Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
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Re:	
Abstract	
Purpose	To be used in further work.
Notice	
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802.16-2004 Support

Paragraph	Text	Comments

6.3.2 MAC PDU Format	**6.3.2.3.33 Channel measurement Report Request/Response (REP-REQ/RSP)**
	If the BS, operating in bands below 11 GHz or DM configured BS operating at any frequency, requires RSSI and CINR channel measurement reports it shall send the channel measurements Report Request message. In license-exempt bands, it shall additionally be used to request the results of the DFS measurements the BS has previously scheduled.
	Table 62—Channel measurements Report Request (REP-REQ) message format
	Syntax Size Notes
	Report_Request_Message_Format() {
	Management Message Type = 36 8 bits
	Report Request TLVs *variable*
	}
	The REP-REQ message shall contain the following TLV encoded parameters:
	Report Request
	The channel measurement Report Response message shall be used by the SS to respond to the channel measurements listed in the received Report Requests. In license-exempt bands, the SS shall also send a REPRSP in an unsolicited fashion upon detecting a Primary User on the channel it is operating in. The SS may also send a REP-RSP containing channel measurement reports, in an unsolicited fashion, or when non-primary user interference is detected above a threshold value.
	Table 63—Channel measurement Report Response (REP-RSP) message format
	Syntax Size Notes
	Report_Response_Message_Format {
	Management Message Type = 37 8 bits
	Report Response TLVs *variable*
	}
	The REP-RSP shall contain the following TLV encoded parameters:
	Report
	Compound TLV that shall contain the measurement Report in accordance with the Report Request (see 11.11).	

	6.3.2.3.34 Fast Power Control (FPC) message Power control shall be effected by the use of periodic ranging. In addition, the BS may adjust the power levels of multiple subscribers simultaneously with the Fast Power Control (FPC) message. SSs shall apply indicated change within the "SS downlink management message processing time". FPC shall be sent on broadcast CID. This message shall only apply to SCa, OFDM, and OFDMA PHY specifications.	

	Table 64—Fast power control message format
	Syntax **Size** **Notes**
	Fast_Power_Control message format () {
	Management message type = 38 8 bits
	Number of stations 8 bits
	for (i=0;i<Number of stations;i++) {
	Basic CID 16 bits
	Power adjust 8 bits
	}
	}
	Number of stations
	Number of CID and Power Adjust tuples contained in this message
	Basic CID
	Basic connection identifier associated with the SS.
	Power Adjust
	Signed integer, which expresses the change in power level (in multiples of 0.25 dB) that the SS shall apply to its current transmission power.	

6.3.10 Ranging	**6.3.10.2 Uplink periodic ranging** Uplink ranging consists of two procedures: initial ranging and periodic ranging. Initial ranging (see 6.3.9.5) allows an SS joining the network to acquire correct transmission parameters, such as time offset and Tx power level, so that the SS can communicate with the BS. Following initial ranging, periodic ranging allows the SS to adjust transmission parameters so that the SS can maintain uplink communications with the BS. The following summarizes the general algorithm for periodic ranging available to all PHY layers. Diagrams of the SS and BS processes are provided in Figures 82, 83, and 84. CDMA-based ranging for OFDMA systems is described in 6.3.10.3. 1) For each SS, the BS shall maintain a T27 timer. At each expiration of the timer, the BS shall grant bandwidth to the SS for an uplink transmission. The timer is restarted each time a unicast grant is made to the SS. As a result, as long as the SS remains active, the BS does not specifically grant bandwidth to the SS for a ranging opportunity. 2) Each SS shall maintain a T4 timer. The expiration of this timer indicates to the SS that it has not been given the opportunity to transmit to the BS for an extended period of time. Operating on the assumption that its uplink transmission parameters are no longer usable, the SS initiates a restart of its MAC operations 3) For each unicast uplink burst grant, the BS determines whether or not a transmitted signal is present. If no signal is detected in a specified number of successive grants, the BS shall terminate link management for the associated SS. 4) For each unicast uplink burst grant in which a signal is detected, the BS makes a determination	

	as to the quality of the signal. If the signal is within acceptable limits and the data carried in the burst includes the RNG-REQ message, the RNG-RSP message shall be issued with a status of *success*. If the signal is not within acceptable limits, the RNG-RSP message shall be issued which includes the appropriate correction data and a status of *continue*. If a sufficient number of correction messages are issued without the SS signal quality becoming acceptable, the BS shall send the RNG-RSP message with a status of *abort*, and terminate link management of the SS. 5) The SS shall process each RNG-RSP message it receives. Implementing any PHY corrections that are specified (when the status is *continue)* or initiating a restart of MAC activities when the status is (*abort*). 6) The SS shall respond to each uplink bandwidth grant addressed to it. When the status of the last RNG-RSP message received is *continue*, the RNG-REQ message shall be included in the transmitted burst. When the status of the last RNG-RSP message received is *success*, the SS shall use the grant to service its pending uplink data queues. If no data is pending, the SS shall respond to the grant by transmitting a block of padded data.	
6.3.15 DFS for license-exempt operation	**6.3.15.1 Introduction** DFS is mandatory for license-exempt operation. Systems should detect and avoid primary users. Further, the use of channel selection algorithms is required, which result in uniform channel spreading across a minimum number of channels. This specification is intended to be compliant with the regulatory requirements set forth in [B10]. The timing parameters used for DFS are specified by each regulatory administration. The DFS procedures provide for: — Testing channels for primary users (6.3.15.2). — Discontinuing operations after detecting primary users (6.3.15.3). — Detecting primary users (6.3.15.4). — Scheduling for channel testing (6.3.15.5). — Requesting and reporting of measurements (6.3.15.6). — Selecting and advertising a new channel (6.3.15.7).	
	6.3.15.2 Testing channels for primary users A BS or SS shall not use a channel that it knows contains primary users or has not been tested recently for the presence of primary users. A BS shall test for the presence of primary users for at least the following: — **Startup Test Period** before operating in a new channel if the channel has not been tested for primary users for at least **Startup Test Period** during the last **Startup Test Valid**. — **Startup Test Period** before operating in a new channel if a channel was previously determined to contain primary users during the last **Startup Test Valid**.	
	6.3.15.2 Testing channels for primary users	

	A BS or SS shall not use a channel that it knows contains primary users or has not been tested recently for the presence of primary users. A BS shall test for the presence of primary users for at least the following: — **Startup Test Period** before operating in a new channel if the channel has not been tested for primary users for at least **Startup Test Period** during the last **Startup Test Valid**. — **Startup Test Period** before operating in a new channel if a channel was previously determined to contain primary users during the last **Startup Test Valid**. — **Operating Test Period** (where the period is only accumulated during testing) of each **Operating Test Cycle** period while operating in a channel. Testing may occur in quiet periods or during normal operation. An SS may start operating in a new channel without following the above start-up testing procedures if: — The SS moves to the channel as a result of the receipt of a Channel Switch Announcement from the BS. — The SS is initializing with a BS that is not currently advertising, using the Channel Switch Announcement that it is about to move to a new channel. — A BS may start operating in a new channel without following the above start-up testing procedures if it has learned from another BS by means outside the scope of this standard that it is usable.	
	6.3.15.3 Discontinuing operations after detecting primary users If a BS or an SS is operating in a channel and detects primary users, which interference might be caused in the channel, it shall discontinue any transmission of the following: — MAC PDUs carrying data within **Max Data Operations Period**. — MAC PDUs carrying MAC Management messages within **Management Operations Period**.	
	6.3.15.4 Detecting primary users Each BS and SS shall use a method to detect primary users operating in a channel that satisfies the regulatory requirements. The particular method used to perform the primary user detection is outside the scope of this specification.	
	6.3.15.5 Scheduling for channel testing A BS may measure one or more channels itself and request any SS to measure one or more channels on its behalf, either in a quiet period or during normal operation. To request the SSs to measure one channel the BS shall include in the DL-MAP a Report Measurement IE as specified in 8.3.6.2.3. The BS that requests the SSs to perform a measurement shall not transmit MAC PDUs to any SS during the measurement interval. If the channel measured is the operational channel, the BS shall not schedule any uplink transmissions from SSs to take place during the measurement period. An SS upon receiving a DL-MAP with the DFS Measurement IE shall start to measure the indicated channel no later than **Max. Channel Switch Time** after the start of the measurement period. An SS may stop the measurement no sooner than **Max. Channel Switch Time** before the expected start of the next frame or the next scheduled uplink transmission (of any SS). If the channel to be measured is the operating channel, **Max. Channel Switch Time** shall be equal to the value of RTG, as specified in Table 356. **Max. Channel Switch Time** shall not exceed 2 ms.	

	6.3.15.6 Requesting and reporting of measurements The SS shall for each measured channel keep track of the following information: — Frame Number of the frame during which the first measurement was made — Accumulated time measured — Existence of a Primary User on the channel — Whether a WirelessHUMAN using the same PHY system was detected on the measured channel — Whether unknown transmissions [such as radio local area network (RLAN) transmissions] were detected on the channel. The BS may request a measurement report by sending a REP-REQ message. This is typically done after the aggregated measurement time for one or more channels exceeds the regulatory required measurement time. Upon receiving a REP-REQ the SS shall reply with a REP-RSP message and reset its measurement counters for each channel on which it reported. If the SS detects a primary user on the channel it is operating during a measurement interval or during normal operation it shall immediately cease to send any user data and send at the earliest possible opportunity an unsolicited REP-RSP. The BS shall provide transmission opportunities for sending an unsolicited REPRSP frequently enough to meet regulatory requirements. The SS may also send, in an unsolicited fashion, a REP-RSP when non-primary user interference is detected above a threshold value.	
	6.3.15.7 Selecting and advertising a new channel A BS may decide to stop operating in a channel at any time. The algorithm used to decide to stop operating in a channel is outside the scope of this standard but shall satisfy any regulatory requirements. A BS may use a variety of information, including information learned during SS initialization and information gathered from measurements undertaken by the BS and the SSs, to assist in the selection of the new channel. The algorithm to choose a new channel is not standardized but shall satisfy any regulatory requirements, including uniform spreading rules and channel testing rules. If a BS would like to move to a new channel, a channel supported by all SSs in the sector should be selected. A BS shall inform its associated SSs of the new channel using the Channel Nr in the DCD message. The new channel shall be used starting from the frame with the number given by the Channel Switch Frame Number in the DCD message. The BS shall not schedule any transmissions during the last **Max. Channel Switch Time** before the channel change is to take place. The uplink burst profiles used on the old channel defined shall be considered valid also for the new channel, i.e., the BS need not define new uplink Burst Profiles when changing channels. When operating in license-exempt bands the BS shall not send the Frequency (Type=3) parameter as a part of UCD message.	
	8.3.6.2.3 Channel measurement IE format An extended IE with an extended DIUC value of 0x00 is issued by the BS to request a channel measurement report (see 6.3.2.3.33). The IE includes an 8-bit Channel Nr value as shown in Table 237. The Channel_Measurement_IE() shall be followed by the End of map IE (DIUC=14).	

<table>
<tr><td></td><td>Table 237—OFDM Channel measurement IE format
Syntax Size Notes
Channel_Measurement_IE() {
Extended DIUC 4 bits CHM = 0x00
Length 4 bits Length = 0x01.
Channel Nr 8 bits Channel number (see 8.5.1)
Set to 0x00 for licensed bands
}</td><td></td></tr>
<tr><td>8.3.6.3 UL-MAP IE format</td><td>8.3.6.3.5 UL-MAP power control IE format
When a power change for the SS is needed, UIUC = 15 is used with extended UIUC set to 0x00 and with 8 bit Power control value as shown in Table 248. The power control value is an 8-bit signed integer expressing the change in power level (in 0.25 dB units) that the SS should apply to correct it's current transmission power. The CID used in the IE should be the Basic CID of the SS.
Table 248—OFDM power control IE format
<table>
<tr><th>Syntax</th><th>Size</th><th>Notes</th></tr>
<tr><td>Power_Control_IE() {</td><td></td><td></td></tr>
<tr><td>Extended UIUC</td><td>4 bits</td><td>Fast power control = 0x00</td></tr>
<tr><td>Length</td><td>4 bits</td><td>Length = 1</td></tr>
<tr><td>Power control</td><td>8 bits</td><td>Signed integer, which expresses the change in power level (in 0.25 dB units) that the SS should apply to correct its current transmission power.</td></tr>
<tr><td>}</td><td></td><td></td></tr>
</table>
}</td><td></td></tr>
<tr><td>8.3.7.4 Power control</td><td>The base station shall 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 to 30 dB/second with depths of at least 10 dB. 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.
Subscriber stations shall report the maximum available power, and the current 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 SBC-REQ message. The current transmitted power shall also be reported in the REP-RSP message if the relevant flag in the REP-REQ message has been set.</td><td></td></tr>
<tr><td>8.3.9.2 RSSI mean and standard</td><td>When collection of RSSI measurements is mandated by the BS, an SS shall obtain an RSSI measurement from the OFDM downlink preambles. From a succession of RSSI measurements, the SS shall derive and update</td><td></td></tr>
</table>

deviation	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. The specified accuracy shall apply to the range of RSSI values starting from 6dB below the sensitivity level of the most robust mode or -123 dBm (whichever is higher) up to -40dBm. 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: $RSSI = 10^{-\frac{G_{rf}}{10}} \frac{1.2567 \times 10^4 V_c^2}{(2^{2B})R} \left(\frac{1}{N} \sum_{n=0}^{N-1} \left\| Y_{\mathrm{I\ or\ Q}}[k,n] \right\| \right)^2 \mathrm{mW}$ 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_{rf} is analog gain from antenna connector to ADC input $Y_{\mathrm{I\ or\ Q}}[k,n]$ 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: $\hat{\mu}_{RSSI}[k] = \begin{cases} R[0] & k = 0 \\ (1-\alpha_{avg})\hat{\mu}_{RSSI}[k-1] + \alpha_{avg}R[k] & k > 0 \end{cases} \mathrm{mW}$ where is the time index for the message (with the initial message being indexed by , the next message by , etc.), is the RSSI in mW measured during message , and is an averaging parameter specified by the BS. The mean estimate in dBm shall then be derived from: $\hat{\mu}_{RSSI\ dBm}[k] = 10\log(\hat{\mu}_{RSSI}[k]) \quad \mathrm{dBm}$. To solve for the standard deviation in dB, the expectation-squared statistic shall be updated using:	

	$$\hat{x}^2_{RSSI}[k] = \begin{cases} \|R[0]\|^2 & k = 0 \\ (1-\alpha_{avg})\hat{x}^2_{RSSI}[k-1] + \alpha_{avg}\|R[k]\|^2 & k > 0 \end{cases}$$ and the result applied to: $$\hat{\sigma}_{RSSI\,dB} = 5\log(\|\hat{x}^2_{RSSI}[k] - (\hat{\mu}_{RSSI}[k])^2\|) \quad \text{dB}$$	
8.3.9.3 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 264. 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: $$CINR[k] = \frac{\sum_{n=0}^{N-1} \|s[k,n]\|^2}{\sum_{n=0}^{N-1} \|r[k,n] - s[k,n]\|^2}$$ 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: $$\hat{\mu}_{CINR\,dB}[k] = 10\log(\hat{\mu}_{CINR}[k])$$ where	

	$$\hat{\mu}_{CINR}[k] = \begin{cases} CINR[0] & k=0 \\ (1-\alpha_{avg})\hat{\mu}_{CINR}[k-1] + \alpha_{avg} CINR[k] & k>0 \end{cases}$$ k is the time index for the message (with the initial message being indexed by k=0 , the next message by k=1, etc.); CINR[k] is a linear measurement of CINR (derived by any mechanism that 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 $$\hat{x}^2_{CINR}[k] = \begin{cases} \lvert CINR[0]\rvert^2 & k=0 \\ (1-\alpha_{avg})\hat{x}^2_{CINR}[k-1] + \alpha_{avg}\lvert CINR[k]\rvert^2 & k>0 \end{cases}$$ and the result applied to $$\hat{\sigma}_{CINR\ dB} = 5\log(\lvert \hat{x}^2_{CINR}[k] - (\hat{\mu}_{CINR}[k])^2 \rvert) \quad \text{dB} \quad .$$	
8.3.10 Transmitter requirements	**8.3.10.1 Transmit power level control** For an SS not supporting subchannelization, the transmitter shall support a monotonic power level control of 30 dB minimum. For an SS supporting subchannelization, the transmitter shall support a monotonic power level control of 50 dB minimum. The minimum step size shall be no more than 1 dB. The relative accuracy of the power control mechanism is +/-1.5dB for step sizes not exceeding 30dB and +/-3dB for step sizes greater than 30dB. For a BS, the transmitter shall support a monotonic power level control of 10 dB minimum.	
	8.3.11.2 Receiver adjacent and alternate channel rejection The receiver adjacent and alternate channel rejection shall be met over the required dynamic range of the receiver, from 3dB above the reference sensitivity level specified in 8.3.11.1 to the maximum input signal level as specified in 8.3.11.3. The adjacent channel rejection and alternate channel rejection shall be measured at minimum sensitivity by setting the desired signal's strength 3dB above the rate dependent receiver sensitivity (see Equation (94)) and raising the power level of the interfering signal until the error rate specified in 8.3.11.1 is obtained. The adjacent channel rejection and alternate channel rejection shall also be measured at maximum input level by setting the interfering channel signal strength to the receiver maximum signal level as specified in 8.3.10.3 and decreasing the power level of the desired signal until the specified error rate is obtained. In both cases, the power difference between the desired signal and the interfering channel is the corresponding C/I ratio. The interfering signal shall be a conforming OFDM signal, unsynchronized with the signal in the channel under test. The requirement shall be met on both sides of the desired signal channel. 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 265—Adjacent and nonadjacent channel rejection** **Modulation/coding Adjacent Channel Interference C/I (dB) Nonadjacent channel rejection C/I (dB)** 16-QAM-3/4 -11 -30 64-QAM-3/4 -4 -23 **8.3.11.3 Receiver maximum input signal** The receiver shall be capable of decoding a maximum on-channel signal of –30 dBm. **8.3.11.4 Receiver maximum tolerable signal** The receiver shall tolerate a maximum signal of 0 dBm without damage. **8.3.11.5 Receiver image rejection**	

8.4.5.3.5 Channel measurement IE	An extended IE with an extended DIUC value of 0x00 is issued by the BS to request a channel measurement report (see 6.3.15). The IE includes an 8-bit Channel Nr value as shown in Table 278.
	Table 278—OFDMA channel measurement IE
	Syntax Size Notes
	Channel_Measurement_IE() {
	Extended DIUC 4 bits CHM = 0x00
	Length 4 bits Length = 0x04
	Channel Nr 8 bits Channel number (see 8.5.1) Set to zero for licensed bands
	OFDMA symbol offset 8 bits
	CID 16 bits Basic CID of the SS for which the Channel measurement IE is directed
	}	

	8.4.5.4.2 PAPR reduction/Safty zone allocation IE Table 287 defines the PAPR reduction allocation and safety zone allocation IE. This IE is identified by UIUC =13. **Table 287—PAPR reduction and safty zone allocation IE format Syntax Size Notes** PAPR_Reduction_and_Safty_Zone_Allocation_IE() { **OFDMA symbol offset** 8 bits **Subchannel offset** 7 bits **OFDMA symbols** 7 bits **subchannels** 7 bits **PAPR Reduction/Safety Zone** 1 bit; 0 = PAPR reduction allocation; 1 = Safety zone allocation *reserved* 2 bits Shall be set to zero **OFDMA Symbol offset** The offset of the OFDMA symbol in which the burst starts, the offset value is defined in units of OFDMA symbols and is relevant to the Allocation Start Time field given in the UL-MAP message. **Subchannel offset** The lowest index subchannel used for carrying the burst, starting from subchannel 0.	

	No. OFDMA Symbols. The number of OFDMA symbols that are used to carry the uplink Burst. **Number of subchannels** The number subchannels with subsequent indexes, used to carry the burst.	

	8.4.5.4.5 Power Control IE format
	When a power change for the SS is needed, the extended UIUC = 15 may be used with the subcode 0x00 and with 8-bit Power control value as shown in Table 290. The power control value is an 8-bit signed integer expressing the change in power level (in 0.25 dB units) that the SS should apply to correct it's current transmission
	power. The CID used in the IE should be the Basic CID of the SS.
	Table 290—OFDMA Power Control IE
	Syntax Size Notes
	Power_Control_IE() {
	Extended UIUC 4 bits Fast power control = 0x00
	Length 4 bits Length = 0x01
	Power control 8 bits Signed integer, which expresses the change in power level (in 0.25 dB units) that the SS should apply to correct its current transmission power.
	}	

	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/second 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 a TX power value set according to the formula (in dB),

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

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 modualtion/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 332. These values may be overridden by the BS by using a dedicated UCD message TLV.

Table 332—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
64-QAM 2/3	20
64QAM 3/4	21
64QAM 5/6	23

To maintaing at the BS a power density consitent 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 bt 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 Temporary_TX_Powr =Last_TX_Power_Normalized_C/N_of_last_modualtion + Normalized_C/N_of_QPSK_1/2_modulation.
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 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 which 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 QAM64power 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: $$RSSI = 10^{-\frac{G_{rf}}{10}} \frac{1.2567 \times 10^4 V_c^2}{(2^{2B})R} \left(\frac{1}{N} \sum_{n=0}^{N-1} \left\| Y_{\mathrm{I\ or\ Q}}[k,n] \right\| \right)^2 \mathrm{mW}$$ 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_{rf} is analog gain from antenna connector to ADC input	

	YI or Q[k,n] is nth 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 $\hat{\mu}_{RSSI}[k] = \begin{cases} R[0] & k = 0 \\ (1-\alpha_{avg})\hat{\mu}_{RSSI}[k-1] + \alpha_{avg}R[k] & k > 0 \end{cases} \quad \text{mW}$ <u>In continuation, see text and equations at **8.3.9.2 RSSI mean and standard deviation**</u>	
8.4.11.3 CINR mean and standard deviation	<u>See text and equations at **8.3.9.3 CINR mean and standard deviation**</u>	
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.	
8.4.13 Receiver requirements	**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 335) 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 337—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.	
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: — 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: — 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.	
	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 QAM16. Byte 3: Maximum transmitted power for QAM64. SSs that do not support 64-QAM shall report the value 0x00. SBC-REQ	
	11.8.3.3 Current transmit power 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	
	11.11 REP-REQ management message encodings **Name** **Type** **Length** **Value** Report request 1 *variable* 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 = *Reserved*

11.12 REP-RSP management message encodings

Name	Type	Length	Value
Report	1	*variable*	Compound
Channel Type Report in WirelessMAN OFDMA PHY	2	*variable*	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 0xFFFFFF, report 0xFFFFFF.
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)