrarily chosen by the BS and is only unique within the MAC domain.

Table 352—UCD PHY-specific channel encodings — WirelessMAN-OFDM

Name	Type (1 byte)	Length	Value
Subchannelization REQ Region-Full Parameters	150	1	Bits 0...2 Number of subchannels used by each transmit opportunity when REQ Region-Full is allocated in subchannelization region, per the following enumeration: 0: 1 Subchannel. 1: 2 Subchannels. 2: 4 Subchannels. 3: 8 Subchannels. 4: 16 Subchannels. 5-7: Shall not be used. Bits 3...7: Number of OFDM symbols used by each transmit opportunity when REQ Region-Full is allocated in subchannelization region.
Subchannelization focused contention codes	151	1	Number of contention codes (C_{SE}) that shall only be used to request a subchannelized allocation. Default value 0. Allowed values 0–8.

Table 353—UCD PHY-specific channel encodings — WirelessMAN-OFDMA

Name	Type (1 byte)	Length	Value
Initial ranging codes	150	1	Number of initial ranging CDMA codes. Possible values are 0–255. ^a
Periodic ranging codes	151	1	Number of periodic ranging CDMA codes. Possible values are 0–255. ^a
Bandwidth request codes	152	1	Number of bandwidth request codes. Possible values are 0–255. ^a
Periodic ranging backoff start	153	1	Initial backoff window size for periodic ranging contention, expressed as a power of 2. Range: 0–15 (the highest order bits shall be unused and set to 0).
Periodic ranging backoff end	154	1	Final backoff window size for periodic ranging contention, expressed as a power of 2. Range: 0–15 (the highest order bits shall be unused and set to 0).
Start of ranging codes group	155	1	Indicates the starting number, S , of the group of codes used for this uplink. All the ranging codes used on this uplink will be between S and $((S+N+M+L) \bmod 256)$. Where, N is the number of initial-ranging codes M is the number of periodic-ranging codes L is the number of bandwidth-request codes The range of values is $0 \leq S \leq 255$.
Permutation base	156	1	Determines the UL_IDcell parameter for the subcarrier permutation to be used on this uplink channel.
UL allocated subchannels bitmap	157	9	This is a bitmap describing the subchannels allocated to the segment in the UL, when using the uplink PUSC permutation. The LSB of the first byte shall correspond to subchannel 0. For any bit that is not set, the corresponding subchannel shall not be used by the SS on that segment.
Optional permutation UL Allocated subchannels bitmap	158	13	This is a bitmap describing the subchannels allocated to the segment in the UL, when using the uplink optional PUSC permutation (see 8.4.6.2.5). The LSB of the first byte shall correspond to subchannel 0. For any bit that is not set, the corresponding subchannel shall not be used by the SS on that segment.
Band AMC Allocation Threshold	159	1	dB unit
Band AMC Release Threshold	160	1	dB unit
Band AMC Allocation Timer	161	1	Frame unit
Band AMC Release Timer	162	1	Frame unit
Band Status Reporting MAX Period	163	1	Frame unit
Band AMC Retry Timer	164	1	Frame unit
Safety Channel Allocation Threshold	165	1	dB unit
Safety Channel Release Threshold	166	1	dB unit
Safety Channel Allocation Timer	167	1	Frame unit

Table 353—UCD PHY-specific channel encodings — WirelessMAN-OFDMA (continued)

Name	Type (1 byte)	Length	Value
Safety Channel Release Timer	168	1	Frame unit
Bin Status Reporting MAX Period	169	1	Frame unit
Safety Channel Retry Timer	170	1	Frame unit
H-ARQ ACK delay for UL burst	171	1	1 = one frame offset 2 = two frames offset 3 = three frames offset
CQICH Band AMC-Transition Delay	172	1	Frame unit

^aThe total number of codes shall be equal or less than 256.

11.3.1.1 Uplink burst profile encodings

The uplink burst profile encodings unique to each PHY specification are provided in Table 354, Table 355, Table 356, and Table 357.

Table 354—UCD burst profile encodings—WirelessMAN-SC

Name	Type (1 byte)	Length	Value (variable-length)
Modulation type	150	1	1=QPSK, 2=16-QAM, 3=64-QAM
Preamble length	151	1	The number of symbols in the preamble pattern. The preamble consumes the first n PS of the intervals allocated in the UL-MAP. That is, UL-MAP entries include the bandwidth for a burst's preamble.
FEC Code Type	152	1	1 = Reed–Solomon only 2 = Reed–Solomon + Inner (24,16) Block Convolutional Code (BCC) 3 = Reed–Solomon + Inner (9,8) Parity Check Code 4 = BTC (Optional) 5–255 = <i>Reserved</i>
RS information bytes (K)	153	1	$K = 6$ –255
RS parity bytes (R)	154	1	$R = 0$ –32 (error correction capability $T = 0$ –16)
BCC code type	155	1	1 = (24,16) 2–255 = <i>Reserved</i>
BTC row code type	156	1	1 = (64,57) Extended Hamming 2 = (32,26) Extended Hamming 3–255 = <i>Reserved</i> .
BTC column code type	157	1	1 = (64,57) Extended Hamming 2 = (32,26) Extended Hamming 3–255 = <i>Reserved</i>

Table 354—UCD burst profile encodings—WirelessMAN-SC

Name	Type (1 byte)	Length	Value (variable-length)
BTC interleaving type	158	1	1 = No interleaver, 2 = Block Interleaving, 3–255 = <i>Reserved</i> .
Randomizer seed	159	2	The 15 bit seed value left-justified in the 2 byte field. Bit 15 is the MSB of the first byte, and the LSB of the second byte is not used.
Last codeword length	160	1	1 = fixed; 2 = shortened

Table 355—UCD burst profile encodings—WirelessMAN-SCa

Name	Type (1 byte)	Length	Value (variable length)
Modulation type	150	1	4 MSB: 1 = QPSK, 2 = 16-QAM, 3 = 64-QAM, 4 = 256-QAM, 5 = BPSK, 6–10 = Spread BPSK with $F_s=0-4$, 11–15 = <i>Reserved</i> 4 LSB: 1 = CC+RS without block interleaving 2 = CC+RS with block interleaving 3 = no FEC, 4 = BTC, 5 = CTC, 6–15 = <i>Reserved</i>
Preamble length	151	1	4 MSB: Number of Unique Words in Preamble (0–7) 4 LSB: Number of PSs in ramp up (0–15)
RS Information bytes (K)	152	1	$K = 6-239$
RS Parity bytes (R)	153	1	$R = 0-16$ bytes (error correction capability = 0–8 bytes) $R = 17-255$ <i>Reserved</i>
Block interleaver depth	154	1	Number of rows (Reed–Solomon code words) used in block interleaver between Reed–Solomon and CC: rows = 2–66; <i>Reserved</i> = 0, 1, 67–255
CC/CTC-Specific parameters	155	1	0 = rate 1/2 (for BPSK, QPSK, 16-QAM) 1 = rate 2/3 (for QPSK, 64-QAM) 2 = rate 3/4 (for BPSK, QPSK, 16-QAM, 256-QAM) 3 = rate 5/6 (for QPSK, 64-QAM) 4 = rate 7/8 (for QPSK, 256-QAM) 5–255 = <i>Reserved</i>
Unique word length	156	1	Number of symbols (U) in a Unique Word: 0 = 16, 1 = 64, 2 = 256
Pilot word parameters	157	1	4 MSB: Pilot Word Interval [Regular bursts] (Pilot word's length in symbols included in interval). 0 = No pilot words, 1 = 256, 2 = 512, 3 = 1024, 4 = 2048, 5 = 4096, 6–15 <i>reserved</i> [STC-encoded bursts] 0 = No pilot words, 1–15 = Number of paired blocks between pilot words 4 LSB: Number of contiguous Unique Words composing a Pilot Word (1–5)

Table 355—UCD burst profile encodings—WirelessMAN-SCa (continued)

Name	Type (1 byte)	Length	Value (variable length)
Burst set type	158	1	0 = Standard, 1 = STC, 2 = Subchannel, 3–255 = <i>Reserved</i>
STC Parameters	159	2	4 MSB: Block length (segments are paired), in symbols: 1 = 64, 2 = 128, 3 = 256, 4 = 512, ..., 7 = 4096, 8–15 <i>Reserved</i> 4 LSB: Block burst profile type: 0 = CP derived from data and no UWs embedded within block 1 = CP derived from data an additional UW as first payload data element in block 2 = CP derived from UWs at beginning and end of segment 3–15 = <i>Reserved</i>
BTC Code selector	160	1	Value used to choose set of BTC row/column codes. 1–3 = C_{bank} 0, 4–255 = <i>Reserved</i>
Spreading Parameters	161	1	0–15 = PN sequence generator seed labels 0–15, 16–255 = <i>Reserved</i>
Subchannel framing parameters	162	1	4 MSB: {k,d} specification 0 = {0,1}, 1 = {0,2}, 2 = {1,0}, 3 = {1,1}, 4 = {1,2}, 5 = {2,2}, 6–15 = <i>Reserved</i> 4 LSB: Repeat segment length, r, in symbols 0:7 = $2^{(\text{value} > +8)}$, 7–15 = <i>Reserved</i>

Table 356—UCD burst profile encodings—WirelessMAN-OFDM

Name	Type (1 byte)	Length	Value (variable length)
FEC Code type and modulation type	150	1	0 = BPSK (CC) 1/2 11 = 64-QAM (BTC) 2/3 1 = QPSK (RS+CC/CC) 1/2 12 = 64-QAM (BTC) 5/6 2 = QPSK (RS+CC/CC) 3/4 13 = QPSK (CTC) 1/2 3 = 16-QAM (RS+CC/CC) 1/2 14 = QPSK (CTC) 2/3 4 = 16-QAM (RS+CC/CC) 3/4 15 = QPSK (CTC) 3/4 5 = 64-QAM (RS+CC/CC) 2/3 16 = 16-QAM (CTC) 1/2 6 = 64-QAM (RS+CC/CC) 3/4 17 = 16-QAM (CTC) 3/4 7 = QPSK (BTC) 1/2 18 = 64-QAM (CTC) 2/3 8 = QPSK (BTC) 3/4 19 = 64-QAM (CTC) 3/4 9 = 16-QAM (BTC) 3/5 20–255 = <i>Reserved</i> 10 = 16-QAM (BTC) 4/5
Focused conten- tion power boost	151	1	The power boost in dB of focused contention carriers, as described in 8.3.7.3.3.
TCS_enable	152	1	0 = TCS disabled 1 = TCS enabled 2–255 = <i>Reserved</i>

Table 357—UCD burst profile encodings—WirelessMAN-OFDMA

Name	Type (1 byte)	Length	Value (variable length)
FEC Code type and modulation type	150	1	0 = QPSK (CC) 1/2 14 = QPSK (CTC) 3/4 1 = QPSK (CC) 3/4 15 = 16-QAM (CTC) 1/2 2 = 16-QAM (CC) 1/2 16 = 16-QAM (CTC) 3/4 3 = 16-QAM (CC) 3/4 17 = 64-QAM (CTC) 2/3 4 = 64-QAM (CC) 2/3 18 = 64-QAM (CTC) 3/4 5 = 64-QAM (CC) 3/4 19 = 64-QAM (CTC) 5/6 6 = QPSK (BTC) 1/2 20 = QPSK (ZT CC) 1/2 7 = QPSK (BTC) 2/3 21 = QPSK (ZT CC) 3/4 8 = 16-QAM (BTC) 3/5 22 = 16-QAM (ZT CC) 1/2 9 = 16-QAM (BTC) 4/5 23 = 16-QAM (ZT CC) 3/4 10 = 64-QAM (BTC) 5/8 24 = 64-QAM (ZT CC) 2/3 11 = 64-QAM (BTC) 4/5 25 = 64-QAM (ZT CC) 3/4 12 = QPSK (CTC) 1/2 26..255 = <i>Reserved</i> 13 = QPSK (CTC) 2/3
Ranging data ratio	151	1	Reducing factor in units of 1 dB, between the power used for this burst and power should be used for CDMA Ranging.
Normalized C/N override	152	5	This is a list of numbers, where each number is encoded by one nibble, and interpreted as a signed integer. The nibbles correspond in order to the list define by Table 334, starting from the second line, such that the LS nibble of the first byte corresponds to the second line in the table. The number encoded by each nibble represents the difference in normalized C/N relative to the previous line in the table.

11.4 DCD management message encodings

The DCD message encodings are specific to the DCD message (see 6.3.2.3.1).

11.4.1 DCD channel encodings

The DCD Channel Encoding are provided in Table 358.

Table 358—DCD channel encoding

Name	Type (1 byte)	Length	Value (variable length)	PHY scope
Downlink_Burst_Profile	1		May appear more than once (see 6.3.2.3.1). The length is the number of bytes in the overall object, including embedded TLV items.	All
BS EIRP	2	2	Signed in units of 1 dBm.	All
Frame duration	3	4	The number of PSs contained in a Burst FDD or TDD frame. Required only for framed downlinks.	SC
PHY Type	4	1	The PHY Type to be used.	SC
Power adjustment rule	5	1	0=Preserve Peak Power 1=Preserve Mean Power Describes the power adjustment rule when performing a transition from one burst profile to another.	SC, SCa
Channel Nr	6	1	Downlink channel number as defined in 8.5. Used for license-exempt operation only.	SCa, OFDM, OFDMA
TTG	7	1	TTG (in PSs).	SCa, OFDM, OFDMA
RTG	8	1	RTG (in PSs).	SCa, OFDM, OFDMA
$RSS_{IR,max}$	9	2	Initial Ranging Max. Received Signal Strength at BS Signed in units of 1 dBm.	All
Channel Switch Frame Number	10	3	Channel switch frame number as defined in 6.3.15.7. Used for license-exempt operation only.	SCa, OFDM, OFDMA
Frequency	12	4	Downlink center frequency (kHz).	All
BS ID	13	6	Base Station ID.	SCa, OFDM, OFDMA
Frame Duration Code	14	1	The duration of the frame. The frame duration code values are specified in Table 232.	OFDM
Frame Number	15	3	The number of the frame containing the DCD message.	OFDM

Table 358—DCD channel encoding (*continued*)

Name	Type (1 byte)	Length	Value (variable length)	PHY scope
Size of CQICH_ID field	16	1	0 = <i>Reserved</i> 1 = 3 bits 2 = 4 bits 3 = 5 bits 4 = 6 bits 5 = 7 bits 6 = 8 bits 7 = 9 bits 8...255 = <i>Reserved</i>	OFDMA
H-ARQ ACK delay for DL burst	17	1	1 = 1 frame offset 2 = 2 frame offset 3 = 3 frame offset	OFDMA
MAC version	148	1	See 11.1.3.	All

11.4.2 Downlink burst profile encodings

Downlink burst profile encodings are presented in Table 360. Encodings for TLVs common to all PHY specifications are presented in Table 359.

Table 359—DCD PHY-common burst profile encodings

Name	Type (1 byte)	Length	Value (variable length)
Frequency	1	4	Downlink frequency (kHz)

Downlink burst profile encodings that are unique to each PHY specification are provided in Table 360, Table 361, Table 362, and Table 363.

Table 360—DCD burst profile encodings—WirelessMAN-SC

Name	Type (1 byte)	Length	Value (variable-length)
Modulation Type	150	1	1 = QPSK 2 = 16-QAM 3 = 64-QAM
FEC Code Type	151	1	1 = Reed–Solomon only 2 = Reed–Solomon + Inner Block Convolutional Code (BCC) 3 = Reed–Solomon + Inner (9,8) Parity Check Code 4 = BTC (Optional) 5–255 = <i>Reserved</i>
RS information bytes (<i>K</i>)	152	1	<i>K</i> = 6–255
RS Parity Bytes (<i>R</i>)	153	1	<i>R</i> = 0–32 (error correction capability <i>T</i> = 0–16)

Table 360—DCD burst profile encodings—WirelessMAN-SC (continued)

Name	Type (1 byte)	Length	Value (variable-length)
BCC code type	154	1	1 = (24,16) 2–255 = <i>Reserved</i>
BTC Row code type	155	1	1 = (64,57) Extended Hamming 2 = (32,26) Extended Hamming 3–255 = <i>Reserved</i>
BTC Column code type	156	1	1 = (64,57) Extended Hamming 2 = (32,26) Extended Hamming 3–255 = <i>Reserved</i>
BTC Interleaving type	157	1	1 = No interleaver, 2 = Block Interleaving, 3–255 = <i>Reserved</i>
Last codeword length	158	1	1=fixed; 2=shortened allowed (optional) This allows for the transmitter to shorten the last codeword, based upon the allowable shortened codewords for the particular code type.
DIUC mandatory exit threshold	159	1	CINR at or below which this DIUC can no longer be used and at which a change to a more robust DIUC is required, in 0.25 dB units. See Figure 81.
DIUC minimum entry threshold	160	1	The minimum CINR required to start using this DIUC when changing from a more robust DIUC is required, in 0.25 dB units. See Figure 81.
Preamble presence	161	1	0 = burst not preceded with preamble 1 = burst preceded with preamble. If the preamble is present, it consumes the first PSs of the interval.
CID_In_DL_IE	162	1	0 – CID does not appear DL-MAP IE (default) 1 – CID does appear in DL-MAP IE 2..255 – <i>Reserved</i>

Table 361—DCD burst profile encodings—WirelessMAN-SCa

Name	Type (1 byte)	Length	Value (variable length)
Modulation type	150	1	4 MSB: 1 = QPSK, 2 = 16-QAM, 3 = 64-QAM, 4 = 256-QAM, 5 = BPSK, 6–9 = Spread BPSK with $F_s = 0-3$, 10–15 = <i>Reserved</i> 4 LSB: 1 = CC+RS without block interleaving, 2 = CC+RS with block interleaving 3 = no FEC, 4 = BTC, 5 = CTC, 6–15 = <i>Reserved</i>
RS Information bytes (K)	151	1	$K = 6 - 239$
RS Parity bytes (R)	152	1	$R = 0-16$ bytes (error correction capability = 0–8 bytes) $R = 17-255$ <i>Reserved</i>

Table 361—DCD burst profile encodings—WirelessMAN-SCa (continued)

Name	Type (1 byte)	Length	Value (variable length)
DIUC Mandatory exit threshold	153	1	0–63.75 dB CINR at or below where this DIUC can no longer be used and at which a change to a more robust DIUC is required, in 0.25 dB units. See Figure 81.
DIUC Minimum entry threshold	154	1	0–63.75 dB The minimum CINR required to start using this DIUC when changing from a more robust DIUC is required, in 0.25 dB units. See Figure 81.
CC/CTC-Specific parameters	155	1	0 = rate 1/2 (for BPSK, QPSK, 16-QAM) 1 = rate 2/3 (for QPSK, 64-QAM) 2 = rate 3/4 (for BPSK, QPSK, 16-QAM, 256-QAM) 3 = rate 5/6 (for QPSK, 64-QAM) 4 = rate 7/8 (for QPSK, 256-QAM) 5–255 = <i>Reserved</i>
Block interleaver depth	156	1	Number of rows (Reed–Solomon code words) used in block interleaver between Reed–Solomon and CC: 2–66 = rows 0, 1, 67–255 = <i>Reserved</i>
BTC Code selector	157	1	Value used to choose set of BTC row/column codes. 1–3 = C_{bank} 0, 4–255 = <i>Reserved</i>
Spreading Parameters	159	1	0–15 = PN sequence generator seed labels 0–15, 16–255 = <i>Reserved</i>
CID_In_DL_IE	160	1	0 = CID does not appear DL-MAP IE (default) 1 = CID does appear in DL-MAP IE 2–255 = <i>Reserved</i>

Table 362—DCD burst profile encodings—WirelessMAN-OFDM

Name	Type (1 byte)	Length	Value (variable length)
FEC Code type	150	1	0 = BPSK (CC) 1/2 11 = 64-QAM (BTC) 2/3 1 = QPSK (RS+CC/CC) 1/2 12 = 64-QAM (BTC) 5/6 2 = QPSK (RS+CC/CC) 3/4 13 = QPSK (CTC) 1/2 3 = 16-QAM (RS+CC/CC) 1/2 14 = QPSK (CTC) 2/3 4 = 16-QAM (RS+CC/CC) 3/4 15 = QPSK (CTC) 3/4 5 = 64-QAM (RS+CC/CC) 2/3 16 = 16-QAM (CTC) 1/2 6 = 64-QAM (RS+CC/CC) 3/4 17 = 16-QAM (CTC) 3/4 7 = QPSK (BTC) 1/2 18 = 64-QAM (CTC) 2/3 8 = QPSK (BTC) 3/4 or 2/3 19 = 64-QAM (CTC) 3/4 9 = 16-QAM (BTC) 3/5 20–255 = <i>Reserved</i> 10 = 16-QAM (BTC) 4/5
DIUC mandatory exit threshold	151	1	0–63.75 dB CINR at or below where this DIUC can no longer be used and where this change to a more robust DIUC is required, in 0.25 dB units. See Figure 81.
DIUC minimum entry threshold	152	1	0–63.75 dB The minimum CINR required to start using this DIUC when changing from a more robust DIUC is required, in 0.25 dB units. See Figure 81.
TCS_enable	153	1	0 = TCS disabled 1 = TCS enabled 2–255 = <i>Reserved</i>

Table 363—DCD burst profile encodings—WirelessMAN-OFDMA

Name	Type (1 byte)	Length	Value (variable length)
FEC Code type	150	1	0 = QPSK (CC) 1/2 14 = QPSK (CTC) 3/4 1 = QPSK (CC) 3/4 15 = 16-QAM (CTC) 1/2 2 = 16-QAM (CC) 1/2 16 = 16-QAM (CTC) 3/4 3 = 16-QAM (CC) 3/4 17 = 64-QAM (CTC) 2/3 4 = 64-QAM (CC) 2/3 18 = 64-QAM (CTC) 3/4 5 = 64-QAM (CC) 3/4 19 = 64-QAM (CTC) 5/6 6 = QPSK (BTC) 1/2 20 = QPSK (ZT CC) 1/2 7 = QPSK (BTC) 3/4 or 2/3 21 = QPSK (ZT CC) 3/4 8 = 16-QAM (BTC) 3/5 22 = 16-QAM (ZT CC) 1/2 9 = 16-QAM (BTC) 4/5 23 = 16-QAM (ZT CC) 3/4 10 = 64-QAM (BTC) 2/3 or 5/8 24 = 64-QAM (ZT CC) 2/3 11 = 64-QAM (BTC) 5/6 or 4/5 25 = 64-QAM (ZT CC) 3/4 12 = QPSK (CTC) 1/2 26..255 = <i>Reserved</i> 13 = QPSK (CTC) 2/3
DIUC Mandatory exit threshold	151	1	0–63.75 dB CINR at or below where this DIUC can no longer be used and where this change to a more robust DIUC is required, in 0.25 dB units. See Figure 81.
DIUC Minimum entry threshold	152	1	0–63.75 dB The minimum CINR required to start using this DIUC when changing from a more robust DIUC is required, in 0.25 dB units. See Figure 81.

11.5 RNG-REQ management message encodings

The encodings in Table 364 are specific to the RNG-REQ message (6.3.2.3.5).

Table 364—RNG-REQ message encodings

Name	Type (1 byte)	Length	Value (variable-length)	PHY Scope
Requested Downlink Burst Profile	1	1	Bits 0–3: DIUC of the downlink burst profile requested by the SS for downlink traffic. Bits 4–7: 4 LSB of Configuration Change Count value of DCD defining the burst profile associated with DIUC.	All
SS MAC Address	2	6	The MAC address of the SS	All
Ranging Anomalies	3	1	A parameter indicating a potential error condition detected by the SS during the ranging process. Setting the bit associated with a specific condition indicates that the condition exists at the SS. Bit #0 — SS already at maximum power. Bit #1 — SS already at minimum power. Bit #2 — Sum of commanded timing adjustments is too large.	All
AAS broadcast capability	4	1	0 = SS can receive broadcast messages 1 = SS cannot receive broadcast messages	SCa, OFDM, OFDMA

Table 365—SCa-specific RNG-REQ message encodings

Name	Type (1 byte)	Length	Value (variable-length)
SCa AAS feedback	150	6	Bytes #0–1: Phase offsets Bits #0–4: Antenna 1 relative to antenna 0 signed value units of 360°/32 Bits #5–9: Antenna 2 relative to antenna 0 signed value units of 360°/32 Bits #10–14: Antenna 3 relative to antenna 0 signed value units of 360°/32 Bit #15: <i>Reserved</i> ; shall be set to zero Antenna CINR values (see 8.2.2) Byte #2 – Antenna 0 Byte #3 – Antenna 1 Byte #4 – Antenna 2 Byte #5 – Antenna 3

11.6 RNG-RSP management message encodings

The encodings in Table 367 are specific to the RNG-RSP message (6.3.2.3.6).

Table 366—SCa-specific RNG-RSP message encodings

Name	Type (1 byte)	Length	Value (variable-length)
AAS preamble index	150	1	0, 1, 2, 3 = Index of the AAS preamble to be used on future AAS transmissions to the SS

Table 367—RNG-RSP message encodings

Name	Type (1 byte)	Length	Value (variable-length)	PHY Scope
Timing Adjust	1	4	Tx timing offset adjustment (signed 32-bit). The time required to advance SS transmission so frames arrive at the expected time instance at the BS. Units are PHY specific (see 10.3).	All
Power Level Adjust	2	1	Tx Power offset adjustment (signed 8-bit, 0.25 dB units) Specifies the relative change in transmission power level that the SS is to make in order that transmissions arrive at the BS at the desired power. When subchannelization is employed, the subscriber shall interpret the power offset adjustment as a required change to the transmitted power density.	All
Offset Frequency Adjust	3	4	Tx frequency offset adjustment (signed 32-bit, Hz units) Specifies the relative change in transmission frequency that the SS is to make in order to better match the BS. (This is fine-frequency adjustment within a channel, not reassignment to a different channel.)	All
Ranging Status	4	1	Used to indicate whether uplink messages are received within acceptable limits by BS. 1 = continue, 2 = abort, 3 = success, 4 = rerange	All
Downlink frequency override	5	4	Center frequency, in kHz, of new downlink channel where the SS should redo initial ranging. If this TLV is used, the Ranging Status value shall be set to 2. Shall be used for licensed bands only.	SCa OFDM OFDMA
Uplink channel ID override	6	1	Licensed bands: The identifier of the uplink channel with which the SS is to redo initial ranging (not used with PHYs without channelized uplinks). License-exempt bands: The Channel Nr (see 8.5.1) where the SS should redo initial ranging.	All

Table 367—RNG-RSP message encodings (continued)

Name	Type (1 byte)	Length	Value (variable-length)	PHY Scope
Downlink Operational Burst Profile	7	2	This parameter is sent in response to the RNG-REQ Requested Downlink Burst Profile parameter. Byte 0: Specifies the least robust DIUC that may be used by the BS for transmissions to the SS. Byte 1: Configuration Change Count value of DCD defining the burst profile associated with DIUC.	All
SS MAC Address	8	6	SS MAC Address in MAC-48 format	All
Basic CID	9	2	Basic CID assigned by BS at initial access.	All
Primary Management CID	10	2	Primary Management CID assigned by BS at initial access.	All
AAS broadcast permission	11	1	0 = SS may issue contention-based Bandwidth Requests permission 1 = SS shall not issue contention-based Bandwidth Request	SCa OFDM OFDMA
Frame number	12	3	Frame number where the associated RNG_REQ message was detected by the BS. Usage is mutually exclusive with SS MAC Address (Type 8). The opportunity within the frame is assumed to be 1 (the first) if the Initial Ranging Opportunity field is not supplied.	SCa OFDM
Initial ranging opportunity number	13	1	Initial Ranging opportunity (1–255) in which the associated RNG_REQ message was detected by the BS. Usage is mutually exclusive with SS MAC Address (Type 8).	SCa OFDM

In addition to the RNG-RSP TLVs listed in Table 367, which are applicable to multiple PHY specifications, sets of PHY specification specific RNG-RSP TLVs are provided in Table 368 and Table 369.

Table 368—OFDM-specific RNG-RSP message encodings

Name	Type	Length	Value
Ranging subchannel	150	1	Used to indicate the OFDM subchannel reference that was used to transmit the initial ranging message (OFDM with subchannelization). Ranging subchannels are numbered from 01 to 0x1F according to Table 213.

Table 369—OFDMA-specific RNG-RSP message encodings

Name	Type	Length	Value
Ranging code attributes	150	4	Bits 31:22 – Used to indicate the OFDM time symbol reference that was used to transmit the ranging code. Bits 21:16 – Used to indicate the OFDMA subchannel reference that was used to transmit the ranging code. Bits 15:8 – Used to indicate the ranging code index that was sent by the SS. Bits 7:0 – The 8 least significant bits of the frame number of the OFDMA frame where the SS sent the ranging code.

11.7 REG-REQ/RSP management message encodings

The TLV encodings defined in this subclause are specific to the REG-REQ (6.3.2.3.7), and REG-RSP (6.3.2.3.8) MAC Management messages.

11.7.1 ARQ Parameters

This field provides the fragmentation and ARQ parameters applied during the establishment of the secondary management connection. For purposes of ARQ parameter negotiation, the appearance of the field in the REG-REQ message is equivalent to its appearance in the DSA-REQ message. The appearance of the field in the REG-RSP message is equivalent to its appearance in the DSA-RSP message.

This field is a compound TLV that may take on any of the ARQ parameters described in 11.13.18. The subtype values defined for use within the 145/146 service flow definitions are applicable for this TLV as well.

Type	Length	Value	Scope
1	<i>variable</i>	Compound	REG-REQ REG-RSP

11.7.2 SS management support

This field indicates whether or not the SS is managed by standard-based IP messages over the secondary management connection. When the SS indicates in the REG-REQ that it is managed, the BS and SS shall perform stages g), h), and i) of the initial network entry process (see 6.3.9). Otherwise, these stages shall be skipped by the BS and SS.

Type	Length	Value	Scope
2	1	0: no secondary management connection 1: secondary management connection	REG-REQ REG-RSP

11.7.3 IP management mode

The IP management mode parameter dictates whether the provider intends to manage the SS on an ongoing basis via IP-based mechanisms.

Type	Length	Value	Scope
3	1	0 - Unmanaged mode 1 - IP-managed mode	REG-REQ (see 6.3.2.3.7), REG-RSP (see 6.3.2.3.8)

11.7.4 IP version

This field indicates the version of IP used on the Secondary Management Connection.

Type	Length	Value	Scope
4	1	Bits #0: 4 (default) Bits #1: 6 Bits #2-7: <i>Reserved</i> ; shall be set to zero	REG-REQ REG-RSP

11.7.5 Secondary Management CID

This parameter contains the Secondary Management CID issued to an SS .

Type	Length	Value	Scope
5	2	Secondary Management CID	REG- RSP

11.7.6 Number of uplink CID supported

This field shows the number of Uplink CIDs the SS can support. The minimum value is three for managed SSs and two for unmanaged SSs. An SS shall support a Basic CID, a Primary Management CID, and 0 or more Transport CIDs. A managed SS shall also support a Secondary Management CID.

Type	Length	Value	Scope
6	2	Number of Uplink CIDs the SS can support.	REG-REQ, REG-RSP

11.7.7 Convergence Sublayer Capabilities

11.7.7.1 Classification/PHS options and SDU encapsulation support

This parameter indicates which classification/PHS options and SDU encapsulation the SS supports. By default, Packet, IPv4 and 802.3/Ethernet shall be supported, thus absence of this parameter in REG-REQ means that named options are supported by the SS.

Type	Length	Value	Scope
7	2	Bit #0: ATM Bit #1: Packet, IPv4 Bit #2: Packet, IPv6 Bit #3: Packet, 802.3/Ethernet Bit #4: Packet, 802.1Q VLAN Bit #5: Packet, IPv4 over 802.3/Ethernet Bit #6: Packet, IPv6 over 802.3/Ethernet Bit #7: Packet, IPv4 over 802.1Q VLAN Bit #8: Packet, IPv6 over 802.1Q VLAN Bits #9–15: <i>Reserved</i> ; Shall be set to zero	REG-REQ REG-RSP

11.7.7.2 Maximum number of classifiers

This is the maximum number of admitted Classifiers that the SS supports.

Type	Length	Value	Scope
8	2	Maximum number of simultaneous admitted classifiers	REG-REQ REG-RSP

The default value is 0 (no limit).

11.7.7.3 PHS support

This parameter indicates the level of PHS support.

Type	Length	Value	Scope
9	2	0: no PHS support 1: ATM PHS 2: Packet PHS	REG-REQ REG-RSP

The default value is 0 (no PHS).

11.7.8 SS capabilities encodings**11.7.8.1 ARQ Support**

This field indicates the availability of SS support for ARQ.

Type	Length	Value	Scope
10	1	0: No ARQ support capability 1: ARQ supported 2–255: <i>Reserved</i>	REG-REQ REG-RSP

11.7.8.2 DSx flow control

This field specifies the maximum number of concurrent DSA, DSC, or DSD transactions that may be outstanding.

Type	Length	Value	Scope
11	1	0 indicates no limit (default) 1–255 indicate maximum concurrent transactions	REG-REQ REG-RSP

11.7.8.3 MAC CRC support

This field indicates whether or not the SS supports MAC level CRC. A value of 0 indicates no CRC support. A value of 1 indicates that the SS supports MAC CRC.

Type	Length	Value	Scope
12	1	0 = No MAC CRC support 1 = MAC CRC support (default)	REG-REQ REG-RSP

11.7.8.4 MCA flow control

This field specifies the maximum number of concurrent MCA transactions that may be outstanding.

Type	Length	Value	Scope
13	1	0 indicates no limit (default) 1–255 indicate maximum concurrent transactions	REG-REQ REG-RSP

11.7.8.5 Multicast polling group CID support

This field indicates the maximum number of simultaneous Multicast Polling Groups the SS is capable of belonging to.

Type	Length	Value	Scope
14	1	0–255 default = 0	REG-REQ REG-RSP

11.7.8.6 PKM flow control

This field specifies the maximum number of concurrent PKM transactions that may be outstanding.

Type	Length	Value	Scope
15	1	0 indicates no limit (default) 1–255 indicate maximum concurrent transactions	REG-REQ REG-RSP

11.7.8.7 Authorization Policy Support

This field indicates authorization policy that both SS and BS need to negotiate and synchronize. A bit value of 0 indicates “not supported” while 1 indicates “supported.” If this field is omitted, then both SS and BS shall use the IEEE 802.16 security, constituting X.509 digital certificates and the RSA public key encryption algorithm, as authorization policy.

Type	Length	Value	Scope
16	1	Bit #0: IEEE 802.16 privacy supported Bits #1–7: <i>Reserved</i> ; shall be set to zero	REG-REQ REG-RSP

11.7.8.8 Maximum number of supported security associations

This field specifies the maximum number of supported security association of the SS.

Type	Length	Value	Scope
17	1	Maximum number of security association supported by the SS (default = 1)	REG-REQ REG-RSP

11.8 SBC-REQ/RSP management message encodings

The TLV encodings defined in this subclause are specific to the SBC-REQ (6.3.2.3.23), and SBC-RSP (6.3.2.3.24) MAC Management message dialog.

11.8.1 Bandwidth Allocation Support

This field indicates properties of the SS that the BS needs to know for bandwidth allocation purposes.

Type	Length	Value	Scope
1	1	Bit #0: <i>Reserved</i> ; shall be set to zero Bit #1 = 0: Half-Duplex (FDD only) Bit #1 = 1: Full-Duplex (FDD only) Bits #2–7: <i>Reserved</i> ; shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.2 Capabilities for Construction and Transmission of MAC PDUs

Type	Length	Value	Scope
4	1	Bit #0: Ability to receive requests piggybacked with data Bit #1: Specifies the size of FSN values used when forming MAC PDUs on non-ARQ connections 0: Only 3-bit FSN values are supported 1: Only 11-bit FSN values are supported Bits #2–7: <i>Reserved</i> ; shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3 Physical Parameters Supported

11.8.3.1 Subscriber transition gaps

This field indicates the transition speed SSTTG and SSRTG for TDD and H-FDD SSs. This parameter is not used by WirelessMAN-SC. Instead, performance is mandated in Table 169.

Type	Length	Value	Scope
2	2	Bits #0–7: SSTTG (μs) Bits #8–15: SSRTG (μs) Allowed values: OFDM mode: TDD and H-FDD 0...100. Other modes: TDD: 0...50; H-FDD: 0...100	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.2 Maximum transmit power

The maximum available power for BPSK, QPSK, 16-QAM, and 64-QAM constellations. The maximum power parameters are reported in dBm and quantized in 0.5 dBm steps ranging from -64 dBm (encoded 0x00) to 63.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme. SSs that do not support QAM64 shall report the value of 0x00 in the maximum QAM64 power field. This parameter is only applicable to systems supporting the SCA, OFDM or OFDMA PHY specifications.

Type	Length	Value	Scope
3	4	Byte 0: Maximum transmitted power for BPSK. Byte 1: Maximum transmitted power for QPSK. Byte 2: Maximum transmitted power for 16-QAM. Byte 3: Maximum transmitted power for 64-QAM. SSs that do not support 64-QAM shall report the value 0x00.	SBC-REQ

11.8.3.3 Current transmit power

This parameter indicates the transmitted power used for the burst which carried the message. The parameter is defined in the common TLV encodings subclause (11.1.1). When included in an SBC-REQ message, the TLV is encapsulated in the physical supported parameters compound TLV.

Type	Length	Value	Scope
147	1	Current transmitted power (11.1.1)	SBC-REQ

11.8.3.4 WirelessMAN-SC specific parameters

11.8.3.4.1 SC SS demodulator types

This field indicates the different modulation types supported by an SS for downlink reception. This field is not used for other PHY specifications. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
150	1	Bit #0: QPSK Bit #1: 16-QAM Bit #2: 64-QAM Bits #3–7: <i>Reserved</i> ; shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.4.2 SC SS modulator types

This field indicates the different modulation types supported by an SS for uplink transmission. This field is not used for other PHY specifications. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
151	1	Bit #0: QPSK Bit #1: 16-QAM Bit #2: 64-QAM Bits #3–7: <i>Reserved</i> , shall be set to 0	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.4.3 SC SS downlink FEC types

This field indicates the different FEC types supported by an SS for downlink reception. This field is not used for other PHY specifications. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
152	1	Bit #0: Code Type 1 as in Table 146 Bit #1: Code Type 2 as in Table 146 Bit #2: Code Type 3 as in Table 123 Bits #3–7: <i>Reserved</i> , shall be set to 0	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.4.4 SC SS uplink FEC types

This field indicates the different FEC types supported by an SS for uplink transmission. This field is not used for other PHY specifications. A bit value of 0 indicates “not supported,” while 1 indicates “supported.”

Type	Length	Value	Scope
153	1	Bit #0: Code Type 1 as in Table 146 Bit #1: Code Type 2 as in Table 146 Bit #2: Code Type 3 as in Table 123 Bits #3–7: <i>Reserved</i> , shall be set to 0	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5 WirelessMAN-SCa specific parameters

11.8.3.5.1 SCa SS demodulation types

This field indicates the optional modulation (and FEC) types supported by an SS for downlink reception. Note that BPSK, QPSK, 16-QAM, and 64-QAM shall be supported, as is the Concatenated FEC and no-FEC QPSK. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
150	1	Bit #0: 256-QAM Bit #1: BTC Bit #2: CTC Bit #3: no FEC and QAM Bit #4: STC support, dual blocks without UWs Bit #5: STC support, dual blocks with UWs Bits #6–7: <i>Reserved</i> ; shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.2 SCa SS demodulator roll-off factor

This field indicates the optional roll-off factors supported by an SS for downlink reception. Note that support of a roll-factor of 0.25 is mandatory. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
151	1	Bit #0: 0.15 Bit #1: 0.18 Bits #2–7: <i>Reserved</i> ; shall be set to 0	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.3 SCa SS demodulator Unique Word length

This field indicates the optional Unique Word lengths, in symbols, supported by an SS for downlink reception. Note that support of the 64-symbol Unique Word is mandatory. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
152	1	Bit #0: 256 Bits #1–7: <i>Reserved</i> ; shall be set to 0	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.4 SCa SS demodulator block interleaver depth

This field indicates the interleaver depth (number of rows) supported by an SS for downlink reception. The value of 0 (interleaver depth 10 rows) shall be supported.

Type	Length	Value	Scope
153	1	0: interleaver depth of 10 rows 1–54: 11–64 rows 55–255: <i>Reserved</i>	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.5 SCa SS demodulator STC block size

This field indicates the STC block size (block = 1/2 length of a “STC pair”) supported by an SS for downlink reception. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
155	1	Bit #0: 64 Bit #1: 128 Bit #2: 256 Bit #3: 512 Bit #4: 1024 Bit #5: 2048 Bit #6: 4096 Bit #7: <i>Reserved</i> , shall be set to 0.	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.6 SCa SS modulation types

This field indicates the optional modulation (and FEC) types supported by an SS for uplink transmission. Note that QPSK, 16-QAM, and 64-QAM shall be supported, as is the Concatenated FEC without block interleaving and no-FEC QPSK. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
156	1	Bit #0: 256-QAM Bit #1: BTC Bit #2: CTC Bit #3: no FEC and QAM Bit #4: STC support, dual blocks without UWs Bit #5: STC support, dual blocks with UWs Bits #6,7: <i>Reserved</i> , shall be set to 0.	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.7 SCa SS modulator roll-off factor

This field indicates the optional roll-off factors supported by an SS for uplink transmission. Note that support of a roll-factor of 0.25 is mandatory. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
157	1	Bit #0: 0.15 Bit #1: 0.18 Bits #2–7: <i>Reserved</i> ; shall be set to 0.	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.8 SCa SS modulator unique word length

This field indicates the optional Unique Word lengths, in symbols, supported by an SS for uplink transmission. Note that support of the 64-symbol Unique Word is mandatory. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
158	1	Bit #0: 256 Bits #1–7: <i>Reserved</i> ; shall be set to 0.	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.9 SCa SS modulator block interleaver depth

This field indicates the interleaver depth (number of rows) supported by an SS for uplink transmission. The value of 0 (interleaver depth 10 rows) shall be supported.

Type	Length	Value	Scope
159	1	0: interleaver depth of 10 rows 1–54: 11–64 rows 55–255: <i>Reserved</i>	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.10 SCa SS modulator STC block size

This field indicates the STC block size (block = 1/2 length of a “STC pair”) supported by an SS for uplink transmission. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
161	1	Bit #0: 64 Bit #1: 128 Bit #2: 256 Bit #3: 512 Bit #4: 1024 Bit #5: 2048 Bit #6: 4096 Bit #7: <i>Reserved</i> , shall be set to 0	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.11 SCa SS modulator maximum uplink channel width

This field indicates the maximum uplink channel width over which an SS can transmit.

Type	Length	Value	Scope
162	2	Bits #0–15: Channel Width, in 10 kHz increments.	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.12 SCa SS modulator minimum uplink channel width

This field indicates the minimum uplink channel width over which an SS can transmit.

Type	Length	Value	Scope
163	2	Bits #0–15: Channel Width, in 10 kHz increments.	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.13 SCa SS modulator power control limits

This field indicates the maximum transmit power, power control range, and power control granularity that an SS can deliver to the transmit antenna over the given uplink channel.

Type	Length	Value	Scope
164	3	Bits #0–5: Maximum output power in dBm, from 0 to 63 Bits #6–12: Power control range, in dB, from 0 to 127 Bits #13–17: Power control granularity in 0.25 dB increments, from 0.25 to 8 dB. Bits #18–23: <i>Reserved</i> ; shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.14 SCa SS modulator Subchannel framing support

This field indicates the lengths of a Repeat Segment in a subchannel burst set supported by an SS for uplink transmission. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
165	1	Bit #0: r = 256 Bit #1: r = 512 Bit #2: r = 1024 Bit #3: r = 2048 Bit #4: r = 4096 Bit #5: r = 8096 Bits #6–7: <i>Reserved</i> ; shall be set to 0	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.5.15 SCa maximum transmit power

This parameter indicates the maximum available power for BPSK, QPSK, 16-QAM, 64-QAM, and 256-QAM constellations. The maximum power parameters are reported in dBm and quantized in 0.5 dBm steps ranging from –64 dBm (encoded 0x00) to 63.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme. SSs that do not support 256-QAM shall report the value of 0x00 in the maximum 256-QAM power field.

Type	Length	Value	Scope
166	5	Byte 0: Transmit power backoff for BPSK Byte 1: Transmit power backoff for QPSK Byte 2: Transmit power backoff for 16-QAM Byte 3: Transmit power backoff for 64-QAM Byte 4: Transmit power backoff for 256-QAM. SSs that do not support 256-QAM shall report the value 0x00.	SBC-REQ (see 6.3.2.3.23)

11.8.3.6 WirelessMAN-OFDM specific parameters

11.8.3.6.1 OFDM SS FFT sizes

This field indicates the FFT sizes supported by the SS. For each FFT size, a bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
150	1	Bit #0: FFT-256 Bit #1: FFT-2048 Bits #2–7: <i>Reserved</i> , shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.6.2 OFDM SS demodulator

This field indicates the different demodulator options supported by a WirelessMAN-OFDM PHY SS for downlink reception. This field is not used for other PHY specifications. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
151	1	Bit #0: 64-QAM Bit #1: BTC Bit #2: CTC Bit #3: STC Bit #4: AAS Bits #5–7: <i>Reserved</i> ; shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.6.3 OFDM SS modulator

This field indicates the different modulator options supported by a WirelessMAN-OFDM PHY SS for uplink transmission. This field is not used for other PHY specifications. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
152	1	Bit# 0: 64-QAM Bit# 1: BTC Bit# 2: CTC Bit# 3: Subchannelization Bit# 4: Focused contention BW request Bits# 5–7: <i>reserved</i> . Set to 0	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.6.4 OFDM SS focused contention support

This field indicates whether the SS supports Focused Contention (see 8.3.7.3.3). A bit value of 0 indicates “not supported” while 1 indicates “supported”.

Type	Length	Value	Scope
153	1	Bit #0: Focused Contention Support Bits #1–7: <i>Reserved</i> , shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.6.5 OFDM SS TC sublayer support

This field indicates whether or not the SS supports the TC sublayer (see 8.3.4). A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
154	1	Bit #0: TC sublayer support; default value = 0 Bits #1–7: <i>Reserved</i> , shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.7 WirelessMAN-OFDMA specific parameters**11.8.3.7.1 OFDMA SS FFT sizes**

This field indicates the FFT sizes supported by the SS. For each FFT size, a bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
150	1	Bit #0: FFT-256 Bit #1: FFT-2048 Bits #2–7: <i>Reserved</i> , shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.7.2 OFDMA SS demodulator

This field indicates the different demodulator options supported by a WirelessMAN-OFDMA PHY SS for downlink reception. This field is not used for other PHY specifications. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
151	1	Bit #0: 64-QAM Bit #1: BTC Bit #2: CTC Bit #3: STC Bit #4: AAS Diversity Map Scan Bit #5: AAS Direct Signaling Bit #6: H-ARQ Bit #7: <i>Reserved</i> ; shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.7.3 OFDMA SS modulator

This field indicates the different modulator options supported by a WirelessMAN-OFDMA PHY SS for uplink transmission. This field is not used for other PHY specifications. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
152	1	Bit# 0: 64-QAM Bit# 1: BTC Bit# 2: CTC Bit# 3: AAS Diversity Map Scan Bit# 4: AAS Direct Signaling Bit# 5: H-ARQ Bits# 6–7: <i>Reserved</i> ; shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)
153	1	The number of HARQ ACK Channel	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.8.3.7.5 OFDMA SS Permutation support

This field indicates the different optional OFDMA permutation modes (optional PUSC, optional FUSC and AMC) supported by a WirelessMAN-OFDMA SS. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
154	1	Bit# 0: Optional PUSC support Bit# 1: Optional FUSC support Bit# 2: AMC support Bits# 3–7: <i>Reserved</i> , shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

11.9 PKM-REQ/RSP management message encodings

A summary of the TLV encoding format is shown below. The fields are transmitted from left to right.

Type	Length	Value
1 byte	<i>variable</i>	Length bytes

Type: The Type field is one byte. Values of the PKM Type field are specified in Table 370. Note that Type values between 0 and 127 are defined within the PKM Specification, while values between 128 and 255 are vendor-assigned Attribute Types.

- A PKM server shall ignore attributes with an unknown type.
- A PKM client shall ignore attributes with an unknown type.
- PKM client and server (i.e., SS and BS) may log receipt of unknown attribute types.

Length: The Length field indicates the length of this attribute’s Value field, in bytes. The length field *does not include* the Type and Length fields.

Value: The Value field is zero or more bytes and contains information specific to the attribute. The format and length of the Value field is determined by the Type and Length fields.

- The format of the value field is one of the five data types shown in Table 371.

Table 370—PKM attribute types

Type	PKM attribute
0–5	<i>reserved</i>
6	Display-String
7	AUTH-Key
8	TEK
9	Key-Lifetime
10	Key-Sequence-Number
11	HMAC-Digest
12	SAID
13	TEK-Parameters
14	<i>reserved</i>
15	CBC-IV
16	Error-Code
17	CA-Certificate
18	SS-Certificate
19	Security-Capabilities
20	Cryptographic-Suite
21	Cryptographic-Suite-List
22	Version
23	SA-Descriptor
24	SA-Type
25	<i>reserved</i>
26	<i>reserved</i>
27	PKM Configuration Settings
28–255	<i>reserved</i>

Table 371—Attribute value data types

Data type	Structure
string	0 – <i>n</i> bytes
uint8	8-bit unsigned integer
uint16	16-bit unsigned integer
uint32	32-bit unsigned integer
compound	collection of attributes

11.9.1 Display string

Description: This attribute contains a textual message. It is typically used to explain a failure response and might be logged by the receiver for later retrieval by an SNMP manager. Display strings shall be no longer than 128 bytes. A summary of the Display-String attribute format is shown below. The fields are transmitted from left to right.

Type	Length	Value (string)
6	> 0 and ≤ 128	A string of characters. The character string shall be null-terminated.

11.9.2 AUTH-Key

Description: The AK (AUTH-Key) is a 20 byte quantity, from which a KEK, and two message authentication keys (one for uplink requests, and a second for downlink replies) are derived. This attribute contains a 128 byte quantity containing the AK RSA-encrypted with the SS’s 1024 bit RSA public key. Details of the RSA encryption procedure are given in 7.5. The ciphertext produced by the RSA algorithm shall be the length of the RSA modulus, i.e., 128 bytes.

Type	Length	Value (string)
7	128	128 byte quantity representing an RSA-encrypted AK.

11.9.3 TEK

Description: This attribute contains a quantity that is a TEK key, encrypted with a KEK derived from the AK.

Type	Length	Value (string)
8	8	Encrypted TEK.

11.9.4 Key lifetime

Description: This attribute contains the lifetime, in seconds, of an AK or a TEK. It is a 32-bit unsigned quantity representing the number of remaining seconds for which the associated key shall be valid. Note that this attribute can be used as top level attribute (AK) as well as a subattribute (TEK).

Type	Length	Value (uint32)
9	4	32-bit quantity representing key lifetime A key lifetime of zero indicates that the corresponding AK or TEK is not valid.

11.9.5 Key-Sequence-Number

Description: This attribute contains sequence number for a TEK or AK. The 2-bit or 4-bit quantity, however, is stored in a single byte, with the high-order 6 or 4 bits set to 0. A summary of the Key-Sequence-Number attribute format is shown below. Note that this attribute can be used as top level attribute (AK) as well as a subattribute (TEK).

Type	Length	Value (uint8)
10	1	2-bit sequence number (TEK) 4-bit sequence number (AK)

11.9.6 HMAC-Digest

Description: This attribute contains a keyed hash used for message authentication. The HMAC algorithm is defined in IETF RFC 2104.

Type	Length	Value (string)
11	20 bytes	A 160-bit (20 byte) keyed SHA hash

11.9.7 SAID

Description: This attribute contains a 16-bit SAID used by the Privacy Protocol to identify the SA.

Type	Length	Value (uint16)
12	2	16-bit quantity representing an SAID

11.9.8 TEK parameters

Description: This attribute is a compound attribute, consisting of a collection of subattributes. These subattributes represent all security parameters relevant to a particular generation of an SAID's TEK. A summary of the TEK-Parameters attribute format is shown below.

Type	Length	Value (compound)
13	variable	The Compound field contains the subattributes as defined in Table 372

Table 372—TEK-parameters subattributes

Attribute	Contents
TEK	TEK, encrypted with the KEK
Key-Lifetime	TEK Remaining Lifetime
Key-Sequence-Number	TEK Sequence Number
CBC-IV	CBC Initialization Vector

11.9.9 CBC-IV

Description: This attribute contains a value specifying a CBC Initialization Vector (CBC-IV). A summary of the CBC-IV attribute format is shown below. The fields are transmitted from left to right.

Type	Length	Value (string)
15	Equal to Block length of cipher	CBC-IV

11.9.10 Error code

Description: This attribute contains a 1-byte error code providing further information about an Authorization Reject, Key Reject, Authorization Invalid, or TEK Invalid. A summary of the Error-Code attribute format is shown below. Table 373 lists code values for use with this attribute. The BS may employ the nonzero error codes (1–6) listed below; it may, however, return a code value of zero (0). Error code values other than those defined in Table 373 shall be ignored. Returning a code value of zero sends no additional failure information to the SS; for security reasons, this may be desirable.

Type	Length	Value (uint8)	Scope
16	1	Error-Code	Authorization Reject, Authorization Invalid, Key Reject, TEK Invalid

Table 373—Error-code attribute code values

Error Code	Messages	Description
0	All	No information
1	Auth Reject, Auth Invalid	Unauthorized SS
2	Auth Reject, Key Reject	Unauthorized SAID
3	Auth Invalid	Unsolicited
4	Auth Invalid, TEK Invalid	Invalid Key Sequence Number
5	Auth Invalid	Message (Key Request) authentication failure
6	Auth Reject	Permanent Authorization Failure

Error Code 6 (Permanent Authorization Failure) is used to indicate a number of different error conditions affecting the PKM authorization exchange. These include:

- a) An unknown manufacturer; i.e., the BS does not have the CA certificate belonging to the issuer of an SS certificate
- b) SS certificate has an invalid signature
- c) ASN.1 parsing failure during verification of SS certificate
- d) SS certificate is on the “hot list”
- e) Inconsistencies between certificate data and data in accompanying PKM attributes
- f) SS and BS have incompatible security capabilities

The common property of these error conditions is that the failure condition is considered permanent; any reattempts at authorization would continue to result in Authorization Rejects. Details about the cause of a Permanent Authorization Failure may be reported to the SS in an optional Display-String attribute that may accompany the Error-Code attribute in Authorization Reject messages. Note that providing this additional detail to the SS should be administratively controlled within the BS. The BS may log these Authorization failures, or even trap them to an SNMP manager.

11.9.11 CA certificate

Description: This attribute is a string attribute containing an X.509 CA Certificate, as defined in 7.6. A summary of the CA-Certificate attribute format is shown below. The fields are transmitted from left to right.

Type	Length	Value (string)
17	Variable. Length shall not cause resulting MAC management message to exceed the maximum allowed size.	X.509 CA Certificate (DER-encoded ASN.1)

11.9.12 SS certificate

Description: This attribute is a string attribute containing an SS's X.509 User Certificate, as defined in 7.6. A summary of the SS-Certificate attribute format is shown below. The fields are transmitted from left to right.

Type	Length	Value (string)
18	<i>variable.</i> Length shall not cause resulting MAC management message to exceed the maximum allowed size.	X.509 SS Certificate (DER-encoded ASN.1)

11.9.13 Security capabilities

Description: The Security-Capabilities attribute is a compound attribute whose subattributes identify the version of PKM an SS supports and the cryptographic suite(s) an SS supports.

Type	Length	Value (compound)
19	<i>variable</i>	The Compound field contains the subattributes as defined in Table 374

Table 374—Security-capabilities subattributes

Attribute	Contents
Cryptographic-Suite-List	List of supported cryptographic suites
Version	Version of Privacy supported

11.9.14 Cryptographic suite**Table 375—Data encryption algorithm identifiers**

Value	Description
0	No data encryption
1	CBC-Mode, 56-bit DES
2	AES, CCM mode
3–255	<i>reserved</i>

Table 376—Data authentication algorithm identifiers

Value	Description
0	No data authentication
1–255	<i>reserved</i>

Table 377—TEK encryption algorithm identifiers

Value	Description
0	<i>reserved</i>
1	3-DES EDE with 128-bit key
2	RSA with 1024-bit key
3	AES with 128-bit key
4–255	<i>reserved</i>

Type	Length	Value (uint8,uint8,uint8)
20	3	A 24-bit integer identifying the cryptographic suite properties. The most significant byte, as defined in Table 375, indicates the encryption algorithm and key length. The middle byte, as defined in Table 376 indicates the data authentication algorithm. The least significant byte, as defined in Table 377, indicates the TEK Encryption Algorithm.

The allowed cryptographic suites are itemized in Table 378.

Table 378—Allowed cryptographic suites

Value	Description
0x000001	No data encryption, no data authentication and 3-DES,128
0x010001	CBC-Mode 56-bit DES, no data authentication and 3-DES,128
0x000002	No data encryption, no data authentication and RSA, 1024
0x010002	CBC-Mode 56-bit DES, no data authentication and RSA, 1024
0x020003	CCM-mode AES, no data authentication and AES, 128
all remaining values	<i>reserved</i>

11.9.15 Cryptographic-Suite-List

This parameter contains a list of supported cryptographic suites.

Type	Length	Value (compound)
21	5*n, where <i>n</i> equals number of cryptographic suites listed	A list of cryptographic suites

11.9.16 Version

Table 379—Version attribute values

Value	Description
0	<i>reserved</i>
1	PKM (Initial standard release)
2–255	<i>reserved</i>

Type	Length	Value (uint8)
22	1	A 1-byte code identifying a version of PKM security as defined in Table 379.

11.9.17 SA-Descriptor

Description: The SA-Descriptor attribute is a compound attribute whose subattributes describe the properties of a Security Association (SA). These properties include the SAID, the SA type, and the cryptographic suite employed within the SA.

Table 380—SA-Descriptor subattributes

Attribute	Contents
SAID	Security Association ID
SA-Type	Type of SA
Cryptographic-Suite	Cryptographic suite employed within the SA

Type	Length	Value (compound)
23	<i>variable</i>	The Compound field contains the subattributes shown in Table 380.

11.9.18 SA type

Description: This attribute identifies the type of SA. Privacy defines three SA types: Primary, Static, Dynamic.

Type	Length	Value (uint8)
24	1	A 1 byte code identifying the value of SA-type as defined in Table 381.

Table 381—SA-type attribute values

Value	Description
0	Primary
1	Static
2	Dynamic
3–127	<i>reserved</i>
128–255	Vendor-specific

11.9.19 PKM configuration settings

This field defines the parameters associated with PKM operation. It is composed of a number of encapsulated TLV fields.

Type	Length	Value (compound)	Scope
27	variable		Auth Reply

11.9.19.1 Authorize wait timeout

The value of the field specifies retransmission interval, in seconds, of Authorization Request messages from the Authorize Wait state.

Type	Length	Value
27.1	4	Authorize Wait Timeout in seconds

11.9.19.2 Reauthorize wait timeout

The value of the field specifies retransmission interval, in seconds, of Authorization Request messages from Reauthorize Wait state.

Type	Length	Value
27.2	4	Reauthorize Wait Timeout in seconds

11.9.19.3 Authorization grace time

The value of this field specifies the grace period for reauthorization, in seconds.

Type	Length	Value
27.3	4	Authorization Grace Time in seconds

11.9.19.4 Operational wait timeout

The value of this field specifies the retransmission interval, in seconds, of Key Requests from the Operational Wait state.

Type	Length	Value
27.4	4	Operational Wait Timeout in seconds

11.9.19.5 Rekey wait timeout

The value of this field specifies the retransmission interval, in seconds, of Key Requests from the Rekey Wait state.

Type	Length	Value
27.5	4	Rekey Wait Timeout in seconds

11.9.19.6 TEK grace time

The value of this field specifies grace period, in seconds, for rekeying the TEK.

Type	Length	Value
27.6	4	TEK Grace time in seconds

11.9.19.7 Authorize reject wait timeout

The value of this field specifies how long (in seconds) an SS waits in the Authorize Reject Wait state after receiving an Authorization Reject.

Type	Length	Value
27.7	4	Authorize Reject Wait Timeout in seconds

11.10 MCA-REQ management message encodings

The type values used shall be those defined in Table 382.

Table 382—Multicast assignment request message encodings

Name	Type (1 byte)	Length	Value (variable-length)
Multicast CID	1	2	
Assignment	2	1	0x00 = Leave multicast group 0x01 = Join multicast group
Multicast group type	3	1	0 = regular (not AAS), default 1 = AAS
Periodic allocation parameters	4	4	Byte #0 (LS byte)= <i>m</i> Byte #1 = <i>k</i> Byte #2 = <i>n</i> Byte #3 = <i>Reserved</i> ; shall be set to zero

Table 382—Multicast assignment request message encodings

Name	Type (1 byte)	Length	Value (variable-length)
Periodic allocation type	5	1	0 = REQ region Full 1 = REQ region Focused Applicable for OFDM PHY only.
Operation	6	1	0 = allocate 1 = deallocate
<i>reserved</i>	7–255		Reserved for future use

Parameters m , k have the following meaning: multicast group gets a multicast polling allocation at the end of the frame # N if $N \bmod k = m$; size of the allocation is n .

11.11 REP-REQ management message encodings

Name	Type	Length	Value
Report request	1	<i>variable</i>	Compound

The Report Command consists of the following parameters:

Name	Type	Length	Value
Report type	1.1	1	Bit #0 = 1 Include DFS Basic report Bit #1 = 1 Include CINR report Bit #2 = 1 Include RSSI report Bit #3–6 α_{avg} \ in multiples of 1/32 (range [1/32, 16/32]) Bit #7 = 1 Include current transmit power report
Channel number	1.2	1	Physical channel number (see 8.5.1) to be reported on. (license-exempt bands only)
Channel Type request	1.3	1	00 = Normal subchannel, 01 = Band AMC Channel, 10 = Safety Channel, 11 = <i>Reserved</i>

11.12 REP-RSP management message encodings

Name	Type	Length	Value
Report	1	<i>variable</i>	Compound
Channel Type Report in WirelessMAN OFDMA PHY	2	<i>variable</i>	Compound
Current transmitted power	147	1	See 8.3.7.4 and 11.1.1

The report consists of the following parameters (see also 8.2.2, 8.3.9, or 8.4.11 for details).

REP-REQ Report type	Name	Type	Length	Value
bit #0 = 1	Channel number	1.1	1	Physical channel number (see 8.5.1) to be reported on
bit #0 = 1	Start frame	1.2	2	Frame number in which measurement for this channel started
bit #0 = 1	Duration	1.3	3	Cumulative measurement duration on the channel in multiples of T_s . For any value exceeding 0xFFFFFFFF, report 0xFFFFFFFF
bit #0 = 1	Basic report	1.4	1	Bit #0: WirelessHUMAN detected on the channel Bit #1: Unknown transmissions detected on the channel Bit #2: Primary User detected on the channel Bit #3: Unmeasured. Channel not measured
bit #1 = 1	CINR report	1.5	2	1 byte: mean (see also 8.2.2, 8.3.9, 8.4.11) for details) 1 byte: standard deviation
bit #2 = 1	RSSI report	1.6	2	1 byte: mean (see also 8.2.2, 8.3.9, 8.4.11) for details) 1 byte: standard deviation

REP-REQ Channel Type request	Name	Type	Length	Value
Channel Type = 00	Normal sub-channel Report	2.1	1	First 5 bits for the CINR measurement report and the rest for don't care
Channel Type = 01	Band AMC Report	2.2	4	First 12 bits for the band indicating bitmap and Next 25 bits for CINR reports (5 bits per each band)
Channel Type = 10	Safety Channel Report	2.3	5	The first 20 bits for the reported bin indices and the next 20 bits for CINR reports (5 bits for each bin)

11.13 Service Flow management encodings

The following fields define the parameters associated with uplink/downlink scheduling for a service flow. It is somewhat complex in that it is composed from a number of encapsulated TLV fields.

Note that the encapsulated uplink and downlink flow classification configuration setting strings share the same subtype field numbering plan, because many of the subtype fields defined are valid for both types of configuration settings except service flow encodings.

Uplink encodings use the type 145. Downlink encodings use the type 146. Entries of the form [145/146] indicate the encoding can be applied to either an uplink or downlink service flow.

Table 383—Service flow encodings

Type	Parameter
1	Service Flow Identifier
2	CID
3	Service Class Name
4	<i>reserved</i>
5	QoS Parameter Set Type
6	Traffic Priority
7	Maximum Sustained Traffic Rate
8	Maximum Traffic Burst
9	Minimum Reserved Traffic Rate
10	Minimum Tolerable Traffic Rate
11	Service Flow Scheduling Type
12	Request/Transmission Policy
13	Tolerated Jitter
14	Maximum Latency
15	Fixed-length versus Variable-length SDU Indicator
16	SDU Size
17	Target SAID
18	ARQ Enable
19	ARQ_WINDOW_SIZE
20	ARQ_RETRY_TIMEOUT - Transmitter Delay
21	ARQ_RETRY_TIMEOUT - Receiver Delay
22	ARQ_BLOCK_LIFETIME
23	ARQ_SYNC_LOSS
24	ARQ_DELIVER_IN_ORDER
25	ARQ_PURGE_TIMEOUT
26	ARQ_BLOCK_SIZE
27	<i>reserved</i>
28	CS Specification
143	Vendor-specific QoS Parameter
99–107	Convergence Sublayer Types

The CC indicates the status for the dynamic service (DSx-xxx) messages. The value may appear in the Confirmation Code field of a DSx message or as the value of a TLV-encoded error parameter.

The CC values are specified in Table 384.

Table 384—CC values

CC	Status
0	OK/success
1	reject-other
2	reject-unrecognized-configuration-setting
3	reject-temporary / reject-resource
4	reject-permanent / reject-admin
5	reject-not-owner
6	reject-service-flow-not-found
7	reject-service-flow-exists
8	reject-required-parameter-not-present
9	reject-header-suppression
10	reject-unknown-transaction-id
11	reject-authentication-failure
12	reject-add-aborted
13	reject-exceeded-dynamic-service-limit
14	reject-not-authorized-for-the-requested-SAID
15	reject-fail-to-establish-the-requested-SA
16	reject-not-supported-parameter
17	reject-not-supported-parameter-value

In the case CC = “reject-not-supported-parameter” or CC = “reject-not-supported-parameter-value”, the corresponding TLV(s) may be returned to caller in DSx-RSP message. In the case of CC = “reject-not-supported-parameter-value,” the value field of the returned TLV should contain the closest value that is supported.

11.13.1 SFID

The SFID is used by the BS as the primary reference of a service flow. Only the BS may issue a SFID. It uses this parameterization to issue SFIDs in BS-initiated DSA-REQ/DSC-REQ messages and in its DSA-RSP/DSC-RSP to SS-initiated DSA-REQ/DSC-REQ messages. The SS specifies the SFID of a service flow using this parameter in a DSC-REQ message.

Type	Length	Value	Scope
[145/146].1	4	1–4 294 967 295	DSx-REQ DSx-RSP DSx-ACK

11.13.2 CID

The value of this field specifies the CID assigned by the BS to a service flow with a non-null AdmittedQosParamSet or ActiveQosParamSet. The 16-bit value of this field is used in bandwidth requests and in MAC PDU headers. This field shall be present in a BS-initiated DSA-REQ or DSC-REQ message related to establishing an admitted or active service flow. This field shall also be present in DSA-RSP and DSC-RSP messages related to the successful establishment of an admitted or active service flow.

Even though a service flow has been successfully admitted or activated (i.e., has an assigned CID) the SFID shall be used for subsequent DSx message signalling as it is the primary handle for a service flow. If a service flow is no longer admitted or active (via DSC-REQ), its CID may be reassigned by the BS.

Type	Length	Value	Scope
[145/146].2	2	CID	DSx-REQ DSx-RSP DSx-ACK

11.13.3 Service Class Name

The value of this field refers to a predefined BS service configuration to be used for this service flow.

Type	Length	Value	Scope
[145/146].3	2 to 128	Null-terminated string of ASCII characters. The length of the string, including null-terminator may not exceed 128 bytes	DSx-REQ DSx-RSP DSx-ACK

When the Service Class Name is used in a service flow encoding, it indicates that all the unspecified QoS parameters of the service flow need to be provided by the BS. It is up to the operator to synchronize the definition of Service Class Names in the BS.

11.13.4 QoS parameter set type

This parameter shall appear within every service flow encoding. It specifies the proper application of the QoS Parameter Set: to the Provisioned set, the Admitted set, and/or the Active set. When two QoS Parameter Sets are the same, a multibit value of this parameter may be used to apply the QoS parameters to more than one set. A single message may contain multiple QoS parameter sets in separate type 145/146 service flow encodings for the same service flow. This allows specification of the QoS Parameter Sets when their parameters are different. Bit 0 is the LSB of the Value field.

For every service flow that is preprovisioned and for every provisioned service flow added after SS initialization, there shall be a service flow encoding that specifies a ProvisionedQoSParamSet. This service flow encoding, or other service flow encoding(s), may also specify an Admitted and/or Active set.

Type	Length	Value	Scope
[145/146].5	1	Bit 0: Provisioned Set Bit 1: Admitted Set Bit 2: Active Set Bits 3–7: <i>Reserved</i>	DSx-REQ DSx-RSP DSx-ACK

A BS shall handle a single update to each of the Active and Admitted QoS parameter sets. The ability to process multiple service flow encodings that specify the same QoS parameter set is not required and is left as a vendor-specific function. If a DSA/DSC contains multiple updates to a single QoS parameter set and the vendor does not support such updates, then the BS shall reply with CC 2 (reject-unrecognized-configuration-setting).

Table 385 lists values used in Dynamic Service messages.

Table 385—Values used in Dynamic Service messages

Value	Messages
001	Apply to Provisioned set only
011	Apply to Provisioned and Admitted set, and perform admission control
101	Apply to Provisioned and Active sets, perform admission control, and activate this service flow
111	Apply to Provisioned, Admitted, and Active sets; perform admission control; and activate this service flow
000	Set Active and Admitted sets to Null
010	Perform admission control and apply to Admitted set
100	Check against Admitted set in separate service flow encoding, perform admission control if needed, activate this service flow, and apply to Active set
110	Perform admission control and activate this service flow, apply parameters to both Admitted and Active sets

11.13.5 Traffic priority

The value of this parameter specifies the priority assigned to a service flow. Given two service flows identical in all QoS parameters besides priority, the higher priority service flow should be given lower delay and higher buffering preference. For otherwise nonidentical service flows, the priority parameter should not take precedence over any conflicting service flow QoS parameter. The specific algorithm for enforcing this parameter is not mandated here.

For uplink service flows, the BS shall use this parameter when determining precedence in request service and grant generation, and the SS shall preferentially select contention Request opportunities for Priority Request CIDs based on this priority and its Request/Transmission Policy (see 11.13.12).

Type	Length	Value	Scope
[145/146].6	1	0 to 7—Higher numbers indicate higher priority Default 0	DSx-REQ DSx-RSP DSx-ACK

11.13.6 Maximum sustained traffic rate

This parameter defines the peak information rate of the service. The rate is expressed in bits per second and pertains to the SDUs at the input to the system. Explicitly, this parameter does not include MAC overhead such as MAC headers or CRCs. This parameter does not limit the instantaneous rate of the service since this is governed by the physical attributes of the ingress port. However, at the SS in the uplink direction, the service shall be policed to conform to this parameter, on the average, over time. At the BS in the downlink direction, it may be assumed that the service was already policed at the ingress to the network and the BS is not required to do additional policing. If this parameter is omitted or set to zero, then there is no explicitly mandated maximum rate. This field specifies only a bound, not a guarantee that the rate is available. The algorithm for policing to this parameter is left to vendor differentiation and is outside the scope of the standard.

Type	Length	Value	Scope
[145/146].7	4	Rate (in bits per second)	DSx-REQ DSx-RSP DSx-ACK

11.13.7 Maximum traffic burst

This parameter defines the maximum burst size that shall be accommodated for the service. Since the physical speed of ingress/egress ports, the air interface, and the backhaul will, in general, be greater than the maximum sustained traffic rate parameter for a service, this parameter describes the maximum continuous burst the system should accommodate for the service, assuming the service is not currently using any of its available resources

Type	Length	Value	Scope
[145/146].8	4	Burst size (bytes)	DSx-REQ DSx-RSP DSx-ACK

11.13.8 Minimum reserved traffic rate

This parameter specifies the minimum rate reserved for this service flow. The rate is expressed in bits per second and specifies the minimum amount of data to be transported on behalf of the service flow when averaged over time. The specified rate shall only be honored when sufficient data is available for scheduling. When insufficient data exists, the requirement imposed by this parameter shall be satisfied by assuring that the available data is transmitted as soon as possible.

The BS shall be able to satisfy bandwidth requests for a service flow up to its Minimum Reserved Traffic Rate. If less bandwidth than its Minimum Reserved Traffic Rate is requested for a service flow, the BS may reallocate the excess reserved bandwidth for other purposes. The aggregate Minimum Reserved Traffic Rate of all service flows may exceed the amount of available bandwidth. The value of this parameter is calculated from the byte following the MAC header HCS to the end of the MAC PDU payload. If this parameter is omitted, then it defaults to a value of 0 bits per second (i.e., no bandwidth is reserved for the flow).

Type	Length	Value	Scope
[145/146].9	4	Rate (in bits per second)	DSx-REQ DSx-RSP DSx-ACK

11.13.9 Minimum tolerable traffic rate

Minimum Tolerable Traffic Rate = R (bits/s) with time base T (sec) means the following. Let S denote additional demand accumulated at the MAC SAP of the transmitter during an arbitrary time interval of the length T . Then the amount of data forwarded at the receiver to CS (in bits) during this interval should be not less than minimum $\{S, R * T\}$.

In the case of downlink connections, Minimum Tolerable Traffic Rate may be monitored by the BS to make decisions on rate change or deletion of the connection in the case of high SDU loss rate.

Type	Length	Value	Scope
[145/146].10	4	Rate (in bits per second)	DSx-REQ DSx-RSP DSx-ACK

11.13.10 Vendor-specific QoS parameters

This allows vendors to encode vendor-specific QoS parameters. The Vendor ID shall be the first TLV embedded inside vendor-specific QoS parameters. If the first TLV inside vendor-specific QoS parameters is not a Vendor ID, then the TLV shall be discarded (see 11.1.6).

Type	Length	Value	Scope
[145/146].143	<i>variable</i>	Compound	DSx-REQ DSx-RSP DSx-ACK

11.13.11 Service flow scheduling type

The value of this parameter specifies the scheduling service that shall be enabled for the associated service flow. If the parameter is omitted, BE service is assumed.

Type	Length	Value	Scope
[145/146].11	1	0: <i>Reserved</i> 1: for Undefined (BS implementation-dependent ^a) 2: for BE (default) 3: for nrtPS 4: for rtPS 5: <i>Reserved</i> 6: for UGS 7–255: <i>Reserved</i>	DSA-REQ DSA-RSP DSA-ACK

^aThe specific implementation-dependent scheduling service type could be defined in a message of Type 145/146.143 (vendor-specific QoS parameters).

11.13.12 Request/transmission policy

The value of this parameter provides the capability to specify certain attributes for the associated service flow. These attributes include options for PDU formation and, for uplink service flows, restrictions on the types of bandwidth request options that may be used. An attribute is enabled by setting the corresponding bit position to 1. For attributes affecting uplink bandwidth request types, a value of zero indicates the default actions described in the scheduling service description in 6.3.5 shall be used. A value of one indicates that the action associated with the attribute bit overrides the default action.

Type	Length	Value	Scope
[145/146].12	4	Bit #0 – Service flow shall not use broadcast bandwidth request opportunities. (Uplink only) Bit #1 – <i>Reserved</i> ; shall be set to zero Bit #2 – The service flow shall not piggyback requests with data. (Uplink only) Bit #3 – The service flow shall not fragment data. Bit #4 – The service flow shall not suppress payload headers (CS parameter) Bit #5 – The service flow shall not pack multiple SDUs (or fragments) into single MAC PDUs. Bit #6 – The service flow shall not include CRC in the MAC PDU. Bit #7 – <i>Reserved</i> ; shall be set to zero	DSA-REQ DSA-RSP DSA-ACK

11.13.13 Tolerated jitter

This parameter defines the maximum delay variation (jitter) for the connection.

Type	Length	Value	Scope
[145/146].13	4	ms	DSx-REQ DSx-RSP DSx-ACK

11.13.14 Maximum latency

The value of this parameter specifies the maximum latency between the reception of a packet by the BS or SS on its network interface and the forwarding of the packet to its RF Interface.

If defined, this parameter represents a service commitment (or admission criteria) at the BS or SS and shall be guaranteed by the BS or SS. A BS or SS does not have to meet this service commitment for service flows that exceed their minimum reserved rate.

Type	Length	Value	Scope
[145/146].14	4	ms	DSx-REQ DSx-RSP DSx-ACK

11.13.15 Fixed-length versus variable-length SDU indicator

The value of this parameter specifies whether the SDUs on the service flow are fixed-length or variable-length. The parameter is used only if packing is on for the service flow. The default value is 0, i.e., variable-length SDUs.

Type	Length	Value	Scope
[145/146].15	1	0 = variable-length SDUs 1 = fixed-length SDUs default = 0	DSA-REQ DSA-RSP DSA-ACK

11.13.16 SDU size

The value of this parameter specifies the length of the SDU for a fixed-length SDU service flow. This parameter is used only if packing is on and the service flow is indicated as carrying fixed-length SDUs. The default value is 49 bytes, i.e., VC-switched ATM cells with PHS. The parameter is relevant for both ATM and Packet Convergence Sublayers.

Type	Length	Value	Scope
[145/146].16	1	Number of bytes. default = 49	DSA-REQ DSA-RSP DSA-ACK

11.13.17 Target SAID

The target SAID parameter indicates the SAID onto which the service flow that is being set up shall be mapped.

Type	Length	Value	Scope
[145/146].17	2	SAID onto which SF is mapped	DSA-REQ DSA-RSP

11.13.18 ARQ TLVs for ARQ-enabled connections

11.13.18.1 ARQ Enable

This TLV indicates whether or not ARQ use is requested for the connection that is being setup. A value of 0 indicates that ARQ is not requested and a value of 1 indicates that ARQ is requested. The DSA-REQ shall contain the request to use ARQ or not. The DSA-RSP message shall contain the acceptance or rejection of

the request. ARQ shall be enabled for this connection only if both sides report this TLV to be non-zero. The SS shall either reject the connection or accept the connection with ARQ.

Type	Length	Value	Scope
[145/146].18 1.18	1	0 = ARQ Not Requested/Accepted 1 = ARQ Requested/Accepted	DSA-REQ, DSA-RSP REG-REQ, REG-RSP

11.13.18.2 ARQ_WINDOW_SIZE

This parameter is negotiated upon connection setup or during operation. The DSA-REQ/DSC-REQ message shall contain the suggested value for this parameter. The DSA-RSP/DSC-RSP message shall contain the confirmation value or an alternate value for this parameter. The smaller of the two shall be used as the **ARQ_WINDOW_SIZE**.

Type	Length	Value	Scope
[145/146].19 1.19	2	> 0 and $\leq (\text{ARQ_BSN_MODULUS}/2)$	DSx-REQ, DSx-RSP REG-REQ, REG-RSP

11.13.18.3 ARQ_RETRY_TIMEOUT

The **ARQ_retry_timeout** should account for the transmitter and receiver processing delays and any other delays relevant to the system.

TRANSMITTER_DELAY: This is the total transmitter delay, including sending (e.g., MAC PDUs) and receiving (e.g., ARQ feedback) delays and other implementation dependent processing delays. If the transmitter is the BS, it may include other delays such as scheduling and propagation delay.

RECEIVER_DELAY: This is the total receiver delay, including receiving (e.g., MAC PDUs) and sending (e.g., ARQ feedback) delays and other implementation-dependent processing delays. If the receiver is the BS, it may include other delays such as scheduling and propagation delay.

The DSA-REQ and DSA-RSP messages shall contain the values for these parameters, where the receiver and transmitter each declare their capabilities. When the DSA handshake is completed, each party shall calculate **ARQ_RETRY_TIMEOUT** to be the sum of **TRANSMITTER_DELAY** and **RECEIVER_DELAY**.

Type	Length	Value	Scope
[145/146].20 1.20	2	TRANSMITTER_DELAY 0–655350 (10 μ s granularity)	DSA-REQ, DSA-RSP REG-REQ, REG-RSP
[145/146].21 1.21	2	RECEIVER_DELAY 0–655350 (10 μ s granularity)	DSA-REQ, DSA-RSP REG-REQ, REG-RSP

11.13.18.4 ARQ_BLOCK_LIFETIME

The DSA-REQ message shall contain the value of this parameter as defined by the parent service flow. If this parameter is set to 0, then the **ARQ_BLOCK_LIFETIME** value shall be considered infinite.

Type	Length	Value	Scope
[145/146].22 1.22	2	0 = Infinite 1–655350 (10 μ s granularity)	DSA-REQ, DSA-RSP REG-REQ, REG-RSP

11.13.18.5 ARQ_SYNC_LOSS_TIMEOUT

The BS shall set this parameter. The DSA-REQ or DSA-RSP messages shall contain the value of this parameter as set by the BS. If this parameter is set to 0, then the **ARQ_SYNC_LOSS_TIMEOUT** value shall be considered infinite.

Type	Length	Value	Scope
[145/146].23 1.23	2	0 = Infinite 1–655350 (10 μ s granularity)	DSA-REQ, DSA-RSP REG-REQ, REG-RSP

11.13.18.6 ARQ_DELIVER_IN_ORDER

The DSA-REQ message shall contain the value of this parameter. This TLV indicates whether or not data is to be delivered by the receiving MAC to its client application in the order in which the data was handed off to the originating MAC.

Type	Length	Value	Scope
[145/146].24 1.24	1	0 – Order of delivery is not preserved 1 – Order of delivery is preserved	DSA-REQ, DSA-RSP REG-REQ, REG-RSP

If this flag is not set, then the order of delivery is not preserved. If this flag is set (to 1), then the order of delivery is preserved.

11.13.18.7 ARQ_RX_PURGE_TIMEOUT

The DSA-REQ message shall contain the value of this parameter as defined by the parent service flow. If this parameter is set to 0, then the **ARQ_RX_PURGE_TIMEOUT** value shall be considered infinite.

Type	Length	Value	Scope
[145/146].25 1.25	2	0 = Infinite 1–65535 (10 μ s granularity)	DSA-REQ, DSA-RSP REG-REQ, REG-RSP

11.13.18.8 ARQ_BLOCK_SIZE

This value of this parameter specifies the size of an ARQ block. This parameter shall be established by negotiation during the connection creation dialog.

The requester includes its desired setting in the REQ message. The receiver of the REQ message shall take the smaller of the value it prefers and value in the REQ message. This minimum value is included in the RSP message and becomes the agreed upon length value.

Absence of the parameter during a DSA dialog shall indicate the originator of the message desires the maximum value.

Type	Length	Value	Scope
[145/146],26 1.26	2	0 = <i>Reserved</i> 1–2040 = Desired/Agreed size in bytes 2041–65535 = <i>Reserved</i>	DSA-REQ, DSA-RSP REG-REQ, REG-RSP

11.13.19 CS specific service flow encodings**11.13.19.1 CS specification**

This parameter specifies the CS that the connection being set up shall use.

Type	Length	Value	Scope
[145/146],28	1	0: No CS 1: Packet, IPv4 2: Packet, IPv6 3: Packet, 802.3/Ethernet 4: Packet, 802.1Q VLAN 5: Packet, IPv4 over 802.3/Ethernet 6: Packet, IPv6 over 802.3/Ethernet 7: Packet, IPv4 over 802.1Q VLAN 8: Packet, IPv6 over 802.1Q VLAN 9: ATM 10–255 <i>Reserved</i>	DSA-REQ

11.13.19.2 CS parameter encoding rules

Each CS defines a set of parameters that are encoded within a subindex under the “cst” values listed below. In the cases of IP over IEEE 802.x, the relevant IP and IEEE 802.x parameters shall be included in the DSx-REQ message.

cst	CS
99	ATM
100	Packet, IPv4
101	Packet, IPv6
102	Packet, 802.3/Ethernet
103	Packet, 802.1Q VLAN
104	Packet IPV4 over 802.3/Ethernet
105	Packet IPV6 over 802.3/Ethernet
106	Packet IPV4 over 802.1Q VLAN
107	Packet IPV6 over 802.1Q VLAN

11.13.19.3 Packet CS encodings for configuration and MAC messaging

The following TLV encoded parameters shall be used in Dynamic Service messages. The CS specific type is denoted in the tables in the following subclauses by the variable “cst,” which takes its value from the table in 11.13.19.2 (e.g., 100, 101, ...) depending upon the exact packet CS used for the service.

11.13.19.3.1 QoS-related encodings

The following TLV encodings shall be used in registration messages and Dynamic Service messages to encode parameters for packet classification and scheduling.

The following configuration settings shall be supported by all SSs that are compliant with this specification.

11.13.19.3.2 Classifier DSC action

When received in a DSC-REQ, this indicates the action to be taken with this classifier.

Type	Length	Value
[145/146].cst.1	1	0 — DSC Add Classifier 1 — DSC Replace Classifier 2 — DSC Delete Classifier

11.13.19.3.3 Classifier error parameter set

This field defines the parameters associated with Classifier Errors.

Type	Length	Value
[145/146].cst.2	<i>variable</i>	Compound

A Classifier Error Parameter Set is defined by the following individual parameters: Packet Classifier Rule Index, Errored Parameter, Error Code, and Error Message.

The Classifier Error Parameter Set is returned in DSA-RSP and DSC-RSP messages to indicate the recipient's response to a Classifier establishment request in a DSA-REQ or DSC-REQ message.

On failure, the sender shall include one Classifier Error Parameter Set for each failed Classifier requested in the DSA-REQ or DSC-REQ message. Classifier Error Parameter Set for the failed Classifier shall include the Error Code and Errored Parameter and may include an Error Message. If some Classifier Sets are rejected but other Classifier Sets are accepted, then Classifier Error Parameter Sets shall be included for only the rejected Classifiers. On success of the entire transaction, the RSP or ACK message shall not include a Classifier Error Parameter Set.

Multiple Classifier Error Parameter Sets may appear in a DSA-RSP or DSC-RSP message, since multiple Classifier parameters may be in error. A message with even a single Classifier Error Parameter Set shall not contain any other protocol Classifier Encodings (e.g., IP, IEEE Std 802.1D-2004, IEEE Std 802.1Q, 2003 Edition).

A Classifier Error Parameter Set shall not appear in any DSA-REQ or DSC-REQ messages.

11.13.19.3.3.1 Errored parameter

The value of this parameter identifies the subtype of a requested Classifier parameter in error in a rejected Classifier request. A Classifier Error Parameter Set shall have exactly one Errored Parameter TLV within a given Classifier Encoding.

Subtype	Length	Value
[145/146].cst.2.1	<i>n</i>	Classifier Encoding Subtype in Error

If the length is 1, then the value is the single-level subtype where the error was found; e.g., 1 indicates an invalid Change Action. If the length is 2, then the value is the multilevel subtype where the error was found; e.g., 3-3 indicates an invalid IP Protocol value.

11.13.19.3.3.2 Error code

This parameter indicates the status of the request. A nonzero value corresponds to the CC as described in 11.13.1. A Classifier Error Parameter Set shall have exactly one Error Code within a given Classifier Encoding.

Subtype	Length	Value
[145/146].cst.2.2	1	CC except OK(0)

A value of OK(0) indicates that the Classifier request was successful. Since a Classifier Error Parameter Set applies only to errored parameters, this value shall not be used.

11.13.19.3.3.3 Error message

This subtype is optional in a Classifier Error Parameter Set. If present, it indicates a text string to be displayed on the SS console and/or log that further describes a rejected Classifier request. A Classifier Error Parameter Set may have zero or one Error Message subtypes within a given Classifier Encoding.

Subtype	Length	Value
[145/146].cst.2.3	<i>n</i>	Null-terminated string of ASCII characters The length of the string, including null-terminator may not exceed 128 bytes

11.13.19.3.4 Packet classification rule

This compound parameter contains the parameters of the classification rule. All parameters pertaining to a specific classification rule shall be included in the same Packet Classification Rule compound parameter.

Type	Length	Value
[145/146].cst.3	<i>variable</i>	Compound

11.13.19.3.4.1 Classifier rule priority

The value of the field specifies the priority for the Classifier, which is used for determining the order of the Classifier. A higher value indicates higher priority.

Classifiers may have priorities in the range 0–255 with the default value being 0.

Type	Length	Value
[145/146].cst.3.1	1	0–255

11.13.19.3.4.2 IP Type of service/differentiated services codepoint (DSCP) range and mask

The values of the field specify the matching parameters for the IP type of service/DSCP (IETF RFC 2474) byte range and mask. An IP packet with IP type of service (ToS) byte value “ip-tos” matches this parameter if $\text{tos-low} \leq (\text{ip-tos AND tos-mask}) \leq \text{tos-high}$. If this field is omitted, then comparison of the IP packet ToS byte for this entry is irrelevant.

Type	Length	Value
[145/146].cst.3.2	3	tos-low, tos-high, tos-mask

11.13.19.3.4.3 Protocol

The value of the field specifies a list of matching values for the IP Protocol field. For IPv6 (IETF RFC 2460), this refers to next header entry in the last header of the IP header chain. The encoding of the value field is that defined by the IANA document “Protocol Numbers.” If this parameter is omitted, then comparison of the IP header Protocol field for this entry is irrelevant.

Type	Length	Value
[145/146].cst.3.3	n	prot1, prot2,...prot n

11.13.19.3.4.4 IP masked source address

This parameter specifies a list of IP source addresses (designated “src_{*i*}”) and their corresponding address masks (designated “smask_{*i*}”). An IP packet with IP source address “ip-src” matches this parameter if $\text{src}_i = (\text{ip-src AND smask}_i)$ for any i from 1 to n . If this parameter is omitted, then comparison of the IP packet source address for this entry is irrelevant.

Type	Length	Value
[145/146].cst.3.4	$n*8$ (IPv4) or $n*32$ (IPv6)	src ₁ , smask ₁ ,..., src _{<i>i</i>} , smask _{<i>i</i>} ,..., src _{<i>n</i>} , smask _{<i>n</i>}

11.13.19.3.4.5 IP destination address

This parameter specifies a list of IP destination addresses (designated “dst_{*i*}”) and their corresponding address masks (designated “dmask_{*i*}”). An IP packet with IP destination address “ip-dst” matches this parameter if $\text{dst}_i = (\text{ip-dst AND dmask}_i)$ for any i from 1 to n . If this parameter is omitted, then comparison of the IP packet destination address for this entry is irrelevant.

Type	Length	Value
[145/146].cst.3.5	$n*8$ (IPv4) or $n*32$ (IPv6)	dst ₁ , dmask ₁ ,..., dst _{<i>i</i>} , dmask _{<i>i</i>} ,..., dst _{<i>n</i>} , dmask _{<i>n</i>}

11.13.19.3.4.6 Protocol source port range

The value of the field specifies a list of nonoverlapping ranges of protocol source port values. Classifier rules with port numbers are protocol specific; i.e., a rule on port numbers without a protocol specification shall not be defined. An IP packet with protocol port value “src-port” matches this parameter if src-port is greater than or equal to sportlow and src-port is less than or equal to sporthigh. If this parameter is omitted, the protocol source port is irrelevant. This parameter is irrelevant for protocols without port numbers.

Type	Length	Value
[145/146].cst.3.6	$n*4$	sportlow 1, sporthigh 2,...,sportlow n , sporthigh n

11.13.19.3.4.7 Protocol destination port range

The value of the field specifies a list of nonoverlapping ranges of protocol destination port values. Classifier rules with port numbers are protocol specific; i.e., a rule on port numbers without a protocol specification shall not be defined. An IP packet with protocol port value “dst-port” matches this parameter if dst-port is greater than or equal to dportlow and dst-port is less than or equal to dphorthigh. If this parameter is omitted the protocol destination port is irrelevant. This parameter is irrelevant for protocols without port numbers.

Type	Length	Value
[145/146].cst.3.7	$n*4$	dportlow 1, dphorthigh 2,...,dportlow n , dphorthigh n

11.13.19.3.4.8 IEEE 802.3/Ethernet destination MAC address

This parameter specifies a list of MAC destination addresses (designated “dst_{*i*}”) and their corresponding address masks (designated “msk_{*i*}”). An IEEE 802.3/Ethernet packet with MAC destination address “etherdst” corresponds to this parameter if dst_{*i*} = (etherdst AND msk_{*i*}) for any *i* from 1 to *n*. If this parameter is omitted, then comparison of the IEEE 802.3/Ethernet destination MAC address for this entry is irrelevant.

Type	Length	Value
[145/146].cst.3.8	$n*12$	dst ₁ , msk ₁ ,..., dst _{<i>i</i>} , msk _{<i>i</i>} ,..., dst _{<i>n</i>} , msk _{<i>n</i>}

11.13.19.3.4.9 IEEE 802.3/Ethernet source MAC address

This parameter specifies a list of MAC source addresses (designated “src_{*i*}”) and their corresponding address masks (designated “msk_{*i*}”). An IEEE 802.3/Ethernet packet with MAC source address “ethersrc” corresponds to this parameter if src_{*i*} = (ethersrc AND msk_{*i*}) for any *i* from 1 to *n*. If this parameter is omitted, then comparison of the IEEE 802.3/Ethernet source MAC address for this entry is irrelevant.

Type	Length	Value
[145/146].cst.3.9	$n \cdot 12$	$src_1, msk_1, \dots, src_i, msk_i, \dots, src_n, msk_n$

11.13.19.3.4.10 Ethertype/IEEE 802.2 SAP

The format of the Layer 3 protocol ID in the Ethernet packet is indicated by type, eprot1, and eprot2 as follows:

If type = 0, the rule does not use the Layer 3 protocol type as a matching criteria. If type = 0, eprot1, eprot2 are ignored when considering whether a packet matches the current rule.

If type = 1, the rule applies only to SDUs that contain an Ethertype value. Ethertype values are contained in packets using the DEC-Intel-Xerox (DIX) encapsulation or the Sub-Network Access Protocol (SNAP) encapsulation (IEEE 802.2, IETF RFC 1042) format. If type = 1, then eprot1, eprot2 gives the 16 bit value of the Ethertype that the packet shall match in order to match the rule.

If type = 2, the rule applies only to SDUs using the IEEE 802.2 encapsulation format with a Destination Service (DSAP) other than 0xAA (which is reserved for SNAP). If type = 2, the lower 8 bits of the eprot1, eprot2 shall match the DSAP byte of the packet in order to match the rule.

If the Ethernet SDU contains an IEEE 802.1D and IEEE 802.1Q Tag header (i.e., Ethertype 0x8100), this object applies to the embedded Ethertype field within the IEEE 802.1D and IEEE 802.1Q header.

Other values of type are reserved. If this TLV is omitted, then comparison of either the Ethertype or IEEE 802.2 DSAP for this rule is irrelevant.

Type	Length	Value
[145/146].cst.3.10	3	type, eprot1, eprot2

11.13.19.3.4.11 IEEE 802.1D User_Priority

The values of this field specify the matching parameters for the IEEE 802.1D user_priority bits. An Ethernet packet with IEEE 802.1D user_priority value “priority” matches these parameters if priority is greater than or equal to pri-low and priority is less than or equal to pri-high. If this field is omitted, then comparison of the IEEE 802.1D user_priority bits for this entry is irrelevant.

If this parameter is specified for an entry, then Ethernet packets without IEEE 802.1Q encapsulation shall NOT match this entry. If this parameter is specified for an entry on an SS that does not support forwarding of IEEE 802.1Q encapsulated traffic, then this entry shall not be used for any traffic.

Type	Length	Value
[145/146].cst.3.11	2	pri-low, pri-high Valid Range: 0–7 for pri-low and pri-high

11.13.19.3.4.12 IEEE 802.1Q VLAN_ID

The value of the field specifies the matching value for the IEEE 802.1Q vlan_id bits. Only the first (i.e. left-most) 12 bits of the specified vlan_id field are significant; the final four bits shall be ignored for comparison. If this field is omitted, then comparison of the IEEE 802.1Q vlan_id bits for this entry is irrelevant.

If this parameter is specified for an entry, then Ethernet packets without IEEE 802.1Q encapsulation shall not match this entry. If this parameter is specified for an entry on an SS that does not support forwarding of IEEE 802.1Q encapsulated traffic, then this entry shall not be used for any traffic.

Type	Length	Value
[145/146].cst.3.12	2	vlan_id1, vlan_id2

11.13.19.3.4.13 Associated PHSI

The Associated PHSI has a value between 1 and 255, which shall mirror the PHSI value of a PHS rule. Packets matching the Packet Classification Rule containing the Associated PHSI parameter shall undergo PHS according to the corresponding PHS rule.

Type	Length	Value
[145/146].cst.3.13	1	Index value

11.13.19.3.4.14 Packet Classifier Rule Index

The Packet Classifier Rule Index identifies a Packet Classifier Rule. The Packet Classifier Rule Index is unique per service flow.

Type	Length	Value
[145/146].cst.3.14	2	Packet Classifier Rule Index

11.13.19.3.4.15 Vendor-specific classifier parameters

This allows vendors to encode vendor-specific classifier parameters. The Vendor ID shall be the first TLV embedded inside vendor-specific classifier parameters. If the first TLV inside vendor-specific classifier parameters is not a Vendor ID, then the TLV shall be discarded (see 11.1.6).

Type	Length	Value
[145/146].cst.3.143	<i>variable</i>	Compound

11.13.19.3.5 PHS DSC action

When received in a DSC-REQ, this indicates the action that shall be taken with this PHS byte string.

Type	Length	Value
[145/146].cst.4	1	0 — Add PHS Rule 1 — Set PHS Rule 2 — Delete PHS Rule 3 — Delete all PHS Rules

The “Set PHS Rule” command is used to add the specific TLVs for an undefined PHS rule. It shall NOT be used to modify existing TLVs.

When deleting all PHS Rules, any corresponding PHSI shall be ignored.

An attempt to add a PHS Rule that already exists is an error condition.

11.13.19.3.6 PHS error parameter set

This field defines the parameters associated with PHS errors.

Type	Length	Value
[145/146].cst.5	<i>variable</i>	Compound field

A PHS Error Parameter Set is defined by the following individual parameters:

- a) PHSI
- b) Errored Parameter
- c) Error Code
- d) Error Message

The PHS Error Parameter Set is returned in DSA-RSP and DSC-RSP messages to indicate the recipient’s response to a PHS Rule establishment request in a DSA-REQ or DSC-REQ message.

On failure, the sender shall include one PHS Error Parameter Set for each failed PHS Rule requested in the DSA-REQ or DSC-REQ message. PHS Error Parameter Set for the failed PHS Rule shall include the Error Code and Errored Parameter and may include an Error Message. If some PHS Rule Sets are rejected but other PHS Rule Sets are accepted, then PHS Error Parameter Sets shall be included for only the rejected PHS Rules. On success of the entire transaction, the RSP or ACK message shall not include a PHS Error Parameter Set.

Multiple PHS Error Parameter Sets may appear in a DSA-RSP or DSC-RSP message, since multiple PHS parameters may be in error. A message with even a single PHS Error Parameter Set shall not contain any other protocol PHS Encodings (e.g., IP or IEEE Std 802.1D-2004/IEEE Std 802.1Q, 2003 Edition).

A PHS Error Parameter Set shall not appear in any DSA-REQ or DSC-REQ messages.

11.13.19.3.6.1 Errored parameter

The value of this parameter identifies the subtype of a requested PHS Parameter in error in a rejected PHS request. A PHS Error Parameter Set shall have exactly one Errored Parameter TLV within a given PHS Encoding.

Type	Length	Value
[145/146].cst.5.1	1	PHS Encoding Subtype in Error

11.13.19.3.6.2 Error code

This parameter indicates the status of the request. A nonzero value corresponds to the CC as described in 11.13.1. A PHS Error Parameter Set shall have exactly one Error Code within a given PHS Encoding.

Type	Length	Value
[145/146].cst.5.2	1	CC except OK(0) as specified in Table 384

A value of OK(0) indicates that the PHS request was successful. Since a PHS Error Parameter Set only applies to errored parameters, this value shall not be used.

11.13.19.3.6.3 Error message

This subtype is optional in a PHS Error Parameter Set. If present, it indicates a text string to be displayed on the SS console and/or log that further describes a rejected PHS request. A PHS Error Parameter Set may have zero or one Error Message subtypes within a given PHS Encoding.

Type	Length	Value
[145/146].cst.5.3	<i>n</i>	Null-terminated string of ASCII characters

The length *n* may not exceed 128 including the terminating NULL.

11.13.19.3.7 PHS Rule

This field defines the parameters associated with a PHS Rule.

Type	Length	Value
[145/146].cst.6	<i>n</i>	

11.13.19.3.7.1 PHSI

The PHSI has a value between 1 and 255, which uniquely references the suppressed byte string. The index is unique per service flow. The uplink and downlink PHSI values are independent of each other.

Type	Length	Value
[145/146].cst.6.1	1	Index value

11.13.19.3.7.2 PHSF

The PHSF is a string of bytes containing the header information to be suppressed by the sending CS and reconstructed by the receiving CS. The most significant byte of the string corresponds to the first byte of the CS-SDU.

Type	Length	Value
[145/146].cst.6.2	<i>n</i>	String of bytes suppressed

The length *n* shall always be the same as the value for PHSS.

11.13.19.3.7.3 PHSM

The value of this field is used to interpret the values in the PHSF. It is used at both the sending and receiving entities on the link. The PHSM allows fields, such as sequence numbers or checksums (which vary in value), to be excluded from suppression with the constant bytes around them suppressed.

Type	Length	Value
[145/146].cst.6.3	<i>n</i>	bit 0: 0 = don't suppress first byte of the suppression field 1 = suppress first byte of the suppression field bit 1: 0 = don't suppress second byte of the suppression field 1 = suppress second byte of the suppression field bit <i>x</i>: 0 = don't suppress (<i>x</i>+1) byte of the suppression field 1 = suppress (<i>x</i>+1) byte of the suppression field

The length *n* is ceiling (PHSS/8). Bit 0 is the MSB of the Value field. The value of each sequential bit in the PHSM is an attribute for the corresponding sequential byte in the PHSF.

If the bit value is a “1,” the sending entity should suppress the byte, and the receiving entity should restore the byte from its cached PHSF. If the bit value is a “0,” the sending entity should not suppress the byte, and the receiving entity should restore the byte by using the next byte in the packet.

If this TLV is not included, the default is to suppress all bytes.

11.13.19.3.7.4 PHSS

The value of this field is the total number of bytes in the header to be suppressed and then restored in a service flow that uses PHS.

Type	Length	Value
[145/146].cst.6.4	1	Number of bytes in the suppression string

This TLV is used when a service flow is being created. For all packets that get classified and assigned to a service flow with PHS enabled, suppression shall be performed over the specified number of bytes as indicated by the PHSS and according to the PHSM. If this TLV is not included in a service flow definition, or is included with a value of 0 bytes, then PHS is disabled. A nonzero value indicates PHS is enabled.

11.13.19.3.7.5 PHSV

The value of this field indicates to the sending entity whether or not the packet header contents are to be verified prior to performing suppression. If PHSV is enabled, the sender shall compare the bytes in the packet header with the bytes in the PHSF that are to be suppressed as indicated by the PHSM.

Type	Length	Value
[145/146].cst.6.5	1	0 = verify 1 = don't verify

If this TLV is not included, the default is to verify. Only the sender shall verify suppressed bytes. If verification fails, the Payload Header shall NOT be suppressed.

11.13.19.3.7.6 Vendor-specific PHS parameters

This allows vendors to encode vendor-specific PHS parameters. The Vendor ID shall be the first TLV embedded inside vendor-specific PHS parameters. If the first TLV inside vendor-specific PHS parameters is not a Vendor ID, then the TLV shall be discarded.

Type	Length	Value
[145/146].cst.6.143	<i>variable</i>	Compound

11.13.19.3.8 IPv6 Flow label

The value of this field specifies a list of matching values for the IPv6 Flow label field. As the flow label field has a length of 20 bits, the first 4 bits of the most significant byte shall be set to 0x0 and disregarded.

Type	Length	Scope
[145/146].[101/105/107].3.15	n*3	Flow Label #*1...Flow label#n

11.13.19.4 ATM CS Encodings for Configuration and MAC Messaging

The TLV encodings listed in 11.13.19.4.1 through 11.13.19.4.3 shall be used in the configuration file, in SS registration requests (when applicable), and in Dynamic Service messages (when applicable). All ATM specific TLVs are prefixed to begin with a Type value of [145/146].99.

11.13.19.4.1 ATM switching encoding

This field defines the switching methodology for the service. If the field = 0, at least one VPI/VCI Classifier pair shall be defined for classifying the service. If the field = 1, exactly one VPI Classifier and zero or one VCI Classifier shall be specified for classifying the service. If the field = 2, exactly one VPI Classifier and one VCI Classifier shall be defined for classifying the service. If the field = 0, PHS is not allowed and the SDU size TLV shall equal 52. If the field = 1 and PHS is on for the service, the SDU size TLV shall equal 51; otherwise it shall be set equal to 52. If the field = 2 and PHS is on for the service, the SDU size TLV shall equal 49; otherwise it shall be set equal to 52.

Type	Length	Value
[145/146].99.1	1	0 = no switching methodology applied 1 = VP switching 2 = VC switching

11.13.19.4.2 ATM Classifier TLV

This field defines an ATM classifier. It is a compound TLV used to describe the VPI and associated VCIs for ATM classification.

Type	Length	Value
[145/146].99.2	<i>variable</i>	Compound

It shall have the following form:

Field	Note
ATM Classifier ID	Always present
VPI Classifier	Always present except for DSC Change action deleting classifier
VCI Classification	0 or more instances (number apparent from ATM Classifier length field) if VPI Classifier is present

11.13.19.4.2.1 VPI classifier

This field defines the VPI on which to classify ATM cells for the service flow.

Type	Length	Value
[145/146].99.2.1	2	8-bit or 12-bit VPI field value

11.13.19.4.2.2 VCI classification

This field defines the VCI on which to classify ATM cells for the service flow.

This TLV shall immediately follow the VPI TLV with which it is associated.

Type	Length	Value
[145/146].99.2.2	2	16-bit VCI field value

11.13.19.4.2.3 ATM Classifier ID

This field is used to identify an ATM classifier.

Type	Length	Value
[145/146].99.2.3	16	16-bit classifier ID

11.13.19.4.3 ATM Classifier DSC Action

When received in a DSC-REQ message, this indicates the action to be taken on a classifier. If the action TLV is Add or Replace, the action is followed by a complete ATM Classifier compound TLV. If the action is delete, the action TLV is followed by the ATM Classifier compound TLV composed only of the ATM Classifier ID TLV.

Type	Length	Value
[145/146].99.3	1	0 – DSC Add Classifier 1 – DSC Replace Classifier 2 – DSC Delete Classifier

11.13.19.4.4 ATM Classifier Error Parameter Set

This field defines the parameters associated with ATM classifier errors.

Type	Length	Value
[145/146].99.4	<i>variable</i>	Compound

The contents of the compound structure shall be identical to the encoding for the Classifier Error Parameter Set for packet services specified in 11.13.19.3.3.

12. System profiles

This clause defines system profiles that list sets of features to be used in typical implementation cases. Each profile is assigned an identifier for use in such documents as PICS proforma statements. Features specified in the standard as optional may be listed in a profile as “required” or “conditionally required.” Profiles do not change “mandatory” status if specified in the standard itself. Any feature that is specified in the standard as optional and does not appear in certain profile is optional for the profile, thus absence of this feature in specific implementation does not affect conformance to the profile. Optional features shall be implemented as specified in the standard.

12.1 WirelessMAN-SC (10–66 GHz) system profiles

This subclause defines system profiles for systems operating with the WirelessMAN-SC air interface.

Table 386—Profile definitions

Identifier	Description
profM1	Basic ATM MAC profile
profM2	Basic packet MAC profile
profP1	25 MHz channel PHY profile
profP1f	25 MHz channel PHY profile – FDD
profP1t	25 MHz channel PHY profile – TDD
profP2	28 MHz channel PHY profile
profP2f	28 MHz channel PHY profile – FDD
profP2t	28 MHz channel PHY profile – TDD

12.1.1 WirelessMAN-SC MAC system profiles

This subclause defines MAC profiles for systems operating with the WirelessMAN-SC air interface.

12.1.1.1 Basic ATM MAC system profile

Profile identifier: profM1.

Mandatory features:

- Support of PVCs.
- Support of VC-switched connections.
- Support of VP-switched connections.
- ATM PHS is mandatory as a capability, but may be turned on or off on a per connection basis.
- IPv4 on the Secondary Management connection.
- Packing of multiple ATM cells into a single MAC PDU is mandatory as a capability, but may be turned on or off on a per-connection basis.
- SDU fragmentation on the Primary Management and Secondary management connections.

Conditionally Mandatory features:

- If nrtPS or BE services are supported, then the SS responding to broadcast polling is mandatory.
- If multicast polling groups are supported, multicast polling must be supported.

12.1.1.2 Basic Packet MAC system profile

Profile identifier: profM2.

Mandatory features:

- Support of provisioned connections.
- IPv4 support on transport connection.
- Classification of packets in the SS based on the incoming physical port.
- Reception of multiple SDUs packed into a single MAC PDU is mandatory as a capability, but may be turned on or off on a per connection basis.
- Fragmentation of SDUs is mandatory as a capability, but may be turned on or off on a per-connection basis.

Conditionally Mandatory features:

- If nrtPS or BE services are supported, then the SS responding to broadcast polling is mandatory.
- If multicast polling groups are supported, multicast polling must be supported.

12.1.1.3 Conventions for MAC Management messages for profiles profM1 and profM2

The following rules shall be followed when reporting parameters in MAC Management messages:

- Service Class Names should not be used.
- No TLVs besides Error Encodings and HMAC Tuples shall be reported back in DSA-RSP and DSC-RSP messages.
- No TLVs besides HMAC Tuples shall be reported back in DSA-ACK messages.
- DSC-REQ messages shall not contain Request/Transmission Policy, Fixed vs. Variable Length SDU Indicator, SDU Size, ATM Switching, or Convergence Sublayer Specification TLVs.

12.1.1.4 MAC Management message Parameter Transmission Order

The following subclauses define the order in which systems meeting profiles profM1 and profM2 shall transmit the TLV encoded parameters for mandatory features in the respective messages. Systems implementing either profile shall only include the parameters listed under the respective message in its transmission of these messages plus any parameters necessary for optional features. Parameters for optional features shall occur after those listed for support of mandatory features. Parameters with defined default values should be omitted if the desired value coincides with the default one. PHY specific messages are described in 12.1.2.

12.1.1.4.1 DCD

The parameters of the DCD message are PHY profile specific.

12.1.1.4.2 DL-MAP

This message contains no TLV encoded information.

12.1.1.4.3 UCD

The parameters of the DCD message are PHY profile specific.

12.1.1.4.4 UL-MAP

This message contains no TLV encoded information.

12.1.1.4.5 RNG-REQ

- Requested downlink Burst Profile
- SS MAC Address
- Ranging Anomalies

12.1.1.4.6 RNG-RSP

If ranging status equals “success” or “continue”:

- Ranging Status
- Timing Adjust (default to 0)
- Power Adjust (default to 0)
- Downlink operational Burst profile (only if changed)
- SS MAC Address (only on CID 0x0000)
- Basic CID (only on CID 0x0000)
- Primary Management CID (only on CID 0x0000)
- Uplink Channel Override (only if allowed by PHY profile)

If ranging status equals “abort”:

- Ranging Status
- SS MAC Address (only on CID 0x0000)
- Downlink frequency Override (if needed)

12.1.1.4.7 REG-REQ

- Vendor ID Encoding (optional)
- Uplink CID Support
- PKM Flow Control (default = no limit)
- DSx Flow Control (default = no limit)
- MCA Flow Control (default = no limit)
- IP version (default = IPv4)
- MAC CRC support (default = support)
- Multicast Polling Group CID support (default = 4)
- Convergence Sublayer Support (1 instance for each CS supported)
- Maximum number of classifiers (default = 0, no limit)
- PHS support (default = 0, no PHS support)
- HMAC Tuple

12.1.1.4.8 REG-RSP

- Secondary Management CID
- Uplink CID Support
- Vendor ID Encoding (if present in REG-REQ)
- PKM Flow Control (if present in REG-REQ or changed from default)

- DSx Flow Control (if present in REG-REQ or changed from default)
- MCA Flow Control (if present in REG-REQ or changed from default)
- IP version (if present in REG-REQ or changed from default)
- MAC CRC support (if present in REG-REQ or changed from default)
- Multicast Polling Group CID support (if present in REG-REQ or changed from default)
- Vendor-specific information (Compound, only allowed if Vendor ID present in REG-REQ, and extensions provided)
- Vendor ID
- Vendor-specific extensions
- HMAC Tuple

12.1.1.4.9 PKM-REQ: Auth Info

- CA-Certificate

12.1.1.4.10 PKM-REQ: Auth Request

- SS-Certificate
- Security Capabilities
- Version (default = 1)
- Cryptographic-Suite-List (default is that both no encryption and 56-bit DES are supported, no data authentication, and 3-DES EDE with 128-bit key)
- SAID

12.1.1.4.11 PKM-REQ: Key Request

- Key Sequence Number
- SAID
- HMAC-Digest

12.1.1.4.12 PKM-RSP: SA Add

- Key-Sequence-Number
- SA-Descriptor(s)
- SAID
- SA-Type
- Cryptographic Suite
- HMAC-Digest

12.1.1.4.13 PKM-RSP: Auth Reply

- AUTH-Key
- Key-Lifetime
- Key-Sequence-Number
- SA-Descriptor(s)
- SAID
- SA-Type
- Cryptographic Suite

12.1.1.4.14 PKM-RSP: Auth Reject

- Error Code
- Display String (optional)

12.1.1.4.15 PKM-RSP: Key Reply

- Key Sequence Number
- SAID
- TEK-Parameters (Older)
- TEK
- Key Lifetime
- Key Sequence Number
- CBC-IV
- TEK-Parameters (Newer)
- TEK
- Key Lifetime
- Key Sequence Number
- CBC-IV
- HMAC-Digest

12.1.1.4.16 PKM-RSP: Key Reject

- Key Sequence Number
- SAID
- Error Code
- Display String (optional)
- HMAC-Digest

12.1.1.4.17 PKM-RSP: Auth Invalid

- Error Code
- Display String (optional)

12.1.1.4.18 PKM-RSP: TEK Invalid

- Key Sequence Number
- SAID
- Error Code
- Display String (optional)
- HMAC-Digest

12.1.1.4.19 DSA-REQ—BS Initiated Service Addition

- Uplink Service Parameters
- Service Flow ID
- Transport CID
- Target SAID
- QoS Parameter Set Type
- Service Flow Scheduling Type
- Request/Grant Transmission Policy
- Convergence Sublayer Specification
- Fixed vs Variable Length SDU Indicator (default = variable)
- SDU Size (required if fixed, forbidden if variable SDU)
- Maximum Sustained Traffic Rate
- Minimum Reserved Traffic Rate (default = 0 for BE, Max Sust Rate for UGS, required for rtPS and nrtPS)
- Maximum Traffic Burst (required for rtPS and nrtPS, excluded otherwise)
- Traffic Priority (optional, BE only)

- Tolerated Jitter (optional)
- Maximum Latency (optional)
- Convergence Sublayer Specific Parameters (see 12.1.1.5 and 12.1.1.6)
- Vendor-specific QoS Parameters
- Downlink Service Parameters
- Service Flow ID
- Transport CID
- Target SAID
- QoS Parameter Set Type
- Service Flow Scheduling Type
- Request/Grant Transmission Policy
- Convergence Sublayer Specification
- Fixed vs. Variable Length SDU Indicator (default = variable)
- SDU Size (required if fixed, forbidden if variable SDU)
- Convergence Sublayer Specific Parameters (see 12.1.1.5 and 12.1.1.6)
- Vendor-specific QoS Parameters
- HMAC Tuple

12.1.1.4.20 DSA-RSP—BS Initiated Service Addition

- Uplink Service Parameters
- Service Flow Error Parameter Set(s) (one per errored parameter)
 - Errored Parameter
 - Error Code
 - Error Message (optional)
- Downlink Service Parameter(s)
- Service Flow Error Parameter Set(s) (one per errored parameter)
 - Errored Parameter
 - Error Code
 - Error Message (optional)
- HMAC Tuple

12.1.1.4.21 DSA-ACK

- HMAC Tuple

12.1.1.4.22 DSC-REQ—BS Initiated Service Change

- Uplink Service Parameters
- Service Flow ID
- Transport CID
- QoS Parameter Set Type
- Maximum Sustained Traffic Rate
- Minimum Reserved Traffic Rate (default = 0 for BE, Max Sust Rate for UGS, required for rtPS and nrtPS)
- Maximum Traffic Burst (required for rtPS and nrtPS, excluded otherwise)
- Traffic Priority (optional, BE only)
- Tolerated Jitter (optional)
- Maximum Latency (optional)
- Convergence Sublayer Specific Parameters (see 12.1.1.5 and 12.1.1.6)
- Vendor-specific QoS Parameters
- Downlink Service Parameters
- Service Flow ID
- Transport CID

- QoS Parameter Set Type
- Convergence Sublayer Specific Parameters (see 12.1.1.5 and 12.1.1.6)
- Vendor-specific QoS Parameters
- HMAC Tuple

12.1.1.4.23 DSC-RSP—BS Initiated Service Change

- Uplink Service Parameters
- Service Flow Error Parameter Set(s) (one per errored parameter)
 - Errored Parameter
 - Error Code
 - Error Message (optional)
- Downlink Service Parameter(s)
- Service Flow Error Parameter Set(s) (one per errored parameter)
 - Errored Parameter
 - Error Code
 - Error Message (optional)
- HMAC Tuple

12.1.1.4.24 DSC-ACK

- HMAC Tuple

12.1.1.4.25 DSD-REQ

- HMAC Tuple

12.1.1.4.26 DSD-RSP

- HMAC Tuple

12.1.1.4.27 MCA-REQ

- Multicast CID
- Assignment

12.1.1.4.28 MCA-RSP

Message contains no TLV encoded information

12.1.1.4.29 DBPC-REQ

Message contains no TLV encoded information

12.1.1.4.30 DBPC-RSP

Message contains no TLV encoded information

12.1.1.4.31 RES-CMD

- HMAC Tuple

12.1.1.4.32 SBC-REQ

- WirelessMAN-SC PHY SS Demod Support
- WirelessMAN-SC PHY SS Modulator Support
- WirelessMAN-SC PHY SSdownlink FEC Types
- WirelessMAN-SC PHY SS uplink FEC Types
- Bandwidth Allocation Support

12.1.1.4.33 SBC-RSP

- WirelessMAN-SC PHY SS Demod Support
- WirelessMAN-SC PHY SS Modulator Support
- WirelessMAN-SC PHY SS downlink FEC Types
- WirelessMAN-SC PHY SS uplink FEC Types

12.1.1.4.34 CLK-CMP

The message contains no TLV encoded information.

12.1.1.4.35 DREG-CMD

- HMAC Tuple

12.1.1.4.36 DSX-RVD

The message contains no TLV encoded information.

12.1.1.4.37 TFTP-CPLT

- HMAC Tuple

12.1.1.4.38 TFTP-RSP

The message contains no TLV encoded information.

12.1.1.5 Message parameters specific to profM1

The following subclauses define the order in which systems meeting profile profM1 shall transmit the TLV encoded parameters specific to the ATM CS. Parameters with defined default values should be omitted if the desired value coincides with the default one.

12.1.1.5.1 ATM CS Parameters for DSA-REQ—BS Initiated

- ATM Switching
- ATM Classifier Rule(s) (default = don't classify)
- ATM Classifier ID
- VPI Classifier
- VCI Classifier(s) (must follow associated VPI, default = don't classify on VCI)

12.1.1.5.2 ATM CS Parameters for DSA-RSP—BS Initiated

- None

12.1.1.5.3 ATM CS Parameters for DSC-REQ—BS Initiated

- ATM Classifier Change Action
- ATM Classifier Rule(s) (default = don't classify)
- ATM Classifier ID
- VPI Classifier
- VCI Classifier(s) (must follow associated VPI, default = don't classify on VCI)

12.1.1.5.4 ATM CS Parameters for DSC-RSP—BS Initiated

- None

12.1.1.6 Message parameters specific to profM2**12.1.1.6.1 Packet CS Parameters for DSA-REQ—BS Initiated**

- Packet Classification Rule(s) (uplink service flows only, default is no classification)
- Classifier Rule ID
- Classifier Rule Priority (default to 0)
- IP Type of Service/DSCP (only for IP CSs, default = don't classify on this)
- Protocol (only for IP CSs, default = don't classify on this)
- IP Masked Source Address (only for IP CSs, default = don't classify on this)
- IP Destination Address (only for IP CSs, default = don't classify on this)
- Protocol Source Port Range (only for IP CSs, default = don't classify on this)
- Protocol Destination Port Range (only for IP CSs, default = don't classify on this)
- Ethernet Destination MAC Address (only for Ethernet CSs, default = don't classify on this)
- Ethernet Source MAC Address (only for Ethernet CSs, default = don't classify on this)
- Ethertype/IEEE 802.2 SAP (only for Ethernet CSs, default = don't classify on this)
- IEEE 802.1D User Priority (only for VLAN CSs, default = don't classify on this)
- IEEE 802.1Q VLAN_ID (only for VLAN CSs, default = don't classify on this)
- Associated PHSI (default is no PHS for this classifier match)
- Vendor-specific Classifier Parameters
- PHS Rule(s)
- PHSI
- PHSS
- PHSF
- PHSM (default is suppress all bytes of the suppression field)
- PHSV (default is verify)
- Vendor-specific PHS Parameters

12.1.1.6.2 Packet CS Parameters for DSA-RSP—BS Initiated

- Packet Classification Rule(s) (uplink service flows only, default is no classification)
- Classifier Error Parameter Set(s) (one per errored parameter)
 - Classifier Rule ID
 - Errored Parameter
 - Error Code
 - Error Message (optional)
- PHS Rule(s)
- PHS Error Parameter Set(s) (one per errored parameter)
- PHSI
 - Errored Parameter
 - Error Code
 - Error Message (optional)

12.1.1.6.3 Packet CS Parameters for DSC-REQ—BS Initiated

- Classifier Dynamic Service Change Action(s)
- Packet Classification Rule(s) (uplink service flows only, 1 per Action)
- Classifier Rule ID
- Classifier Rule Priority (default to 0)
- IP Type of Service/DSCP (only for IP CSs, default = don't classify on this)
- Protocol (only for IP CSs, default = don't classify on this)
- IP Masked Source Address (only for IP CSs, default = don't classify on this)
- IP Destination Address (only for IP CSs, default = don't classify on this)
- Protocol Source Port Range (only for IP CSs, default = don't classify on this)
- Protocol Destination Port Range (only for IP CSs, default = don't classify on this)
- Ethernet Destination MAC Address (only for Ethernet CSs, default = don't classify on this)
- Ethernet Source MAC Address (only for Ethernet CSs, default = don't classify on this)
- Ethertype/IEEE 802.2 SAP (only for Ethernet CSs, default = don't classify on this)
- IEEE 802.1D User Priority (only for VLAN CSs, default = don't classify on this)
- IEEE 802.1Q VLAN_ID (only for VLAN CSs, default = don't classify on this)
- Associated PHSI (default is no PHS for this classifier match)
- Vendor-specific Classifier Parameters
- PHS Dynamic Service Change Action
- PHS Rule(s) (1 per Action)
- PHSI
- PHSS
- PHSF
- PHSM (default is suppress all bytes of the suppression field)
- PHSV (default is verify)
- Vendor-specific PHS Parameters

12.1.1.6.4 Packet CS Parameters for DSC-RSP—BS Initiated

- Uplink Service Parameters
- Service Flow Error Parameter Set(s) (one per errored parameter)
 - Errored Parameter
 - Error Code
 - Error Message (optional)
- Downlink Service Parameter(s)
- Service Flow Error Parameter Set(s) (one per errored parameter)
 - Errored Parameter
 - Error Code
 - Error Message (optional)

12.1.2 WirelessMAN-SC PHY Profiles

This subclause defines PHY profiles for systems operating with the WirelessMAN-SC PHY.

12.1.2.1 WirelessMAN-SC 25 MHz Channel PHY Profile

Profile identifier: profP1.

Mandatory features:

- Frame Duration of 1 ms
- QPSK and QAM-16 in the DL
- QPSK in the UL

- Roll-off Factor = 0.25
- RS outer codes with $t \in \{0, 4, 8, 10, 12\}$.
- Fixed and shortened last code word operation.
- RS block lengths of 6–255.
- 20 MBd symbol rate
- 5000 PS per frame

SSs implementing profP1 shall meet the minimum SS performance requirements listed in Table 387.

Table 387—SS Minimum Performance requirements for profP1

Capability	Minimum performance
Tx Dynamic range	≥ 40 dB
Rx Dynamic Range	≥ 40 dB for QPSK
Tx RMS Power Level at Maximum Power Level Setting for QPSK	≥ 15 dBm
Tx Power Level minimum adjustment step	0.5 dB
Tx Power level adjustment step accuracy $0.5\text{dB} \leq \text{Step size} < 2\text{dB}$	monotonic
Tx Power level adjustment step accuracy $2\text{dB} \leq \text{Step size} < 5\text{dB}$	± 2 dB
Tx Power level adjustment step accuracy Step size ≥ 5 dB	± 3 dB
Peak-to-peak symbol jitter, referenced to the previous symbol zero crossing of the transmitted waveform, as percentage of the nominal symbol duration when measured over a period of 2 seconds	2%
Tx burst timing step size	± 0.25 of a symbol
Tx burst timing step accuracy	± 0.125 of a symbol
Spectral mask (OOB)	Local regulation
Ramp up/ramp down time	≤ 24 symbols
Output noise power spectral density when Tx is not transmitting	≤ -80 dBm/MHz
Modulation accuracy when measured with an ideal receiver without an equalizer for QPSK	12%
Modulation accuracy when measured with an ideal receiver without an equalizer for 16-QAM	6%
Modulation accuracy when measured with an ideal receiver with an equalizer for QPSK	10%
Modulation accuracy when measured with an ideal receiver with an equalizer for 16-QAM	3%
Modulation accuracy when measured with an ideal receiver with an equalizer for 64-QAM	1.5%
BER performance threshold for QPSK, $\text{BER}=10^{-3}$	$-94 + 10\log(25)$ dBm

Table 387—SS Minimum Performance requirements for profP1 (continued)

Capability	Minimum performance
BER performance threshold for 16-QAM, $BER=10^{-3}$	$-87 + 10\log(25)$ dBm
BER performance threshold for 64-QAM, $BER=10^{-3}$	$-79 + 10\log(25)$ dBm
BER performance threshold for QPSK, $BER=10^{-6}$	$-90 + 10\log(25)$ dBm
BER performance threshold for 16-QAM, $BER=10^{-6}$	$-83 + 10\log(25)$ dBm
BER performance threshold for 64-QAM, $BER=10^{-6}$	$-74 + 10\log(25)$ dBm
Transition time from Tx to Rx and from Rx to Tx	TDD: 2 μ s H-FDD: 20 μ s FDD: n/a
1 st adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for QPSK	−9 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for 16-QAM	−2 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for 64-QAM	+5 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for QPSK	−5 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for 16-QAM	+2 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for 64-QAM	+9 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 3 dB degradation C/I for QPSK	−5 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 3 dB degradation C/I for 16-QAM	+2 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 3 dB degradation C/I for 64-QAM	+9 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 1 dB degradation C/I for QPSK	−1 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 1 dB degradation C/I for 16-QAM	+6 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 1 dB degradation C/I for 64-QAM	+13 dB
2 nd adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for QPSK	−34 dB
2 nd adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for 16-QAM	−27 dB
2 nd adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for 64-QAM	−20 dB
2 nd adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for QPSK	−30 dB
2 nd adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for 16-QAM	−22 dB

Table 387—SS Minimum Performance requirements for profP1 (continued)

Capability	Minimum performance
2 nd adjacent channel interference at BER= 10^{-3} for 1 dB degradation C/I for 64-QAM	−16 dB
2 nd adjacent channel interference at BER= 10^{-6} for 3 dB degradation C/I for QPSK	−30 dB
2 nd adjacent channel interference at BER= 10^{-6} for 3 dB degradation C/I for 16-QAM	−23 dB
2 nd adjacent channel interference at BER= 10^{-6} for 3 dB degradation C/I for 64-QAM	−16 dB
2 nd adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for QPSK	−26 dB
2 nd adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for 16-QAM	−20 dB
2 nd adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for 64-QAM	−12 dB
Tx Power Level absolute accuracy	± 6 dB

BSs implementing profP1 shall meet the minimum transmitter performance requirements listed in Table 388. The receiver shall meet the minimum performance requirements in Table 389.

Table 388—BS Tx minimum performance requirements for profP1

Capability	Minimum performance
Peak-to-peak symbol jitter, referenced to the previous symbol zero crossing of the transmitted waveform, as percentage of the nominal symbol duration when measured over a period of 2 seconds	2%
Tx RF frequency	10-66 GHz
Tx RF frequency accuracy	± 10×10^{-6}
Spectral mask (OOB)	Local regulation
Spurious	Local regulation
Ramp up/ramp down time	≤ 24 symbols
Modulation accuracy when measured with an ideal receiver without an equalizer for QPSK	12%
Modulation accuracy when measured with an ideal receiver without an equalizer for 16-QAM	6%
Modulation accuracy when measured with an ideal receiver with an equalizer for QPSK	10%

Table 388—BS Tx minimum performance requirements for profP1 (continued)

Capability	Minimum performance
Modulation accuracy when measured with an ideal receiver with an equalizer for 16-QAM	3%
Modulation accuracy when measured with an ideal receiver with an equalizer for 64-QAM	1.5%

Table 389—BS Rx minimum performance for profP1

Capability	Minimum performance
Dynamic Range	27 dB for QPSK
BER performance threshold for QPSK, $BER=10^{-3}$	$-94 + 10\log(25)$ dBm
BER performance threshold for 16-QAM, $BER=10^{-3}$	$-87 + 10\log(25)$ dBm
BER performance threshold for 64-QAM, $BER=10^{-3}$	$-79 + 10\log(25)$ dBm
BER performance threshold for QPSK, $BER=10^{-6}$	$-90 + 10\log(25)$ dBm
BER performance threshold for 16-QAM, $BER=10^{-6}$	$-83 + 10\log(25)$ dBm
BER performance threshold for 64-QAM, $BER=10^{-6}$	$-74 + 10\log(25)$ dBm
1 st adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for QPSK	-9 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for 16-QAM	-2 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for 64-QAM	+5 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for QPSK	-5 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for 16-QAM	+2 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for 64-QAM	+9 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 3 dB degradation C/I for QPSK	-5 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 3 dB degradation C/I for 16-QAM	+2 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 3 dB degradation C/I for 64-QAM	+9 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 1 dB degradation C/I for QPSK	-1 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 1 dB degradation C/I for 16-QAM	+6 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 1 dB degradation C/I for 64-QAM	+13 dB

Table 389—BS Rx minimum performance for profP1 (continued)

Capability	Minimum performance
2 nd adjacent channel interference at BER= 10^{-3} for 3 dB degradation C/I for QPSK	−34 dB
2 nd adjacent channel interference at BER= 10^{-3} for 3 dB degradation C/I for 16-QAM	−27 dB
2 nd adjacent channel interference at BER= 10^{-3} for 3 dB degradation C/I for 64-QAM	−20 dB
2 nd adjacent channel interference at BER= 10^{-3} for 1 dB degradation C/I for QPSK	−30 dB
2 nd adjacent channel interference at BER= 10^{-3} for 1 dB degradation C/I for 16-QAM	−22 dB
2 nd adjacent channel interference at BER= 10^{-3} for 1 dB degradation C/I for 64-QAM	−16 dB
2 nd adjacent channel interference at BER= 10^{-6} for 3 dB degradation C/I for QPSK	−30 dB
2 nd adjacent channel interference at BER= 10^{-6} for 3 dB degradation C/I for 16-QAM	−23 dB
2 nd adjacent channel interference at BER= 10^{-6} for 3 dB degradation C/I for 64-QAM	−16 dB
2 nd adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for QPSK	−26 dB
2 nd adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for 16-QAM	−20 dB
2 nd adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for 64-QAM	−12 dB

12.1.2.1.1 FDD Specific WirelessMAN-SC 25 MHz Channel PHY Profile Features

Profile identifier: profP1f.

Mandatory features:

- FDD operation
- BS must respect half-duplex nature of half-duplex SSs

12.1.2.1.2 TDD Specific WirelessMAN-SC 25 MHz Channel PHY Profile Features

Profile identifier: profP1t.

Mandatory features:

- TDD operation

12.1.2.2 WirelessMAN-SC 28 MHz Channel PHY Profile

Profile identifier: profP2.

Mandatory features:

- Frame Duration of 1 ms
- QPSK and QAM-16 in the DL
- QPSK in the UL
- Roll-off Factor = 0.25
- RS outer codes with $t \in \{0, 4, 8, 10, 12\}$.
- Fixed and shortened last code word operation
- RS block lengths of 6–255
- 22.4 MBd symbol rate
- 5600 PS per frame

SSs implementing profP2 shall meet the minimum SS performance requirements as listed in Table 390.

Table 390—SS Minimum performance for profP2

Capability	Minimum performance
Tx Dynamic range	≥ 40 dB
Rx Dynamic Range	≥ 40 dB for QPSK
Tx RMS Power Level at Maximum Power Level Setting for QPSK	≥ 15 dBm
Tx Power Level minimum adjustment step	0.5 dB
Tx Power level adjustment step accuracy Step size [0.5, 2) dB	monotonic
Tx Power level adjustment step accuracy Step size [2, 5) dB	± 2 dB
Tx Power level adjustment step accuracy Step size ≥ 5 dB	± 3 dB
Peak-to-peak symbol jitter, referenced to the previous symbol zero crossing of the transmitted waveform, as percentage of the nominal symbol duration when measured over a 2 second period	2%
Tx burst timing step size	± 0.25 of a symbol
Tx burst timing step accuracy	± 0.125 of a symbol
Spectral mask (OOB)	Local regulation
Ramp up/ramp down time	≤ 24 symbols
Output noise power spectral density when Tx is not transmitting	≤ -80 dBm/MHz
Modulation accuracy when measured with an ideal receiver without an equalizer for QPSK	12%
Modulation accuracy when measured with an ideal receiver without an equalizer for 16-QAM	6%
Modulation accuracy when measured with an ideal receiver with an equalizer for QPSK	10%
Modulation accuracy when measured with an ideal receiver with an equalizer for 16-QAM	3%

Table 390—SS Minimum performance for profP2 (continued)

Capability	Minimum performance
Modulation accuracy when measured with an ideal receiver with an equalizer for 64-QAM	1.5%
BER performance threshold for QPSK, $BER=10^{-3}$	$-94 + 10\log(28)$ dBm
BER performance threshold for 16-QAM, $BER=10^{-3}$	$-87 + 10\log(28)$ dBm
BER performance threshold for 64-QAM, $BER=10^{-3}$	$-79 + 10\log(28)$ dBm
BER performance threshold for QPSK, $BER=10^{-6}$	$-90 + 10\log(28)$ dBm
BER performance threshold for 16-QAM, $BER=10^{-6}$	$-83 + 10\log(28)$ dBm
BER performance threshold for 64-QAM, $BER=10^{-6}$	$-74 + 10\log(28)$ dBm
Transition time from Tx to Rx and from Rx to Tx	TDD: 2 μ s H-FDD: 20 μ s FDD: n/a
1 st adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for QPSK	-9 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for 16-QAM	-2 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for 64-QAM	+5 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for QPSK	-5 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for 16-QAM	+2 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for 64-QAM	+9 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 3 dB degradation C/I for QPSK	-5 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 3 dB degradation C/I for 16-QAM	+2 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 3 dB degradation C/I for 64-QAM	+9 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 1 dB degradation C/I for QPSK	-1 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 1 dB degradation C/I for 16-QAM	+6 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 1 dB degradation C/I for 64-QAM	+13 dB

Table 390—SS Minimum performance for profP2 (continued)

Capability	Minimum performance
2 nd adjacent channel interference at BER= 10^{-3} for 3 dB degradation C/I for QPSK	−34 dB
2 nd adjacent channel interference at BER= 10^{-3} for 3 dB degradation C/I for 16-QAM	−27 dB
2 nd adjacent channel interference at BER= 10^{-3} for 3 dB degradation C/I for 64-QAM	−20 dB
2 nd adjacent channel interference at BER= 10^{-3} for 1 dB degradation C/I for QPSK	−30 dB
2 nd adjacent channel interference at BER= 10^{-3} for 1 dB degradation C/I for 16-QAM	−22 dB
2 nd adjacent channel interference at BER= 10^{-3} for 1 dB degradation C/I for 64-QAM	−16 dB
2 nd adjacent channel interference at BER= 10^{-6} for 3 dB degradation C/I for QPSK	−30 dB
2 nd adjacent channel interference at BER= 10^{-6} for 3 dB degradation C/I for 16-QAM	−23 dB
2 nd adjacent channel interference at BER= 10^{-6} for 3 dB degradation C/I for 64-QAM	−16 dB
2 nd adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for QPSK	−26 dB
2 nd adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for 16-QAM	−20 dB
2 nd adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for 64-QAM	−12 dB
Tx Power Level absolute accuracy	± 6 dB

BSs implementing profP2 shall meet the minimum transmitter performance requirements listed in Table 391. The receiver shall meet the minimum performance requirements in Table 392.

Table 391—BS Tx minimum performance for profP2

Capability	Minimum performance
Peak-to-peak symbol jitter, referenced to the previous symbol zero crossing of the transmitted waveform, as percentage of the nominal symbol duration when measured over a period of 2 seconds	2%
Tx RF frequency	10–66 GHz
Tx RF frequency accuracy	± 10×10^{-6}

Table 391—BS Tx minimum performance for profP2 (continued)

Spectral mask (OOB)	local regulation
Spurious	local regulation
Ramp up/ramp down time	≤ 24 symbols
Modulation accuracy when measured with an ideal receiver without an equalizer for QPSK	12%
Modulation accuracy when measured with an ideal receiver without an equalizer for 16-QAM	6%
Modulation accuracy when measured with an ideal receiver with an equalizer for QPSK	10%
Modulation accuracy when measured with an ideal receiver with an equalizer for 16-QAM	3%
Modulation accuracy when measured with an ideal receiver with an equalizer for 64-QAM	1.5%

Table 392—BS Rx minimum performance for profP2

Capability	Minimum performance
Dynamic Range	27 dB for QPSK
BER performance threshold for QPSK, $BER=10^{-3}$	$-94 + 10\log(28)$ dBm
BER performance threshold for 16-QAM, $BER=10^{-3}$	$-87 + 10\log(28)$ dBm
BER performance threshold for 64-QAM, $BER=10^{-3}$	$-79 + 10\log(28)$ dBm
BER performance threshold for QPSK, $BER=10^{-6}$	$-90 + 10\log(28)$ dBm
BER performance threshold for 16-QAM, $BER=10^{-6}$	$-83 + 10\log(28)$ dBm
BER performance threshold for 64-QAM, $BER=10^{-6}$	$-74 + 10\log(28)$ dBm
1 st adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for QPSK	-9 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for 16-QAM	-2 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 3 dB degradation C/I for 64-QAM	+5 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for QPSK	-5 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for 16-QAM	+2 dB
1 st adjacent channel interference at $BER=10^{-3}$ for 1 dB degradation C/I for 64-QAM	+9 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 3 dB degradation C/I for QPSK	-5 dB
1 st adjacent channel interference at $BER=10^{-6}$ for 3 dB degradation C/I for 16-QAM	+2 dB

Table 392—BS Rx minimum performance for profP2 (continued)

1 st adjacent channel interference at BER= 10^{-6} for 3 dB degradation C/I for 64-QAM	+9 dB
1 st adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for QPSK	−1 dB
1 st adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for 16-QAM	+6 dB
1 st adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for 64-QAM	+13 dB
2 nd adjacent channel interference at BER= 10^{-3} for 3 dB degradation C/I for QPSK	−34 dB
2 nd adjacent channel interference at BER= 10^{-3} for 3 dB degradation C/I for 16-QAM	−27 dB
2 nd adjacent channel interference at BER= 10^{-3} for 3 dB degradation C/I for 64-QAM	−20 dB
2 nd adjacent channel interference at BER= 10^{-3} for 1 dB degradation C/I for QPSK	−30 dB
2 nd adjacent channel interference at BER= 10^{-3} for 1 dB degradation C/I for 16-QAM	−22 dB
2 nd adjacent channel interference at BER= 10^{-3} for 1 dB degradation C/I for 64-QAM	−16 dB
2 nd adjacent channel interference at BER= 10^{-6} for 3 dB degradation C/I for QPSK	−30 dB
2 nd adjacent channel interference at BER= 10^{-6} for 3 dB degradation C/I for 16-QAM	−23 dB
2 nd adjacent channel interference at BER= 10^{-6} for 3 dB degradation C/I for 64-QAM	−16 dB
2 nd adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for QPSK	−26 dB
2 nd adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for 16-QAM	−20 dB
2 nd adjacent channel interference at BER= 10^{-6} for 1 dB degradation C/I for 64-QAM	−12 dB

12.1.2.2.1 FDD Specific WirelessMAN-SC 28 MHz Channel PHY Profile Features

Profile identifier: profP2f.

Mandatory features:

- FDD operation
- BS must respect half-duplex nature of half-duplex SSs

12.1.2.2.2 TDD Specific WirelessMAN-SC 28 MHz Channel PHY Profile Features

Profile identifier: profP2t.

Mandatory features:

- TDD operation

12.1.2.3 Conventions for MAC Management messages for profiles profP1 and profP2

The following rules shall be followed when reporting parameters in MAC Management messages for systems operating PHY profiles profP1 or profP2:

- Symbol Rate, Frequency, and Roll-off Factor shall not be reported in UCD messages.
- BCC Code Type shall not be reported in UCD messages.
- Frame Duration shall not be reported in DCD messages.
- BCC Code Type shall not be reported in DCD messages.
- Uplink Channel Override shall not be reported in RNG-RSP messages.

12.1.2.4 UCD and DCD parameter transmission order for profP1 and profP2

The following subclauses define the order in which systems meeting profiles profP1 and profP2 shall transmit the TLV encoded parameters in the respective messages. Systems implementing either profile shall only include the parameters listed under the respective message in its transmission of these messages. Parameters with defined default values should be omitted if the desired value coincides with the default one.

12.1.2.4.1 DCD

- BS Transmit Power
- PHY Type
- Power Adj Rule
- Downlink Burst Profile(s)
- Modulation Type
- FEC Code Type (default to RS only if omitted)
- RS Information Bytes
- RS parity bytes
- Last Codeword Length (default to shortened if omitted)
- Exit Threshold
- Entry Threshold
- Preamble Present (default to “not present” if omitted)

12.1.2.4.2 UCD

- SS Transition Gap (default to 24 symbols if omitted)
- Power Adjustment Rule
- Contention-based Reservation Timeout
- Uplink Burst Profile(s)
- Modulation Type
- Preamble Length
- FEC Code Type (default to RS only)
- RS Information Bytes
- RS Parity Bytes

- Randomizer Seed
- Last Codeword Length (default to shortened)

12.1.2.5 Initial Ranging IE usage for profP1 and profP2

BSs implementing profP1 or profP2 shall include exactly one Initial Ranging IE in the UL-MAP for each intended opportunity for an SS to perform Initial Ranging.

12.2 WirelessMAN-SCa and WirelessHUMAN(-SCa) system profiles

This subclause specifies system profiles for systems using the WirelessMAN-SCa PHY. Its scope includes both licensed and license-exempt (WirelessHUMAN) operation.

A WirelessMAN-SCa system profile contains four components: MAC profiles (12.2.1), a power class profile (12.2.2), a PHY profile with an associated duplexing selection (12.2.3), and an RF channelization profile (12.2.4).

12.2.1 WirelessMAN-SCa MAC System Profiles

This subclause defines MAC profiles for systems operating with the WirelessMAN-SCa air interface.

12.2.1.1 Basic ATM MAC System Profile

Profile identifier: profM4.

Mandatory features:

- Support of PVCs
- Support of VC-switched connections
- Support of VP-switched connections
- ATM payload header suppression is mandatory as a capability, but may be turned on or off on a per connection basis
- IPv4 on the Secondary Management connection
- Packing of multiple ATM cells into a single MAC PDU is mandatory as a capability, but may be turned on or off on a per connection basis
- SDU fragmentation on the Primary Management and Secondary management connections
- ARQ is mandatory as a capability, but may be turned on or off on a per connection basis
- Handling of undecodable transmissions in an initial ranging slot

Conditionally mandatory features:

- If nrtPS or BE services are supported, then the SS responding to broadcast polling is mandatory
- If multicast polling groups are supported, multicast polling must be supported

12.2.1.2 Basic Packet MAC System Profile

Profile identifier: profM5.

Mandatory features:

- Support of provisioned connections
- IPv4 support on transport connection
- Classification of packets in the SS based on the incoming physical port

- Reception of multiple SDUs packed into a single MAC PDU is mandatory as a capability, but may be turned on or off on a per connection basis
- Fragmentation of SDUs is mandatory as a capability, but may be turned on or off on a per connection basis
- ARQ is mandatory as a capability, but may be turned on or off on a per connection basis
- Handling of undecodable transmissions in an initial ranging slot

Conditionally mandatory features:

- If nrtPS or BE services are supported, then the SS responding to broadcast polling is mandatory
- If multicast polling groups are supported, multicast polling must be supported

12.2.1.3 Conventions for MAC Management Messages for profiles profM4 and profM5

The following rules shall be followed when reporting parameters in MAC Management messages:

- Service Class Names should not be used
- DSC-REQ messages shall not contain Request/Transmission Policy, Fixed vs. Variable Length SDU Indicator, SDU Size, ATM Switching, or Convergence Sublayer Specification TLVs

12.2.2 WirelessMAN-SCa Power class profiles

A power class profile contains the class(es) of BS and SS transmitters used in a system. A power class profile may contain transmitters from more than one class, with the profile indicating the highest power level class permitted.

The power classes for BS and SS transmitters in a system are listed in Table 393.

The power ratings, $P_{Tx,max}$, associated with these classes are the maximum average output power ratings at which the appropriate transmitter requirements in Table 394 or Table 396 are met.

Table 393—Power classes

Class identifier	Transmit Power (dBm)
Class 1	$17 \leq P_{Tx,max} < 20$
Class 2	$20 \leq P_{Tx,max} < 23$
Class 3	$23 \leq P_{Tx,max} < 30$
Class 4	$30 \leq P_{Tx,max}$

12.2.3 WirelessMAN-SCa Physical Layer (PHY) Profiles

This subclause specifies PHY profiles for systems using the WirelessMAN-SCa PHY. The scope includes both licensed and license-exempt (WirelessHUMAN) operation.

Table 394 and Table 395 list minimum Tx and Rx performance requirements for an SS. Table 396 and Table 397 list minimum Tx and Rx performance requirements for a BS. Elements in these tables that are not applicable to a particular profile (such as those governing modulations not used by a profile) may be disregarded.

Table 394—SS minimum Tx performance requirements

Capability	Minimum performance
RF frequency	A frequency band (but not necessarily all bands) below 11 GHz
RF frequency accuracy	$\pm 15 \times 10^{-6}$
Tx dynamic range	≥ 30 dB
RMS power level at maximum power level setting	≥ 15 dBm
Power level minimum adjustment step	1 dB
Power level adjustment step relative accuracy	Monotonic, $\pm 25\%$ of adjustment step, but ≤ 4 dB
Power level absolute accuracy	± 6 dB
Peak-to-peak symbol jitter, referenced to the previous symbol zero-crossing of the transmitted waveform, as percentage of nominal symbol duration when measured over period of 2 seconds	2%
Burst timing step size	± 0.25 of a symbol
Burst timing step size accuracy	± 0.125 of a symbol
Spectral mask (OOB)	Local regulation
Ramp up/ramp down time	≤ 5 μ s
Output noise power spectral density when not transmitting	Local regulation; ≤ -80 dBm/Hz when no regulation
Transmitter minimum SNR at antenna feed point	40 dB
Transition time from Tx to Rx and from Rx to Tx	TDD: 2 μ s H-FDD: 20 μ s FDD: n/a

Table 395—SS minimum Rx performance requirements

Capability	Minimum performance
Maximum on-channel input level	-20 dBm
Maximum on-channel input level without Rx damage	0 dBm

Table 395—SS minimum Rx performance requirements (continued)

Capability	Minimum performance
Transition time from Tx to Rx and from Rx to Tx	TDD: 2 μ s H-FDD: 20 μ s FDD: n/a
Uncoded sensitivity at BER = 10^{-3}	BPSK: $-96.2 + 10 \log(\text{BW in MHz})$ dBm QPSK: $-93.2 + 10 \log(\text{BW in MHz})$ dBm 16-QAM: $-86.2 + 10 \log(\text{BW in MHz})$ dBm 64-QAM: $-80.0 + 10 \log(\text{BW in MHz})$ dBm 256-QAM: $-73.8 + 10 \log(\text{BW in MHz})$ dBm
Transition time from Tx to Rx and from Rx to Tx	TDD: 2 μ s H-FDD: 20 μ s FDD: n/a
C/I, with interferer in first adjacent channel resulting in 3 dB degradation at BER = 10^{-3}	BPSK: < -12 dB QPSK: < -9 dB 16-QAM: < -2 dB 64-QAM: < +5 dB 256-QAM: < +12 dB
C/I, with interferer in first adjacent channel resulting in 1 dB degradation at BER = 10^{-3}	BPSK: < -8 dB QPSK: < -5 dB 16-QAM: < +2 dB 64-QAM: < +9 dB 256-QAM: < +16 dB
C/I, with interferer in second adjacent channel resulting in 3 dB degradation at BER = 10^{-3}	BPSK: < -37 dB QPSK: < -34 dB 16-QAM: < -27 dB 64-QAM: < -20 dB 256-QAM: < -13 dB
C/I, with interferer in second adjacent channel resulting in 1 dB degradation at BER = 10^{-3}	BPSK: < -33 dB QPSK: < -30 dB 16-QAM: < -22 dB 64-QAM: < -16 dB 256-QAM: < -9 dB

Table 396—BS minimum Tx performance requirements

Capability	Minimum performance
RF frequency	A frequency band (but not necessarily all bands) below 11 GHz
RF frequency accuracy	$\pm 8 * 10^{-6}$
Tx dynamic range	$\geq 20 \text{ dB} \pm 3 \text{ dB}$
RMS power level at maximum power level setting	$\geq 15 \text{ dBm}$
Power level minimum adjustment step	1 dB
Power level adjustment step relative accuracy	Monotonic, $\pm 25\%$ adjustment step, but $\leq 4 \text{ dB}$

Table 396—BS minimum Tx performance requirements (continued)

Capability	Minimum performance
Power level absolute accuracy	± 6 dB
Peak-to-peak symbol jitter, referenced to the previous symbol zero-crossing of the transmitted waveform, as percentage of nominal symbol duration when measured over a period of 2 seconds	2%
Spectral mask (OOB)	Local regulation
Spurious	Local regulation
Ramp up/ramp down time	$< 5 \mu\text{s}$
Transmitter minimum SNR at antenna feed point	40 dB
Modulation accuracy when measured with an ideal receiver without an equalizer	BPSK: $< 12\%$ QPSK: $< 12\%$ 16-QAM: $< 6\%$ 64-QAM: < 3.1 256-QAM: $< 1.5\%$
Transition time from Tx to Rx and from Rx to Tx	TDD: $2 \mu\text{s}$ H-FDD: $20 \mu\text{s}$ FDD: n/a

Table 397—BS minimum Rx performance requirements

Capability	Minimum performance
Maximum on-channel input level	-40 dBm
Maximum on-channel input level without receiver damage	0 dBm
Uncoded sensitivity at $\text{BER} = 10^{-3}$	BPSK: $-96.2 + 10\log(\text{BW in MHz})$ dBm QPSK: $-93.2 + 10\log(\text{BW in MHz})$ dBm 16-QAM: $-86.2 + 10\log(\text{BW in MHz})$ dBm 64-QAM: $-80.0 + 10\log(\text{BW in MHz})$ dBm 256-QAM: $-73.8 + 10 \log(\text{BW in MHz})$ dBm
C/I, with interferer in first adjacent channel resulting in 3 dB degradation at $\text{BER} = 10^{-3}$	BPSK: < -12 dB QPSK: < -9 dB 16-QAM: < -2 dB 64-QAM: $< +5$ dB 256-QAM: $< +12$ dB
C/I, with interferer in first adjacent channel resulting in 1 dB degradation at $\text{BER} = 10^{-3}$	BPSK: < -8 dB QPSK: < -5 dB 16-QAM: $< +2$ dB 64-QAM: $< +9$ dB 256-QAM: $< +16$ dB
C/I, with interferer in second adjacent channel resulting in 3 dB degradation at $\text{BER} = 10^{-3}$	BPSK: < -37 dB QPSK: < -34 dB 16-QAM: < -27 dB 64-QAM: < -20 dB 256-QAM: < -13 dB

Table 397—BS minimum Rx performance requirements (*continued*)

Capability	Minimum performance
C/I , with interferer in second adjacent channel resulting in 1 dB degradation at $BER = 10^{-3}$	BPSK: < -33 dB QPSK: < -30 dB 16-QAM: < -22 dB 64-QAM: < -16 dB 256-QAM: < -9 dB

All PHY profiles shall share the common characteristics in 12.2.3.1, while individual profiles shall be differentiated by the specific characteristics listed in 12.2.3.2. All Baseline profiles nominally support the mandatory concatenated FEC, and, through the inclusion of additional descriptors, are capable of specifying the use of BTC or CTC FEC options.

12.2.3.1 Common features of PHY profiles

All PHY profiles shall share characteristics listed in the ensuing descendent clauses.

For WirelessHUMAN operation, the channel BW shall be 10 MHz. For WirelessMAN operation, allowed channel bandwidths shall be limited to the regulatory provisioned bandwidth divided by any power of 2, but no less than 1.25 MHz.

12.2.3.1.1 Common Mandatory features

The following features shall be supported by all PHY profiles:

- Spread BPSK, QPSK, 16-QAM, 64-QAM downlink and UL
- Roll-off Factor = 0.25
- Symbol Rate (Mbd/s) = (BW in MHz - 0.088)/1.25
- RS code word length $N = 255$ bytes (with exception of shortened last RS code word)
- RS code words with $R = 16$ bytes
- Downlink Preamble composed of 3 UWs and 4 ramp-up symbols
- Uplink Preamble composed of 1–5 UWs and 4 ramp-up symbols
- No Pilot Words
- Block interleaver, $N_R = 10$
- Frame Duration 4 ms

The following features may be supported, but when supported, must conform to the parameters specified:

- 256-QAM downlink and uplink
- Downlink Pilot words with length 1 UW and interval 1024 symbols
- STC where
 - Downlink preamble composed of 3 UWs per half-dual block (6 UWs total) and 4 ramp-up symbols
 - Downlink STC blocks of length 1024 symbols with block burst profile “0”
 - Downlink Pilot word distribution, determined by Pilot Word DCD burst profile TLV
- Subchannel framing where
 - Preamble composed of 2 UWs,
 - Subchannel framing parameters $\{k, d\} = \{1, 1\}$,
 - $r = 1024$ for 16 symbol UWs and $r = 4096$ for 64-symbol UWs

12.2.3.1.2 Conventions for MAC management messages for profiles

The following rules shall be followed when reporting parameters in MAC Management messages:

- Roll-off Factor shall be reported in UCD message.
- RS Information Byte and RS Parity Bytes shall be reported in UCD message.
- Burst Set Type and STC Parameters shall be reported in UCD message.

12.2.3.1.3 UCD and DCD parameters

12.2.3.1.3.1 and 12.2.3.1.3.2 specify the TLV-encoded parameters which shall be transmitted in the respective DCD and UCD messages by systems meeting a PHY profile. Systems implementing the profile shall only include the parameters listed under the respective message in its transmission of said messages. Parameters with defined default values should be omitted if the desired value coincides with the default one.

12.2.3.1.3.1 DCD

- BS EIRP
- TTG (omitted for FDD)
- RTG (omitted for FDD)
- Power Adjustment Rule
- $RSS_{IR,max}$
- MAC version
- Downlink Burst Profile(s)
- Modulation Type
- Exit Threshold
- Entry Threshold
- CC/CTC-specific Parameters
- Block Interleaver Depth (omitted if Modulation Type does not specify use of a block interleaver)
- BTC Code Selector (omitted if Modulation type does not specify use of a BTC)
- Spreading Parameters (omitted if Modulation type does not reference a spread BPSK type)

12.2.3.1.3.2 UCD

- Symbol Rate (omitted for TDD)
- Frequency (omitted for TDD)
- SSTG
- Power Adjustment Rule
- Contention-based Reservation Timeout
- Initial Ranging SSTG (if omitted, value is same as SSTG)
- Uplink Burst Profile(s)
- Modulation Type
- Preamble Length
- CC/CTC-specific Parameters
- Unique Word Length
- Pilot Word Parameters
- Burst set type
- Block Interleaver Depth (omitted if Modulation Type does not specify use of a block interleaver)
- BTC Code Selector (omitted if Modulation type does not specify use of a BTC)
- STC parameters (omitted if Burst set type is not STC)
- Spreading Parameters (omitted if Modulation type does not reference a spread BPSK type)
- Subchannel framing parameters (omitted if Burst set type does not specify subchannel usage)

12.2.3.2 Specific PHY profiles

12.2.3.2.1 FDD-specific PHY profile features

Mandatory features:

- FDD operation
- BS must respect half-duplex nature of half-duplex SSs
- Center Frequency and symbol rate for uplink must be reported in UCD channel encoding

12.2.3.2.2 TDD-specific PHY profile features

Mandatory features:

- TDD operation
- Center Frequency and symbol rate for uplink are not reported in UCD channel encoding

12.2.3.2.3 WirelessHUMAN-specific PHY profile features

Mandatory features:

- TDD operation
- Center Frequency and symbol rate for uplink are not reported in UCD channel encoding
- Channel Nr is reported in DCD channel encoding
- UW length 16, 64, and 256 symbols
- DFS capability
- Detection of primary users with received signal strength in excess of -64 dBm
- Channel switching within $300\text{ }\mu\text{s}$

12.2.3.2.4 ProfP6: WirelessMAN-SCa PHY profile A

Profile Identifier: profP6

Mandatory features:

- Symbol rate $SR \leq 1.25\text{ MBd/s}$
- UW length 16 symbols

12.2.3.2.5 ProfP7: WirelessMAN-SCa PHY profile B

Profile Identifier: profP7

Mandatory features:

- Symbol rate $1.25 \geq SR \geq 20\text{ MBd/s}$
- UW length 16, 64, and 256 symbols

12.2.3.2.6 ProfP8: WirelessMAN-SCa PHY profile C

Profile Identifier: profP8

Mandatory features:

- Symbol rate $SR > 20\text{ MBd/s}$
- UW length 256 symbols

12.2.4 WirelessMAN-SCa RF profiles

12.2.4.1 RF profiles for 3.5 MHz channelization

12.2.4.1.1 profR1

Mandatory features:

- RF channels: (Uplink for FDD) $2524.75 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 266\}$
 (Downlink for FDD) $2598.75 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 266\}$
 Using FDD, n shall be identical for uplink and downlink.

12.2.4.1.2 profR2

Mandatory features:

- RF channels: (Uplink for FDD) $3411.75 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 126\}$
 (Downlink for FDD) $3461.75 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 126\}$
 Using FDD, n shall be identical for uplink and downlink.

12.2.4.1.3 profR3

Mandatory features:

- RF channels: (Uplink for FDD) $3501.75 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 182\}$
 (Downlink for FDD) $3551.75 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 182\}$
 Using FDD, n shall be identical for uplink and downlink.

12.2.4.1.4 profR4

Mandatory features:

- RF channels: (Uplink for FDD) $3601.75 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 182\}$
 (Downlink for FDD) $3651.75 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 182\}$
 Using FDD, n shall be identical for uplink and downlink.

12.2.4.1.5 profR5

Mandatory features:

- RF channels: (Uplink for FDD) $3701.75 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 182\}$
 (Downlink for FDD) $3751.75 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 182\}$
 Using FDD, n shall be identical for uplink and downlink.

12.2.4.2 RF profiles for 7 MHz channelization

12.2.4.2.1 profR6

Mandatory features:

- RF channels: (Uplink for FDD) $2526.5 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 252\}$
 (Downlink for FDD) $2600.5 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 252\}$
 Using FDD, n shall be identical for uplink and downlink.

12.2.4.2.2 profR7

Mandatory features:

- RF channels: (Uplink for FDD) $3413.5 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 112\}$
(Downlink for FDD) $3463.5 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 112\}$
Using FDD, n shall be identical for uplink and downlink.

12.2.4.2.3 profR8

Mandatory features:

- RF channels: (Uplink for FDD) $3503.5 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 168\}$
(Downlink for FDD) $3553.5 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 168\}$
Using FDD, n shall be identical for uplink and downlink.

12.2.4.2.4 profR9

Mandatory features:

- RF channels: (Uplink for FDD) $3603.5 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 168\}$
(Downlink for FDD) $3653.5 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 168\}$
Using FDD, n shall be identical for uplink and downlink.

12.2.4.2.5 profR10

Mandatory features:

- RF channels: (Uplink for FDD) $3703.5 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 168\}$
(Downlink for FDD) $3753.5 + n \cdot 0.25$ MHz, $\forall n \in \{0, 1, \dots, 168\}$
Using FDD, n shall be identical for uplink and downlink.

12.2.4.3 RF profiles for 10 MHz channelization**12.2.4.3.1 profR11**

Mandatory features:

- RF channels: $5000 + n \cdot 5$ MHz, $\forall n \in \{55, 57, 59, 61, 63, 65, 67\}$
- Spectral mask: See 8.6.2

12.2.4.3.2 profR12

Mandatory features:

- RF channels: $5000 + n \cdot 5$ MHz, $\forall n \in \{148, 150, 152, 154, 156, 158, 160, 162, 164, 166\}$
- Spectral mask: See 8.6.2

12.2.4.3.3 profR13

Mandatory features:

- RF channels: $5000 + n \cdot 5$ MHz, $\forall n \in \{147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169\}$
- Spectral mask: See 8.6.2

12.2.4.4 RF profiles for 20 MHz channelization

12.2.4.4.1 profR14

Mandatory features:

- RF channels: $5000 + n \cdot 5$ MHz, $\forall n \in \{56, 60, 64\}$
- Spectral mask: See 8.6.2

12.2.4.4.2 profR15

Mandatory features:

- RF channels: $5000 + n \cdot 5$ MHz, $\forall n \in \{149, 153, 157, 161, 165\}$
- Spectral mask: See 8.6.2

12.2.4.4.3 profR16

Mandatory features:

- RF channels: $5000 + n \cdot 5$ MHz, $\forall n \in \{148, 152, 156, 160, 164, 168\}$
- Spectral mask: See 8.6.2

12.3 WirelessMAN-OFDM and WirelessHUMAN(-OFDM) System Profiles

This subclause defines system profiles for systems operating with the WirelessMAN-OFDM air interface and with the WirelessHUMAN interface where it uses the OFDM PHY.

A system profile consists of five components: a MAC profile, a PHY profile, a RF profile, a duplexing selection, and a power class. The defined PHY and MAC profiles are listed in Table 398.

Table 398—Profile definitions

Identifier	Description
profM3_PMP	WirelessMAN-OFDM Basic packet PMP MAC profile
profM3_Mesh	WirelessMAN-OFDM Basic packet Mesh MAC profile
profP3_1.75	WirelessMAN-OFDM 1.75 MHz channel basic PHY profile
profP3_3.5	WirelessMAN-OFDM 3.5 MHz channel basic PHY profile
profP3_7	WirelessMAN-OFDM 7 MHz channel basic PHY profile
profP3_3	WirelessMAN-OFDM 3 MHz channel basic PHY profile
profP3_5.5	WirelessMAN-OFDM 5.5 MHz channel basic PHY profile
profP3_10	WirelessHUMAN(-OFDM) 10 MHz channel basic PHY profile

The transmit power class profiles, as shown in Table 399, are based on the maximum mean transmit power $P_{Tx,max}$ using all non-guard subcarriers, for which the transmitter requirements as defined in 8.3.10 are met.

Table 399—Power classes profiles

Identifier	Transmit power performance
profC3_0	$P_{Tx,max} < 14 \text{ dBm}$
profC3_14	$14 \leq P_{Tx,max} < 17 \text{ dBm}$
profC3_17	$17 \leq P_{Tx,max} < 20 \text{ dBm}$
profC3_20	$20 \leq P_{Tx,max} < 23 \text{ dBm}$
profC3_23	$P_{Tx,max} \geq 23 \text{ dBm}$

The duplexing shall be selected as follows: A system shall implement TDD and/or FDD. A FDD SS system may be implemented either as half-duplex or as full-duplex. A FDD BS system must respect the half-duplex nature of half-duplex SSs.

Using these conventions, a sample system profile is shown in Table 400. This sample system profile may also be represented by a concatenation of the profile components:

profM3_PMP,profP3_10,profR10_1,TDD,profC3_17.

Table 400—Sample system profile

Sample system profile
{
profM3_PMP
profP3_10
profR10_1
TDD
profC3_17
}

12.3.1 WirelessMAN-OFDM and WirelessHUMAN(-OFDM) MAC Profiles

This subclause defines MAC profiles for systems operating with the WirelessMAN-OFDM air interface and with the WirelessHUMAN interface where it uses the OFDM PHY.

12.3.1.1 ProfM3_PMP: Basic Packet PMP MAC System Profile

This profile specifies a set of capability requirements when a system is operating in the mandatory PMP mode. Table 401 lists the optional MAC features and designates whether they shall or may be implemented to comply with this profile.

Table 401—Optional feature requirements profM3_PMP

Optional Feature	Required?	Conditions/Notes
Packet convergence sublayer	Yes	
Payload header suppression	No	
Ipv4 over 802.3/Ethernet	Yes	
802.3/Ethernet	Yes	
ATM convergence sublayer	No	
Multicast polling groups	Yes	
Multicast polling		
CRC functionality	Yes	Elective per connection.
Unsolicited grant service functionality	No	
Real-Time Polling services	No	
Best effort services	Yes	
Non-Real-Time Polling services	Yes	
Cryptographic suites:		
No data encryption, no data authentication and 3-DES, 128	No	
CBC-Mode 56-bit DES, no data authentication and 3-DES, 128	Yes	
No data encryption, no data authentication and RSA, 1024	No	
CBC-Mode 56-bit DES, no data authentication and RSA, 1024	No	
AES, CCM mode, no data authentication and AES with 128-bit key	No	
Undecodable initial ranging feature	Conditional	Required for SS. Not required for BS.
ARQ	No	
Mesh	No	If used, apply profM3_Mesh
AAS	No	
DFS	Conditional	Required when intended for license exempt bands. Not required when intended for licensed bands.
BS capability for support of manageable SSs (creating secondary management connections, DHCP, TFTP, SNMP etc.)	Yes	

- Support of IPv4 capabilities at the Packet Convergence Sublayer means capability of classification and IPv4 datagrams encapsulation into MAC SDUs as specified in 5.2.6. It is relevant to both DL and UL.
- Support of IEEE 802.3/Ethernet capabilities at the Packet Convergence Sublayer means capability of classification and IEEE 802.3/Ethernet frames encapsulation into MAC SDUs as specified in 5.2.4. It is relevant to both DL and UL.
- Support of ARQ is defined as the minimum capability to support eight simultaneous ARQ connections.
- Support of CRC means ability to add CRC at Tx and ability to check CRC at Rx in the case when CRC presence is signaled by CI.

12.3.1.1.1 Conventions for MAC Management Messages

The following rules shall be followed when reporting parameters in MAC Management messages:

- Service Class Names should not be used.
- DSC-REQ messages shall not contain Request/Transmission Policy, Fixed vs. Variable Length SDU Indicator, SDU Size, ATM Switching, or Convergence Sublayer Specification TLVs.

12.3.1.1.2 MAC Management Message Parameter Transmission Order

TLVs within MAC Management messages shall be ordered as follows. Parameters for optional features shall occur after those listed for support of mandatory features. Features that are defined as optional, but are mandated by the implemented Profile, if any, shall be ordered as optional. Both mandatory and optional TLVs shall subsequently be sequenced in order of increasing Type value. Parameters with defined default values should be omitted if the desired value coincides with the default one.

12.3.1.2 ProfM3_Mesh: Basic Packet Mesh MAC System Profile

This profile specifies a set of capability requirements when a mesh enabled system is operating in the optional mesh mode. Table 402 lists the optional MAC features and designates whether they shall or may be implemented to comply with this profile.

Table 402—Optional feature requirements profM3_mesh

Optional Feature	Required?	Conditions/Notes
Packet convergence sublayer	Yes	
Payload header suppression	No	
Ipv4	Yes	
802.3/Ethernet	Yes	
ATM convergence sublayer	No	
Provisioned connections	No	
Classification of packets on incoming physical port	No	
Multicast polling groups	N/A	
Multicast polling		
CRC functionality	Yes	
Dynamic services	Yes	
Unsolicited grant service functionality	N/A	
Real-Time Polling services	N/A	
Best effort services	Yes	
Non-Real-Time Polling services	N/A	
Cryptographic suites:		
No data encryption, no data authentication and 3-DES,128	No	
CBC-Mode 56-bit DES, no data authentication and 3-DES,128	No	
No data encryption, no data authentication and RSA, 1024	No	
CBC-Mode 56-bit DES, no data authentication and RSA, 1024	Yes	
AES, CCM mode, no data authentication and AES with 128-bit key	No	
Undecodable initial ranging feature	N/A	
ARQ	Yes	
AAS	No	
DFS	Conditional	Required when intended for license exempt bands. Not required when intended for licensed bands.

- Support of ARQ functionality is mandatory as a capability, but may be turned on or off on a per packet basis. ARQ shall be used when the reliability bit in the Mesh CID is set to 1, and shall not be used otherwise. ARQ parameters shall be set to:

ARQ Window Size = 64_{DEC}

ARQ Retry Timeout = $\lceil 2 \cdot T_F \rceil_{\text{DEC}}$, with T_F the PHY dependent frame duration in μs .

ARQ Block Lifetime = $\lceil T_F/2 \rceil_{\text{DEC}}$, with T_F the PHY dependent frame duration in μs .

ARQ RX Purge Time Timeout = $\lceil 2 \cdot T_F \rceil_{\text{DEC}}$, with T_F the PHY dependent frame duration in μs .

ARQ Sync Loss Timeout = 0

ARQ Deliver in Order = 0

12.3.1.2.1 MAC Management message applicability

For a mesh-enabled system, the messages below and the corresponding functionality are always mandatory to implement:

MSH-NCFG
MSH-NENT
MSH-DSCH
MSH-CSCH
MSH-CSCF
REG-REQ
REG-RSP
PKM-REQ
PKM-RSP
SBC-REQ
SBC-RSP
TFTP-CPLT
TFTP-RSP
RES-CMD

For a mesh enabled system, the following messages and the corresponding functionality are mandatory/optional whenever they are correspondingly optional/mandatory for a PMP system:

ARQ-Feedback

When operating in the mesh mode, the messages below and the corresponding functionality are not used (they are, however, implemented to support the mandatory PMP mode).

DL-MAP
DCD
DSA-ACK
DSA-REQ
DSA-RSP
DSC-ACK
DSC-REQ
DSC-RSP
DSD-RSP
DSX-RVD
UCD
UL-MAP
CLK-CMP
DBPC-REQ
DBPC-RSP
DREG-CMD
MCA-REQ
MCA-RSP

RNG-REQ
 RNG-RSP

Generally, the following procedures are different for a mesh node and a PMP node:

Synchronization
 Network entry
 Scheduling
 Power control
 Ranging

12.3.1.2.2 MAC Management Message Parameter Transmission Order

TLVs within MAC Management messages shall be ordered as follows. Parameters for optional features shall occur after those listed for support of mandatory features. Features that are defined as optional, but are mandated by the implemented Profile, if any, shall be ordered as optional. Both mandatory and optional TLVs shall subsequently be sequenced in order of increasing Type value. Parameters with defined default values should be omitted if the desired value coincides with the default one.

12.3.2 WirelessMAN-OFDM and WirelessHUMAN(-OFDM) Physical Layer Profiles

This subclause defines PHY profiles for systems operating with the WirelessMAN-OFDM and WirelessHUMAN(-OFDM) air interface.

The following set of parameters are common to all defined PHY profiles and shall be complied with in order to comply with each individual profile.

Table 403 lists the optional PHY features and designates whether they shall or may be implemented.

Table 403—Optional PHY feature requirements

Optional feature	Required?	Conditions/Notes
64-QAM	Yes	Required for license bands, but not required for license-exempt bands.
BTC	No	
CTC	No	
subchannelization	No	
STC	No	
Focused contention BW requesting	No	
T_g/T_b	Conditional	BS shall be capable of using at least one value. SS shall be capable of using entire set.

Table 404 lists minimum performance basic requirements for all defined profiles.

Table 404—Minimum Performance basic requirements

Capability	Minimum performance
Tx Dynamic range SS SS (if subchannelization supported) BS	≥ 30 dB ≥ 50 dB ≥ 10 dB
Tx Power Level minimum adjustment step	≤ 1 dB
Tx Power Level minimum relative step accuracy	$\leq \pm 50\%$ of step size, but not more than 4dB
Tx Spectral flatness Absolute difference between adjacent subcarriers: Deviation of average energy in each subcarrier from the measured energy averaged over all 200 active tones: Subcarriers -50 to -1 and $+1$ to $+50$: Subcarriers -100 to -50 and $+50$ to $+100$:	≤ 0.1 dB $\leq \pm 2$ dB $\leq \pm 2/-4$ dB
Spectral mask (OOB)	Local regulation
Tx relative constellation error: BPSK-1/2 QPSK-1/2 QPSK-3/4 16-QAM-1/2 16-QAM-3/4 64-QAM-2/3 64-QAM-3/4	≤ -13.0 dB ≤ -16.0 dB ≤ -18.5 dB ≤ -21.5 dB ≤ -25.0 dB ≤ -28.5 dB ≤ -31.0 dB
Rx max. input level on-channel reception tolerance	≥ -30 dBm
Rx max. input level on-channel damage tolerance	≥ 0 dBm
1 st adjacent channel rejection at BER= 10^{-6} for 3 dB degradation C/I 16QAM-3/4 64QAM-3/4	≥ 11 dB ≥ 4 dB
2 nd adjacent channel rejection at BER= 10^{-6} for 3 dB degradation C/I 16QAM-3/4 64QAM-3/4	≥ 30 dB ≥ 23 dB
SSTTG and SSRTG: TDD and H-FDD	≤ 100 μ s
Reference frequency tolerance BS Mesh system	$\leq \pm 8 \times 10^{-6}$ $\leq \pm 20 \times 10^{-6}$

12.3.2.1 ProfP3_1.75: WirelessMAN-OFDM PHY profile for 1.75MHz channelization

Mandatory features:

- Licensed band usage only
- Channel bandwidth $BW = 1.75$ MHz
- BS shall select Frame duration from code set PMP:{2,4,6}. SSs shall be capable of operating with any of the Frame Durations indicated in the code set.

Systems implementing profP3_1.75 shall meet the minimum performance requirements listed in Table 405.

Table 405—Minimum Performance requirements for profP3_1.75

Capability	Minimum performance
T_b	$= 128 \mu\text{s}$
BER performance threshold, $\text{BER}=10^{-6}$ BPSK-1/2 QPSK-1/2 QPSK-3/4 16QAM-1/2 16QAM-3/4 64QAM-2/3 64QAM-3/4	≤ -94 dBm ≤ -91 dBm ≤ -89 dBm ≤ -84 dBm ≤ -82 dBm ≤ -77 dBm ≤ -76 dBm
Threshold change if subchannelization used	$10 \cdot \log(N_{\text{subchannels}}/16)$
Reference frequency tolerance SS to BS synchronization tolerance	156.25 Hz
Reference time tolerance	$\pm (T_b/32)/2$

12.3.2.2 ProfP3_3.5: WirelessMAN-OFDM PHY profile for 3.5 MHz channelization

Mandatory features:

- Licensed band usage only
- Channel bandwidth $BW = 3.5$ MHz
- BS shall select Frame duration from code set PMP:{2,4,6}, Mesh:{1}. SSs shall be capable of operating with any of the Frame Durations indicated in the code set.

Systems implementing profP3_3.5 shall meet the minimum performance requirements listed in Table 406:

Table 406—Minimum Performance requirements for profP3_3.5

Capability	Minimum performance
T_b	= 64 μ s
BER performance threshold, BER= 10^{-6} BPSK-1/2 QPSK-1/2 QPSK-3/4 16QAM-1/2 16QAM-3/4 64QAM-2/3 64QAM-3/4	≤ -91 dBm ≤ -88 dBm ≤ -86 dBm ≤ -81 dBm ≤ -79 dBm ≤ -74 dBm ≤ -73 dBm
Threshold change if subchannelization used	$10 \cdot \log(N_{subchannels}/16)$
Reference frequency tolerance SS to BS synchronization tolerance Mesh to Mesh synchronization tolerance	≤ 312.5 Hz ≤ 468.75 Hz
Reference time tolerance	$\pm (T_b/32)/2$

12.3.2.3 ProfP3_7: WirelessMAN-OFDM PHY profile for 7 MHz channelization

Mandatory features:

- Licensed band usage only
- Channel bandwidth $BW = 7$ MHz
- BS shall select Frame duration from code set PMP:{2,4,6}, Mesh:{1}. SSs shall be capable of operating with any of the Frame Durations indicated in the code set.

Systems implementing profP3_7 shall meet the minimum performance requirements listed in Table 407:

Table 407—Minimum Performance requirements for profP3_7

Capability	Minimum performance
T_b	$= 32 \mu s$
BER performance threshold, $BER=10^{-6}$ BPSK-1/2 QPSK-1/2 QPSK-3/4 16QAM-1/2 16QAM-3/4 64QAM-2/3 64QAM-3/4	$\leq -88 \text{ dBm}$ $\leq -85 \text{ dBm}$ $\leq -83 \text{ dBm}$ $\leq -78 \text{ dBm}$ $\leq -76 \text{ dBm}$ $\leq -71 \text{ dBm}$ $\leq -70 \text{ dBm}$
Threshold change if subchannelization used	$10 \cdot \log(N_{subchannels}/16)$
Reference frequency tolerance SS to BS synchronization tolerance Mesh to Mesh synchronization tolerance	$\leq 625 \text{ Hz}$ $\leq 937.5 \text{ Hz}$
Reference time tolerance	$\pm (T_b/32)/2$

12.3.2.4 ProfP3_3: WirelessMAN-OFDM PHY profile for 3 MHz channelization

Mandatory features:

- Licensed band usage only
- Channel bandwidth $BW = 3.0 \text{ MHz}$
- BS shall select Frame duration from code set PMP:{2,4,6}, Mesh:{4}. SSs shall be capable of operating with any of the Frame Durations indicated in the code set.

Systems implementing profP3_3 shall meet the minimum performance requirements listed in Table 409:

Table 408—Minimum Performance requirements for profP3_3

Capability	Minimum performance
T_b	$= 73 \frac{99}{437} \mu s$
BER performance threshold, BER= 10^{-6} BPSK-1/2 QPSK-1/2 QPSK-3/4 16-QAM-1/2 16-QAM-3/4 64-QAM-2/3 64-QAM-3/4	≤ -91 dBm ≤ -88 dBm ≤ -87 dBm ≤ -81 dBm ≤ -80 dBm ≤ -75 dBm ≤ -73 dBm
Threshold change if subchannelization used	$10 \cdot \log(N_{subchannels}/16)$
Reference frequency tolerance SS to BS synchronization tolerance Mesh to Mesh synchronization tolerance	≤ 273.13 Hz ≤ 409.67 Hz
Reference time tolerance	$\pm (T_b/32)/2$

12.3.2.5 ProfP3_5.5: WirelessMAN-OFDM PHY profile for 5.5 MHz channelization

Mandatory features:

- Licensed band usage only
- Channel bandwidth $BW = 5.5$ MHz
- BS shall select Frame duration from code set PMP:{2,4,6}, Mesh:{4}. SSs shall be capable of operating with any of the Frame Durations indicated in the code set.

Systems implementing profP3_5.5 shall meet the minimum performance requirements listed in Table 409:

Table 409—Minimum Performance requirements for profP3_5.5

Capability	Minimum performance
T_b	$= 40 \frac{120}{157} \mu\text{s}$
BER performance threshold, $\text{BER}=10^{-6}$ BPSK-1/2 QPSK-1/2 QPSK-3/4 16-QAM-1/2 16-QAM-3/4 64-QAM-2/3 64-QAM-3/4	$\leq -89 \text{ dBm}$ $\leq -86 \text{ dBm}$ $\leq -84 \text{ dBm}$ $\leq -79 \text{ dBm}$ $\leq -77 \text{ dBm}$ $\leq -72 \text{ dBm}$ $\leq -71 \text{ dBm}$
Threshold change if subchannelization used	$10 \cdot \log(N_{\text{subchannels}}/16)$
Reference frequency tolerance SS to BS synchronization tolerance Mesh to Mesh synchronization tolerance	$\leq 490.63 \text{ Hz}$ $\leq 735.94 \text{ Hz}$
Reference time tolerance	$\pm (T_b/32)/2$

12.3.2.6 profP3_10: WirelessHUMAN(-OFDM) PHY profile for 10 MHz channelization

Mandatory features:

- License-exempt band usage only
- Channel bandwidth $BW = 10 \text{ MHz}$
- TDD operation
- BS shall select Frame duration from code set PMP:{2,4,6}, Mesh:{1}. SSs shall be capable of operating with any of the Frame Durations indicated in the code set.
- DFS capability
 - Ability to detect primary users with received signal strength in excess of -67 dBm
 - Ability to switch channel within $300 \mu\text{s}$

Systems implementing profP3_10 shall meet the minimum performance requirements listed in Table 410:

Table 410—Minimum Performance requirements for profP3_10

Capability	Minimum performance
T_b	$= 22\frac{146}{357}\mu\text{s}$
Spectral mask (IB): $f_0 \pm 0\text{ MHz}$ $f_0 \pm 4.75\text{ MHz}$ $f_0 \pm 5.45\text{ MHz}$ $f_0 \pm 9.75\text{ MHz}$ $f_0 \pm 14.75\text{ MHz}$	Linear interpolation between points: 0 dBr 0 dBr −25 dBr −32 dBr −50 dBr
BER performance threshold, $\text{BER}=10^{-6}$ BPSK-1/2 QPSK-1/2 QPSK-3/4 16QAM-1/2 16QAM-3/4 64QAM-2/3 64QAM-3/4 Threshold change if subchannelization used	$\leq -86\text{ dBm}$ $\leq -83\text{ dBm}$ $\leq -81\text{ dBm}$ $\leq -76\text{ dBm}$ $\leq -74\text{ dBm}$ $\leq -69\text{ dBm}$ $\leq -68\text{ dBm}$ $10 \cdot \log(N_{\text{subchannels}}/16)$
Reference frequency tolerance SS to BS synchronization tolerance Mesh to Mesh synchronization tolerance	$\leq 892.5\text{ Hz}$ $\leq 1339\text{ Hz}$
Reference time tolerance	$\pm (T_b/32)/2$

12.3.3 WirelessMAN-OFDM RF profiles

For licensed bands, no explicit RF profiles are defined. A compliant system shall adhere to the requirements of 8.3.10.2 for the specified supported bands.

12.3.3.1 RF profiles for 10 MHz channelization

12.3.3.1.1 ProfR10_1

Mandatory features:

- RF channels: : $5000 + n \cdot 5\text{ MHz}$, $\forall n \in \{55, 57, 59, 61, 63, 65, 67\}$
- Spectral mask: See 8.5.2

12.3.3.1.2 profR10_2

Mandatory features:

- RF channels: : $5000 + n \cdot 5\text{ MHz}$, $\forall n \in \{148, 150, 152, 154, 156, 158, 160, 162, 164, 166\}$
- Spectral mask: See 8.5.2

12.3.3.1.3 profR10_3

Mandatory features:

- RF channels: $:5000 + n \cdot 5 \text{ MHz}$, $\forall n \in \{147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167\}$
- Spectral mask: See 8.5.2

12.4 WirelessMAN-OFDMA and WirelessHUMAN(-OFDMA) system profiles

This subclause defines system profiles for systems operating with the WirelessMAN-OFDMA and WirelessHUMAN-OFDMA air interfaces.

Any feature not mandatory or conditionally mandatory for a profile is optional for the profile except where otherwise forbidden by the standard. Optional features shall be implemented as specified in the standard.

Table 411—Profile definitions

Identifier	Description
OFDMA_profM1	WirelessMAN-OFDMA basic packet PMP MAC Profile
OFDMA_profP1	WirelessMAN-OFDMA 1.25 MHz channel basic PHY Profile
OFDMA_profP2	WirelessMAN-OFDMA 3.5 MHz channel basic PHY Profile
OFDMA_profP3	WirelessMAN-OFDMA 7 MHz channel basic PHY Profile
OFDMA_profP4	WirelessMAN-OFDMA 14 MHz channel basic PHY Profile
OFDMA_profP5	WirelessMAN-OFDMA 28 MHz channel basic PHY Profile
OFDMA_profP6	WirelessHUMAN(-OFDMA) 10 MHz channel basic PHY Profile
OFDMA_profP7	WirelessHUMAN(-OFDMA) 20 MHz channel basic PHY Profile

12.4.1 WirelessMAN-OFDMA Power class profiles

A power class profile contains the class(es) of BS and SS transmitters used in a system. A power class profile may contain transmitters from more than one class, with the profile indicating the highest power level class permitted

The power classes for BS and SS transmitters in a system are listed in Table 412.

The power ratings, $P_{T_x, \max}$, associated with these classes are the maximum average output power ratings at which the appropriate transmitter requirements in 8.4.12 are met.

Table 412—Power classes

Class identifier	Transmit power (dBm)
Class 1	$17 \leq P_{Tx,max} < 20$
Class 2	$20 \leq P_{Tx,max} < 23$
Class 3	$23 \leq P_{Tx,max} < 30$
Class 4	$30 \leq P_{Tx,max}$

12.4.2 WirelessMAN-OFDMA and WirelessHUMAN(-OFDMA) MAC Profiles

This subclause defines MAC profiles for systems operating with the WirelessMAN-OFDMA and WirelessHUMAN-OFDMA air interfaces.

12.4.2.1 Basic Packet PMP MAC Profile

Profile identifier: OFDMA_ProfM1.

Mandatory Features:

- Support of Packet convergence sublayer.
- Support of Internet Protocol Ipv4.
- Support IEEE 802.3/Ethernet specific part.
- CRC functionality shall be supported for all connections.
- Support of dynamic services.
- Support of Best effort services.
- Support of Non-Real-Time Polling services.
- Support of CDMA based Initial and Periodic Ranging.
- Support of Contention based CDMA bandwidth requests.
- DFS shall be required for the license exempt bands only.

12.4.2.1.1 Conventions for MAC Management Messages

The following rules shall be followed when reporting parameters in MAC Management messages:

- Service Class Names should not be used.
- No TLVs besides Error Encodings and HMAC Tuples shall be reported back in DSA-RSP and DSC-RSP messages.
- No TLVs besides HMAC Tuples shall be reported back in DSA-ACK messages.
- DSC-REQ messages shall not contain Request/Transmission Policy, Fixed vs. Variable Length SDU Indicator, SDU Size, ATM Switching, or Convergence Sublayer Specification TLVs.

12.4.2.1.2 MAC Management Message Parameter Transmission Order

Systems implementing the profile OFDMA_ProfM1 shall transmit the TLV encoded parameters for mandatory features in the respective messages. Those systems only include the parameters listed under the respective message in its transmission of these messages plus any parameters necessary for optional features. Parameters for optional features shall occur after those listed for support of mandatory features. For the required features, the relevant parameters shall be transmitted in order of increasing Type value of the parameter's TLV key. Parameters with defined default values should be omitted if the desired value coincides with the default one.

12.4.3 WirelessMAN-OFDMA and WirelessHUMAN(-OFDMA) System PHY Profiles

This subclause defines PHY profiles for systems operating with the WirelessMAN-OFDMA air interface and WirelessHUMAN-OFDMA air interfaces.

12.4.3.1 Common Features of PHY Profiles

All PHY profile shall share the common characteristics as defined in Table 413 while individual profiles shall be differentiated by the specific characteristics listed for each profile.

If one of the PHY profiles has a parameter, which is different from the parameter defined by the common parameters section, then the values stated in the PHY profile override the value stated in the common parameters section.

12.4.3.1.1 General implementation requirements

The following optional features are not required for implementation of any PHY profiles:

- BTC
- CTC
- 64-QAM
- STC

The following features must be supported by all PHY profiles:

Guard Time

BS shall be capable of using at least one allowed value.

SS shall be capable of detecting and using entire set of allowed values

Frame Duration

SSs shall be capable of operating with any of the Frame Durations as defined at 8.4.5.2.

12.4.3.1.2 FDD-Specific PHY Profiles Features

Mandatory features:

- FDD Operation
- BS must respect half-duplex nature of half duplex SS
- Center Frequency for uplink must be reported in the UCD channel encoding

12.4.3.1.3 TDD-Specific PHY Profiles Features

Mandatory features:

- TDD Operation
- Center Frequency for uplink is not reported in the UCD channel encoding

12.4.3.1.4 WirelessHUMAN PHY Profiles Features

Mandatory features:

- TDD Operation

- Ability to detect primary users with received signal strength in excess of -61 dBm
- Center Frequency for uplink is not reported in the UCD channel encoding.
- Channel Nr is reported in DCD channel encoding
- Ability to switch channel within $300\text{ }\mu\text{s}$

12.4.3.1.5 Minimum performance requirements

Table 413 lists the minimum performance requirements needed for all profiles.

Table 413—Minimum performance requirements for all profiles

Capability	Minimum performance
Tx Dynamic range SS BS	≥ 30 dB ≥ 10 dB
Tx Power Level minimum adjustment step	≤ 1 dB
Tx Power Level minimum relative step accuracy	$\leq \pm 0.5$ dB
BS Spectral flatness, when using all subchannels. Absolute difference between adjacent subcarriers: (2.5dB should be added for Pilot carriers within the symbol due to their boosting). Deviation of average energy in each carrier from the measured energy averaged over all 1702 active tones: Carriers -425 to -1 and $+1$ to $+425$: Carriers -851 to -425 and $+425$ to $+851$:	≤ 0.1 dB $\leq \pm 2$ dB $\leq +2/-4$ dB
SS Spectral flatness, when using all subchannels. Absolute difference between adjacent subcarriers: (2.5 dB should be added for Pilot carriers within the symbol due to their boosting). Deviation of average energy in each carrier from the measured energy averaged over all 1696 active tones: Carriers -424 to -1 and $+1$ to $+424$: Carriers -848 to -424 and $+424$ to $+848$:	≤ 0.1 dB $\leq \pm 2$ dB $\leq +2/-4$ dB
Spectral mask (OOB)	Local regulation
Tx relative constellation error: QPSK-1/2 QPSK-3/4 16-QAM-1/2 16-QAM-3/4 64-QAM-2/3 (if 64-QAM supported) 64-QAM-3/4 (if 64-QAM supported)	≤ -19.4 dB ≤ -21.2 dB ≤ -26.4 dB ≤ -28.2 dB ≤ -32.7 dB ≤ -34.4 dB
Rx max. input level on-channel reception tolerance	≥ -30 dBm
Rx max. input level on-channel damage tolerance	≥ 0 dBm

Table 413—Minimum performance requirements for all profiles (*continued*)

Capability	Minimum performance
Number Of Subchannels Supported when receiving/ transmitting SS BS	1-32 1-32
1 st adjacent channel rejection at BER= 10^{-6} for 3 dB degradation C/I 16-QAM-3/4 64-QAM-3/4 (if 64-QAM supported)	≥ 11 dB ≥ 4 dB
2 nd adjacent channel rejection at BER= 10^{-6} for 3 dB degradation C/I 16-QAM-3/4 64-QAM-3/4 (if 64-QAM supported)	≥ 30 dB ≥ 23 dB
SSTG and SSRTG: TDD H-FDD	$\leq 50 \mu s$ $\leq 100 \mu s$
Reference time tolerance	$\pm (T_b/32)/10$

12.4.3.2 WirelessMAN-OFDMA 1.25 MHz channel basic PHY Profile

Profile identifier: OFDMA_ProfP1.

Systems implementing OFDMA_ProfP1 shall meet the minimum performance requirements listed in Table 414:

Table 414—Minimum performance requirements for OFDMA_ProfP1

Capability	Minimum performance
Channel bandwidth	1.25 MHz
Operation mode	Licensed bands only
Tx Dynamic range SS BS	≥ 40 dB ≥ 10 dB
Tx relative constellation error: QPSK-1/2 16-QAM-3/4	≤ -22.4 dB ≤ -28.2 dB
1 st adjacent channel rejection at BER= 10^{-6} for 3 dB degradation C/I 16-QAM-3/4	≥ 30 dB
2 nd adjacent channel rejection at BER= 10^{-6} for 3 dB degradation C/I 16-QAM-3/4	≥ 80 dB

Table 414—Minimum performance requirements for OFDMA_ProfP1 (continued)

Capability	Minimum performance
BER performance threshold, BER= 10^{-6} (using all subchannels BS/SS) QPSK-1/2 16-QAM-3/4 [Add to sensitivity $10 \cdot \log_{10}(\text{NumberOfSub-ChannelsUsed}/32)$ when using less subchannels in the BS Rx]	≤ -90 dBm ≤ -80 dBm
Reference frequency tolerance BS SS to BS synchronization tolerance	$\leq \pm 1 \cdot 10^{-6}$ ≤ 2 Hz
TTG (TDD only)	≥ 200 μ s
RTG (TDD only)	≥ 5 μ s
Frame duration code set	{4,7}

12.4.3.3 WirelessMAN-OFDMA 3.5 MHz channel basic PHY Profile

Profile identifier: OFDMA_ProfP2.

Systems implementing OFDMA_ProfP2 shall meet the minimum performance requirements listed in Table 415:

Table 415—Minimum Performance requirements for OFDMA_ProfP2

Capability	Minimum performance
Channel bandwidth	3.5 MHz
Operation mode	Licensed bands only
BER performance threshold, BER= 10^{-6} (using all subchannels BS/SS) QPSK-1/2 QPSK-3/4 16QAM-1/2 16QAM-3/4 64QAM-2/3 (if 64-QAM supported) 64QAM-3/4 (if 64-QAM supported) [Add to sensitivity $10 \cdot \log_{10}(\text{NumberOfSub-ChannelsUsed}/32)$ when using less subchannels in the BS Rx]	≤ -87 dBm ≤ -84 dBm ≤ -80 dBm ≤ -77 dBm ≤ -73 dBm ≤ -71 dBm
Reference frequency tolerance BS SS to BS synchronization tolerance	$\leq \pm 4 \cdot 10^{-6}$ ≤ 20 Hz
Frame duration code set	{4,7}

12.4.3.4 WirelessMAN-OFDMA 7 MHz channel basic PHY Profile

Profile identifier: OFDMA_ProfP3.

Systems implementing OFDMA_ProfP3 shall meet the minimum performance requirements listed in Table 416:

Table 416—Minimum Performance requirements for OFDMA_ProfP3

Capability	Minimum performance
Channel bandwidth	7 MHz
Operation mode	Licensed bands only
BER performance threshold, BER=10 ^{−6} (using all subchannels BS/SS) QPSK-1/2 QPSK-3/4 16QAM-1/2 16QAM-3/4 64QAM-2/3 (if 64-QAM supported) 64QAM-3/4 (if 64-QAM supported) [Add to sensitivity 10*log10(NumberOfSub-ChannelsUsed/32) when using less subchannels in the BS Rx]	≤ −84 dBm ≤ −81 dBm ≤ −77 dBm ≤ −74 dBm ≤ −71 dBm ≤ −68 dBm
Reference frequency tolerance BS SS to BS synchronization tolerance	≤ ± 4*10 ^{−6} ≤ 40 Hz
Frame duration code set	{2,3,5}

12.4.3.5 WirelessMAN-OFDMA 8.75 MHz channel basic PHY Profile

Profile identifier: OFDMA_ProfP4.

Systems implementing OFDMA_ProfP4 shall meet the minimum performance requirements listed in Table 417:

Table 417—Minimum Performance requirements for OFDMA_ProfP4

Capability	Minimum performance
Channel bandwidth	8.75 MHz
Operation mode	Licensed bands only
BER performance threshold, BER=10 ⁻⁶ (using all subchannels BS/SS) QPSK-1/2 QPSK-3/4 16QAM-1/2 16QAM-3/4 64QAM-2/3 (if 64-QAM supported) 64QAM-3/4 (if 64-QAM supported) [Add to sensitivity 10*log10(NumberOfSub-ChannelsUsed/32) when using less subchannels in the BS Rx]	≤ −82.5 dBm ≤ −79.5 dBm ≤ −75.5 dBm ≤ −72.5 dBm ≤ −68.5 dBm ≤ −66.6 dBm
Reference frequency tolerance BS SS to BS synchronization tolerance	≤ ± 4*10 ⁻⁶ ≤ 48 Hz
Frame duration code set	{2, 4, 6, 8}
Spectrum mask	Local regulation

NOTE—When using this profile, the sampling frequency (see 8.4.2.4) shall be: $F_s = \text{floor}(n \times BW/2000) \times 2000$

12.4.3.6 WirelessMAN-OFDMA 14 MHz channel basic PHY Profile

Profile identifier: OFDMA_ProfP5.

Systems implementing OFDMA_ProfP4 shall meet the minimum performance requirements listed in Table 418:

Table 418—Minimum Performance requirements for OFDMA_ProfP5

Capability	Minimum performance
Channel bandwidth	14 MHz
Operation mode	Licensed bands only
BER performance threshold, $BER=10^{-6}$ (using all subchannels BS/SS) QPSK-1/2 QPSK-3/4 16-QAM-1/2 16-QAM-3/4 64-QAM-2/3 (if 64-QAM supported) 64-QAM-3/4 (if 64-QAM supported) [Add to sensitivity $10 \cdot \log_{10}(\text{NumberOfSub-ChannelsUsed}/32)$ when using less subchannels in the BS Rx]	≤ -81 dBm ≤ -78 dBm ≤ -74 dBm ≤ -71 dBm ≤ -67 dBm ≤ -65 dBm
Reference frequency tolerance BS SS to BS synchronization tolerance	$\leq \pm 4 \cdot 10^{-6}$ ≤ 80 Hz
Frame duration code set	{2,3,5}

12.4.3.7 WirelessMAN-OFDMA 17.5 MHz channel basic PHY Profile

Profile identifier: OFDMA_ProfP6.

Systems implementing OFDMA_ProfP6 shall meet the minimum performance requirements listed in Table 419:

Table 419—Minimum Performance requirements for OFDMA_ProfP6

Capability	Minimum performance
Channel bandwidth	17.5 MHz
Operation mode	Licensed bands only
BER performance threshold, BER=10 ⁻⁶ (using all subchannels BS/SS) QPSK-1/2 QPSK-3/4 16-QAM-1/2 16-QAM-3/4 64-QAM-2/3 (if 64-QAM supported) 64-QAM-3/4 (if 64-QAM supported) [Add to sensitivity 10*log10(NumberOfSub-ChannelsUsed/32) when using less subchannels in the BS Rx]	≤ -79.5 dBm ≤ -76.5 dBm ≤ -72.5 dBm ≤ -69.5 dBm ≤ -65.5 dBm ≤ -63.6 dBm
Reference frequency tolerance BS SS to BS synchronization tolerance	≤ ± 4*10 ⁻⁶ ≤ 97 Hz
Frame duration code set	{2, 4, 6, 8}
Spectrum mask	Local regulation

NOTE—When using this profile, the sampling frequency (see 8.4.2.4) shall be: $F_s = \text{floor}(n \times BW / 2000) \times 2000$

12.4.3.8 WirelessMAN-OFDMA 28 MHz channel basic PHY Profile

Profile identifier: OFDMA_ProfP7.

Systems implementing OFDMA_ProfP7 shall meet the minimum performance requirements listed in Table 420:

Table 420—Minimum Performance requirements for OFDMA_ProfP7

Capability	Minimum performance
Channel bandwidth	28 MHz
Operation mode	Licensed bands only
BER performance threshold, $BER=10^{-6}$ (using all subchannels BS/SS) QPSK-1/2 QPSK-3/4 16-QAM-1/2 16QAM-3/4 64QAM-2/3 (if 64-QAM supported) 64QAM-3/4 (if 64-QAM supported) [Add to sensitivity $10 \cdot \log_{10}(\text{NumberOfSub-ChannelsUsed}/32)$ when using less subchannels in the BS Rx]	≤ -78 dBm ≤ -75 dBm ≤ -71 dBm ≤ -68 dBm ≤ -64 dBm ≤ -62 dBm
Reference frequency tolerance BS SS to BS synchronization tolerance	$\leq \pm 4 \cdot 10^{-6}$ ≤ 160 Hz
Frame duration code set	{2,3,5}

12.4.3.9 WirelessHUMAN(-OFDMA) 10 MHz channel basic PHY Profile

Profile identifier: OFDMA_ProfP8.

Systems implementing OFDMA_ProfP8 shall meet the minimum performance requirements listed in Table 421:

Table 421—Minimum Performance requirements for OFDMA_ProfP8

Capability	Minimum performance
Channel bandwidth	10 MHz
Operation mode	Licensed-exempt band usage only
BER performance threshold, $BER=10^{-6}$ (using all subchannels BS/SS) QPSK-1/2 QPSK-3/4 16QAM-1/2 16QAM-3/4 64QAM-2/3 (if 64-QAM supported) 64QAM-3/4 (if 64-QAM supported) [Add to sensitivity $10 \cdot \log_{10}(\text{NumberOfSubChannelsUsed}/32)$ when using less subchannels in the BS Rx]	≤ -82 dBm ≤ -79 dBm ≤ -75 dBm ≤ -72 dBm ≤ -68 dBm ≤ -66 dBm
Reference frequency tolerance BS SS to BS synchronization tolerance	$\leq \pm 4 \cdot 10^{-6}$ ≤ 55 Hz
Frame duration code set	{2,4,5}

12.4.3.10 WirelessHUMAN(-OFDMA) 20 MHz channel basic PHY Profile

Profile identifier: OFDMA_ProfP9.

Systems implementing OFDMA_ProfP9 shall meet the minimum performance requirements listed in Table 422:

Table 422—Minimum Performance requirements for OFDMA_ProfP9

Capability	Minimum performance
Channel bandwidth	20 MHz
Operation mode	Licensed-exempt band usage only
BER performance threshold, $BER=10^{-6}$ (using all subchannels BS/SS) QPSK-1/2 QPSK-3/4 16QAM-1/2 16QAM-3/4 64QAM-2/3 (if 64-QAM supported) 64QAM-3/4 (if 64-QAM supported) [Add to sensitivity $10 \cdot \log_{10}(\text{NumberOfSub-ChannelsUsed}/32)$ when using less subchannels in the BS Rx]	≤ -79 dBm ≤ -76 dBm ≤ -72 dBm ≤ -69 dBm ≤ -65 dBm ≤ -63 dBm
Reference frequency tolerance BS SS to BS synchronization tolerance	$\leq \pm 4 \cdot 10^{-6}$ ≤ 110 Hz
Frame duration code set	{2,4,5}

12.4.4 WirelessMAN-OFDMA RF profiles

This subclause defined RF profiles for the WirelessMAN-OFDMA and WirelessHUMAN(-OFDMA) air interfaces.

Table 423 defines the RF channels for the license bands, the channels shall be calculated using the following formula: $F_{start} + n \cdot \Delta F_c, \forall n \in N_{range}$

where:

F_{start} is the start frequency for the specific band,

ΔF_c is the center frequency step,

N_{range} is the range values for the n parameter.

Table 423—License bands RF Profiles List

RF profile name	Channel bandwidth	Center frequency step ΔF_c	Uplink F_{start}	Downlink F_{start}	N_{range}
OFDMA_ProfR1	1.25	1.25	2150.625	N/A	{0,1,...,7}
OFDMA_ProfR2	1.25	1.25	2305.625	N/A	{0,1,...,12}
OFDMA_ProfR3	1.25	1.25	2345.625	N/A	{13,14,...,24}
OFDMA_ProfR4	1.25	1.25	2500.625	N/A	{0,1,...,150}
OFDMA_ProfR5	1.25	1.25	3400.625	N/A	{0,1,...,240}
OFDMA_ProfR6	3.5	1.75	2524.75	2598.75	{0,1,...,38}
OFDMA_ProfR7	3.5	1.75	3411.75	3461.75	{0,1,...,18}
OFDMA_ProfR8	3.5	1.75	3501.75	3551.75	{0,1,...,55}
OFDMA_ProfR9	3.5	1.75	3601.75	3651.75	{0,1,...,55}
OFDMA_ProfR10	3.5	1.75	3701.75	3751.75	{0,1,...,55}
OFDMA_ProfR11	7	1.75	2526.5	2600.5	{0,1,...,36}
OFDMA_ProfR12	7	1.75	3413.5	3463.5	{0,1,...,16}
OFDMA_ProfR13	7	1.75	3503.5	3553.5	{0,1,...,53}
OFDMA_ProfR14	7	1.75	3603.5	3653.5	{0,1,...,53}
OFDMA_ProfR15	7	1.75	3703.5	3753.5	{0,1,...,53}
OFDMA_ProfR16	14	1.75	2530	2604	{0,1,...,32}
OFDMA_ProfR17	14	1.75	3417	3467	{0,1,...,12}
OFDMA_ProfR18	14	1.75	3507	3550	{0,1,...,49}
OFDMA_ProfR19	14	1.75	3607	3650	{0,1,...,49}
OFDMA_ProfR20	14	1.75	3707	3750	{0,1,...,49}
OFDMA_ProfR21	28	1.75	2537	2611	{0,1,...,24}
OFDMA_ProfR22	28	1.75	3424	3467	{0,1,...,4}
OFDMA_ProfR23	28	1.75	3514	3557	{0,1,...,41}

Table 423—License bands RF Profiles List (continued)

RF profile name	Channel bandwidth	Center frequency step ΔF_c	Uplink F_{start}	Downlink F_{start}	N_{range}
OFDMA_ProfR24	28	1.75	3614	3657	{0,1,...,41}
OFDMA_ProfR25	28	1.75	3714	3757	{0,1,...,41}
OFDMA_ProfR26	10	5	5000	N/A	{55,57,59,61,63,65,67}
OFDMA_ProfR27	10	5	5000	N/A	{148, 150, 152, 154, 156, 158, 160, 162, 164, 166}
OFDMA_ProfR28	10	5	5000	N/A	{147, 149, 151, 153, 155, 157, 159, 161, 163, 165, 167, 169}
OFDMA_ProfR26	20	5	5000	N/A	{56,60,64}{149, 153, 157, 161, 165}
OFDMA_ProfR27	20	5	5000	N/A	{149, 153, 157, 161, 165}
OFDMA_ProfR28	20	5	5000	N/A	{148, 152, 156, 160, 164, 168}
OFDMA_ProfR29	8.75	0.125	2304.375	N/A	{0,...,730}
OFDMA_ProfR30	17.5	0.125	2308.75	N/A	{0,...,660}

NOTES:

1—For 10,20 MHz channels, a spectral mask as defined in 8.6.2 should be applied.

2—For FDD and H-FDD cases, both uplink and downlink shall have the same n value.

Annex A

(informative)

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Annex B

(informative)

Supporting material for frequencies below 11 GHz

B.1 Targeted frequency bands

Table B.1 indicates frequency bands, and their allowed channel spacings, where WirelessMAN-SCa, WirelessMAN-OFDM or WirelessMAN-OFDMA may be applicable.

Table B.1—Frequency bands and channel allocation

Frequency bands (GHz) (licensed unless noted)		Allowed channel spacing	Reference
2.305–2.320 2.345–2.360		1 or $2 \times (5 + 5 \text{ MHz})$ or $1 \times 5 \text{ MHz}$ (Can be aggregated in any combinations) Interference Protection to digital audio radio satellite (DARS)	USA CFR 47 part 27 (WCS) See FCC Docket IB95-91 for potential (increased) interference from DARS repeaters.
2.150–2.162 2.500–2.690		125 kHz to $(n \times 6) \text{ MHz}$ Single or multiple, contiguous or non-contiguous and combinations. Interference Protection to video and ITFS users	USA CFR 47 part 21.901 (MDS) USA CFR 47 part 74.902 [ITFS, multichannel multipoint distribution service (MMDS)]
2.150–2.160 2.500–2.596 2.686–2.688		$1 \text{ MHz} - (n \times 6) \text{ MHz}$ (1 or 2-way) $25 \text{ kHz} - (n \times 25 \text{ kHz})$ “return” Contiguous channels preferred	Canada SRSP-302.5 (MCS) MDS service allocated to adjacent sub-bands (incl. separate “return” channels)
2.400–2.483.5 (license-exempt)		Frequency Hopping or Direct Sequence Spread Spectrum etc.	CEPT/ERC/REC 70-03 USA CFR 47 Part 15, subpart E [B19]
3.400–4.990	3.410–4.200	1.75–30 MHz paired with 1.75–30 MHz Symmetric only. (50 MHz or 100 MHz separation)	Rec. ITU-R F.1488 Annex II ETSI EN 301 021[B15], CEPT/ERC Rec. 14-03 E, CEPT/ERC Rec. 12-08 E
	3.400–3.700	$n \times 25 \text{ MHz}$ (single or paired) (50 MHz or 100 MHz separation if paired)	Rec. ITU-R F.1488 Annex I CITEL PCC.III/REC.47 (XII-99) Canada SRSP-303.4 (BWA)
	3.650–3.700	Rulemaking in progress	USA FCC Docket WT00-32
	4.940–4.990	Rulemaking in progress	USA FCC Dockets WT00-32 and ET-98-237

Table B.1—Frequency bands and channel allocation (continued)

Frequency bands (GHz) (licensed unless noted)		Allowed channel spacing	Reference
5.150–5.850 (license-exempt)	5.150–5.350	$n \times 20$ MHz (HIPERLAN) Restricted to Indoor Use	CEPT/ERC/REC 70-03
	5.470–5.725	$n \times 20$ MHz (HIPERLAN)	
	5.250–5.350	100 MHz maximum Restricted to Indoor Use	USA CFR 47 Part 15, subpart E [B19] USA CFR 47 Part 15, subpart C [B19]
	5.250–5.350	100 MHz maximum	
	5.725–5.850	125 MHz maximum	
10.000–10.680		3.5–28 MHz paired with 3.5–28 MHz. Symmetric only 350 MHz separation	CEPT/ERC/REC. 12-05 ETSI EN 301 021 [B15]

B.2 License-exempt co-existence and interference analyses

B.2.1 Interference mitigation and sharing mechanisms

A number of license-exempt interference mitigation and sharing mechanisms are identified. Two categories are considered—mechanisms that fall within the scope of this standard and methods that fall outside that scope.

Within the scope of this standard, two methods are identified: DFS and transmit power control, both are mandated in this document (see 6.3.15 and 8.3.7.4, respectively) as well as by some regulatory regions (ERC/DEC/(99)23, [B10]).

Two methods outside the scope of this standard are identified—antenna directivity and antenna polarization.

B.2.1.1 DFS

As frequency planning is not practical in licensed-exempt bands, DFS can be used to avoid assigning a channel to a channel occupied by another system. DFS is generally based on comparison of a C/I threshold against idle time RSSI measurements. DFS is predominantly effective to combat interference from and to ground-based systems, such as RLANS, RTTT, radar and other WirelessHUMAN-compliant systems. It is generally ineffective to combat interference from and to airborne systems, such as airborne radars and satellites.

B.2.1.2 Transmit power control

With power control, the transmitter EIRP is reduced according to the link margin. Shorter link ranges result in lower transmitted power levels. For PMP systems, the average EIRP will typically be several decibels below the legal limit assuming that SSs are spread throughout the coverage area. For Mesh systems, this means that EIRP values decrease rapidly as customer deployment density increases. As power control is also influenced by C/I levels, the use of adaptive power control with DFS, where possible, tends to result in the most effective interference mitigation.

B.2.1.3 Antenna directivity

Antenna directivity, in horizontal but especially in vertical direction, can significantly reduce a BWA system's interference potential and resilience. Vertical directivity especially reduces the interference caused to satellite systems, which are designated primary users of part of the addressed bands. It also can significantly help reduce interference to and from indoor RLAN systems. Horizontal directivity significantly reduces the probability of interference to other systems (assuming interference is mainly caused in the main lobe), but tends to increase the severity of the interference, as the energy in the main lobe is generally higher.

B.2.1.4 Antenna polarization

Antenna cross-polarization in the 5-GHz band can achieve an isolation of up to 15 dB in LOS, but reduces significantly in near-LOS and NLOS environments. Most deployments use both horizontal and vertical polarization (circular polarization is not as common in currently known systems) to maximize spectral reuse. Polarization hence has the potential to provide some isolation between differently polarized systems, especially in LOS, but given the operational needs and implementation of most systems in the targeted spectrum, the effectiveness will be mostly marginal.

B.2.2 Services in the 5 GHz band

To enable co-existence studies, a short description of the systems and services in the 5-GHz bands is provided together with the necessary parameters for the subsequent interference analysis. This includes assumptions on parameters of WirelessHUMAN-compliant systems that are beyond the scope of this standard.

B.2.2.1 WirelessHUMAN PMP system

PMP are based upon the use of a central BS with distributed SSs.

Parameters shown in Table B.2 for sample BWA systems BWA1 and BWA2 are assumed.

Table B.2—Single U-NII BWA to synthetic aperture radar 4 (SAR-4) Interference

Parameter	BWA ₁	BWA ₂	units
Transmitted power (antenna port)	0		dBW
Antenna high elevation gain	0	−4	dB
Building loss (dB)	0		dB
Polarization	H/V	H/V	

B.2.2.2 WirelessHUMAN Mesh system

The Mesh deployment scenario is abstracted into a regular hexagonal shape as shown in Figure B.1. On each corner of each hexagon, one Mesh node is located. By parameterizing the distance between a set of neighboring nodes, different Mesh deployment density scenarios can relatively easily be analyzed.

If the distance between two nodes is denoted r , then from each node, there are 3 neighbors at distance r ; 6 nodes at distance $2r\sqrt{3}/2$; 3 nodes at distance $2r$; 6 nodes at distance $3r\sqrt{3}/2$; 6 nodes at distance $3r$; 12 nodes at distance $\sim 4r\sqrt{3}/2$; 3 nodes at distance $4r$; 12 nodes at distance $\sim 5r\sqrt{3}/2$ etc.

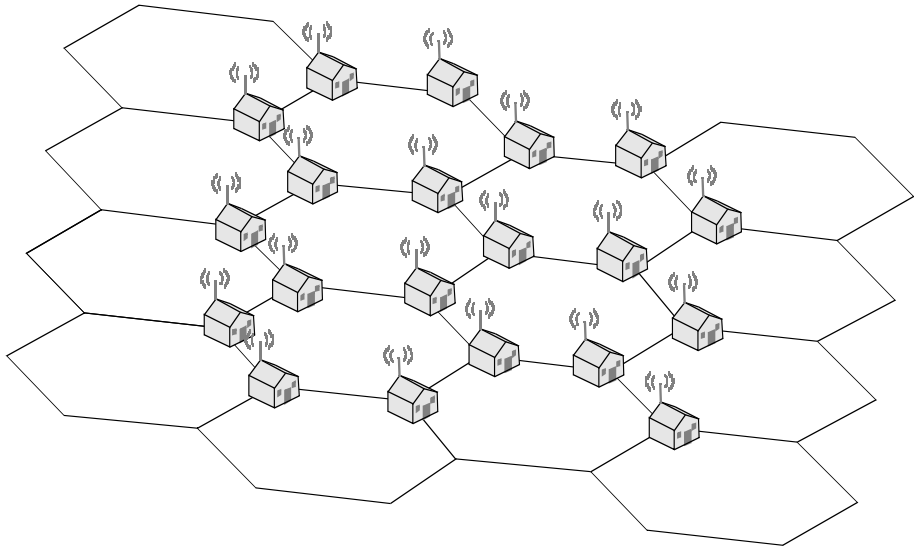


Figure B.1—WirelessHUMAN Mesh deployment model

Mesh devices that are close to each other cannot transmit at the same time on the same channel. This is normally defined in terms of extended neighborhoods, which comprises all nodes within two hops from the transmitting node. For modeling purposes, it is assumed that if a node is transmitting, all other nodes on the three hexagons that intersect on that node are silent. This translates into all nodes within a distance of $2r$ being silent.

In Table B.3, the topology and traffic assumptions are shown. The Tx activity of a node depends heavily on its position in the network, i.e., the amount of traffic that has to be forwarded from or to other nodes; and the activity of neighboring nodes. To keep the analysis simple, an average of 5% is assumed (This is based on the current average household internet usage of 30 minutes per day, as well as the activity probability during this on-time).

Table B.3—Tx activity parameters

Parameter	Value
Typical hops/packet	2
Total Tx activity	5%

Based on this model, the background interference at any node can be computed, which can be added to the interference from the node in question, resulting in the overall system interference.

B.2.2.2.1 Antenna parameters

The Mesh device is assumed to be using omni-directional antennas at all times, which is a worst-case assumption, as nonbroadcast communications between nodes could be performed with multiple antennas to reduce overall interference.

It is extremely important to notice that the Mesh device is by necessity a roof-mounted device, as it has to extend coverage in all directions. In contrast to PMP SSs, which are typically installed under the eaves, the amount of vertical scattering, which is harmful to both ground-based RLAN devices and satellites, is significantly less despite the lack of horizontal directivity. This is due to the relatively good probability of clear LOS of the nodes to each other due to their individual mounting location as well as the significantly shorter distances to each other than a PMP SS typically enjoys to its BS.

For these reasons, no extra scattering in the vertical direction is assumed for this evaluation besides the antenna pattern.

As shown in Table B.4, the antenna is an 8 dBi gain omni-directional antenna with a –22 dBi vertical gain and worst-case –15 dBi between 30° and 50° from vertical.

Table B.4—Antenna parameters

Parameter	Value
Mounting	Outdoors/rooftop
Gain (Horizontal omni-directional)	8 dBi @ 90° –22 dBi @ 0–30° –15 dBi @ 30–50°
Polarization	Vertical

B.2.2.2.2 Radio parameters

Although 10 MHz channelization is also defined, the focus here is on the mandatory 20 MHz channelization, which gives the worst-case scenarios.

It is important to note that, throughout this study, the use of 6 dBW maximum EIRP is assumed for all parts of the spectrum with a backoff of only 3 dB for RLAN type devices. It should be understood that this study errs on the side of caution when considering the amount of interference that can be tolerated; as an example, in a practical OFDM system, the backoff is in the order of at least 6 dB minimum, whereas the rules commonly specify at most 0 dBW maximum mean EIRP (ERC/DEC/(99)23 [B10]) or 6 dBW maximum peak EIRP (FCC CFR Title 47 [B19]) for fractions of the band. The relevant assumed ratio parameters are shown in Table B.5.

Table B.5—Relevant radio parameters

Parameter	Value
Transmit power	28 dBm (i.e., 36 dBm maximum EIRP) with dynamic power control
20 dB bandwidth	21 MHz
Peak-to-Average power ratio	3 dB

The Rx sensitivity and C/I parameters are obtained from Equation (98) (NF = 7 dB, margin = 5 dB).

For the purpose of analytical full network interference analysis, the receiver sensitivity of the Mesh system is chosen to be –75 dBm, an average of the modulation and coding mode sensitivities up to rate 1/2, 16-QAM, which will be the most likely used in practical deployments.

B.2.2.3 Earth exploratory satellite system (EESS) and fixed satellite service (FSS)

Two types of satellite services are deployed in the 5 GHz—FSS and EESS services. EESS services are provided by two distinct types of satellite—Altimeter satellites and SAR satellites.

B.2.2.3.1 Altimeter satellites

The characteristics of altimeter satellites, as shown in Table B.6, have been derived from ERC *Report 72* [B12].

Table B.6—Altimeter satellite characteristics

Parameter	Value
Bandwidth	320 MHz
Rx sensitivity	–88 dBm
On-axis antenna gain	32.5 dBi
Off-axis antenna gain	$10^{3.25(\sin(\varphi)/\varphi)^2}$ ^a
Antenna size	1.2 m
Height	1344 km
Input loss = Output loss	1 dB
Coverage	$\varphi \in [-60^\circ, 60^\circ]$
Bandwidth	320 MHz

^a φ is the angle between the vertical and the direction of the ground-based device.

B.2.2.3.2 SAR satellites

The characteristics of SAR-1 through SAR-4 satellites, as shown in Table B.7, have been derived from ERC *Report 72* [B12].

Table B.7—Typical space borne imaging radar characteristics

Parameter	Value			
	SAR1	SAR2	SAR3	SAR4
Orbital altitude	426 km (circular)	600 km (circular)	400 km (circular)	400 km (circular)
Orbital inclination	57°	57°	57°	57°
RF Centre frequency	5305 MHz	5305 MHz	5305 MHz	5300 MHz

Table B.7—Typical space borne imaging radar characteristics (continued)

Parameter	Value			
	SAR1	SAR2	SAR3	SAR4
Peak radiated power	4.8 Watts	4800 Watts	1700 Watts	1700 Watts
Polarization	Horizontal (HH)	Horizontal and Vertical (HH,HV,VH,VV)	Horizontal and Vertical (HH,HV,VH,VV)	Horizontal and Vertical (HH,HV,VH,VV)
Pulse modulation	Linear FM chirp	Linear FM chirp	Linear FM chirp	Linear FM chirp
Pulse bandwidth	8.5 MHz	310 MHz	310 MHz	40 MHz
Pulse duration	100 μ s	31 μ s	33 μ s	33 μ s
Pulse repetition rate	650 pps	4492 pps	1395 pps	1395 pps
Duty cycle	6.5%	13.9%	5.9%	5.9%
Range compression ratio	850	9610	10230	1320
Antenna type	Planar phased array 0.5 m $\times$ 16.0 m	Planar phased array 1.8 m $\times$ 3.8 m	Planar phased array 0.7 m $\times$ 12.0 m	Planar phased array 0.7 m $\times$ 12.0 m
Antenna peak gain	42.2 dBi	42.9 dBi	42.7/38 dBi (full focus/beam-spoiling)	42.7/38 dBi (full focus/beam-spoiling)
Antenna median sidelobe gain	−5 dBi	−5 dBi	−5 dBi	−5 dBi
Antenna orientation	30° from nadir	20–38° from nadir	20–55° from nadir	20–55° from nadir
Antenna half-power beamwidth	8.5° (El), 0.25° (Az)	1.7° (El), 0.78° (Az)	4.9/18.0° (El), 0.25° (Az)	4.9/18.0° (El), 0.25° (Az)
Antenna polarization	Linear horizontal/ vertical	Linear horizontal/ vertical	Linear horizontal/ vertical	Linear horizontal/ vertical
System noise temperature	550 K	550 K	550 K	550 K
Image swath width	50 km	20 km	16 km/ 320 km	16 km/ 320 km

For both the SAR imaging missions and the topographic missions, a minimum SNR is defined, below which the radar image pixels, and/or differential phase measurements are unacceptably degraded. Studies suggest that:

- The degradation of the normalized standard deviation of power received from a pixel should be less than 10% in the presence of interference;
- The aggregate interference power-to-noise power ratio (corresponding to a pixel SNR of 0 dB) should be less than −6 dB;
- These levels may be exceeded upon consideration of the interference mitigation effect of SAR processing discrimination and the modulation characteristics of the radiolocation/ radio-navigation systems operating in the band;

- The maximum allowable interference level should not be exceeded for more than 1% of the images in the sensor service area for systematic occurrences of interference and should not be exceeded for more than 5% of the images in the sensor service area for random occurrences of interference.

The data loss criteria have been fully utilized to achieve sharing with the radio determination service. This study therefore uses the degradation interference criteria to derive the sharing constraints on BWA devices. Assuming that the interfering signal distribution is white Gaussian noise, the maximum acceptable interference signal is indicated in Table B.8.

Table B.8—Typical space borne imaging radar characteristics

Parameter	Value			
Noise (dBW)	−129.5	−113.8	−113.8	−122.7
Min. desired signal (dBW)	−189.7	−198.6	−187.1	−187.0
Max. acceptable interfering signal (dBW)	−135.5	−119.8	−119.8	−128.7
Receiver bandwidth (MHz)	9.8	356.5	356.5	46
Max. acceptable interfering spectral power density (dBW/Hz)	−205.4	−205.4	−205.4	−205.4
Antenna polarization	Linear horizontal/ vertical	Linear horizontal/ vertical	Linear horizontal/ vertical	Linear horizontal/ vertical
System noise temperature	550 K	550 K	550 K	550 K
Receiver front end 1 dB compression point ref to receiver input	−62 dBW input	−62 dBW input	−62 dBW input	−62 dBW input
Ground illumination area	93 km (elevation), 2.2 km (azimuth)	At 20° from nadir: 20 km (elevation), 8.7 km (azimuth)	At 20° from nadir: 40 km (elevation) 2 km (azimuth)	At 20° from nadir: 40 km (elevation) 2 km (azimuth)

B.2.2.3.3 FSS satellites

The characteristics of FSS satellites have been derived from *ERC Report 72* [B12].

The maximum allowable interference power spectral density tolerated by FSS satellites is given by

$$p = -42 + (G/T) - \gamma \quad \text{dBW/Hz} \quad (155)$$

where G is the gain of the satellite antenna, T the noise temperature (G/T is termed the merit factor), and γ the link gain. FSS satellites are geo-stationary and located at 36 000 km, resulting in 199 dB pathloss. In the case of the Telecom 3 network (*ERC Report 72* [B12]), which is used as an example, γ is 0 dB, the total link equivalent noise temperature is 870 K, the gain for the “Metropole” spot is 34 dBi and the coverage area of this spot is all of Europe. G/T then becomes 4.6 dB.

B.2.2.4 RLANs

The RLAN deployments considered here are the ETSI BRAN HIPERLAN/2 [B17] and IEEE 802.11a devices. Only indoor deployments are considered in detail. It is clear that outdoor RLAN devices cannot generally co-exist in the same channel with BWA devices in the same geographical area. However, the use of DFS, as well as the fact that the hotspot locations envisioned for outdoor RLAN deployments (such as airports and school campuses) do not generally coincide with the residential areas Mesh devices are targeted towards, easily resolve this type of RLAN deployments. The relevant RLAN assumptions are shown in Table B.9 and Table B.10.

Table B.9—RLAN Parameters I

Parameter	Value
Antenna type	Isotropical
Tx probability RLAN device	5%
Tx power	30 dBm maximum EIRP with dynamic power control
Radio access	TDD/TDMA

Table B.10—RLAN parameters II^a

Modulation	Coding rate	Rx sensitivity (dBm @ 10% PER)	C/I (dB @ 10% PER)
BPSK	1/2	−82	6
	3/4	−81	11
QPSK	1/2	−79	9
	3/4	−77	14
16-QAM	1/2	−74	16
	3/4	−70	20
64-QAM	1/2	−66	25
	3/4	−65	30

^aCopied from IEEE Std 802.11a™-1999 [B29], Table 91.

B.2.2.5 Road transport and traffic telematics (RTTT)

Road transport and traffic telematics (RTTT) devices (ETSI EN 300 674 [B14]) are allocated in the band 5795-5805 MHz (2×5 or 1×10), with an extension band 5805-5815 MHz (2×5 or 1×10), which may be used on a national basis at multi-lane road junctions. These devices are split into the Road Side Unit (RSU) and the onboard unit (OBU), the parameters for which are shown in Table B.11 and Table B.12.

Table B.11—RTTT RSU parameters

Parameter	Value
Tx power (maximum EIRP)	3 dBW
Rx sensitivity	−105 to −130 dBW ^a
Antenna gain	20 dB
C/I: 2 / 4 / 8 - PSK	6 / 9 / 12 dB
Polarization	circular

^aThis range is merely informative. The device shall merely meet the manufacturer's claim.

Table B.12—RTTT OBU Parameters (−35° to +35°)

Parameter	Value	
Class	A,B,C,D	E
Re-radiated carrier power (maximum EIRP)	−54 dBW	−44 dBW
Antenna gain	1 dB	
Rx sensitivity	−73 dBW	−70 dBW
C/I: 2 / 4 / 8 -PSK	6 / 9 / 12 dB	C/I: 2 / 4 / 8 - PSK
Polarization	Circular	Polarization

In analyzing the compatibility between WirelessHUMAN systems and RTTT the basic approach taken is to use the Minimum Coupling Loss (MCL) technique to determine the necessary separation distances between the two systems.

$$\text{Minimum coupling loss:} \quad L = P_t - \max \left\{ 10 \log \left(\frac{B_i}{B_{Rx}} \right), 0 \right\} - I_{Rx} \quad (156)$$

where

- P_t is the transmitter power,
- B_{Rx} is the receiver bandwidth (MHz),
- B_i is the interferer bandwidth (MHz),
- I_{Rx} is the tolerable interference at receiver (dBW).

Required separation distance: $d = \frac{\lambda}{4\pi} 10^{pathloss/23}$ where $pathloss = L + \text{Antenna and feeder gains and losses}$.

B.2.2.6 Radar

The radar parameters used in the radar analysis are taken from and ERC *Report 15* [B11] and ERC *Report 72* [B12]. In the analysis, the MCL technique described in B.2.2.5 will be used, with the exception that for the airborne radar (radar type B), a propagation exponent 2.0 instead of 2.3 is used.

Table B.13—Relevant radar parameters

Parameter	Value				
Radar type	A	B	C	D	E
Peak EIRP (dBW)	98.6	26	60	93	97
Bandwidth _{radar} (MHz)	3	15	30	14	3
Antenna gain (dBi)	40	0	46	43	43
Tuning range (GHz)	5.30–5.60	5.70–5.80	5.40–5.82	5.25–5.85	5.60–5.65
Use	Transportable long range	Airborne	Fixed long range	Transportable multi-function	Fixed long range

B.2.3 WirelessHUMAN PMP interference analyses

B.2.3.1 Coexistence with SAR satellites in middle UNII

SAR-4 is used because the SAR-4 system is more interference sensitive than SAR-3, and the SAR-4 center frequency is 5.3 GHz. The SAR-4 scans a path from 20° to 55° from Nadir. This corresponds to Earth incident angles of 21° and 60°, which can be translated to angles of 69° and 30° with respect to the horizon. That is, any radiation from U-NII devices within that angular range could cause/contribute to satellite interference.

An approach that can be used in analyzing the interference potential from Middle U-NII BWA systems into space-borne SAR-4 receiver is to determine the worst-case signal power received from a single BWA transmitter at the space borne SAR. Then, the single interferer margin can be calculated by comparing the single BWA interferer level with the SAR-4 interference threshold. Knowing the SAR-4 footprint, the allowable density of active BWA transmitters can then be calculated, if a positive margin, as calculated from Table B.14, results from a single BWA interferer.

Table B.14—Single U-NII BWA to SAR-4 interference

Parameter	BWA ₁	BWA ₂	Units
Tx Power	0		dBW
Building loss	0		dB
Interference gain due to SS antenna directivity [B45]	−6		dB
Antenna high elevation gain	0	−4	dB
Pathloss (425.67 km)	−160.3		dB
Polarization gain (V/H → H/V)	−3		dB

Table B.14—Single U-NII BWA to SAR-4 interference (continued)

Parameter	BWA ₁	BWA ₂	Units
Noise figure	−4.62		dB
Noise power (46 MHz Rx bandwidth)	−122.73		dB
SAR-4 Interference threshold (I/N=−6dB)	128.71		dB
Margin (dB)	−4.71	−0.71	dB

Note that real-world antennas do not exhibit unity gain at high elevation look angles, and this feature can be used to mitigate interference.

A conclusion that can be drawn is that antenna directivity, if properly utilized, will provide interference margin for multiple transmitters. However, it should be noted that the satellite footprint is large (53 sq. km at 20° from Nadir and 208 sq. km at 55° from Nadir). Therefore, given the potential variables associated with the design, installation and maintenance of the various unlicensed transmitters, antenna directivity alone may not be sufficient to assure non-interference.

The margin calculation in Table B.14 includes 3 dB polarization loss. The fact that most PMP systems rely on polarization for maximizing channelization, as many as half of the U-NII transmitters in a given area could be transmitting on each polarization. If so, the 3 dB polarization loss may not be fully realizable.

If the satellite were restricted to one linear polarization and the U-NII transmitters were restricted to the other linear polarization, greater polarization isolation could be achieved. Given the operational needs of both services, this is unlikely to happen.

B.2.4 WirelessHUMAN Mesh interference analyses

B.2.4.1 Interference to EESS and FSS

B.2.4.1.1 Altimeter satellites

The interference from one Mesh node into the boresight of the SAR can be described by Equation (157)(see ERC Report 72 [B12]).

$$P_r = \frac{P_m G_m G_a \lambda^2}{(4\pi)^2 R^2} L \quad (157)$$

where $P_m G_m = 6$ dBm (28 dBm Output power −22 dBi top lobe) is the EIRP of the Mesh antenna in the vertical direction, $G_a = 32.5$ dBi the gain of the altimeter antenna, $\lambda = 5.66$ cm the wavelength, $L = -1$ dB the input loss of the altimeter, and $R = 1344$ km the lowest orbit.

From this a value for $P_r = -132$ dBm can be obtained.

The altimeter interference threshold is −88 dBm; thus, it can be deduced that the altimeter can withstand the operation of huge numbers of Mesh devices simultaneously, since there is a 44 dB margin. Furthermore, the altimeter is built to provide measurements mainly over oceans and is not able to provide accurate data when a significant amount of land is in view of its antenna beam. From this analysis, it is clear that the altimeter will not suffer from the operation of Mesh networks; however, for completeness, the number of Mesh devices per square kilometer tolerable by the altimeter can be calculated.

The distance between the satellite and a Mesh node under angle ϕ is $R \tan(\phi)$ km. Only freespace attenuation, which ignores atmospheric properties (which further attenuate the signal, especially when $\phi \gg 0$) has been considered.

For simplicity, the three Mesh nodes that on average exist in one hexagon, are assumed to be in the centre point of the hexagon. The hexagon grid then reduces to a square grid with 3 nodes every 2 times the distance of a single set of nodes.

The value for P_r is then obtained as follows:

$$P_r = \sum_{r_1} \sum_{r_2} \frac{3P_m G_m G_a \lambda^2}{(4\pi)^2 R^2} L \left(1 + 4A \sum_{r_1} \sum_{r_2} \sin^2 [2\phi(r_1, r_2)] \right) \quad \forall \sqrt{r_1^2 + r_2^2} < \frac{R\sqrt{3}}{2} \quad \phi = \arctan \left[\frac{2\sqrt{r_1^2 + r_2^2}}{R} \right] \quad (158)$$

where r_1 and r_2 enumerate over the square grid, and A is the activity factor.

This derivation is easily computed numerically. According to *Digest of environmental Statistics* [B44], significantly less than 15%⁵ of land is used for residential areas and normally a significant fraction of the footprint covers water as well. Hence a Residential fraction of 0.05 is introduced, to simulate clusters of nodes spread out over the whole satellite footprint. The receiver sensitivity is, as discussed in B.2.2.2.2, chosen to be -75 dBm.

⁵ Number includes land used for urban and other purposes, e.g., transport and recreation, and nonagricultural, semi-natural environments, e.g., sand dunes, grouse moors and non agricultural grasslands, and inland waters.

```

%Satellite specifications
Ga = 32.5;           % dBi  Antenna gain
lambda = 0.0566;     % m    Wavelength
L = -1;              % dB   Insertion Loss
R = 1344;             % km   Height
Int_limit = 88;       % dBm  Interference limit
%Mesh specifications
Rbase = 0.5;          % km    Distance between two Mesh nodes
AntGain = 8           % dBi   Mesh antenna gain (max)
AntTop = -22          % dBi   Mesh antenna gain (top-lobe)
RxSens = -105          % dBW  Rx sensitivity Mesh
Pout = 28;            % dBm   Max. output power Mesh
Backoff = 3;          % dB    Average Backoff
Activity = 0.05;
pi = 3.1415;
pathloss = -20*log10(3E8/(4*pi*5.3E9))+2.3*10*log10(Rbase*1000);
PmGm = (pathloss - AntGain + FadingMargin + RxSens) + (AntTop-AntGain) -Backoff+ 30; %
dBm
Residential = 0.15;    % fraction residential landuse
Pr1 = 0;nodes =0;
for r1 = Rbase : Rbase/sqrt(Residential): R*sqrt(3)/2
    for r2 = Rbase : Rbase/sqrt(Residential): R*sqrt(3)/2
        if( sqrt(r1*r1+r2*r2) < R*sqrt(3)/2)
            nodes = nodes+3;
            phi = atan( 2*sqrt(r1*r1+r2*r2)/R );
            Pr1 = Pr1 + sinc(2*phi/pi)*sinc(2*phi/pi);
        end;
    end;
end;
end;

```

Figure B.2—Mesh interference code sample

The result of the simulation, as shown in Figure B.2, is that over 30 million nodes can be supported under the footprint, with 6 dB in interference margin. In many cases, shorter distances between the nodes will result in lower used power due to power control. Hence, in practice many more nodes could be supported without violating the interference limit.

B.2.4.1.2 SAR satellites

In analogy with *ERC Report 72* [B12], only the case for SAR-1 satellites is examined, since this provides the worst-case analysis. However, contrary to this report, it will show that, using Mesh technology, an increase in network density actually reduces the interference into the SAR satellite, since the dynamic power-control reduces the power for shorter links. The receiver sensitivity is, as discussed in B.2.2.2.2, chosen to be -75 dBm.

As can be seen from Table B.15, a Mesh network has limitations both on the maximum distance and maximum density of the network. The maximum distance that can be achieved by the Mesh network using 4 W EIRP is about 1 km, which retains a margin of 10 dB to the interference threshold.

Deployments with distances between nodes of one km are however exceedingly sparse and not practical except in the very early stages of service rollout (i.e., when seeding the service area).

Reducing the distance increases the number of nodes, but reduces the necessary power levels, hence reducing the overall interference into the satellite. Increasing the density, and hence the number of nodes to very high levels, up to about one device per 92 m would still obtain tolerable interference levels. Deployment densities of this nature, especially in the areas of major interest to the satellite community (oceanic and agrarian), are extremely unlikely.

To allow an easier comparison with the RLAN results in ERC *Report 72* [B12], Table B.15 computes the number of Mesh devices that can be situated in the SAR footprint without exceeding the interference limit.

Table B.15—WirelessHUMAN Mesh devices in the SAR footprint

Parameter	Value				
Node distance	1	0.5	0.25	0.1	km
Tx antenna gain	8				dBi
Rx sensitivity	−105				dBW
path loss	115.93	109.00	10.08	92.93	dB
P _{out} required (EIRP)	2.93	−4.00	−10.92	−20.07	dBW
P _{out} required (conducted)	−5.07	−12.00	−18.92	−28.07	dBW
Freespace distance	−160.8				dB
Building attenuation	0				dB
Tx antenna gain (top lobe)	−22				dBi
Polarization loss	−3				dB
Peak-to-Average ratio	−3				dB
Rx antenna gain (main lobe)	42.4				dBi
Rx Power	−224.90	−231.82	−238.74	−247.90	dBW/Hz
SAR threshold	−205				dBW/Hz
Margin	19.54	26.46	33.38	42.54	dB/Hz
SAR footprint	22.59				dB
Tx activity	−13.01				dB
Permissible density/km ² /ch	9.91	498.78	240.22	1976.39	nodes
Nodes within SAR footprint (CEPT region)	26967	132804	654001	5380723	nodes

In Table B.15, it is assumed that all Mesh devices are located in the boresight of the SAR satellite, which provides the worst-case scenario.

B.2.4.1.3 FSS satellites

The bandwidth of the Mesh device is 21 MHz (73.2 dBHz). The maximum allowable interference power spectral density tolerated by the Telecom 3 network (see B.2.2.3.3) then becomes 27 dBW/Hz.

Appendix S8 of the ITU Radio Regulations [B32] gives the method to calculate the maximum interference power produced by an earth station to a satellite receiver. When calculating the maximum interference power from Mesh devices into a satellite receiver, consider all the Mesh devices under the satellite footprint as a single source. This means that the source is not specifically located, and only the direct top lobe of the Mesh antenna is taken into account.

Table B.16—Tolerable Mesh nodes for FSS operation

Parameter	Value				
Tx EIRP	−6	0	3	6	dBW
Tx antenna gain (main lobe)	8				dBi
Tx antenna gain (top lobe)	−22				dBi
Peak-to-Average Ratio	3				dB
Shielding effect	0				dB
Acceptable interference	27				dBW
Active users	1000	251	126	63	nodes (thousands)
Average Tx ratio	5				%
Tolerable nodes	300	75.4	37.8	18.9	nodes (millions)

From Table B.16, it shows that by using 4 W (6 dBW) EIRP, an enormous amount of Mesh nodes can be in operation within the FSS footprint.

B.2.4.2 Interference to RLANs

B.2.4.2.1 Immediate neighborhood analysis

B.2.4.2.1.1 “Same building” analysis (1)

In the immediate neighborhood scenario, the interference from a Mesh node to a RLAN device in the same building is analyzed (link 1 in Figure B.3).

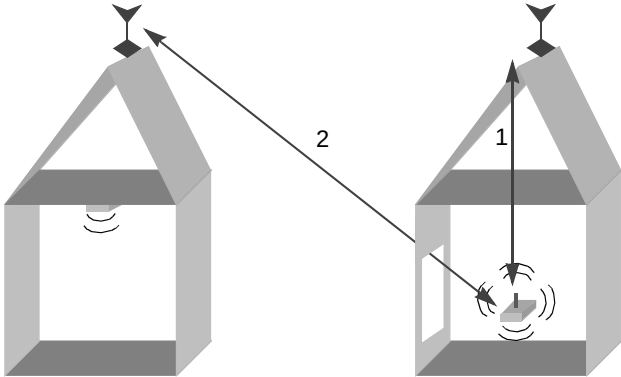


Figure B.3—Immediate neighborhood scenario

It is assumed for this scenario, that the distance between the Mesh node and the RLAN device in the same building is 5 m. The structural isolation plus attenuation due to multipath/scattering is assumed to be 25 dB over that distance, based to Annex 2 of *ERC Report 72* [B12]. Note that this is not the same as the average 13.4 dB assumed in *ERC Report 72* [B12], since only placement of Mesh devices on the roof are considered, and not placement outside in general as in the outside RLAN case. This is likely to be a very modest value for a typical (European) home with concrete ceiling and stone tile roofing. The total attenuation is then $25 + 20 \cdot \log_{10}(4 \cdot \pi \cdot d \cdot f_0 / c) = 86$ dB. Given the radiation pattern of a Mesh node transmitting at full 28 dBm (i.e., 36 dBm EIRP), the interference level at the RLAN = $28 - 22 - 86 = -80$ dBm. Taking into account the backoff, 3 dB, and the effect of the Mesh activity factor, an additional 13 dB, brings the average interference level, -97 dBm, far below receiver sensitivity values. Operation of a Mesh device on the roof, while running an RLAN network inside is hence feasible, even in the same channel.

In this scenario, to operate the RLAN at its highest modulation and coding rate (64-QAM, 3/4 coding) while the Mesh device is transmitting, would require the separation to be at least 20 m (instead of the 5 m used). For 16-QAM, 1/2 coding, the separation would be 10 m.

B.2.4.2.1.2 “Across the street” analysis (2)

Another critical consideration is the analysis of illumination of indoor RLANs in adjacent buildings. This is due to the fact that despite the larger distance, normally only one isolating building layer (which may also be a window) is situated in-between, and the Mesh antenna gain increases with the angle from the vertical axis.

It is assumed for this scenario that the street is 10 m wide, which gives an antenna gain of -15 dBi and an outdoor distance of $\sqrt{125} = 11.2$ m. The structural isolation plus attenuation due to multipath/scattering is assumed to be 10 dB (window plus some indoor scattering). The total attenuation is then $10 + 20 \cdot \log_{10}(4 \cdot \pi \cdot d \cdot f_0 / c) = 78$ dB. Taking into account the antenna gain, the backoff and the Mesh activity factor of the Mesh node reduces the average level at the RLAN to -78 dBm.

Of course, the numbers in the above analysis fluctuate by a number of decibels for individual deployments. The average structural attenuation was quoted to be 13.4 dB in *ERC Report 72* [B12], but there may be variations in building height or terrain sloping that increase the antenna gain in the direction of the RLAN by a few dBs. Typically the above results of this subclause are broadly applicable as conservative estimates to a wide range of deployment scenarios.

Power-control and DFS can assist in further reducing these interference levels. Note that the transmit probability of the RLAN device, (13 dB), has not been taken into consideration.

B.2.4.2.2 Outdoor RLAN analysis

An argument often used against the use of BWA devices in the 5-GHz bands is that it will interfere with outdoor deployments of RLAN devices. It is quite obvious that co-location of these two types of devices on a roof (or neighboring roofs) will cause severe interference when operating in the same channel; however, it should be realized that exactly the same issue exists when two RLAN APs on a roof (or neighboring roofs) are competing for the same channel. (To be specific, this is mostly the case for HIPERLAN/2, which is schedule based). Attempting to avoid this type of interference, which works well for low duty cycles, IEEE 802.11a uses CSMA/CD. In both cases, the requirement for a DFS mechanism can gracefully resolve the problem. In addition, outdoor RLAN deployments are predominantly used for hot-spot coverage and bridging, which implies the use of down-tilted antennas and oftentimes geographical isolation for hot-spot coverage and very directive antennas for bridging, each of which reduces the interference potential. In the cases where RLANs are currently used for access provisioning, WirelessHUMAN-compliant systems will likely not be deployed or be used as more efficient substitutes.

BWA deployments require broad coverage and reasonable frequency reuse numbers to maintain sufficient SNR plus limited DFS flexibility to avoid local interference sources. Therefore, the likelihood of roof-mounted RLAN devices unable to find a sufficient noise-free channel for proper operation are rather small.

B.2.4.2.3 Network analysis

To illustrate the interference analysis further, a typical scenario consisting of a 4-node indoor RLAN network and a nearby 4-node Mesh network, is examined.

From Annex 2 of ERC *Report 72* [B12], it can be extracted that the typical indoor attenuation on top of free-space attenuation at 5 m is 4 dB for a mixture of LOS through NLOS scenarios. The additional attenuation through one wall is 7.1 dB and the additional attenuation through two walls is 12.5 dB (the walls in these cases were breeze blocks and the rooms contained both wooden and metal furniture). The attenuation through a double-glazed window was found to be 7 dB.

In the case under study, a SU is assumed from each of these cases in a Small Office setting. The SU in the same room is assumed at 10 m; the SU in the adjacent room at 30 m; and the SU behind two walls at 50 m.

The Small Office is assumed to be a single-floor building with a flat roof. The attenuation through the roof is 22 dB. A typical indoor cross-floor attenuation according to Annex 2 of ERC *Report 72* [B12] is 19 dB, which is probably a fairly pessimistic value. The Mesh #4 node is situated on the roof directly atop AP #1 and provides the “Internet access” for the RLAN service within the building. The cabling distance between the data gathering point, the AP, and the access service, Mesh #4 node, is shortest. The distance between AP #1 and Mesh #4 is assumed to be 5 m.

The nearest neighboring node, Mesh #1, is 50 m away on an adjacent building. The building attenuation is 10 dB (a window plus indoor scattering, as in B.2.4.2.1.2). It is assumed that this building is lower than the building with the RLANs, resulting in an antenna gain of -10 dBi in the direction of the RLANs, rather than the -15 dBi specified in Table B.4). Two other nodes are each 200 m away as shown in Figure B.4. All Mesh nodes are on the roof and hence only have free-space (FS) attenuation to each other. Mesh #3 is assumed to have an additional 15 dB obstruction to the RLANs in the form of a building (basically the building on which Mesh #2 is located).

Note that in the Path Losses in Figure B.4, the antenna gain of the Mesh nodes (see Table B.4) in the direction of the RLANs has been included.

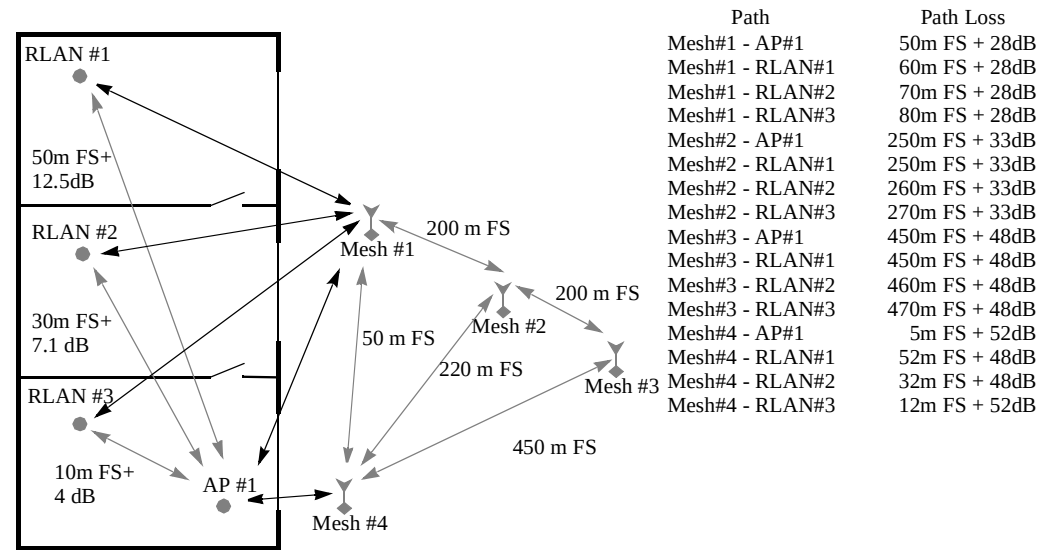


Figure B.4—Example network scenario

In Table B.17, the ranges and corresponding total link attenuations, which are assumed to be symmetrical, are gathered. In general, it can be observed that only nodes that are really close or in LOS through little attenuation (particularly windows) result in significant interference.

Table B.17—Link attenuations and ranges

	Link attenuation/Range							
	Mesh #1	Mesh #2	Mesh #3	Mesh #4	AP #1	RLAN #1	RLAN #2	RLAN #3
Mesh#1	-----	200 m	400 m	50 m	50 m	60 m	60 m	60 m
Mesh#2	94 dB	-----	200 m	220 m	220 m	230 m	230 m	230 m
Mesh#3	100 dB	94 dB	-----	450 m	450 m	460 m	460 m	460 m
Mesh#4	82 dB	94 dB	101 dB	-----	5 m	52 m	32 m	12 m
AP#1	110 dB	127 dB	149 dB	106 dB	-----	50 m	30 m	10 m
RLAN#1	111 dB	128 dB	149 dB	130 dB	94 dB	-----	50 m	20 m
RLAN#2	111 dB	128 dB	149 dB	126 dB	84 dB	132 dB	-----	30 m
RLAN#3	111 dB	128 dB	149 dB	121 dB	72 dB	94 dB	107 dB	-----

In Table B.18, the maximum power and EIRP values for each of the devices is shown. For the RLAN devices and their AP, values are chosen that reflect implementations that are currently available in the market.

Table B.18— Tx Power, conducted and EIRP (regulatory limited)

	AP	RLAN	Mesh
Tx Power (mW)	200	200	500
Antenna (dBi)	2	0	8
EIRP (dBm)	25	23	35

In Table B.19, the resulting received signal strengths are shown assuming transmission with EIRP values as shown in Table B.18. Note that especially between the Mesh nodes, the Rx values are extremely high, which would automatically be reduced by the AGC. For simplicity of computation, this is however ignored. This table is not symmetric since different antenna gains at each end can affect the perceived signal level.

Table B.19—Received Signal Levels (dBm)

	Mesh #1	Mesh #2	Mesh #3	Mesh #4	AP #1	RLAN #1	RLAN #2	RLAN #3
Mesh #1	-----	−54	−60	−42	−80	−83	−83	−83
Mesh #2	−54	-----	−54	−54	−97	−100	−100	−100
Mesh #3	−60	−54	-----	−61	−119	−121	−121	−121
Mesh #4	−42	−54	−61	-----	−84	−102	−98	−93
AP #1	−76	−93	−115	−80	-----	−72	−62	−50
RLAN#1	−79	−96	−117	−98	−72	-----	−112	−74
RLAN#2	−79	−96	−117	−94	−62	−112	-----	−87
RLAN#3	−79	−96	−117	−89	−50	−74	−87	-----

Table B.20 shows resulting sustainable modulations. The top row in each box shows the actual communication direction, the used modulation and the Noise threshold. The next four rows illustrate the effect of interference from each source (using maximum allowed EIRP). If the modulation differs from the top box, then switch to a more robust modulation scheme was mandatory to maintain 3% PER. The last column defines the interference margin. A positive value means the threshold has been exceeded and is shown in bold.

Table B.20—Sustainable modulation during interference

RLAN#1 =>AP#1	3/4 QPSK	−90	RLAN#2 =>AP#1	2/3 64-QAM	−95	RLAN#3 =>AP#1	3/4 64-QAM	−95
Mesh #1	PER>3%	4	Mesh #1	1/2 QPSK	−5	Mesh #1	1/2 QPSK	−5
Mesh #2	3/4 QPSK	−13	Mesh #2	2/3 64-QAM	−22	Mesh #2	2/3 64-QAM	−22
Mesh #3	3/4 QPSK	−35	Mesh #3	2/3 64-QAM	−44	Mesh #3	3/4 64-QAM	−44
Mesh #4	PER>3%	0	Mesh #4	3/4 QPSK	−9	Mesh #4	3/4 QPSK	−9
AP#1 => RLAN#1	3/4 QPSK	−90	AP#1 => RLAN#2	2/3 64-QAM	−95	AP#1 => RLAN#3	3/4 64-QAM	−95
Mesh #1	PER>3%	1	Mesh #1	3/4 QPSK	−8	Mesh #1	3/4 QPSK	−8
Mesh #2	3/4 QPSK	−16	Mesh #2	3/4 64-QAM	−25	Mesh #2	3/4 64-QAM	−25
Mesh #3	3/4 QPSK	−37	Mesh #3	3/4 64-QAM	−46	Mesh #3	3/4 64-QAM	−46
Mesh #4	3/4 QPSK	−18	Mesh #4	2/3 64-QAM	−23	Mesh #4	3/4 16-QAM	−18

From Table B.20, two observations can be generalized. The first is that in certain scenarios interference is unavoidable if DFS is not used. The second is that interference only occurs when nodes are really close (such as Mesh #4) or have relatively good LOS properties (such as Mesh #1, which only has a window in-between and a reduced height antenna) to the RLAN network. The later generalization means that very few nodes in a Mesh network will cause degradation of a RLAN network. Realizing that the interference excess is relatively low, and the Mesh network uses power-control to reduce the EIRP where possible, interference from a transmitting Mesh device will be very limited. Combined with the activity factors for both devices (on average 13 dB each) and DFS mechanisms, the likelihood of interference becomes so small that it is easily handled with Automatic Repeat Request (ARQ) causing minimal degradation of performance.

B.2.4.2.4 Adjacent channel issues

A feature of the OFDM technology used in both RLANs and Mesh technology at 5 GHz, is that the adjacent channel rejection is very high, at least 35 dB (see 8.3.11.2). Since the interference levels between RLANs and Mesh devices are relatively low compared to this, it is reasonable to assume that adjacent channels using RLAN and Mesh technology will not cause any noticeable interference to each other; therefore, this requires no further consideration.

B.2.4.3 Interference to RTTT

In accordance with CEN/TC 278 prEN 12253 [B5] and ERC *Report 72* [B12], the cross-polarization is assumed to be 10–15 dB to the RSU and 6–10 dB to the OBU (Table B.21 uses the lower numbers).

Table B.21—Needed separation distance Mesh to RSU and OBU

Parameter	RSU		OBU
P_t	6		6
B_{Rx}	10	5	10
B_i	22		22

Table B.21—Needed separation distance Mesh to RSU and OBU (continued)

Parameter	RSU		OBU
$I_{Rx}=R_{x_{sens}}-C/I_{8PSK}$	−117		−90
L	119.6	116.6	92.6
Cross-polarization	10		6
Antenna and feeder gain	8		8
Separation distance	553	394	53

It should be noted that in the above calculations of Table B.21, the duty cycle of the Mesh devices, which significantly reduces the interference scenario, has not been taken into consideration.

Especially for the RSU case, where the separation distance is fairly significant, it can be shown that the interference to the Mesh device is significantly larger than the other way around. Since RTTT devices normally have a fairly high duty cycle, a close Mesh device would not be able to operate properly in this channel and would need to use the DFS mechanisms to switch to another channel. Therefore, for RSUs, proper operation is virtually guaranteed by virtue of its own interference potential.

B.2.4.4 Interference to radar

For radars, a somewhat similar situation exists as with RTTT RSUs. To show this, the interference distance from radars into Mesh devices is derived, followed by the derivation of the interference distance from Mesh devices into radars. Comparing Table B.22 and Table B.23, the interference distance from radars to Mesh is much larger than the interference distance from Mesh to radars.

For analysis of the minimum distance at which an Mesh device still operates, shown in Table B.22, the most robust modulation and coding mode is used.

Table B.22—Minimum separation distance of radar to Mesh

Radar type	A	B	C	D	E	
Peak EIRP	98.6	26	60	93	97	dBW
Antenna gain	40	0	46	43	43	dBi
P_t	58.6	26	14	50	54	dBW
Bandwidth _{radar}	3	15	30	14	3	MHz
$I_{mesh}=R_{x_{sens}}-C/I_{BPSK1/2}$	−116					dBW
L	174.6	142.0	131.3	166.0	170.0	dB
Gain and feeder loss	48	8	54	51	51	dB
Propagation loss	222.6	150	185.3	217	221	dB
Distance at 5.5 GHz	20693	137	497	11813	17630	km
Radio horizon	51.4	346.6	51.4	51.4	51.4	km (see [B11])
Separation distance	51.4	137	51.4	51.4	51.4	km

In Table B.23, the thermal noise level has been assumed -204 dBW/Hz whereas the Rx noise factor is assumed to be 5 dB. The maximum I/N is -6 dB as specified by NATO (see ERC *Report 72* [B12], ERC *Report 15* [B11]).

Table B.23—Minimum separation distance of Mesh to radar

Radar type	A	B	C	D	E	
P_t mesh	-2					dBW
Bandwidth _{radar}	3	15	30	14	3	MHz
Noise (dBW)	-134.2	-127.2	-124.2	-127.5	-134.2	dBW
On-tune rejection	-8.9	-1.9	0.0	-2.2	-8.9	dB (see [B12])
Max. Interference	-131.3	-131.3	-130.2	-131.3	-131.3	dBW
L	129.3					dB
Gain + feeder loss	48	8	54	51	51	dB
Propagation loss	177.3	145.3	191.6	188.3	188.3	dB
Distance at 5.5 GHz	220.1	79.4	916.3	662.7	662.0	km

Comparing the required distances at 5.5 GHz from Table B.22 and Table B.23, it is shown that in all cases, the separation distance is larger for the BWA system, forcing it effectively out of the channel used by the radar. In all cases, the separation distance is effectively limited by the radio horizon.

In the case of radar type B, which is airborne, depending on the exact location of the radar, the gain+feeder loss will reduce from +8 to -22 dB, significantly reducing the necessary separation distance. Since the angle of detection (if any) is not known, this factor has not been used in the previous tables. For the other types, the distance is limited by the radio horizon, but in practice likely much lower due to obstructions and clutter.

From Table B.22 and Table B.23, similar conclusions to the RLAN analysis in ERC *Report 72* [B12] can be drawn. Sharing with maritime radars (which are not likely operating anywhere near residential areas) and S5.452 meteorological radars in band B, and radiolocation radars in both band B and C is feasible when an effective DFS mechanism is employed by the Mesh system and the radar density is not too high.

B.3 Performance characteristics

B.3.1 WirelessMAN-SCa PHY throughput

Table B.24 indicates the raw bit rates delivered by the WirelessMAN-SCa PHY for typical bandwidths and a roll-off of 0.25, while Table B.25 indicates the raw bit rates for a roll-off of 0.15.

The raw bite rate (in Mb/s) is defined as shown in Equation (159).

$$\frac{(BW - 0.088) \cdot Bpm \cdot R_{outer} \cdot R_{inner}}{(1 + \alpha)} \quad (159)$$

where

BW is the bandwidth in MHz,

α is the roll-off,

Bpm is the number of bits per modulation symbol,

$R_{outer} = 239/255$ is the outer (Reed-Solomon) code rate,

R_{inner} is the inner (TCM) code rate that specified in the first column of each table.

Table B.24—WirelessMAN-SCa raw bit rates (Mb/s) for 0.25 roll-off

Modulation and inner code rate	6 MHz (MMDS)	7 MHz (ETSI)	20 MHz (UNII)
BPSK 1/2	2.22	2.59	7.47
BPSK 3/4	3.32	3.89	11.20
QPSK 1/2	4.43	5.18	14.93
QPSK 2/3	5.91	6.91	19.91
QPSK 3/4	6.65	7.77	22.40
QPSK 5/6	7.39	8.64	24.88
QPSK 7/8	7.76	9.07	26.13
16-QAM 1/2	8.87	10.37	29.86
16-QAM 3/4	13.30	15.55	44.79
64-QAM 2/3	17.73	20.73	59.72
64-QAM 5/6	22.16	25.91	74.65
256-QAM 3/4	26.60	31.10	89.58
256-QAM 7/8	31.03	36.28	104.51

Table B.25—WirelessMAN-SCa raw bit rates (Mb/s) for 0.15 roll-off

Modulation and inner code rate	6 MHz (MMDS)	7 MHz (ETSI)	20 MHz (UNII)
BPSK 1/2	2.41	2.82	8.11
BPSK 3/4	3.61	4.22	12.17
QPSK 1/2	4.82	5.63	16.23
QPSK 2/3	6.42	7.51	21.64
QPSK 3/4	7.23	8.45	24.34
QPSK 5/6	8.03	9.39	27.05
QPSK 7/8	8.43	9.86	28.40
16-QAM 1/2	9.64	11.27	32.46
16-QAM 3/4	14.45	16.90	48.69
64-QAM 2/3	19.27	22.53	64.91

Table B.25—WirelessMAN-SCa raw bit rates (Mb/s) for 0.15 roll-off (continued)

Modulation and inner code rate	6 MHz (MMDS)	7 MHz (ETSI)	20 MHz (UNII)
64-QAM 5/6	24.09	28.17	81.14
256-QAM 3/4	28.91	33.80	97.37
256-QAM 7/8	33.73	39.43	113.60

B.3.2 WirelessMAN-OFDM/OFDMA PHY symbol and performance parameters

The effective bandwidth of the transmitted signal is related to the subcarrier spacing and the number of subcarriers.

In order to calculate the sampling frequency for any bandwidth, the bandwidth efficiency is defined as shown in Equation (160).

$$BW_{Efficiency} = \frac{F_s}{BW} \cdot \frac{(N_{used} + 1)}{N_{FFT}} = \frac{\Delta f \cdot (N_{used} + 1)}{BW} \quad (160)$$

where

- BW is the Channel bandwidth (Hz),
- F_s is the Sampling frequency (Hz),
- Δf is the Subcarrier spacing (Hz),
- $N_{used} + 1$ is the Number of active subcarriers used in the FFT (pilot and data subcarriers) + DC subcarrier,
- N_{FFT} is the FFT size.

The bandwidth efficiency is designed to be in the range of 83–95%, depending mainly on the FFT size, in order to occupy the maximum usable bandwidth but still allow adequate RF filtering.

The following tables give some calculations of the subcarrier spacing, symbol duration and CP duration for different masks. The sampling rate is defined as $F_s = BW \cdot 8/7$, except for 256-OFDM (see 8.3.2.4) in licensed bandwidths, which are not a multiple of 1.75 MHz. In those cases, the sampling rate is $F_s = BW \cdot 7/6$.

Table B.26—OFDM channelization parameters for licensed bands

Bandwidth (MHz)		OFDM ($N_{FFT} = 256$)					
		Δf (kHz)	T_b (μ s)	T_g (μ s)			
				$T_b/32$	$T_b/16$	$T_b/8$	$T_b/4$
MMDS ($n = 86/75$)	1.5	$6\frac{23}{32}$	$148\frac{36}{43}$	$4\frac{28}{43}$	$9\frac{13}{43}$	$18\frac{26}{43}$	$36\frac{9}{43}$
	3.0	$13\frac{7}{16}$	$74\frac{18}{43}$	$2\frac{14}{43}$	$4\frac{28}{43}$	$9\frac{13}{43}$	$18\frac{26}{43}$
	6.0	$26\frac{7}{8}$	$37\frac{9}{43}$	$1\frac{7}{43}$	$2\frac{14}{43}$	$4\frac{28}{43}$	$9\frac{13}{43}$
	12.0	$53\frac{3}{4}$	$18\frac{26}{43}$	$\frac{25}{43}$	$1\frac{7}{43}$	$2\frac{14}{43}$	$4\frac{28}{43}$
	24.0	$107\frac{1}{2}$	$9\frac{13}{43}$	$\frac{25}{86}$	$\frac{25}{43}$	$1\frac{7}{43}$	$2\frac{14}{43}$
ETSI ($n = 8/7$)	1.75	$7\frac{13}{16}$	128	4	8	16	32
	3.5	$15\frac{5}{8}$	64	2	4	8	16
	7.0	$31\frac{1}{4}$	32	1	2	4	8
	14.0	$62\frac{1}{2}$	16	$\frac{1}{2}$	1	2	4
	28.0	125	8	$\frac{1}{4}$	$\frac{1}{2}$	1	2
WCS ($n = 144/145$)	2.5	$11\frac{1}{4}$	$88\frac{8}{9}$	$2\frac{7}{9}$	$5\frac{5}{9}$	$11\frac{1}{9}$	$22\frac{2}{9}$
	5.0	$22\frac{1}{2}$	$44\frac{4}{9}$	$1\frac{7}{18}$	$2\frac{7}{9}$	$5\frac{5}{9}$	$11\frac{1}{9}$
	10.0	45	$22\frac{2}{9}$	$\frac{25}{36}$	$1\frac{7}{18}$	$2\frac{7}{9}$	$5\frac{5}{9}$
	15.0	$67\frac{3}{16}$	$14\frac{38}{43}$	$\frac{20}{43}$	$\frac{40}{43}$	$1\frac{37}{43}$	$3\frac{31}{43}$

Table B.27—OFDMA channelization parameters for licensed bands

Bandwidth (MHz)		OFDMA ($N_{FFT} = 2048$)					
		Δf (kHz)	T_b (μ s)	T_g (μ s)			
				$T_b/32$	$T_b/16$	$T_b/8$	$T_b/4$
MMDS ($f_s/BW = 8/7$)	1.5	$\frac{36}{43}$	$1194\frac{2}{3}$	$37\frac{1}{3}$	$74\frac{2}{3}$	$149\frac{1}{3}$	$298\frac{2}{3}$
	3.0	$1\frac{60}{89}$	$597\frac{1}{3}$	$18\frac{2}{3}$	$37\frac{1}{3}$	$74\frac{2}{3}$	$149\frac{1}{3}$
	6.0	$3\frac{8}{23}$	$298\frac{2}{3}$	$9\frac{1}{3}$	$18\frac{2}{3}$	$37\frac{1}{3}$	$74\frac{2}{3}$
	12.0	$6\frac{39}{56}$	$149\frac{1}{3}$	$4\frac{2}{3}$	$9\frac{1}{3}$	$18\frac{2}{3}$	$37\frac{1}{3}$
	24.0	$13\frac{11}{28}$	$74\frac{2}{3}$	$2\frac{1}{3}$	$4\frac{2}{3}$	$9\frac{1}{3}$	$18\frac{2}{3}$
ETSI ($f_s/BW = 8/7$)	1.75	$\frac{83}{85}$	1024	32	64	128	256
	3.5	$1\frac{61}{64}$	512	16	32	64	128
	7.0	$3\frac{29}{32}$	256	8	16	32	64
	14.0	$7\frac{13}{16}$	128	4	8	16	32
	28.0	$15\frac{5}{8}$	64	2	4	8	16
WCS ($f_s/BW = 8/7$)	2.5	$1\frac{32}{81}$	$714\frac{4}{5}$	$22\frac{2}{5}$	$44\frac{4}{5}$	$89\frac{3}{5}$	$179\frac{1}{5}$
	5.0	$2\frac{64}{81}$	$358\frac{2}{5}$	$11\frac{1}{5}$	$22\frac{2}{5}$	$44\frac{4}{5}$	$89\frac{3}{5}$
	10.0	$5\frac{47}{81}$	$179\frac{1}{5}$	$5\frac{3}{5}$	$11\frac{1}{5}$	$22\frac{2}{5}$	$44\frac{4}{5}$
	15.0	$8\frac{10}{27}$	$119\frac{7}{15}$	$3\frac{11}{15}$	$7\frac{7}{15}$	$14\frac{14}{15}$	$29\frac{13}{15}$

Table B.28—OFDM/OFDMA channelization parameters for license-exempt bands

		OFDM	OFDMA
	n	144/25	8/7
Bandwidth (MHz)	N_{FFT}	256	2048
10	Δf (kHz)	45	$5\frac{47}{81}$
	T_b (μ s)	$22\frac{2}{9}$	$179\frac{1}{5}$
	T_g (μ s)	$\frac{T_b}{32}$	$5\frac{3}{5}$
		$\frac{T_b}{16}$	$11\frac{1}{5}$
		$\frac{T_b}{8}$	$22\frac{2}{5}$
		$\frac{T_b}{4}$	
20	Δf (kHz)	90	$11\frac{9}{56}$
	T_b (μ s)	$11\frac{1}{9}$	$89\frac{3}{5}$
	T_g (μ s)	$\frac{T_b}{32}$	$2\frac{4}{5}$
		$\frac{T_b}{16}$	$5\frac{3}{5}$
		$\frac{T_b}{8}$	$11\frac{1}{5}$
		$\frac{T_b}{4}$	$22\frac{2}{5}$

In Table B.29, raw bit rates are shown for typical bandwidths. The raw bite rate is defined as $N_{used} \cdot b_m \cdot c_r / T_s$, where b_m is the number of bits per modulation symbol and c_r is the coding rate.

Table B.29—OFDM/OFDMA raw bitrates (Mb/s)

Bandwidth (MHz)	T_g	BPSK 1/2	QPSK 1/2	QPSK 3/4	16-QAM 1/2	16-QAM 3/4	64-QAM 2/3	64-QAM 3/4
OFDM 256-FFT								
6 MHz (MMDS)	$T_b/32$	2.50	5.00	7.51	10.01	15.01	20.01	22.52
	$T_b/16$	2.43	4.86	7.28	9.71	14.57	19.43	21.85
	$T_b/8$	2.29	4.59	6.88	9.17	13.76	18.35	20.64
	$T_b/4$	2.06	4.13	6.19	8.26	12.38	16.51	18.58

Table B.29—OFDM/OFDMA raw bitrates (Mb/s)

7 MHz (ETSI)	$T_b/32$	2.92	5.82	8.73	11.64	17.45	23.27	26.18
	$T_b/16$	2.82	5.65	8.47	11.29	16.94	22.59	25.41
	$T_b/8$	2.67	5.33	8.00	10.67	16.00	21.33	24.00
	$T_b/4$	2.40	4.80	7.20	9.60	14.40	19.20	21.60
20 MHz (U-NII)	$T_b/16$	8.13	16.26	24.40	32.53	48.79	65.05	73.19
	$T_b/8$	7.68	15.36	23.04	30.72	46.08	61.44	69.12
	$T_b/4$	6.91	13.82	20.74	27.65	41.47	55.30	62.21
OFDMA 2048-FFT								
6 MHz (MMDS)	$T_b/32$		4.99	7.48	9.97	14.96	19.95	22.44
	$T_b/16$		4.84	7.26	9.68	14.52	19.36	21.78
	$T_b/8$		4.57	6.86	9.14	13.71	18.29	20.57
	$T_b/4$		4.11	6.17	8.23	12.34	16.46	18.51
7 MHz (ETSI)	$T_b/32$		5.82	8.73	11.64	17.45	23.27	26.18
	$T_b/16$		5.65	8.47	11.29	16.94	22.59	25.41
	$T_b/8$		5.33	8.00	10.67	16.00	21.33	24.00
	$T_b/4$		4.80	7.20	9.60	14.40	19.20	21.60

B.4 Frequency reuse of 1 for OFDMA

This subclause defines extensions of OFDMA system for working in deployment scenarios with frequency reuse of 1.

B.4.1 Introduction

The definition of an OFDMA system as defined in 8.4 is well suited to work with deployment scenarios with frequency reuse factor >1 , but in order to satisfy requirement of reliability, coverage, capacity, spectral efficiency, and location base service. The system can be configured to work in a reuse of 1, which means the same RF frequency is allocated to all sectors in the cell. In this case, a new scheme of work must be introduced in order to achieve the needed performance. A scenario using a reuse of 1 is given in Figure B.5:

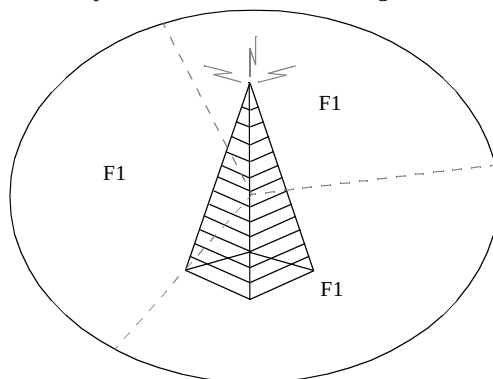


Figure B.5—Reuse of 1 configuration, 3 sectors per cell

There are three options of operation in the reuse of 1 scenario:

- **Asynchronous configuration**—In this configuration, every base-station uses its own permutation, the frame lengths and starting times are not synchronized among the base-stations. Therefore, orthogonality is kept within the base-station but not between base-stations. In this scenario, the base-stations could be synchronized or not to the same reference clock. This mode will introduce interference between base-station (subcarriers from different subchannels collide in a controlled way, determined by the different permutations). This configuration could be easily used as an independent low-cost hot spot deployment (as an example).
- **Synchronous configuration**—In this configuration, all base-stations use the same reference clock (for example, by using GPS), the frame durations and starting times are also synchronized among the base-stations but still each base station uses different permutations. Therefore, the time/frequency orthogonality is kept between and within the base-stations operation but still interference between the same subchannels of different base-station occurs. Due to the time synchronization in this scenario and the long symbol duration of the OFDMA symbol, fast handoff as well as soft handoff is possible. This configuration could be used as an independent base-stations deployment with a controlled interference level (as an example).
- **Coordinated Synchronous configuration**—In this configuration, all base-stations work in the synchronous mode but use also the same permutations. An upper layer is responsible for the handling of subchannels allocations within the sectors of the base-station, making sure that better handling of the bandwidth is achieved and the system could handle and balance load between the sectors and within the system. This mode is identical in performance as the regular coverage scenarios, beside the fact that the bandwidth allocated to each sector is only a portion of the overall bandwidth, but when using the load balancing additional system gain is achieved. This configuration could be used as a full scale system deployment, with a common backbone (as an example).

The preferred scenario is the Coordinated Synchronous mode (when using this configuration with different permutations per base-station we get the synchronous mode, and do not use a synchronized clock between the base stations as well we end up with the asynchronous mode of operation); the configuration of the base-station sectors are presented in Figure B.6

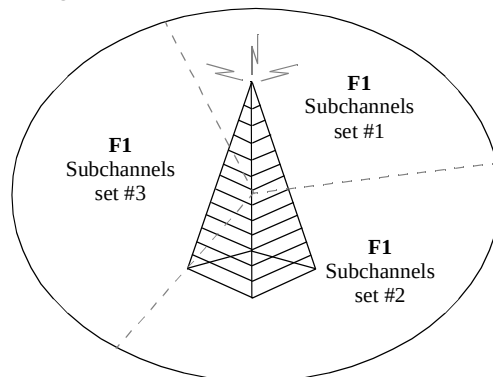


Figure B.6—Reuse of 1 configuration, 3 sectors per cell

B.5 FLI modulation codeword sequences for AAS Direct Signaling Method

The following list contains 8064*2 FLI modulation codeword sequences, first codeword representing in-phase and second codeword representing quadrature-phase.

FLI Codeword sequence =

0x5bbf,0x47cc,0x66b7,0x5e1f,0x2787,0x2256,0x1f04,0x2b03,0x5cfa,0x0443,0x0443,0x659a,0x20fe,0x2a91,0x7a89,0x6cd8,0x035c,0x1a8f,0x6300,0x5776,0x4f1c,0x712e,0x3e7f,0x36af,0x6922,0x23b5,0x658d,0x4781,0x4ee8,0x0955,0x594d,0x328a,0x19a2,0x034b,0x0454,0x7148,0x74d4,0x5d43,0x343b,0x677f,0x1239,0x2de8,0x1165,0x1ddd,0x2863,0x760d,0x1799,0x1086,0x6978,0x7386,0x5a2d,0x282e,0x7edd,0x1165,0x4f6d,0x35f3,0x180c,0x17c3,0x4247,0x7537,0x786c,0x40ef,0x52c1,0x5971,0x23ef,0x20e9,0x724e,0x7c62,0x4564,0x6423,0x35e4,0x1239,0x6e16,0x61d9,0x61e5,0x3bae,0x7f29,0x0734,0x4490,0x6bfb,0x2575,0x4ea5,0x2dd4,0x0ce2,0x5e34,0x2230,0x7ac4,0x35a9,0x01ae,0x5e6e,0x088a,0x5024,0x208f,0x3e25,0x14b4,0x27dd,0x4da3,0x5f8d,0x27ac,0x5ba8,0x0ba7,0x3fc6,0x77a3,0x7b41,0x715f,0x6b9d,0x3a00,0x438f,0x097e,0x5900,0x1159,0x2241,0x1856,0x2b72,0x4156,0x4604,0x2da5,0x3cb1,0x375b,0x1c29,0x5bf2,0x7174,0x071f,0x2121,0x7aa2,0x44bb,0x79d5,0x757a,0x337e,0x06fc,0x178e,0x4a97,0x301e,0x529b,0x5d0e,0x3bf4,0x3e32,0x1263,0x4ec3,0x724e,0x06eb,0x1f49,0x7c38,0x4b2e,0x1eaa,0x31a7,0x1df6,0x43a4,0x5d25,0x43c2,0x5593,0x52ea,0x1989,0x186a,0x4828,0x38e5,0x3693,0x0e4a,0x4abc,0x3701,0x395c,0x2790,0x08ec,0x7b27,0x6d61,0x55de,0x5467,0x77ee,0x0708,0x761a,0x7097,0x602d,0x3c8d,0x6a33,0x7b1b,0x7d81,0x1ddd,0x003c,0x166d,0x51fb,0x23f8,0x55b8,0x780a,0x08c7,0x757a,0x5a77,0x6a33,0x7080,0x543d,0x32ec,0x602d,0x1651,0x4c0d,0x2b3f,0x13cd,0x342c,0x36e2,0x40b5,0x1531,0x66a0,0x462f,0x069a,0x4675,0x20fe,0x632b,0x5042,0x0caf,0x5416,0x4f7a,0x0d67,0x712e,0x7ddb,0x5b94,0x47aa,0x6fde,0x0fbee,0x6e4c,0x29da,0x43b3,0x7c75,0x44ca,0x3cd7,0x3333,0x5707,0x7c5e,0x7a89,0x08ec,0x605c,0x715f,0x74d4,0x7080,0x4247,0x575d,0x2a86,0x19a2,0x47f0,0x65a6,0x44e1,0x669c,0x1afe,0x3d6e,0x79c2,0x38bf,0x4675,0x70ab,0x40a2,0x3bae,0x14c5,0x38a8,0x5feb,0x4247,0x0d01,0x3078,0x36c9,0x2acb,0x2c1c,0x0311,0x089d,0x4662,0x05a0,0x3e68,0x6d07,0x3324,0x0933,0x4991,0x2504,0x7ef6,0x2c0b,0x27e1,0x7386,0x4af1,0x5a3a,0x7b30,0x49dc,0x5be5,0x0e4a,0x7c13,0x2acb,0x002b,0x1dca,0x2af7,0x767c,0x6fc9,0x1637,0x2eb4,0x4b48,0x3b92,0x2562,

0x10e0,0x7c13,0x49ba,0x70da,0x0294,0x6a0f,0x61d9,0x6183,0x6e70,0x0caf,0x0e5d,0x6e67,0x1799,0x4df9,0x0942,0x13ab,0x32c7,0x7eac,0x5a3a,0x77b4,0x20a4,0x0cde,0x7e87,0x24cc,0x6944,0x4828,0x4d9f,0x2098,0x7148,0x220c,0x221b,0x1531,0x6d10,0x74ff,0x68a7,0x3a00,0x14f9,0x36f5,0x2b14,0x49ad,0x44bb,0x4b48,0x1540,0x180c,0x5885,0x4859,0x7499,0x113f,0x43d5,0x2136,0x1646,0x5682,0x51ec,0x0734,0x2787,0x5d32,0x47cc,0x3bb9,0x3d1f,0x0942,0x4564,0x3d79,0x6b9d,0x125f,0x5353,0x10cb,0x4250,0x52d6,0x076e,0x65fc,0x6317,0x5bf2,0x56d8,0x6ca9,0x6faf,0x2c6d,0x113f,0x239e,0x3369,0x40c4,0x1b21,0x4ae6,0x1d90,0x1c3e,0x24aa,0x77ee,0x2504,0x20c2,0x2c51,0x1f5e,0x74e8,0x0708,0x7163,0x6e67,0x766b,0x0942,0x1f75,0x0a78,0x5055,0x7821,0x3bae,0x6d3b,0x7de7,0x6366,0x0f82,0x4604,0x7265,0x0d5b,0x38d9,0x3bf4,0x74b2,0x227d,0x150d,0x58f4,0x7d96,0x4eb2,0x282e,0x7ac4,0x40d3,0x7f58,0x6cf3,0x7631,0x10e0,0x5fa6,0x6e2a,0x6e67,0x06d7,0x394b,0x7998,0x0e10,0x4ea5,0x1128,0x1ac2,0x2230,0x08c7,0x4221,0x5a4b,0x49ad,0x5bf2,0x1091,0x43fe,0x7112,0x6909,0x2f1a,0x6935,0x1d90,0x1e81,0x0294,0x5a3a,0x3977,0x2f26,0x35be,0x4487,0x1b7b,0x032d,0x5b94,0x47db,0x51a1,0x328a,0x1c15,0x73cb,0x24f0,0x79d5,0x2839,0x536f,0x0a22,0x51a1,0x70cd,0x724e,0x5584,0x7203,0x17b2,0x097e,0x330f,0x696f,0x1380,0x3318,0x40d3,0x2504,0x6a18,0x1a98,0x3894,0x1dac,0x635a,0x01f4,0x44bb,0x2658,0x7ac4,0x0bb0,0x5a5c,0x7eac,0x2241,0x2ea3,0x05c6,0x65fc,0x374c,0x6479,0x7657,0x08d0,0x4573,0x2790,0x4f51,0x5a60,0x13e6,0x05d1,0x2e88,0x55de,0x7537,0x4573,0x7af8,0x2839,0x74a5,0x0c93,0x1ebd,0x5e1f,0x6a69,0x38d9,0x7ebb,0x2997,0x20b3,0x634d,0x6743,0x5593,0x01b9,0x6a24,0x4c40,0x1ddd,0x31ea,0x7c49,0x31a7,0x4ed4,0x2496,0x5f8d,0x5d19,0x77c5,0x646e,0x23b5,0x3318,0x1f04,0x2575,0x62e3,0x1afe,0x1212,0x7551,0x6a55,0x0ba7,0x670e,0x05fa,0x2147,0x3342,0x3f8b,0x6fde,0x004d,0x06eb,0x3d45,0x641f,0x74e8,0x7df0,0x52fd,0x0cde,0x593c,0x5fb1,0x7259,0x0017,0x27ca,0x3369,0x097e,0x3e54,0x3fd1,0x7520,0x17ff,0x29f1,0x6d2c,0x1ef0,0x1ee7,0x55b8,0x3e68,0x1ebd,0x0d2a,0x0ff3,0x4613,0x6fc9,0x226a,0x4872,0x5ced,0x4803,0x79b3,0x5a4b,

0x2dff,0x633c,0x3b85,0x5bce,0x4089,0x77b4,0x688c,0x373d,0x0918,0x55c9,0x32b6,0x65eb,0x29da,0x0734,0x542a,0x06c0,0x5033,0x181b,0x5344,0x02e5,0x2602,0x2af7,0x454f,0x6faf,0x6292,0x0c84,0x5b83,0x3906,0x748e,0x3716,0x4f7a,0x7f02,0x47f0,0x0723,0x5761,0x6452,0x3035,0x6bd0,0x1128,0x29bc,0x0432,0x7e87,0x36e2,0x7f58,0x1c29,0x2c0b,0x6077,0x02bf,0x51d0,0x79fe,0x7520,0x187d,0x7edd,0x1c02,0x47bd,0x1526,0x6978,0x151a,0x24bd,0x20a4,0x31d6,0x43c2,0x2549,0x7499,0x5467,0x6371,0x677f,0x161c,0x3ca6,0x787b,0x7836,0x669c,0x7f64,0x17e8,0x51ec,0x19d3,0x51b6,0x688c,0x0752,0x7f4f,0x0183,0x0708,0x68b0,0x3911,0x3053,0x3911,0x226a,0x6ba1,0x2b65,0x52c1,0x5c9c,0x4814,0x3d6e,0x5bbf,0x484e,0x6fb8,0x4aab,0x1ad5,0x1c58,0x1274,0x31c1,0x2549,0x1f13,0x004d,0x465e,0x6ff5,0x3977,0x1827,0x519d,0x44e1,0x4b5f,0x3693,0x29ab,0x36de,0x3d45,0x1f04,0x14f9,0x544c,0x73e0,0x2256,0x2dd4,0x3e19,0x3693,0x3bae,0x0a22,0x507e,0x0a1e,0x4490,0x2b03,0x4638,0x2f40,0x6292,0x641f,0x55af,0x6445,0x55b8,0x3324,0x6c95,0x0071,0x6006,0x4649,0x0e10,0x1531,0x01e3,0x0969,0x06b1,0x2f0d,0x5707,0x4c0d,0x7c75,0x6725,0x7c62,0x4c6b,0x6d61,0x1c3e,0x2848,0x4b05,0x5e08,0x7b30,0x7c49,0x61ce,0x3d1f,0x122e,0x6bc7,0x58df,0x65eb,0x1eaa,0x3bc8,0x56e4,0x531e,0x77d2,0x06eb,0x0d5b,0x3e25,0x52ea,0x090f,0x688c,0x4127,0x6060,0x395c,0x7080,0x1b0a,0x528c,0x35d8,0x38a8,0x7c5e,0x74d4,0x033a,0x1c15,0x032d,0x0017,0x7c38,0x6e3d,0x7eca,0x6935,0x61f2,0x44ac,0x2f6b,0x52a7,0x575d,0x5695,0x410c,0x7e90,0x2848,0x66a0,0x156b,0x7c04,0x097e,0x6434,0x167a,0x1e81,0x6909,0x6fb8,0x748e,0x1205,0x2c7a,0x4986,0x5344,0x06c0,0x5309,0x7631,0x2ef9,0x0745,0x4acd,0x306f,0x595a,0x4f7a,0x74e8,0x2513,0x49cb,0x3e7f,0x6719,0x5d32,0x6f84,0x0f82,0x329d,0x1239,0x73ba,0x5f9a,0x6006,0x47bd,0x20d5,0x068d,0x3bf4,0x633c,0x1c64,0x4c40,0x51a1,0x1f75,0x14ee,0x1f62,0x4c6b,0x49f7,0x58e3,0x2ec5,0x5c8b,0x0cde,0x10e0,0x2db2,0x059c,0x2629,0x2874,0x2e9f,0x61ce,0x1ae9,0x3ca6,0x4af1,0x01c8,0x2150,0x410c,0x5470,0x6ba1,0x003c,0x0bd6,0x4b12,0x282e,0x24e7,0x0a35,0x23f8,0x536f,0x465e,0x4d88,0x507e,0x0ce2,0x2513,0x1114,0x52fd,0x4f6d,

0x6a42,0x1f2f,0x1ac2,0x6e67,0x7ee1,0x6732,0x2aba,0x0185,0x7b27,0x29cd,0x0b9b,0x4eff,0x23d3,0x43fe,0x285f,0x374c,0x35e4,0x61e5,0x1114,0x7df0,0x10cb,0x65d7,0x17ff,0x7626,0x0745,0x7203,0x17c3,0x4db4,0x3883,0x61a8,0x5885,0x7d81,0x0e2c,0x4c31,0x7b1b,0x4c1a,0x6a42,0x7ad3,0x3fed,0x1a8f,0x49cb,0x3a71,0x19b5,0x4f0b,0x4dee,0x7b1b,0x35f3,0x5bce,0x7b56,0x2f26,0x1989,0x7e90,0x217b,0x3407,0x603a,0x6ccf,0x4f37,0x02e5,0x543d,0x27bb,0x4986,0x02d9,0x6006,0x089d,0x125f,0x221b,0x3582,0x0bea,0x344a,0x420a,0x20e9,0x1f2f,0x2256,0x27ca,0x6944,0x0d67,0x4529,0x5d32,0x1c02,0x2b59,0x35be,0x1540,0x5018,0x23f8,0x2adc,0x58b9,0x6e4c,0x779f,0x1b6c,0x61bf,0x5069,0x73f7,0x750b,0x0e5d,0x0d67,0x780a,0x68c1,0x4814,0x220c,0x2b65,0x17d4,0x0bfd,0x7228,0x4db4,0x6bb6,0x3333,0x4130,0x5ced,0x31fd,0x2481,0x199e,0x3a3c,0x38d9,0x2812,0x7272,0x5710,0x62b9,0x1620,0x518a,0x0377,0x264f,0x3a71,0x4c57,0x2e9f,0x6c82,0x3324,0x7105,0x4e8e,0x01b9,0x51b6,0x29bc,0x1397,0x760d,0x5e79,0x20fe,0x4f20,0x3cd7,0x4872,0x6953,0x4d88,0x13f1,0x2389,0x0360,0x2790,0x1c64,0x3410,0x3bc8,0x2f7c,0x32c7,0x05fa,0x4558,0x4221,0x211d,0x1e81,0x4236,0x7105,0x7b1b,0x1ac2,0x4c31,0x08c7,0x51fb,0x5018,0x0e76,0x002b,0x6768,0x005a,0x3be3,0x3cd7,0x08a1,0x5055,0x2997,0x6d76,0x5917,0x19ef,0x5b83,0x604b,0x4c26,0x5378,0x0ff3,0x032d,0x20c2,0x3d52,0x7b41,0x74e8,0x2f1a,0x6cd8,0x0b9b,0x5d54,0x263e,0x3cc0,0x255e,0x7ef6,0x4e99,0x1540,0x5695,0x05b7,0x4f1c,0x1aa4,0x4398,0x392d,0x2aba,0x1edb,0x1d87,0x211d,0x7af8,0x575d,0x7c75,0x43d5,0x1f49,0x2664,0x3960,0x2496,0x3d45,0x32ec,0x2615,0x3977,0x1c15,0x7259,0x0283,0x35be,0x20b3,0x38ce,0x77f9,0x1856,0x658d,0x1557,0x2f31,0x3ceb,0x186a,0x7dbd,0x427b,0x779f,0x3410,0x2dd4,0x0a22,0x3d1f,0x417d,0x1c58,0x034b,0x343b,0x2c46,0x2db2,0x7f29,0x73dc,0x6285,0x114e,0x069a,0x5d19,0x3684,0x2e9f,0x05ed,0x4f51,0x4638,0x62df,0x79c2,0x5e45,0x779f,0x6e2a,0x4f46,0x691e,0x181b,0x4250,0x06a6,0x2f7c,0x55e2,0x2121,0x5fa6,0x160b,0x20e9,0x0bc1,0x6d76,0x6317,0x1159,0x4991,0x604b,0x0185,0x5e6e,0x4acd,0x0d3d,0x5c8b,0x1827,0x5e79,0x4236,0x58f4,0x0071,0x08d0,0x6a55,0x3035,

0x29bc,0x0924,0x52b0,0x2aba,0x5d0e,0x05c6,0x0f82,0x6d4a,0x605c,0x7aef,0x2b59,0x454f,0x01c8,0x2673,0x5378,0x6ce4,0x712e,0x0a35,0x149f,0x6fe2,0x56be,0x2b72,0x3476,0x076e,0x454f,0x7ac4,0x77ee,0x3461,0x52d6,0x49e0,0x3894,0x040e,0x7391,0x68c1,0x17e8,0x5e45,0x55f5,0x1ad5,0x24cc,0x604b,0x77d2,0x73ba,0x712e,0x56be,0x545b,0x65a6,0x36de,0x2389,0x6754,0x49ba,0x4796,0x7080,0x7836,0x3ceb,0x6d4a,0x1263,0x5322,0x70e6,0x125f,0x4dc5,0x40f8,0x7de7,0x7631,0x5d7f,0x1b0a,0x4b05,0x4b63,0x7f73,0x748e,0x2adc,0x2c20,0x7f73,0x40c4,0x36f5,0x61ce,0x6452,0x77ee,0x632b,0x6953,0x56f3,0x4502,0x66d1,0x1637,0x66c6,0x4986,0x6e70,0x6ff5,0x483f,0x5309,0x2ed2,0x2adc,0x17d4,0x0bfd,0x7998,0x1248,0x3c9a,0x01c8,0x4c1a,0x6d76,0x2980,0x08b6,0x14d2,0x2c6d,0x4abc,0x5cfa,0x62b9,0x61f2,0x411b,

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0x669c,0x1b50,0x416a,0x545b,0x329d,0x574a,0x7499,0x420a,0x227d,0x2b3f,0x2f40,0x2481,0x19c4,0x6a33,0x40c4,0x7214,0x3fc6,0x180c,0x7c2f,0x7272,0x6285,0x161c,0x4781,0x5cd1,0x0377,0x5069,0x0377,0x6e01,0x2db2,0x1a8f,0x6479,0x4529,0x29ab,0x47e7,0x5024,0x484e,0x29ab,0x2d8e,0x5322,0x2c0b,0x125f,0x31c1,0x4089,0x02bf,0x05a0,0x0fbe,0x0360,0x1dac,0x06a6,0x44dd,0x1b36,0x1e96,0x61f2,0x1ab3,0x574a,0x56d8,0x2e9f,0x2658,0x2dd4,0x032d,0x51ec,0x62f4,0x264f,0x1dac,0x2aad,0x6e01,0x4b74,0x02ce,0x5971,0x47cc,0x216c,0x7631,0x6a7e,0x5f8d,0x13bc,0x27ca,0x66fa,0x282e,0x24db,0x536f,0x6754,0x35d8,0x47e7,0x178e,0x6fc9,0x0779,0x79a4,0x35e4,0x4991,0x06d7,0x1531,0x77c5,0x73cb,0x6a0f,0x58ae,0x29cd,0x1c3e,0x1f04,0x0fbe,0x47e7,0x263e,0x465e,0x44f6,0x3684,0x3a3c,0x19c4,0x4c31,0x186a,0

x252f,0x4eff,0x31a7,0x416a,0x5f8d,0x79d5,0x6194,0x4f1c,0x0cb8,0x756d,0x7174,0x761a,0x6d07,0x2da5,0x05c6,0x51c7,0x5f8d,0x0d67,0x635a,0x4f37,0x51b6,0x1de1,0x73dc,0x6366,0x7c5e,0x79a4,0x0311,0x2f57,0x6e4c,0x1df6,0x38bf,0x0a44,0x14b4,0x5322,0x77d2,0x3fd1,0x4f37,0x2673,0x14c5,0x51b6,0x40a2,0x7edd,0x0443,0x150d,0x5be5,0x2150,0x2de8,0x4573,0x3977,0x58f4,0x40b5,0x4781,0x4814,0x19c4,0x4c31,0x7f3e,0x3a4d,0x1103,0x4130,0x65fc,0x375b,0x74e8,0x7998,0x6732,0x2839,0x3d1f,0x7174,0x2dd4,0x01df,0x77d2,0x7551,0x3684,0x13f1,0x66d1,0x32c7,0x5f9a,0x7eac,0x216c,0x4613,0x3d34,0x3a17,0x05b7,0x58e3,0x427b,0x05ed,0x0ce2,0x2790,0x77c5,0x394b,0x264f,0x47cc,0x2de8,0x426c,0x23ef,0x715f,0x4872,0x73ad,0x29e6,0x49cb,0x58b9,0x08fb,0x7ef6,0x1dca,0x58df,0x20c2,0x0a6f,0x595a,0x29e6,0x4ec3,0x5e34,0x1212,0x4c31,0x7139,0x20d5,0x4dc5,0x5d43,0x7e87,0x1ee7,0x5cfa,0x5fb1,0x411b,0x7e90,0x6a24,0x62c8,0x51fb,0x32fb,0x66fa,0x1ebd,0x2c1c,0x7203,0x641f,0x2227,0x0bea,0x58ae,0x08ec,0x0468,0x781d,0x5e45,0x6ff5,0x20a4,0x7163,0x51fb,0x4ec3,0x44ca,0x20c2,0x01df,0x5971,0x2dc3,0x36f5,0x13bc,0x1841,0x5018,0x31ea,0x180c,0x7850,0x3053,0x6f93,0x3b85,0x604b,0x52a7,0x689b,0x1de1,0x6cbe,0x7105,0x151a,0x66ed,0x2513,0x156b,0x6bd0,0x1de1,0x6445,0x08c7,0x6953,0x4c26,0x6d5d,0x47e7,0x531e,0x632b,0x61bf,0x2673,

0x5ffc,0x595a,0x767c,0x79e9,0x3b85,0x0a09,0x4675,0x3701,0x593c,0x6bbf,0x49ba,0x7139,0x0419,0x65b1,0x393a,0x01f4,0x0c93,0x4f6d,0x7de7,0x1dac,0x62df,0x2ed2,0x1114,0x47cc,0x68c1,0x0360,0x2997,0x77ee,0x65b1,0x0d4c,0x6754,0x180c,0x6ce4,0x1e81,0x6d5d,0x113f,0x6d61,0x29f1,0x19a2,0x52fd,0x6d10,0x73e0,0x77c5,0x0a53,0x73ad,0x6371,0x24e7,0x181b,0x1646,0x592b,0x7f15,0x4f6d,0x0924,0x150d,0x605c,0x0e76,0x004d,0x421d,0x7ab5,0x2ae0,0x1103,0x10ba,0x6d10,0x330f,0x181b,0x2d99,0x24f0,0x1172,0x0066,0x319b,0x7214,0x7d81,0x2805,0x2f57,0x29ab,0x426c,0x005a,0x798f,0x6d76,0x5042,0x68c1,0x1557,0x220c,0x56cf,0x603a,0x4c31,0x2dc3,0x0942,0x221b,0x6434,0x6317,0x0cf5,0x7391,0x05c6,0x7f15,0x3355,0x6ce4,0x410c,0x604b,0x6d3b,0x6c95,0x4b05,0x0377,0x4ee8,0x62b9,0x6c95,0x7203,0x6ff5,0x4b74,0x51ec,0x05fa,0x712e,0x2256,0x1d87,0x6978,0x6754,0x2673,0x19a2,0x603a,0x7391,0x4662,0x518a,0x0360,0x114e,0x593c,0x73ad,0x65c0,0x114e,0x1f38,0x0311,0x5feb,0x7d96,0x167a,0x6f84,0x35d8,0x090f,0x047f,0x166d,0x033a,0x0fe4,0x6a55,0x1dac,0x29f1,0x3009,0x23c4,0x715f,0x61f2,0x3e7f,0x4156,0x156b,0x66a0,0x0745,0x500f,0x3355,0x0432,0x4236,0x5584,0x7203,0x375b,0x2673,0x7b27,0x6434,0x20a4,0x3410,0x58df,0x38ce,0x1ef0,0x632b,0x3894,0x2098,0x7499,0x05fa,0x5fb1,0x5cb7,0x44ac,0x35be,0x2121,0x3fa0,0x24bd,0x0cc9,0x1557,0x090f,0x4b5f,0x7b1b,0x166d,0x646e,0x1841,0x14c5,0x1557,0x3044,0x5e34,0x7c62,0x1ae9,0x226a,0x52c1,0x6d2c,0x696f,0x484e,0x3d08,0x3883,0x5f8d,0x1ebd,0x239e,0x3b92,0x1ecc,0x0bea,0x069a,0x0c93,0x7c38,0x06fc,0x757a,0x156b,0x7aef,0x7ef6,0x43d5,0x395c,0x7a89,0x1526,0x4f0b,0x1edb,0x38ce,0x7aef,0x7520,0x27ac,0x634d,0x3cfc,0x44dd,0x3960,0x61e5,0x62b9,0x7f02,0x5710,0x4398,0x1646,0x4f51,0x4b2e,0x38bf,0x7c2f,0x5d54,0x4f1c,0x1637,0x3e25,0x29bc,0x36e2,0x5885,0x10e0,0x7105,0x7626,0x5a2d,0x7b6a,0x4ed4,0x6d3b,0x0ba7,0x344a,0x5900,0x5d54,0x519d,0x1d90,0x7ad3,0x52d6,0x44f6,0x5bd9,0x7546,0x0a78,0x1f49,0x5feb,0x6743,0x6300,0x4573,0x0432,0x500f,0x3407,0x7aa2,0x1380,0x17ff,0x13cd,0x1091,0x4796,0x1f5e,0x5e1f,0x715f,0x395c,0x3078,0x372a,0x0b8c,0x58e3,0x6a24,0x10f7,

0x696f,0x7b7d,0x02a8,0x1eaa,0x49cb,0x6bbf,0x1c58,0x6bb6,0x10ba,0x2b65,0x4247,0x4487,0x7e87,0x6d07,0x31a7,0x70ab,0x6fb8,0x1159,0x6452,0x40d3,0x375b,0x4250,0x19d3,0x05d1,0x17b2,0x70cd,0x7f73,0x7aef,0x427b,0x0a1e,0x2863,0x3e7f,0x035c,0x5cc6,0x4d88,0x6ca9,0x7139,0x51a1,0x74b2,0x4c7c,0x5584,0x2673,0x51c7,0x3a5a,0x2ed2,0x6c95,0x5892,0x0294,0x4859,0x7788,0x5761,0x374c,0x61f2,0x3582,0x069a,0x65a6,0x24db,0x14f9,0x0443,0x7640,0x462f,0x19f8,0x2af7,0x5c9c,0x13bc,0x43d5,0x6452,0x3bb9,0x594d,0x1557,0x2673,0x594d,0x1b0a,0x1212,0x2658,0x52a7,0x4f51,0x328a,0x005a,0x3078,0x3be3,0x31ea,0x7112,0x51d0,0x47cc,0x55af,0x68a7,0x090f,0x0fe4,0x5416,0x5018,0x4c1a,0x08a1,0x757a,0x5fa6,0x5a77,0x5e45,0x1e81,0x572c,0x462f,0x4b12,0x1b36,0x77d2,0x74c3,0x77b4,0x6bb6,0x122e,0x167a,0x210a,0x635a,0x08b6,0x5ca0,0x44f6,0x44ac,0x2af7,0x1103,0x6ba1,0x1248,0x068d,0x4e8e,0x5e08,0x160b,0x0017,0x040e,0x2f0d,0x23c4,0x1086,0x02ce,0x529b,0x2f26,0x760d,0x3701,0x6300,0x4604,0x5d54,0x19f8,0x7aef,0x32c7,0x761a,0x221b,0x66ed,0x786c,0x6183,0x5e79,0x6bd0,0x004d,0x0d2a,0x56cf,0x417d,0x593c,0x5710,0x5682,0x3009,0x2513,0x2f57,0x2dc3,0x319b,0x076e,0x29f1,0x2c51,0x4abc,0x5e79,0x3701,0x0745,0x761a,0x6732,0x2256,0x0a44,0x344a,0x319b,0x2da5,0x5018,0x5378,0x5309,0x6e70,0x13ab,0x29bc,0x58ae,0x01f4,0x318c,0x6743,0x766b,0x0d70,0x13cd,0x3d34,0x4247,0x2b65,0x0d70,0x2db2,0x536f,0x51b6,0x10ad,0x47bd,0x604b,0x10cb,0x1c02,0x088a,0x0779,0x5e23,0x0e07,0x2b4e,0x4f46,0x766b,0x756d,0x23c4,0x6194,0x0360,0x43a4,0x52fd,0x02e5,0x5e23,0x239e,0x161c,0x40c4,0x3770,0

x3476,0x330f,0x2b4e,0x1380,0x5900,0x5cd1,0x4f20,0x3595,0x2a86,0x58c8,0x058b,0x52fd,0x0d01,0x756d,0x1165,0x3a17,0x3716,0x2481,0x66a0,0x32c7,0x23c4,0x6d4a,0x757a,0x6f84,0x62e3,0x2b72,0x0360,0x23a2,0x2121,0x4c40,0x3fb7,0x1c02,0x3e32,0x47bd,0x658d,0x088a,0x0b9b,0x3e7f,0x7657,0x6bb6,0x51b6,0x70e6,0x6e70,0x7139,0x2136,0x0caf,0x4aab,0x7b0c,0x6285,0x3fd1,0x1b36,0x161c,0x5378,0x7ab5,0x178e,0x6935,0x0969,0x6b8a,0x1eaa,0x761a,0x462f,0x4991,0x6e01,0x32a1,0x5d43,0x1103,0x3595,0x4662,0x2d8e,0x44f6,0x7097,0x4db4,0x77c5

Annex C

(informative)

Example MAC common part sublayer service definition

C.1 MAC service definition

This annex describes the services between the MAC and the CSs. This is a logical interface. As such, the primitives described are informative. Their purpose is to describe the information that must necessarily be exchanged between the MAC and the CSs to enable each to perform its requirements as specified in the remainder of this document. This subclause does not impose message formats or state machines for the use of these primitives.

In a layered protocol system, the information flow across the boundaries between the layers can be defined in terms of primitives that represent different items of information and cause actions to take place. These primitives do not appear as such on the medium (the air interface) but serve to define more clearly the relations of the different layers. The semantics are expressed in the parameters that are conveyed with the primitives.

C.1.1 MAC service definition for PMP

C.1.1.1 Primitives

The IEEE 802.16 MAC supports the following primitives at the MAC SAP, to support services between the MAC and the CSs in PMP mode.

MAC_CREATE_SERVICE_FLOW.request
MAC_CREATE_SERVICE_FLOW.indication
MAC_CREATE_SERVICE_FLOW.response
MAC_CREATE_SERVICE_FLOW.confirmation

MAC_CHANGE_SERVICE_FLOW.request
MAC_CHANGE_SERVICE_FLOW.indication
MAC_CHANGE_SERVICE_FLOW.response
MAC_CHANGE_SERVICE_FLOW.confirmation

MAC_TERMINATE_SERVICE_FLOW.request
MAC_TERMINATE_SERVICE_FLOW.indication
MAC_TERMINATE_SERVICE_FLOW.response
MAC_TERMINATE_SERVICE_FLOW.confirmation

MAC_DATA.request
MAC_DATA.indication

The use of these primitives to provide peer communication is shown in Figure C.1. The initial request for service from a higher layer is provided by the “request” primitive. When this request is sent across the air link to the peer MAC, it generates an “indicate” primitive to inform the peer CS of the request; the convergence entity responds with a “response” to the MAC. Again this is sent across the air link to the MAC on the originating side, which sends a “confirm” primitive to the original requesting entity.

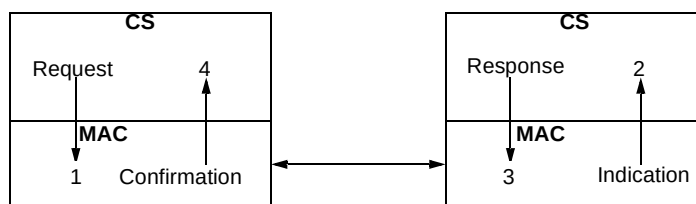


Figure C.1—Use of primitives to request service of MAC and generate response

In some cases, it is not necessary to send information to the peer station and the “confirm” primitive is issued directly by the MAC on the originating side. Such cases may occur, for example, when the request is rejected by the MAC on the requesting side. In cases where it is necessary to keep the other side of the link informed, an unsolicited “response” may be sent, in turn leading to the generation of an unsolicited “confirmation” for benefit of the CS.

For actions other than DATA.request and DATA.indication, the initiating CS sends a REQUEST primitive to its MAC. The initiating side MAC sends the appropriate Dynamic Service Addition, Change, or Deletion (DSx) Request message (see 6.3.14.7.1 and 6.3.14.8) to the receiving MAC. The noninitiating side MAC sends an INDICATION primitive to its CS. The noninitiating CS responds with a RESPONSE primitive, stimulating its MAC to respond to the initiating side MAC with the appropriate DSx Response message. The initiating side MAC responds to its CS with a CONFIRMATION primitive and, if appropriate, with the appropriate DSx Acknowledge message. At any point along the way, the request may be rejected (for lack of resources, etc.), terminating the protocol.

C.1.1.1.1 MAC_CREATE_SERVICE_FLOW.request

C.1.1.1.1.1 Function

This primitive is issued by a CS entity in a BS or SS unit to request the dynamic addition of a connection.

C.1.1.1.1.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_CREATE_SERVICE_FLOW.request
(
    MAC Address
    scheduling service type,
    convergence sublayer,
    service flow parameters,
    payload header suppression indicator,
    encryption indicator,
    Packing on/off indicator,
    Fixed-length or variable-length SDU indicator,
    SDU length (only needed for fixed-length SDU connections),
    CRC request,
    ARQ parameters,
    sequence number
)
```

For connection requests initiated from a BS, the 48-bit MAC Address value identifies the SS with which the connection is to be established. The parameter has no significance for connection requests initiated from an SS.

The scheduling service type (see 6.3.5) is one of the following: Unsolicited grant service (UGS), real-time polling service (rtPS), non-real-time polling service (nrtPS), and Best Effort (BE) service.

The convergence sublayer parameter indicates which CS handles data received on this connection. If the value is zero, then no CS is used; other values for specific CSs are given in 11.13.19.

The service flow parameters include details on such issues as peak and average rate, or reference to a service class. These parameters are the same as those in the DSC Request MAC Management message.

The payload header suppression indicator specifies whether the SDUs on the service flow are to have their headers suppressed.

The encryption indicator specifies that the data sent over this connection is to be encrypted, if ON. If OFF, then no encryption is used.

The packing on/off indicator specifies whether packing may be applied to the MAC SDUs on this connection. A value of ON means that packing is allowed for the connection.

The fixed-length or variable-length SDU indicator specifies whether the SDUs on the service flow are fixed-length or variable-length.

The SDU length specifies the length of the SDU for a fixed-length SDU service flow. The parameter has no significance for a variable length SDU service flow.

Cyclic redundancy check (CRC) request, if ON, requests that the MAC SDUs delivered over this connection are transported in MAC PDUs with a CRC added to them.

The ARQ parameters are: whether or not ARQ is used for the connection, maximum retransmission limit, and acknowledgment window size.

The sequence number is used to correlate this primitive with its response from the BS via the MAC.

C.1.1.1.1.3 When generated

This primitive is generated by a CS of a BS or SS unit to request the BS to set up a new connection.

C.1.1.1.1.4 Effect of receipt

If the primitive is generated on the SS side, the receipt of this primitive causes the MAC to pass the request (in the form of a DSA-REQ message) to the MAC entity in the BS. The SS MAC remembers the correlation between sequence number and the requesting convergence entity.

If the primitive is generated on the BS side, the BS checks the validity of the request and, if valid, chooses a CID and includes it in the DSA-REQ message (6.3.14.9.3) sent to the SS. This CID shall be returned to the requesting CS via the CONFIRM primitive. If the primitive originated at the SS, the actions of generating a CID and authenticating the request are deferred to the INDICATION/RESPONSE portion of the protocol.

C.1.1.1.2 MAC_CREATE_SERVICE FLOW.indication**C.1.1.1.2.1 Function**

This primitive is sent by the noninitiating MAC entity to the CS, to request the dynamic addition of a connection in response to the MAC receiving a DSA-REQ message. If the noninitiating MAC entity is at the BS, an SFID and possibly CID are generated and the request is authenticated.

C.1.1.1.2.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_CREATE_SERVICE FLOW.indication
(
  service type,
  convergence sublayer,
  service flow parameters,
  sequence number
)
```

Parameters: see MAC_CREATE_SERVICE FLOW.request. The encryption and CRC flags are not delivered with the indication primitive since they will have already been acted on by lower layers, to decrypt the data or to check a CRC, before the MAC SDU is passed up to the CS.

C.1.1.1.2.3 When generated

This primitive is generated by the MAC of the noninitiating side of the protocol when it receives a DSA-REQ message from the initiating side of the connection.

C.1.1.1.2.4 Effect of receipt

When the CS receives this primitive, it checks the validity of the request from the point of view of its own resources. It accepts or rejects the request via the MAC_CREATE_SERVICE FLOW.response primitive.

If the connection request was originated on the SS side, the BS sends the CID to the SS side in this RESPONSE primitive. Otherwise, if the origin was the BS, the RESPONSE contains the CID contained in the DSA header bearing the indication.

C.1.1.1.3 MAC_CREATE_SERVICE FLOW.response**C.1.1.1.3.1 Function**

This primitive is issued by a noninitiating MAC entity in response to a MAC_CREATE_SERVICE FLOW.indication requesting the creation of a new connection.

C.1.1.1.3.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_CREATE_SERVICE FLOW.response
(
    Connection ID,
    response code,
    response message,
    sequence number,
    ARQ parameters
)
```

The Connection ID is returned to the requester for use with the traffic specified in the request. If the request is rejected, then this value shall be ignored.

The response code indicates success or the reason for rejecting the request.

The response message provides additional information to the requester, in type/length/value (TLV) format.

The sequence number is returned to the requesting entity to correlate this response with the original request.

The ARQ parameters are: whether or not ARQ is used for the connection, maximum retransmission limit and acknowledgment window size.

C.1.1.1.3.3 When generated

This primitive is generated by the noninitiating CS entity when it has received a MAC_CREATE_SERVICE FLOW.indication.

C.1.1.1.3.4 Effect of receipt

The receipt of this primitive causes the MAC to send the DSA Response (DSA-RSP) message to the requesting MAC entity. Once the DSA Acknowledgment (DSA-ACK) is received, the MAC is prepared to pass data for this connection on to the air link.

C.1.1.1.4 MAC_CREATE_SERVICE FLOW.confirmation**C.1.1.1.4.1 Function**

This primitive confirms to a convergence entity that a requested connection has been provided. It informs the CS of the status of its request and provides a CID for the success case.

C.1.1.1.4.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_CREATE_SERVICE FLOW.confirmation
(
    Connection ID,
    response code,
    response message,
    sequence number
)
```

Parameters: see MAC_CREATE_SERVICE_FLOW.response.

C.1.1.1.4.3 When generated

This primitive is generated by the initiating side MAC entity when it has received a DSA-RSP message.

C.1.1.1.4.4 Effect of receipt

The receipt of this primitive informs the convergence entity that the requested connection is available for transmission requests.

C.1.1.1.5 Changing an existing connection

Existing connections may be changed in their characteristics on a dynamic basis to, for example, reflect changing bandwidth requirements. The following primitives are used:

```
MAC_CHANGE_SERVICE_FLOW.request
MAC_CHANGE_SERVICE_FLOW.indication
MAC_CHANGE_SERVICE_FLOW.response
MAC_CHANGE_SERVICE_FLOW.confirmation
```

The semantics and effect of receipt of these primitives are the same as for the corresponding CREATE primitives. A new CID shall be generated in the case of changing a service flow type from provisioned to admitted or active.

C.1.1.1.6 MAC_TERMINATE_SERVICE_FLOW.request

C.1.1.1.6.1 Function

This primitive is issued by a CS entity in a BS or SS unit to request the termination of a connection.

C.1.1.1.6.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_TERMINATE_SERVICE_FLOW.request
(
    SFID
)
```

The SFID parameter specifies which service flow is to be terminated.

C.1.1.1.6.3 When generated

This primitive is generated by a CS of a BS or SS unit to request the termination of an existing connection.

C.1.1.1.6.4 Effect of receipt

If the primitive is generated on the SS side, the receipt of this primitive causes the MAC to pass the request to the MAC entity in the BS via the DSD Request (DSD-REQ) message. The BS checks the validity of the request, and if it is valid it terminates the connection.

If the primitive is generated on the BS side, it has already been validated and the BS MAC informs the SS by issuing a DSD-REQ message.

C.1.1.1.7 MAC_TERMINATE_SERVICE FLOW.indication**C.1.1.1.7.1 Function**

This primitive is issued by a the MAC entity on the noninitiating side to request the termination of a connection in response to the receipt of a DSD-REQ message.

C.1.1.1.7.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_TERMINATE_SERVICE FLOW.indication
(
    SFID
)
```

The SFID parameter specifies which service flow is to be terminated.

C.1.1.1.7.3 When generated

This primitive is generated by the MAC when it receives a DSD-REQ message to terminate a connection, or when it finds it necessary for any reason to terminate a connection.

C.1.1.1.7.4 Effect of receipt

If the protocol was initiated by the SS, when it receives this primitive, the BS checks the validity of the request. In any case, the receiving CS returns the MAC_TERMINATE_SERVICE FLOW.response primitive and deletes the SFID from the appropriate polling and scheduling lists.

C.1.1.1.8 MAC_TERMINATE_SERVICE FLOW.response**C.1.1.1.8.1 Function**

This primitive is issued by a CS entity in response to a request for the termination of a connection.

C.1.1.1.8.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_TERMINATE_SERVICE FLOW.response
(
    SFID,
    response code,
    response message
)
```

The SFID is returned to the requesting entity.

The response code indicates success or the reason for rejecting the request.

The response message provides additional information to the requester, in TLV format.

C.1.1.1.8.3 When generated

This primitive is generated by the CS entity when it has received a MAC_TERMINATE_SERVICE_FLOW.indication from its MAC.

C.1.1.1.8.4 Effect of receipt

The receipt of this primitive causes the MAC to pass the message to the initiating side via the DSD Response (DSD-RSP) message. The initiating MAC in turn passes the CONFIRM primitive to the requesting convergence entity. The convergence entity shall no longer use this CID for data transmission.

C.1.1.1.9 MAC_TERMINATE_SERVICE_FLOW.confirmation**C.1.1.1.9.1 Function**

This primitive confirms to a convergence entity that a requested connection has been terminated.

C.1.1.1.9.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_TERMINATE_SERVICE_FLOW.confirmation
(
    SFID,
    response code,
    response message
)
```

Parameters: see MAC_TERMINATE_SERVICE_FLOW.response.

C.1.1.1.9.3 When generated

This primitive is generated by the MAC entity when it has received a DSD-RSP message.

C.1.1.1.9.4 Effect of receipt

The receipt of this primitive informs the convergence entity that a connection has been terminated. The convergence entity shall no longer use this CID for data transmission.

C.1.1.1.10 MAC_DATA.request**C.1.1.1.10.1 Function**

This primitive defines the transfer of data to the MAC entity from a CS SAP.

C.1.1.1.11 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_DATA.request
(
    Connection ID,
    length,
    data,
    discard-eligible flag
)
```

The Connection ID parameter specifies the connection over which the data is to be sent; the service class is implicit in the Connection ID.

The length parameter specifies the length of the MAC SDU in bytes.

The data parameter specifies the MAC SDU as received by the local MAC entity.

The discard-eligible flag specifies whether the MAC SDU is to be preferentially discarded by the scheduler in the event of link congestion and consequent buffer overflow.

The encryption flag specifies that the data sent over this connection is to be encrypted, if ON. If OFF, then no encryption is used.

C.1.1.1.11.1 When generated

This primitive is generated by a CS whenever a MAC SDU is to be transferred to a peer entity or entities.

C.1.1.1.11.2 Effect of receipt

The receipt of this primitive causes the MAC entity to process the MAC SDU through the MAC and to pass the appropriately formatted PDUs to the PHY Transmission Convergence sublayer for transfer to peer MAC entities, using the CID specified.

C.1.1.1.12 MAC_DATA.indication

C.1.1.1.12.1 Function

This primitive defines the transfer of data from the MAC to the CS. The specific CS to receive the indicate message is implicit in the CID.

C.1.1.1.12.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_DATA.indication
(
    Connection ID,
    length,
    data,
    reception status,
)
```

The Connection ID parameter specifies the connection over which the data was sent.

The length parameter specifies the length of the data unit in bytes.

The data parameter specifies the MAC SDU as received by the local MAC entity.

The reception status parameter indicates transmission success or failure for those PDUs received via the MAC_DATA.indication.

C.1.1.1.12.3 When generated

This primitive is generated whenever a MAC SDU is to be transferred to a peer convergence entity or entities.

C.1.1.1.12.4 Effect of receipt

The effect of receipt of this primitive by a convergence entity is dependent on the validity and content of the MAC SDU. The choice of CS is determined by the CID over which the MAC SDU was sent.

C.1.1.2 MAC service stimulation of DSx messages

This subclause describes the logical interaction between the MAC Service primitives and the DSx messages.

The sequence of logical MAC SAP events and the associated actual MAC events effecting a CS-stimulated connection creation are shown in Figure C.2.

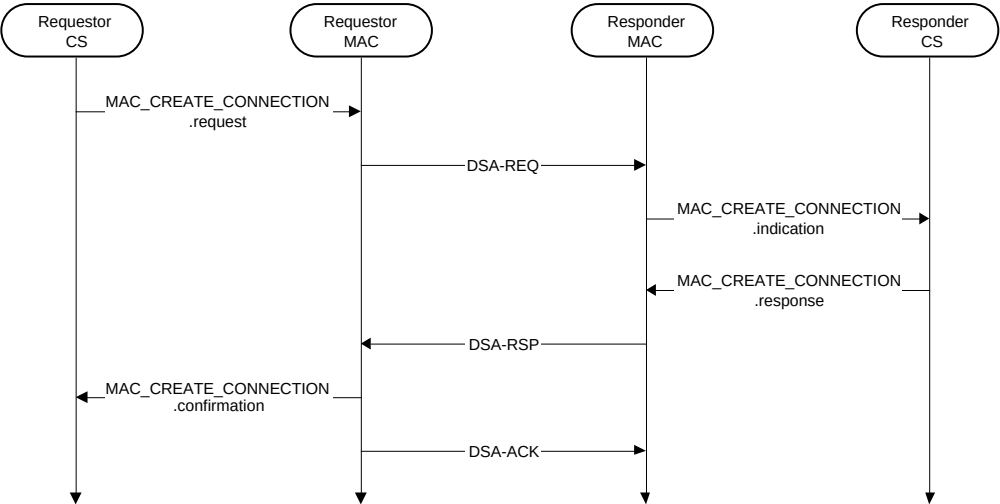


Figure C.2—MAC SAP event and MAC event sequence for connection creation stimulated by CS

The sequence of logical MAC SAP events and the associated actual MAC events effecting a CS stimulated connection change are shown in Figure C.3.

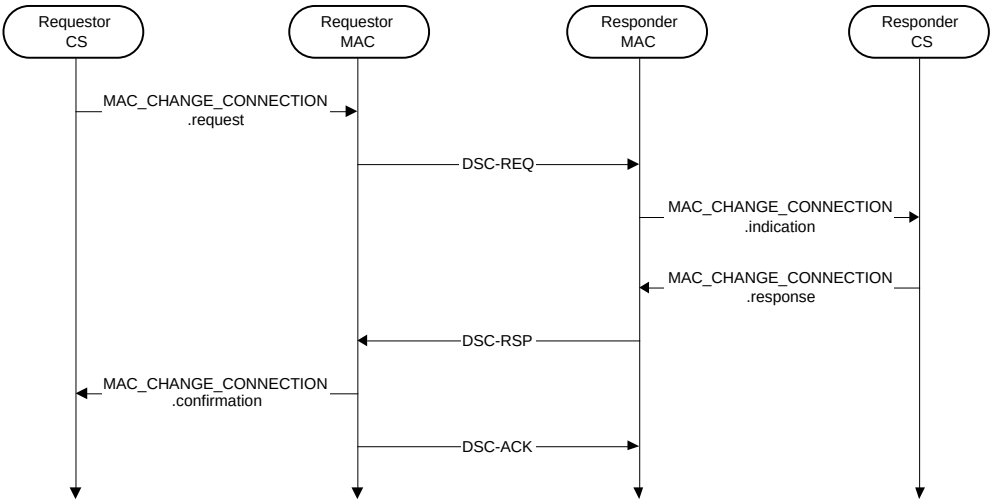


Figure C.3—MAC SAP event and MAC event sequence for connection change stimulated by CS

The sequence of logical MAC SAP events and the associated actual MAC events effecting a CS stimulated connection deletion are shown in Figure C.4.

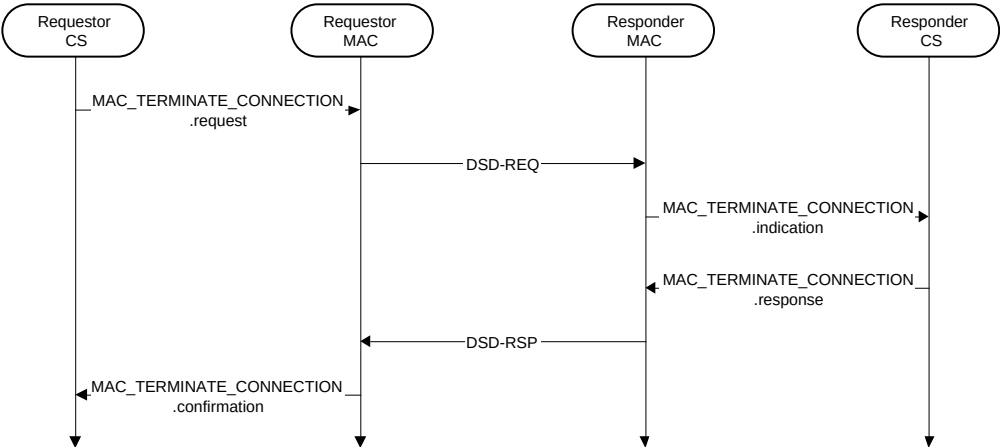


Figure C.4—MAC SAP event and MAC event sequence for connection deletion stimulated by CS

C.1.2 MAC service definition for Mesh

C.1.2.1 Primitives

The IEEE 802.16 MAC supports the following primitives at the MAC SAP in Mesh mode:

```
MAC_CREATE_SERVICE_FLOW.indication

MAC_CHANGE_SERVICE_FLOW.indication

MAC_TERMINATE_SERVICE_FLOW.request
MAC_TERMINATE_SERVICE_FLOW.indication

MAC_DATA.request
MAC_DATA.indication

MAC_FORWARDING_UPDATE.request
MAC_FORWARDING_UPDATE.indication
```

In Mesh mode none of the actions cause the initiating CS to send a REQUEST primitive to its MAC. They are either indications of the results from the processes handled by the MAC CPS management entity, or data delivery actions needed to convey information to the peer CS.

C.1.2.1.1 MAC_CREATE_SERVICE_FLOW.indication

C.1.2.1.1.1 Function

This primitive is issued by a MAC entity to the CS, to report a new link established to a neighbor node.

C.1.2.1.1.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_CREATE_SERVICE_FLOW.indication
{
  CID
  max length,
  service flow parameters,
  encryption flag
}
```

The CID is the Connection ID in Mesh as conveyed in the generic MAC header.

The max length parameter specifies the maximum length of SDUs that are allowed over the link.

The service flow parameters include information on

- Data rate (Mb/s)
Data rate associated with the profile for the physical link over which the connection is created.
- Transmit power (dBm)
Transmit power at the antenna port for the physical link over which the connection is created.
- Estimate of packet error rate for 256-byte packets
Estimate of PER for the physical link over which the connection is created.

The encryption flag specifies that the data carried over this link is encrypted, if ON, If OFF, then no encryption is used.

C.1.2.1.1.3 When generated

This primitive is generated whenever a new link has been established to a neighbor node.

C.1.2.1.1.4 Effect of receipt

The receipt of the primitive is an indication to the CS that a link to the given neighbor node is up and can be used for data delivery.

C.1.2.1.2 MAC_CHANGE_SERVICE_FLOW.indication

C.1.2.1.2.1 Function

This primitive is issued by a MAC entity to the CS, to report new parameters of an existing link to a neighbor node.

C.1.2.1.2.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_CHANGE_SERVICE_FLOW.indication
{
  CID,
  max length,
  service parameters,
  encryption flag
}
```

The CID is the Connection ID in Mesh as conveyed in the generic MAC header.

The max length parameter specifies the maximum length of SDUs that are allowed over the link.

The service parameters include information on

- Target data rate for the link in Mb/s
- Transmit energy for the link
- Estimate of packet error rate for 256 byte packets

The encryption flag specifies that over this link encryption is possible, if ON, If OFF, then no encryption is possible.

C.1.2.1.2.3 When generated

This primitive is generated whenever parameters of an existing link has changed.

C.1.2.1.2.4 Effect of receipt

The CS shall take into account new link parameters in the use of the link.

C.1.2.1.3 MAC_TERMINATE_SERVICE FLOW.request**C.1.2.1.3.1 Function**

This primitive is issued by a CS, to terminate an existing link to a neighbor node.

C.1.2.1.3.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_TERMINATE_SERVICE FLOW.request
{
  CID
}
```

The CID is the Connection ID in Mesh as conveyed in the generic MAC header.

C.1.2.1.3.3 When generated

This primitive is generated to bring down an existing link to a neighbor node.

C.1.2.1.3.4 Effect of receipt

The receipt of the primitive causes the MAC to terminate the connection and report that to the MAC entity in the neighbor the link was to.

C.1.2.1.4 MAC_TERMINATE_SERVICE FLOW.indication**C.1.2.1.4.1 Function**

This primitive is issued by the MAC entity of the noninitiating side to indicate termination of the link to a neighbor node.

C.1.2.1.4.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_TERMINATE_SERVICE FLOW.indication
{
  CID,
}
```

The CID is the Connection ID in Mesh as conveyed in the generic MAC header.

C.1.2.1.4.3 When generated

This primitive is generated by the MAC when it receives an indication in a Mesh Network Configuration (MSH-NCFG) message.

C.1.2.1.4.4 Effect of receipt

The receipt of the primitive is an indication to the CS that the link to the given neighbor node is down and cannot be used for data delivery.

C.1.2.1.5 MAC_DATA.request**C.1.2.1.5.1 Function**

This primitive defines the transfer of data to the MAC entity from a CS SAP.

C.1.2.1.5.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_DATA.request
{
    CID,
    length,
    data,
    encryption flag
}
```

The CID is the Connection ID in Mesh as conveyed in the generic MAC header.

The length parameter specifies the length of the MAC SDU in bytes.

The data parameter specifies the MAC SDU as received by the local MAC entity.

The priority/class parameter embedded in the CID specifies priority class of the MAC SDU.

The reliability parameter embedded in the CID specifies maximum number of transmission attempts at each link.

The drop precedence parameter embedded indicates relative MSDU dropping likelihood.

The encryption flag specifies that the data sent over this link is to be encrypted, if ON. If OFF, then no encryption is used.

C.1.2.1.5.3 When generated

This primitive is generated by a CS whenever an MAC SDU is to be transferred to a peer entity.

C.1.2.1.5.4 Effect of receipt

The receipt of the primitive causes the MAC entity to process the MAC SDU through the MAC and pass the appropriately formatted PDUs to the PHY for transfer to the peer MAC entity, using the Node ID specified.

C.1.2.1.6 MAC_DATA.indication**C.1.2.1.6.1 Function**

This primitive defines the transfer of data from the MAC to the CS.

C.1.2.1.6.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_DATA.request
{
  CID
  length,
  data,
  reception status,
  encryption flag
}
```

The CID is the Connection ID in Mesh as conveyed in the generic MAC header.

The length parameter specifies the length of the MAC SDU in bytes.

The data parameter specifies the MAC SDU as received by the local MAC entity.

The reception status parameter indicates transmission success or failure for those PDUs received via the MAC_DATA.indication.

C.1.2.1.6.3 When generated

This primitive is generated whenever an MAC SDU is to be transferred to a peer convergence entity.

C.1.2.1.6.4 Effect of receipt

The effect of receipt of this primitive by a convergence entity is dependent on the validity and content of the MAC SDU.

C.1.2.1.7 MAC_FORWARDING_UPDATE.request**C.1.2.1.7.1 Function**

This primitive defines the transfer of the centralized scheduling configuration to the MAC entity from a CS SAP in the Mesh BS.

C.1.2.1.7.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_FORWARDING_UPDATE.request
{
  number of nodes,
  node parameters[number of nodes]
}
```

The number of nodes parameter indicates number of nodes in the scheduling tree of this Mesh BS.

The node parameters entry shall contain the following information:

- Node ID: The Node ID parameter indicates the node.
- Number of children: The number of nodes parameter indicates number of children the given node.
- Child parameters[number of children]

Each child parameters entry shall contain the following information:

- Child index: The child index indicates index into the list of Node IDs
- Uplink burst profile: The uplink burst profile indicates burst profile of link to child node
- Downlink burst profile: The downlink burst profile indicates burst profile of link from child node

C.1.2.1.7.3 When generated

This primitive is generated in the Mesh BS whenever it has changed the schedule tree.

C.1.2.1.7.4 Effect of receipt

The receipt of this primitive causes the MAC to generate a MSH-CSCF message with the given information. The message shall be distributed to all the nodes listed in the tree.

C.1.2.1.8 MAC_FORWARDING_UPDATE.indication

C.1.2.1.8.1 Function

This primitive defines the transfer of the centralized scheduling configuration from the MAC to the CS.

C.1.2.1.8.2 Semantics of the service primitive

The parameters of the primitive are as follows:

```
MAC_FORWARDING_UPDATE.indication
{
  Node ID self
  number of nodes,
  node parameters[number of nodes]
}
```

The Node ID self indicates the Node ID of the node itself.

The number of nodes parameter indicates number of nodes in the scheduling tree of this Mesh BS.

The node parameters entry shall contain the following information:

- Node ID: The Node ID parameter indicates the node.
- Number of children: The number of nodes parameter indicates number of children the given node.
- Child parameters[number of children]

Each child parameters entry shall contain the following information:

- Child index: The child index indicates index into the list of Node IDs
- Uplink burst profile: The uplink burst profile indicates burst profile of link to child node
- Downlink burst profile: The downlink burst profile indicates burst profile of link from child node

C.1.2.1.8.3 When generated

This primitive is generated by the MAC at all the nodes, which have received the MSH-CSCF message, when new centralized schedule with revised schedule tree takes effect.

C.1.2.1.8.4 Effect of receipt

The receipt of this primitive synchronizes the forwarder and MAC scheduler to routing changes.