IEEE P802.11  
Wireless LANs

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| Proposed Comment Resolutions | | | | |
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Abstract

Submission for P802.11af draft text. This document contains proposed resolutions for comments

275,580, 603, 604, 847, 853

591, 592, 460, 761, 842, 606, 735, 766, 846

301, 6, 404, 436, 46, 134,221, 266, 762

583, 588, 459, 595, 732, 760, 841, 607, 736, 856

The baseline of this text is P802.11af\_D2.1

## Interpretation of a Motion to Adopt

A motion to approve this submission means that the editing instructions and any changed or added material are actioned in the TGaf Draft. This introduction is not part of the adopted material.

***Editing instructions formatted like this are intended to be copied into the TGaf Draft (i.e. they are instructions to the 802.11 editor on how to merge the text with the baseline documents).***

***TGaf Editor: Editing instructions preceded by “TGaf Editor” are instructions to the TGaf editor to modify existing material in the TGaf draft. As a result of adopting the changes, the TGaf editor will execute the instructions rather than copy them to the TGaf Draft.***

The editing instructions are shown in ***bold italic***. Four editing instructions are used: ***change, delete, insert, and replace***. Change is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using ~~strikethrough~~ (to remove old material) and underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editorial notes will not be carried over into future editions because the changes will be incorporated into the base standard.

**Relevant comments and discussion**

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| **CID** | **Page** | **Clause** | **Comment** | **Proposed Change** | **Proposed resolution** |
| 275 |  | 23 | If 7 MHz channels have more tones than 6 MHz channels, why don't they have more throughput | Make use of the extra tones to boost the throughput (to something between the 6 and 8 MHz throughputs) | Rejected.  In order to minimize implementation options it was agreed to re-use the design for 6MHz channels in the very few locations that use 7MHz channels |
| 580 | 228.00 | 23.1.1 | TTVHT\_MODE\_2N and TVHT\_MODE\_4N are not sufficient to cover the transmission modes in TVWS operation, especially in some areas, e.g., urban areas, where two non-contigous frequency sections may not necessarily contain the same number of contigous channels | Current operation modes defined in the spec are not sufficient to cover all typical cases existing in TVWS operation, especially in some highly populated areas (e.g., urban aras) where TVWS are scarce and 2W+2W is not the typical case. | Rejected.  The current draft is not intended to cover all combinatorial options of non-contiguous channel availability. We have expanded the 11ac non-contiguous mode by adding one more mode (MODE\_2N) and the two available modes should be sufficient for the vast majority of cases. |
| 603 | 238.00 | 23.3.7 | if there are more than these operation modes (1, 2C, 2N, 4C, 4N), then the corresponding indices are missing | Current operation modes is insufficient to support all typical cases in TVWS operation, especially in some highly populated areas, e.g., urban areas. | Rejected.  See resolution for comment 580 |
| 604 | 239.00 | 23.3.7 | Table 23-5 needs to be updated if more operation modes are added | Current operation modes is insufficient to support all typical cases in TVWS operation, especially in some highly populated areas, e.g., urban areas. | Rejected.  See resolution for comment 580 |
| 847 | 247.00 | 23.3.14 | TVWS channels are co-shared and a limited resource. In highly populated areas, e.g., urban areas, there may only be 2W+W channels available. Therefore the existing transmission modes are not sufficient to cover the typical scenarios expected to exist in the TVWS. | Table 23-11 needs to be updated if more operation modes are added to supported more robust operation in the TVWS bands. | Rejected.  See resolution for comment 580 |
| 853 | 253.05 | 23.3.19.2 | TVWS channels are co-shared and a limited resource. With unique and varying channel requirements. The current Minimum required adjacent and nonadjacent channel rejectedion levels table (Table 23-16) may not support enough operational modes to allow for efficient use of the TVWS resources. | Additional operation modes should be added to Table 23-16 to allow for more efficient use of the TVWS resources. | Rejected.  See resolution for comment 580 |
| 591 | 235.00 | 23.3.4.9.1 | Using the same concept of segment parser of Clause 22 (g) (simply distribute the coded bits among two channels) is optimum for TVWS channels (significant SINR variations over multi-TVWS channels)? | Inconsistence with later statement. | Rejected.  Simply splitting the coded bits between two channels can be viewed as a special case of an interleaver and is therefore worse than an optimized interleaver structure regardless of the SINR variation. The interleaver choice was also simulated with unequal SINR (see contribution 839). |
| 592 | 235.00 | 23.3.4.9.1 | Similar comment to the previous comment, using the same concept of segment parser of Cluase 22 (f) (simply distribute the coded bits among two channels) is optimum for TVWS channels (significant SINR variations over multi-TVWS channels)? | Inconsistence with later statement. | Rejected.  See resolution for comment 591 |
| 593 | 236.00 | 23.3.5 | Due to regulations and/or realtime channel usage siutations, the conditions of available TV channels could be quite different from each other. Need to optionally specify independent MCS value for each available TV channel, if multiple TV channels are to be used. | Need to specify an option to permit use of independent MCS value for each available TV channel, if multiple TV channels are to be used. | Rejected.  See multiple MCS discussion. |
| 594 | 236.00 | 23.3.5 | Can the common MCS applied to the multiple TVWS channels where SINR values are highly fluctuated? | Common MCS applied to the multiple TVWS channels could degrade the performance of TVWS network, where channel conditions are widely varied. | Rejected.  See multiple MCS discussion. |
| 595 | 236.34 | 23.3.5 | For aggregated channels, It is better to allow unequal MCS. Unequal MCS is more efficient when conditions varies from channel to channel. | Insert 'Unequal MCSs could be applied to streams assigned to non-contiguous channels'. | Rejected.  See multiple MCS discussion. |
| 596 | 236.00 | 23.3.5 | Use separate interleaving and coding on different frequency segments. This will allow the easy use of different MCS on different frequency segments. | Allow separate interleaving/coding/modulation per frequency segment. | Rejected.  See multiple MCS discussion. |
| 585 | 230.36 | 23.2.2 | The modifications to Table 22-1 is not sufficient to optimize the performance in TVWS: e.g, 1)SNR (when FORMAT is VHT) is a measure of the received SNR per spatial stream cannot be simply reused in the multi-channel case. In TVWS operation, SNR values of the multi-channels could be significantly different; 2) TXPWR\_LEVEL: a single tx power level is not sufficient in multi-TVWS-channel case, especially when one aggregated channel is adajacent to the DTV occupied channel. TXPWR\_LEVEL should be modified; 3) Single MCS is not sufficient in multi-channel case, where SNR values are highly fluctuated. | More modifications of Table 22-1 (TXVECTOR and RXVECTOR) are required to optimize the TVWS operation. | Rejected.  See multiple MCS discussion. |
| 759 | 233.52 | 23.3.3 | Unlike in 802.11ac, unequal power transmission should be specified in 802.11af for cases where more than one frequency segment is used. For example, if one of the aggregated channels has a limitation of 40 mW (adjacent channel) and another channel has a limit of 100 mW, 802.11af should allow transmission of unequal power levels | Insert a multiplicative factor on each frequency segment prior to D/A to reflect difference in transmitted power. Alternatively, insert different TxPwrLevels for each channel/frequency segment in the TXVector | Rejected.  11ac operates in several different band where power limits vary much more than 40mW vs. 100mW.  The topic has been discussed in 11ac and the decision should uphold in 11af as well |
| 761 | 236.00 | 23.3.5 | Use separate interleaving and coding on different frequency segments. | Allow separate interleaving/coding/modulation per frequency segment. | Rejected.  Using one interleaver for both frequency segments is superior to maximize diversity out of narrow 5MHz channels |
| 460 | 236.00 | 23.3.5 | Use separate interleaving and coding on different frequency segments. This will allow the easy use of different MCS on different frequency segments. | add proper text to Allow separate interleaving/coding/modulation per frequency segment. | Rejected.  We don’t see the need/benefit for multiple MCS at this point.  See multiple MCS discussion. |
| 842 | 236.00 | 23.3.5 | Allow for separate interleaving and coding on different frequency segments. This will enable the use of different MCS on different frequency segments. | Allow separate interleaving/coding/modulation per frequency segment. | Rejected.  We don’t see the need/benefit for multiple MCS at this point.  See multiple MCS discussion. |
| 606 | 244.00 | 23.3.10.8 | Design a single interleaver across frequency segments that will allow different modulation levels for each frequency segment. This will keep the code-rate the same, but change the signal constellation. | Interleaver needs to be redesigned. | Rejected.  We don’t see the need/benefit for multiple MCS at this point.  See multiple MCS discussion. |
| 735 | 244.00 | 23.3.10.8 | Design a single interleaver across frequency segments that will allow different modulation levels for each frequency segment. This will keep the code-rate the same, but change the signal constellation. | Interleaver needs to be redesigned. | Rejected.  We don’t see the need/benefit for multiple MCS at this point.  See multiple MCS discussion. |
| 736 | 266.13 | 23.6.4.4 | Table 23-31: Single TXPWR\_LEVEL and single MCS may not be sufficient for TVWS operation. Multiple power and multiple MCS's for multi-aggregated TVWS channel should be supported | FCC rules define depending on the combination of gelocation and channel location, the TX power could be varied from one channel to the other channel. Single TxPOW Level would not be sufficient. Single MCS would not be good for the multi-channel case where SINRs are highly fluctuated. | Rejected.  We don’t see the need/benefit for multiple MCS and power levels at this point.  See multiple MCS discussion. |
| 846 | 244.00 | 23.3.10.8 | Design a single interleaver across frequency segments that will allow for different modulation levels for each frequency segment. This will allow the code-rate the same, but for different signal constellations. | Redesign the interleaver to allow for different signal constellations for different frequency segments. | Rejected.  We don’t see the need/benefit for multiple MCS at this point.  See multiple MCS discussion. |
| 583 | 230.00 | 23.2.2 | Multiple MCS values should be added to Table 22-1 to support idependent MCS. | Due to regulations and/or realtime channel usage siutations, the conditions of available TV channels could be quite different from each other. Is it suitable to use a single MCS value, as shown in Table 22-1, for the PPDUs to be sent over multiple TV channels? | Rejected.  We don’t see the need/benefit for multiple MCS at this point.  See multiple MCS discussion. |
| 759 | 233.52 | 23.3.3 | Unlike in 802.11ac, unequal power transmission should be specified in 802.11af for cases where more than one frequency segment is used. For example, if one of the aggregated channels has a limitation of 40 mW (adjacent channel) and another channel has a limit of 100 mW, 802.11af should allow transmission of unequal power levels | Insert a multiplicative factor on each frequency segment prior to D/A to reflect difference in transmitted power. Alternatively, insert different TxPwrLevels for each channel/frequency segment in the TXVector | Rejected.  11ac operates in several different band where power limits vary much more than 40mW vs. 100mW.  The topic has been discussed in 11ac and the decision should uphold in 11af as well |
| 760 | 236.34 | 23.3.5 | For aggregated channels, It may be beneficial to allow unequal MCS, as unequal MCS is more efficient when conditions vary from channel to channel. | Insert 'Unequal MCSs may be applied to streams assigned to non-contiguous channels'. | Rejected.  We don’t see the need/benefit for multiple MCS at this point.  See multiple MCS discussion. |
| 588 | 233.00 | 23.3.3 | Simply using the PHY bonding of Clause 22 (same coding rate and modulation mode on aggregated channels) is not appropriate for the TVWS cases, where channel conditions are widely varied from channel to channel. | PHY bonding may not be optimum to support TVWS operation. | Rejected.  We don’t see the need/benefit for multiple MCS at this point.  See multiple MCS discussion. |
| 459 | 236.34 | 23.3.5 | For aggregated channels, It might be good to allow unequal MCS. Unequal MCS is more efficient when conditions varies from channel to channel. |  | Rejected.  We don’t see the need/benefit for multiple MCS at this point.  See multiple MCS discussion. |
| 732 | 236.34 | 23.3.5 | For aggregated channels, we need to add an option for independent MCS per channel, as described in 11-12-0924-00-00af-SNR\_Variance&Effects. Unequal MCS is more efficient when conditions varies from channel to channel. | Insert 'Unequal MCSs could be applied to streams assigned to non-contiguous channels'. | Rejected.  We don’t see the need/benefit for multiple MCS at this point.  See multiple MCS discussion. |
| 841 | 236.34 | 23.3.5 | As channel conditions in aggregated channels will typically vary is seems overly restrictive to not unequal MCS in aggregated channels. Unequal MCS should allow for more efficient channel use and higher throughput, if allowed. | Insert 'Unequal MCSs may be applied to streams assigned to non-contiguous channels'. | Rejected.  We don’t see the need/benefit for multiple MCS at this point.  See multiple MCS discussion. |
| 607 | 266.13 | 23.6.4.4 | Table 23-31: Single TXPWR\_LEVEL and single MCS may not be sufficient for TVWS operation. Multiple power and multiple MCS's for multi-aggregated TVWS channel should be supported | FCC rules define depending on the combination of gelocation and channel location, the TX power could be varied from one channel to the other channel. Single TxPOW Level would not be sufficient. Single MCS would not be good for the multi-channel case where SINRs are highly fluctuated. | Rejected.  We don’t see the need/benefit for multiple MCS and multiple power levels at this point.  See multiple MCS discussion. |
| 856 | 266.13 | 23.6.4.4 | FCC rules define the TX power depending on the combination of geolocation and channel location, in addition the TX power can vary depending on the specific frequency channel. A single TxPOW Level is not sufficient to allow for this variation. Also a single MCS applied to multiple aggregated channels does not allow for optimal throughput performance for the case where the SINRs fluctuate between channels. Therefore, multiple MCSs and TXPOW Levels should be supported for aggregated channels. Therefore, Table 23-31 should support Multiple TxPOWs and multiple MCSs for aggregated TVWS channels. | Table 23-31 should support Multiple TxPOWs and multiple MCSs for aggregated TVWS channels. | Rejected.  We don’t see the need/benefit for multiple MCS at this point.  See multiple MCS discussion. |
| 301 | 237.25 | 23.3.6 | Timing related parameters are very essential. It looks quite strange that instead of calculating and presenting those in table 23-3 only a reference is added to Table 22-5 with scaling factor. Specification | Define all timing parameters exactly | Rejected.  Clause 23 relies heavily on clause 22 for all detailed definitions including preamble description. All the essential parameters have been defined in table 23-3 and the rest can be directly inferred. The main idea of clause 23 is to point out the difference relative to clause 22 |
| 6 | 238.06 | 23.3.7 | Hard to read subclause 23.3.7, since modes 2C, 2N, 4C and 4N are new PHY modes, why not directly give the complete math equations? | Give math expressions for modes 2C, 2N, 4C, and 4N | Rejected.  The guiding principle in writing clause 23 is to only point out the difference relative to 11ac in order to make sure that the design has not changed relative to clause 22. |
| 404 | 238.06 | 23.3.7 | The mathematical description of signals is not clear. |  | Rejected.  The guiding principle in writing clause 23 is to only point out the difference relative to 11ac in order to make sure that the design has not changed relative to clause 22. |
| 436 | 238.06 | 23.3.7 | Please provide the related math equations for modes 2C, 2N, 4C and 4N. |  | Rejected.  The guiding principle in writing clause 23 is to only point out the difference relative to 11ac in order to make sure that the design has not changed relative to clause 22. |
| 46 | 45.06 | 8.4.1.48a | The whole subcluase is very difficult to follow. |  | Accepted modified.  The text describes a simple shift of the BF feedback tones by a constant which is dependent on the TVHT mode. There is no need to redefine the table as in clause 22 since the tone locations in clause 23 are identical for each frequency segment (unlike in clause 22) and based on the 40MHz clause 23 tone locations.  However, there is one mistake:  Change ‘table 23-7’ in line 3 page 43 to table 23-8 |
| 221 | 228.38 | 23.1.1 | Please make the use of 144 tones instead of 128 tones clearer in the specification. |  | Accepted.  Add in line 44: The choice of 144 and not 128 was made to reduce the PHY channel BW from 6MHz to 51/3MHz in order to allow shrper filtering to achieve 55dB ACLR. |
| 266 | 246.03 | 23.3.10.9.3 | The second sentence is not appropriate and redundant. |  | Accepted.  Change the text to "The segment deparser is not used in Clause 23 as no segment parser is used in Clause 23." |
| 762 | 239.62 | 23.3.7 | This 'Note' is implementation related. Do we really need to specify this in the spec? Moreover, TVHT\_2W is utilized in Table 23-5, while TVHT\_Mode\_2N is utilized in the 'Note'. It is not consistant. |  | Rejected.  The Note is copied from clause 22. |
| 134 | 45.27 | 8.4.48a | "sent in the lowest, second to lowest, second to highest and highest frequency segments are based on subtracting 216, subtracting 72, adding 72 and adding 216 from the values shown in table 8-53g respectively"    I understand the intent of not repeating stuff defined in .11ac, but the .11ac definitions are not going to change now, and this recipe is easy to misread. | Except where the change is trivial and self-evident, enumerate the subcarriers for TVHT in this subclause.    Ditto at 45.57 | Rejected.  See resolution to comment 46. |
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**Multiple MCS Discussion:**

802.11n has defined multiple QAM symbols sharing the same encoder for use in beamforming spatial multiplexing (closed loop MIMO) whereby the strongest streams use higher QAM and the weaker stream use lower QAM so as to better match the SNR seen by each spatial stream. However 802.11ac moved away from this complexity towards one MCS for all spatial streams.

This is somewhat similar to using different QAM size for different frequency domain channels. Enabling multiple QAM sizes or multiple MCS increases system complexity as far as estimating and reporting the preferred MCS and as far signalling the used MCS and is not inline with the spirit of 11ac design.

The following table looks at several unequal QAM sizes as in 802.11n and tries to estimate the gain compared to usage of one MCS.

For channels with around 6dB difference in SNR (the first 5 options) we see that as long as a system with one MCS can use one MCS higher than the minimum there is no gain from using two different QAM sizes.

For channels with around 12dB difference in SNR there could be som potential gain of up to 20% at best but such high SNR discrepancy is less likely.

To summarize, much more work is needed in order to establish that multiple MCS are indeed benficial and worth the increased complexity and we leave such work to next generation WiFi work if and when TGaf based products have gaining market share.

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| Two MCS on two Channels | Tput Gain over min MCS +1 |  |  |
| QPSK, 16QAM (coding ½) | 0% |  |  |
| QPSK, 16QAM (coding ¾) | 12.5% |  |  |
| 16QAM,64QAM (coding ¾) | -6.5% |  |  |
| 64QAM, 256QAM (coding ¾) | 5% |  |  |
| 64QAM, 256QAM (coding 5/6) | -2.8% |  |  |
|  | Tput Gain over max MCS over **one channel** | Tput Gain over next higher MCS relative to min | Tput Gain over next second higher MCS relative to min |
| QPSK,64QAM (coding ¾) | 20% | 50% | 0% |
| 16QAM, 256QAM (coding ¾) | 35% | 12.5% | 0% |
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