IEEE 802.16 Working Group on Broadband Wireless Access

http://WirelessMAN.org

Dr. Roger B. Marks
325 Broadway, MC 813.00
Boulder, CO 80305 USA
Tel: +1 303 497 3037
Fax: +1 509 756 2642
mailto:r.b.marks@ieee.org
27 November 2002

Dear P802.16a Balloting Group:

This letter supplements the materials in the P802.16a/D7 Third Recirculation Ballot.

The following table lists the remaining unresolved Disapprove comments in this ballot:

Remaining Disapprove Balloter	Unresolved Disapprove Comments in Third Recirculation	Unresolved Disapprove Comments Previously Recirculated
John Barr		123, 124, 325, 326, 330
Naftali Chayat		
Mike Geipel		004
Marianna Goldhammer	357, 358, 359, 361, 362, 367, 368, 369	
Tal Kaitz	365, 366 (satisfied with 360)	344, 348
Paul Nikolich		006
Vladimir Yanover	364	

The comments in the second column ("Unresolved Disapprove Comments in Third Recirculation") have been available to you since 20 November in the original ballot package for the Third Recirculation Ballot.

This supplement includes, on the following pages, the comments and resolutions mentioned in the third column ("Unresolved Disapprove Comments Previously Recirculated"). Note that these have already been recirculated in either the First or Second Recirculation Ballots; this means that this material is not new to you. However, based on the request of one balloter, we are using this supplement to remind you of these previously-recirculated unresolved comments. Note that the previously-recirculated Comments 336, 345, and 346 are excluded because the balloter has agreed to withdraw them and stipulate that they are to be considered as superceded by Comments 367, 361, and 362, respectively. Balloters Chayat, Goldhammer, Kaitz, and Yanover have noted that are dissatisfied with the level of support for OFDM subchannelization in the draft.

Because we are providing new material, the IEEE-SA Balloting Center will be extending the return deadline.

Once again, you need not reply; if you do not, your current vote will stand. Instructions have been provided by the IEEE Balloting Center.

Sincerely,

Roger Marks

Document under Review: 802.16a/D5 **Ballot Number:** 802.16a **Comment Date**

Comment # 336 **Submitted by:** Marianna Goldhammer Member 2002/10/10

Comment Type Technical, Binding **Starting Page #** 143 **Starting Line #** **Fig/Table#** **Section** 8.4.3.

Enhance the OFDM 256FFT mode with optional sub-channelization, to improve both link-budget and granularity and align with BRAN-HM.

The comment resolution does not indicate the technical arguments against the OFDM channelization, that obiously introduces similar concepts with those implemented by the OFDMA PHY in uplink. The proposed mode has better granularity performance, better robustness to phase-noise, better frequency diversity than the optional 2k permutation mode.

To make more clear that the proposed enhancement is an option, the "optional" word has been inserted now.

Suggested Remedy

Supporting subchannelization requires the following: changes
a. Divide the channel into subchannels.
b. Change the UL map to support Subchannelization. The approach here was proposed by Nico and is similar to that of HiperMAN. A new Subchannelization_IE is defined. This element defines a region in the UL for which subchannelization is employed. The element also defines how many subchannelization UL map elements are to follow.
c. Change the FEC mechanism to CC only for subchannelization. No change when subchannelization is not employed. The motivation is that CC code work better for small block sizes than CC+RS.

a. Divide the channel into subchannels

page 143:
"
When subchannelization is employed, the channel is dived into subchannels as shon in table 116ab:

table 116ab

Subchannel number:	Allocated frequency offset indices of carriers
1:	{-100,…,-89},{-50,...,-39},{1,...13},{51,...,63}
2:	{-88,…,-76},{-38,...,-26},{14,...,25},{64,...,75}
3:	{-75,…,-64},{-25,...,-14},{26,...,38},{76,...,88}
4:	{-63,…,-51},{-13,...,-1},{39,...,50},{89,...,100}

"
b. Change the UL map

Add section 8.4.4.3.5 UL MAP Subchannelization information element

Within a frame, the BS may allocate a portion of the UL allocations to sub-channelized traffic. The UL_subchannelization_IE implicitly indicates the start of the allocation and explicitly indicates the Duration and the Number of allocations. A SS not capable of subchannelization shall skip the number of allocation times 7 nibbles that follow, and resume interpreting the UL-MAP afterwards with the start of the next allocation Duration OFDM symbols after the last allocation ended.

Table 116az-OFDM UL subchannelization IE Format

Subchannelization_IE() {		
extended UIUC	4 bits	subchannelization = 0x03
Duration	12 bits	Cumulative duration of the allocations
Number of allocations	12 bits	Number of sub-channelized allocations following this IE
}		

….

A SS capable of sub-channelization shall decode the sub-channelized allocations, whereby the 12 bit Duration field in non-sub-channelized UL-MAP messages is replaced by a 3 bit Subchannel Index field and 5 bit Duration field as shown in Table 116at. A sub-channelized allocation shall start when all previous allocations to all allocated sub-channels have terminated.

In table 116at replace the 'Duration' row with:

"

else If (BS supports subchannelization and UIUC = 1,2 ,5:13) {	
Subchannel Index	3 bits
0x0	Reserved
0x1	Sub-channel 1
0x2	Sub-channel 2
0x3	Sub-channel 3
0x4	Sub-channel 4
0x5	Sub-channel 1 and 3
0x6	Sub-channel 2 and 4
0x7	Reserved

Duration 5 bits
}
else
Duration 12 bits

}

"
Add
"
"If several consecutive allocations are granted to the same SS on same subchannels and UIUC values, then the SS shall use all allocations for sending a single PHY burst"

c. add CC only

Add to Table 116ab 1/2, 10, 1,1,X1Y1

When sub-channelization is active (see 8.4.4.3.5), the FEC shall bypass the RS encoder and use the Overall Coding Rate as indicated in Table 116ac as CC Code Rate. The Uncoded Block Size and Coded Block size may be computed by dividing the values listed in Table 116ac by 4 and 2 for 1 and 2 sub-channel allocations respectively.

Resolution of Group **Decision of Group: Accepted-Modified**

Adopt changes in C802.16a-02/90r7.

Reason for Group's Decision/Resolution

Document C802.16a-02/90r7 encompass the suggested remedy with two exceptions: 1) It does not allow UIUC's 1 ("Initial ranging") and 2 ("REQ Region Full") to be used during subchannelization. 2) It does not contain the language: "If several consecutive allocations are granted to the same SS on same subchannels and UIUC values, then the SS shall use all allocations for sending a single PHY burst".

The language under point 1) above was omitted because it would allow a subscriber to demand service from a BS when its link

budget is sufficient only to allow the use of 1 subchannel. This would occur if the SS implements a PA which is economized to the point where it anticipates the gain achieved by subchannelization. This gain is in theory 6 dB (1/4th the bandwidth), but in practice will be less due to the effects of smaller possible FEC blocks, only 2 pilots per subchannel, and interference from the other subchannels.

Three problems would arise from this.

The first problem is that the peak UL data rate for an SS with such a link budget would be reduced by a factor of 4. The second problem is that it would force the BS scheduler to always provision UL allocations to SSs with such a link budget, instead of having the choice to optimize allocations over subchannels and full symbol allocations. Consider for example a 7 MHz licensed channel in which an SS capable of communicating only over one subchannel requests an allocation for 1500 bytes. This would mandate the BS to allocate a total of 8.25 ms (the order of an entire frame duration) solely for this subchannelized traffic. To allow this single allocation in combination with a few mandatory full OFDM symbol allocations, the BS would be forced to spread the allocation over multiple frames, causing excessive end to end delays. The third problem is that during initial ranging, substantial offsets from the desired received power can occur at the BS side, which could produce substantial distortion in other subchannels, were this to be allowed. With the adopted C80216a-02/90r7 language, subchannelization is only allowed after the SS power has been adjusted to result in near-equal received power at the BS side, so that this problem would not occur.

In addition, the adopted C80216a-02/90r7 language does not allow the use of UIUC 2, since an efficient method of requesting bandwidth has already been defined through UIUC 3 ("REQ Region Focused"), which also allows the SS to indicate its preference (though not a demand) for a subchannelized allocation. Of course, a SS can also use the REQ Region Full or the "piggy-backing" mechanism to request bandwidth. There is hence no need to duplicate the bandwidth request through a fourth mechanism.

The language under point 2) was omitted because it would not achieve any substantial additional preamble overhead reduction (which is the second aim of subchannelization, after granularity reduction), whereas the BS would have to deal with the increasingly difficult phase tracking problem due to the availability of only two pilots. The adopted C80216a-02/90r7 language allows for 5 bit, or 32 OFDM symbols of subchannelized allocation (allowing for 180 to 830 bytes of data). The overhead, 1 OFDM symbol preamble, would hence result in about 3% of overhead.

In addition, Comment 336 motivates the sought changes as a harmonization with the ETSI BRAN HIPERMAN OFDM PHY. It should be noted that this has been achieved fully by the language in C802.16a-02/90r7, as the omitted changes listed above are not part of that draft standard either (see BRAN30d023r1).

Document under Review: 802.16a/D5 Ballot Number: 802.16a Comment Date

Comment # 330 Submitted by: Tal Kaitz Member 2002/10/10

Comment Type Technical, Binding Starting Page # 10 Starting Line # Fig/Table# Section

Related to comment 11 (and also to comments 162, 166, 167)

The 256 OFDM system can be greatly improved by adding an optional sub-channelization support in the UL.
Sub-channelization has the following advantages:

a. It reduces data granularity.
b. It reduces overheads due to preambles.
c. It allows power concentration in increased link budget in the UL.

The proposed scheme fits naturally into the existing OFDM mode and is completely interoperable with it. This scheme was already adopted by HiperMAN.

During the comment resolution process, the subchannelization-related comments did not gain the required 75 % support. In my view the technical arguments against subchannelization were not justified. Some of these arguments are discussed below.

a. High degree of UL synchronization is required:

The proposed sub-subchannelization scheme is inherently robust to synchronization errors. In the proposed scheme, the subcarriers are arranged in clusters of 12 or 13. When frequency errors are present some inter-carrier interference is introduced. Because of the clustered allocation, only the clusters' edges interact and the overall inter subchannel interference is small.
In fact, the proposed scheme is more robust to frequency offsets than the 2K OFDMA. This is due to:

1. The carrier allocation. The 2K OFDMA uses a permutation approach in which subcarriers form different sub-channel are adjacent in frequency. Thus the inter-subchannel interference is much more severe.
2. The subcarrier spacing. The 2K OFDMA systems employ a much narrower subcarriers spacing than that of the 256 OFDM systems. For the same frequency error in Hz, the interference in the 2K system is much higher.

b. Due to shorter block sizes the Coding gain is reduced
.
This is only partly true. In some case the coding loss may be up to 1.5dB. However:

1. Using shorter block is one of the motivations of introducing subchannelization
2. The loss is well compensated by the 6dB power concentration gain.

c. Loss of estimation accuracy

The same estimation techniques can be used for both the OFDM and subchannelization modes. The estimation accuracy is expected to be the same.

d. Not enough frequency diversity.

The clustered approach was selected as a compromise between frequency diversity and robustness to frequency errors. The clusters are spread over the entire bandwidth. The loss in the frequency diversity is small.
It is true that one can obtain pathological channel responses for which the entire subchannel is faded. For instance, the channel 1+z-5, has notches at a period of 256/5=50 subcarriers, and a single subchannel is completely faded.
In such rare cases, the dynamics at the MAC level will insure that the SS sees this channel only for 25% of the time.

e. Not enough pilots

There are only 2 pilots per sub-channel. From a technical perspective it would be advantageous to increase the number of pilots. This can be accomplished by increasing the total number of subcarriers (say from 200 to 208 giving 4 pilots per subchannel). This will increase the occupied bandwidth by a small fraction.
However, to align with the existing OFDM mode the number of subcarreris was not increased.
To operate with a small number of pilots the BS can:
1. Allocate only short bursts, in which phase tracking is less important. (Not enough time for phase drift accumulation).
2. Use decision aided techniques in which no pilot subcarriers are necessary.

Suggested Remedy

copied from 42r3 comment 166.

Supporting subchannelization requires the following changes:
a. Divide the channel into sub-channels.
b. Change the UL map to support Subchannelization. The approach here was proposed by Nico and is similar to that of HiperMAN. A new Subchannelization_IE is defined. This element defines a region in the UL for which subchannelization is

employed. The element also defines how many subchannelization UL map elements are to follow.
c. Change the FEC mechanism to CC only for subchannelization. No change when subchannelization is not employed. The motivation is that CC code work better for small block sizes than CC+RS.

a. Divide the channel into subchannels

page 143:
"
When subchannelization is employed, the channel is dived into subchannels as shon in table 116ab:

table 116ab

Subchannel number:	Allocated frequency offset indices of carriers
1:	{-100,…,-89},{-50,...,-39},{1,...13},{51,...,63}
2:	{-88,…,-76},{-38,...,-26},{14,...,25},{64,...,75}
3:	{-75,…,-64},{-25,...,-14},{26,...,38},{76,...,88}
4:	{-63,…,-51},{-13,...,-1},{39,...,50},{89,...,100}

"
b. Change the UL map

Add section 8.4.4.3.5 UL MAP Subchannelization information element

Within a frame, the BS may allocate a portion of the UL allocations to sub-channelized traffic. The UL_subchannelization_IE implicitly indicates the start of the allocation and explicitly indicates the Duration and the Number of allocations. A SS not capable of subchannelization shall skip the number of allocation times 7 nibbles that follow, and resume interpreting the UL-MAP afterwards with the start of the next allocation Duration OFDM symbols after the last allocation ended.

Table 116az-OFDM UL subchannelization IE Format

Subchannelization_IE() {		
extended UIUC	4 bits	subchannelization = 0x03
Duration	12 bits	Cumulative duration of the allocations
Number of allocations	12 bits	Number of sub-channelized allocations following this IE
}		

….

A SS capable of sub-channelization shall decode the sub-channelized allocations, whereby the 12 bit Duration field in non-sub-channelized UL-MAP messages is replaced by a 3 bit Subchannel Index field and 5 bit Duration field as shown in Table

116at. A sub-channelized allocation shall start when all previous allocations to all allocated sub-channels have terminated.

In table 116at replace the 'Duration' row with:
"
else If (BS supports subchannelization and UIUC = 1,2 ,5:13) {
Subchannel Index 3 bits
0x0 Reserved
0x1 Sub-channel 1
0x2 Sub-channel 2
0x3 Sub-channel 3
0x4 Sub-channel 4
0x5 Sub-channel 1 and 3
0x6 Sub-channel 2 and 4
0x7 Reserved

Duration 5 bits
}
else
Duration 12 bits

}

"
Add
"
"If several consecutive allocations are granted to the same SS on same subchannels and UIUC values, then the SS shall use all allocations for sending a single PHY burst"

c. add CC only:

Add to Table 116ab 1/2, 10, 1,1,X1Y1

When sub-channelization is active (see 8.4.4.3.5), the FEC shall bypass the RS encoder and use the Overall Coding Rate as indicated in Table 116ac as CC Code Rate. The Uncoded Block Size and Coded Block size may be computed by dividing the values listed in Table 116ac by 4 and 2 for 1 and 2 sub-channel allocations respectively.

Resolution of Group **Decision of Group: Accepted-Modified**

Adopt changes in C802.16a-02/90r7.

Reason for Group's Decision/Resolution

The comment is similar to that of Comment 336, and the proposed remedy is identical. Please see Comment 336 comments for discussion of this issue.

Document under Review: 802.16a/D5 **Ballot Number:** 802.16a **Comment Date**

Comment # 344 **Submitted by:** Tal Kaitz Member 2002/10/10

Comment Type Technical, Binding **Starting Page #** 168 **Starting Line #** **Fig/Table#** **Section** 8.4.5.3

Comment 212, resubmitted

This comment is supplementary to the subchannelization comment (#11 #162 #166 #167), and is resubmitted.

To gain the full benefits of subchannelization, the system needs to optionally support subchannelized transmissions in the REQ-region-full.

Suggested Remedy

Add in pg 168/line 62:
"REQ-region Full interval can be allocated to SSs which use subchannelization. In this case the BS allocates an UL interval using the procedure of 8.4.4.3.5 and an UIUC code of 2"

Resolution of Group **Decision of Group:** **Accepted-Modified**

Adopt changes in C802.16a-02/90r7.

Reason for Group's Decision/Resolution

The proposed remedy is identical in scope to permitting the usage of UIUC 2 ("REQ Region Full) when using subchannelization in Table 116at as proposed in Comments 330, 336 and 337. Please see the response to Comment 336 for discussion of this issue.

Document under Review: 802.16a/D5 **Ballot Number:** 802.16a **Comment Date**

Comment # 348 **Submitted by:** Tal Kaitz Member 2002/10/10

Comment Type Technical, Binding **Starting Page #** 168 **Starting Line #** 62 **Fig/Table#** **Section** 8.4.5.2

Comment 211, resubmitted

TThis comment is supplementary to the subchannelization comment (#11 #162 #166 #167), and is resubmitted.

To gain the full benefits of subchannelization, the system needs to optionally support subchannelized transmissions in the initial ranging interval.

Suggested Remedy

Add in pg 168/line 62:
"The initial ranging interval can be allocated to SSs which use subchannelization. In this case the BS allocates an UL interval using the procedure of 8.4.4.3.5 and an UIUC code of 1."

Resolution of Group **Decision of Group:** **Accepted-Modified**

Reason for Group's Decision/Resolution

The proposed remedy is identical in scope to permitting the usage of UIUC 1 ("Initial Ranging") when using subchannelization in Table 116 as proposed in Comments 330, 336 and 337. Please see the response to Comment 336 for discussion of this issue.

Document under Review: 802.16a/D5 **Ballot Number:** 802.16a **Comment Date**

Comment # 326 **Submitted by:** John Barr Member 2002/10/11

Comment Type Technical, Binding **Starting Page #** **Starting Line #** **Fig/Table#** **Section**

The process used by the 802.16 committee during recirculation does not allow balloters to reasonably access totality of changes resulting from resolution of comments. Also, the originally provided documentation for the recirculation ballot was incomplete and not corrected until one day before the recirculation ballot closed.

Suggested Remedy

Declare the recirculation ballot invalid until a time when the following are completed:

1. All Technical Binding commenters are asked to state whether their comments were satisfactorly resolved and documentation of unsatisfactory resolutions are included with the recirculation ballot.

2. An updated draft is prepared with appropriate change indications to allow balloters to determine where changes were made and how they may affect their next ballot.

Resolution of Group **Decision of Group:** **Accepted-Modified**

Conduct a second recirculation, to include an updated draft incorporating changes as documented by resolutions adopted by Ballot Resolution Committee. This second recirculation will include all comments requiring recirculation in which relevant fields were truncated during first recirculation.

Reason for Group's Decision/Resolution

The Ballot Resolution Committee recognizes the importance of recirculating an updated draft

The Ballot Resolution Committee recognizes that some balloters had incomplete access to comments and resolutions due to field truncation in the PDF distributed with the first recirculation.

The recirculation process provides the requested opportunity for commenters “to state whether their comments were satisfactorly resolved.” Also as requested, the resulting “documentation of unsatisfactory resolutions” (as collected during recirculation) is included with the recirculation package. The process followed is as described in the IEEE-SA Standards Board Operations Manual: 'If the negative vote is not satisfied, either entirely or in part, the negative voter shall be informed of the reasons for the rejection and be given an opportunity either to change his or her vote to "approve" or to retain his or her negative vote *during a recirculation ballot*.'

The request for an updated draft with change indications is labor-intensive and difficult to accommodate. However, in order to accommodate the balloter's request ("to allow balloters to determine where changes were made"), recirculation will follow the appropriate rule in the IEEE-SA Standards Board Operations Manual: "all substantive changes" will be recirculated.

Document under Review: 802.16a/D5 **Ballot Number:** 802.16a **Comment Date**

Comment # 325 **Submitted by:** John Barr Member 2002/10/11

Comment Type Technical, Binding **Starting Page #** **Starting Line #** **Fig/Table#** **Section**

Resolution of comments 123 and 124 are not satisfactory and my disapprove vote still holds.

Suggested Remedy

Correct draft to include methods for realistic coexistence with other IEEE 802 radios that are designed to share the license-exempt bands or remove operation of 802.16a in any of the license-exempt bands to prevent interference with privately owned WLANs or other radios using the license-exempt bands that conform to realistic coexistence rules.

Resolution of Group **Decision of Group:** Rejected

Reason for Group's Decision/Resolution

802.16's approach is in line with the approach taken by the other wireless groups within 802.
Within this context, “primary user” refers to a regulatory designation, regardless of technology.
Requiring the detection of any 802 compliant wireless system, current and future, would be prohibitive.

The specified DFS mechanism is frequency independent.

This issue would be different if all license-exempt systems required DFS (as in the CEPT RLAN bands). However, given that other 802 standards do not mandate DFS, placing the entire burden on MAN systems is unreasonable.

Document under Review: 802.16a/D5 **Ballot Number:** 802.16a **Comment Date**

Comment # 123 **Submitted by:** John Barr Member

Comment Type Technical, Binding **Starting Page #** 90 **Starting Line #** **Fig/Table#** **Section** 6.2.14

The use of only "primary users" to determine when a channel should not be used does not prevent a P802.16a BS or SS from interferring with a currently operating IEEE 802 wireless system using that same channel. P802.16a should follow recommendations for allowing multiple IEEE 802 wireless systems to operate on separate channels in license-exempt bands.

The informative text in appendix B provides a good analysis of possible interference with existing IEEE 802 wireless systems, but mistakenly makes the assumption that P802.16a deployments will not interfere with other IEEE 802 wireless systems in the license-exempt bands since the only outdoor usage would be for public hot spots. However, there is a growing acceptance of 802.11b/a/g wireless systems for home usage, some of which will be extended to 'backyard' areas around a home for the convenience of the homeowner. The lack of a mechanism within P802.16a to mitigate interference with home IEEE 802 wireless systems must be corrected before this becomes an official IEEE standard.

Suggested Remedy

Modify text in 6.2.14 to include IEEE 802 wireless systems as users of channels to be avoided as stated for primary users. Also update to ensure that avoidance of operating IEEE 802 wireless systems includes those operating in the 2.4 GHz license-exempt band.

Resolution of Group **Decision of Group:** Rejected

vote: in favor 0
against 20

Reason for Group's Decision/Resolution

{Note: this comment was included in the first recirculatation, but in truncated form. Therefore, it is being included in the second recirculation verbatim.}

802.16's approach is in line with the approach taken by the other wireless groups with 802.
Within this context, primary user refers to a regulatory designation, regardless of technology.
Requiring the detection of any 802 compliant wireless system, current and future, would be prohibitive.
The specified DFS mechanism is frequency independent.
This issue would be different if all license-exempt systems required DFS (as in the CEPT RLAN bands), but given that other 802 standards do not mandate DFS, placing the entire burden on MAN systems is unreasonable.

Document under Review: 802.16a/D5 **Ballot Number:** 802.16a **Comment Date**

Comment # 124 **Submitted by:** John Barr Member

Comment Type Technical, Binding **Starting Page #** 90 **Starting Line #** 10 **Fig/Table#** **Section** 6.2.14.2

The definition of "primary user" used in this document does not promote the coexistence of P802.16a with other IEEE 802 standards that may also be operating in the license-exempt bands. The statement "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." does not prevent a BS or SS from establishing operation on a channel already being used by another IEEE 802 wireless system (e.g., 802.11b/a/g or 802.15.1/3/4).

Suggested Remedy

Change "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." to "A BS or SS shall not use a channel that it knows contains primary users or other IEEE 802 wireless systems, or has not been tested recently for the presence of primary users or other IEEE 802 wireless systems."

Resolution of Group **Decision of Group:** Rejected

Reason for Group's Decision/Resolution

see comment 123

Document under Review: 802.16a/D5 **Ballot Number:** 802.16a **Comment Date**

Comment # 004 **Submitted by:** Mike Geipel Member

Comment Type Technical, Binding **Starting Page #** **Starting Line #** **Fig/Table#** **Section**

The 802.16 standard needs to reflect the current realities of dimished R&D spending. While the technological concepts included in the latest version of the standard is impressive, the odds are slim that a critical mass of companies will commit the level of R&D investment required to realize the current spec into a commercial system. To establish itself as a true industry standard the 802.16 specification must be more than an optimal engineering solution to wireless propagation, it must also achieve a balance with respect to the level of effort required to realize the associate hardware and software.

The history of technology adoption teaches us that technology changes typically occur in incremental steps and that the most deterministic (i.e. low risk) steps are the simple ones. With this simplicity heuristic as our guide, a number of changes are suggested to the current 802.16a/D5-2002 standard in order to match the current realities of R&D investments.

Suggested Remedy

- Make ITU J.83 Annex A or B an optional transmit encoding scheme
- Make adaptive modulation optional.
- The MAC is functionally equivalent to the DOCSIS MAC, why not adopt the DOCSIS MAC and list possible enhancements as options.

Resolution of Group **Decision of Group:** Rejected

vote:
0 in favor
21 against

Reason for Group's Decision/Resolution

{Note: this comment was included in the first recirculatation, but in truncated form. Therefore, it is being included in the second recirculation verbatim.}

The Working Group recognizes the economic realities that influence the acceptance of a standard. It believes that it has found the right balance, introducing advanced technology that can be economically developed and deployed. The group does not believe it would benefit the standard to introduce addtional transmit encoding options. It believes that adaptive modulation is essential to the successful operation of a system in the long term.

In order for a standard to be success, it also has to be capable of effective operation in the intended environment. The ITU J.83 PHY (which, by the way, is used in DOCSIS) was designed for FDD *cable* systems, and solves a different set of problems from BWA. Some of the shortcomings of the ITU J.83 PHY and DOCSIS MAC proposal for the 802.16a application are as follows: it

a) is not defined for TDD systems (a functional requirement of 802.16a);

b) does not perform well (has low capacity) in the NLOS slow fading environments typical of 802.16a applications (see BWIF white paper for documented details, since it does use the DOCSIS PHY in comparisons with V-OFDM);

c) does not possess framing/modulation structures that facilitate capacity-improving channel estimation and equalization techniques;

d) does not possess pilot symbols and preambles that enable fast acquisition and re-acquisition when a fade is experienced (note that preambles also facilitate TDD operation);

e) does not enable the operator to implement MAC-based ARQ, and therefore must rely on ARQ from TCP/IP, which greatly reduces capacity over a slow fading channel;

f) does not enable the use of per-user adaptive modulation which greatly improves capacity, since, unlike cable, not all users have the same CINR (both distances and shadowing).

g) Has no mechanism to introduce other BWA capacity enhancing options, including space-time coding, AAS, and MESH.

Document under Review: 802.16a/D5 **Ballot Number:** 802.16a **Comment Date**

Comment # 006 **Submitted by:** Paul Nikolich Member

Comment Type Technical, Binding **Starting Page #** **Starting Line #** **Fig/Table#** **Section**

The MAC protocol relies on a higher layer (TCP/IP) functions like DHCP, UDP, and Time-of-Day services to provide configuration information to the MAC and is specified to be the 'communication channel' between the Base Station and the Subscriber stations (for example in 6.2.15 MAC Management Message tunneling in Mesh Mode).

This causes architectural problems - ideally protocol layer (n) should be independent of protocol layer (n+1). In the case of 802.16a, if the higher layer functionality is not working, then the layer 2 network does not operate correctly.

Suggested Remedy

Restrict node state, MAC messaging and inter-node communications within layer 2 and to not be reliant on any higher layer functionality.

Resolution of Group **Decision of Group:** **Accepted-Modified**

Insert on page 6, line 44: Though the MAC specification invokes IP protocols, they are required only as a standard basis for element management rather than MAC operation, since, in all practicality, element management is necessary in this type of network.

Reason for Group's Decision/Resolution

For PMP systems:
The MAC does not really rely on the higher layer protocols. These functions are intended to be a standard way of providing connectivity between the SS and a network management and/or element management system. From the MAC's point of view, the SS could simply respond to the BS with a TFTP-CPLT message and be done with it. The SS would be unmanageable at the NOC level, but you could still authenticate, set up services, transfer data, perform RLC functions, etc. So from a MAC point of view none of the higher layer functions are required. However, they are required as a standard basis for element management (rather than MAC) since, in all practicality, element management is necessary in this type of network.

For mesh systems:
In mesh systems there is need to support transactions that take place between entities separated by multiple hops. This need arises out of the following:
The intermediate nodes neither have access to nor should be trusted with all information necessary to complete all transactions that currently rely on MAC message tunneling.

Also in 802 the CIDs (the addresses used by the MAC layer) are unique only over a single hop and not known by the BS if separated from a node by more than a single hop. Also 802.16 does not include routing functionality that is necessary for making correct forwarding decisions as this functionality is non-trivial and is already readily available for IP.

The current choice of tunneling the MAC messages over UDP is motivated by the following facts:
1) Tunneling the messages over UDP provides, in conjunction with off the shelf higher layer protocols, a mechanism to deliver the MAC message over multiple hops to the intended recipient.
2) The implementation burden of the current approach is minimal on the devices supporting mesh.
3) The tunneling does not compromise the security of the authentication and authorization transactions.