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Power control elements in subchannelization

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Alvarion

Introduction

The following text introduces the required changes to [1], in order to implement an efficient power control mechanism for use in conjunction with UL OFDMA. Two issues are addressed:

a. Power control policy of SS.

b. Report of power amplifier backoff.

Power control Policy

Power control policy refers to the situation when the number of subchannels allocated to a given SSs is changed. According to the current specifications, the SS should maintain the same transmitted power level and change the transmitted power density accordingly. This is an unwanted situation when OFDMA is employed because:

- Inter subchannel interference is governed by the differences in the received power density rather than the received power.

- The required dynamic range of the BS is determined by lack of balance in power density.

For the above reasons it is desirable to set the target of the power control mechanism to be the received power density. The approach proposed here is as follows:

1. SSs always maintain the same transmitted power density levels. When the number of subchannels is reduced the total transmitted power is reduced proportionally. When the number of subchannels is increased, the total power is increased, unless the maximum power level is reached.
2. Power control messages are interpreted as required changes to the transmitted power density.

Report of power amplifier backoff.

For an efficient subchannel allocation strategy, the BS can make use of the knowledge of the SS's power amplifier backoff. By knowing this parameter, which determines how much transmit power is available, BS can make judicious allocations. Consider the case where the received signal from a given SS is too weak and that the SS is near its maximum transmit power. The BS can reduce the number of allocated subchannels thereforew allowing the SS to concentrate the available power into fewer subchannels.

Power control policy in subchannelization

Add in section 8.4[1] / 8.4.5.4[2]

"As with frequency 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 objective of the power control algorithm is to bring the received power density from a given subscriber to a desired level. The received power density is defined as total power received from a given subscriber divided by the number of active subcarriers. When subchannelization is not employed, the number of active subcarriers is equal for all the subscribers and the power control algorithm shall bring the total received power from a given subscriber to the desired level.

The base station ~~should~~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 subscriber station in a calibration message coming from the MAC sub-layer. 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. 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.

When subchannelization is employed the SS shall maintain the same transmitted power density 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.

When subchannelization is employed, SS shall interpret power control messages as the required changes to the transmitted power density.

Change in interpretation of power control TLV

Add in table 127 (baseline doc)

Name	Type (1 byte)	Length	Value (Variable Length)
…			
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.

Report of PA backoff

Add in section 8.4[1] / 8.4.5.4[2]

Subscriber stations 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 normalized transmitted power shall also reported in the REP-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 QAM64 power field.

Add in ([3] 4.3.4/ [4]) (REG-REQ)

In PMP mode during Registration, the SS shall generate REG-REQ messages including the following parameter in addition to those specified in **Error! Reference source not found.**:

MAC Version

Maximum transmit power for QAM64 (OFDM PHY only)
Maximum transmit power for QAM16 (OFDM PHY only)
Maximum transmit power for QPSK (OFDM PHY only)
Current transmitted power. (OFDM PHY only)

The transmitted power parameters are defined in section 8.4/8.4.5.4.

Add where appropriate for REG-REQ TLVs

Name	Type (1 byte)	Length	Value (Variable Length)	Scope
Report	1	1	Compound	
Max transmitted power	2	2	(see 8.4.7 for details) Byte 0: Transmit power backoff for QPSK Byte 1: Transmit power backoff for QAM16 Byte 2: Transmit power backoff for QAM64. SSs that do not support QAM64 shall report the value 0x00.	
Current transmitted power	3	1	(see 8.4/8.4.5.4 for details) Current transmitted power.	

Add in [3] 4.3.4 (REP-REQ TLVs)

Name	Type (1 byte)	Length	Value (Variable Length)	Scope
Report Type	1.1	1	bit #0 =1 Include DFS Basic report bit #1 =1 Include CINR report	Sca OFDM

			bit #2 =1 Include RSSI report bit #3-6 a_{avg} in multiples of 1/32 (range [1/32, 16/32]) bit #7 Include current transmit power report	OFDMA
Channel Number	1.2	1	Physical channel number (see 8.6.1) to be reported on. (license-exempt bands only)	OFDM, (license-exempt bands only)

Add where appropriate for REP-RSP TLVs

Name	**Type (1 byte)**	**Length**	**Value (Variable Length)**	**Scope**
Report	1	1	Compound	
Current transmitted power	2	1	(see 8.4/8.4.5.4 for details) Current transmit power.	

References:

[1] ETSI TS 102 177 V<0.0.7> Broadband Radio Access Networks, HiperMAN, PHY layer.
[2] IEEE 802.16a
[3] ETSI TS 102 178 V<0.0.7> Broadband Radio Access Networks, HiperMAN, DLC layer.
[4] IEEE 802.16-2001