IEEE P802.11  
Wireless LANs

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| D2 Comment Resolution, brianh, part 6 | | | | |
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##### Baseline is 11ac D2.2. Changes indicated by a mixture of Word track-changes and instructions. For equation changes, Latex notation is sometimes used. E.g. a\_{xyz}^b denotes axyzb

PHY CID addressed: 4681, 4986, 5002, 5396

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| 4681 | 802.11ac throughput gains are mainly based on bandwidth increase. 80MHz transmission mode is the main difference with 802.11n. However, this mode is strongly dependant on the availability of channels. In busy environment, 802.11ac will not show any gains compared to 802.11n. | Non contiguous 40+40MHz mode should be included in 802.11ac in order to benefit from its high robustness to band saturation. | The 40+40 mode was addressed during SFD development, and the group decided that the value of 40+40 MHz did not merit inclusion in the SFD. Technical reasons were summarized in 11/1042r1 under CID 2938. With additional investigation, the reasons are more refined but the conclusion is the same, as follows:  1) Related docs 10/1159r1, 10/846r1, 10/1274r2 assume that the implementation cost of 40+40 is the same as 80, and find benefits for 40+40. However, this ignores the associated implementation costs. In particular, a STA with N spatial streams over 40+40 requires 2N RF chains and 2N sets of converters, so its complexity is actually comparable to 2N-SS 40 MHz, yet its spectral efficiency is only half as good. Thus 40+40 is not good direction for the industry  2) A 80/40+40-capable device will not be interoperable with an 80-only device. 40+40 is not an identical waveform to 80 when the two frequency segments are placed adjacent to each other, particularly at the mid-band. If a 40+40 device places its two 40 MHz wide RF chains adjacent to each other to communicate with an 80-only device, then it must use an 80 MHz PPDU, then effectively, each 40 MHz RF chain much operate with only 1 guard tone (corresponding to the 3 DC tones of 80).  This is not practical, and hence most 40+40 STAs would need a separate RF mode to support 80 MHz (since the existing contiguous 80MHz mode is mandatory): i.e. 40+40 or 80+off. This is a huge burden on implementation  Another option is to require 80 devices to support 40+40 tone allocation, but 40+40 devices would not have to support 80. But this is an additional burden on 80 devices and is a significant departure from the accumulated wisdom expressed by the SFD.  3) 40+40 (216 data tones) has lower throughput than 80 (234 data tones)  4) US has six 80 MHz channels. Japan has four 80 MHz channels, and we’ve recently discovered that Europe has five 80 MHz channels, and with modest regulatory changes, even six 80 MHz channels. (Albeit one 80 MHz channel is currently not available in some regulatory domains due to TDWR. TDWR is present in certain areas, but not everywhere, so a range of technical solutions may lead to mutually satisafactory sharing of this bandwidth in many areas). Even with three channels, we saw in 2.4 GHz that three channels works well.  5) 802.11ac offers 256QAM-rate5/6, up to 8 spatial streams, a single sounding protocol, and MU-MIMO. Each of these are important and valuable extensions to 802.11n, and deliver a capacity increase even in busy environments.  6) In several places in the draft, the bandwidth field is 2 bits and is optimized to carry up to 4 bandwidths (20, 40, 80, 160 and 80+80 where either 20 and 40 are lunped together or 160 and 80+80 are lumped together. How to retrofit additional bandwidth options to these fields is unknown in general, and certainly no proposal has been made. In particular, consider the problem of extending the CH\_BANDWIDTH\_IN\_NON\_HT field that is painfully inserted into 2 bits of the scrambling sequence of an 802.11a PPDU and consumes PAPR robustness for select MAC addresses.  Commenter is invited to re-submit the comment if they can present a feasible solution for a 40+40 device that can interoperate with a mainstream 20/40/80 MHz device, and  if they can also present a feasible solution for signalling a multitude of bandwidths across the range of 802.11ac frames and fields. |
| 4986 | The VHT PHY currently supports only 80+80 MHz non-contiguous channel widths. It will be useful to extend this for other channel width combinations while considering operations in overlapping BSSs, and for the greater flexibility. | Recommend adding non-contiguous channel bonding for lower channel widths (e.g., 20+ 20, 20+ 40, 40+40 MHz) | The 40+40 mode was addressed during SFD development, and the group decided that the value of 40+40 MHz did not merit inclusion in the SFD. Technical reasons were summarized in 11/1042r1 under CID 2938. With additional investigation, the reasons are more refined but the conclusion is the same, as follows:  1) Related docs 10/1159r1, 10/846r1, 10/1274r2 assume that the implementation cost of 40+40 is the same as 80, and find benefits for 40+40. However, this ignores the associated implementation costs. In particular, a STA with N spatial streams over 40+40 requires 2N RF chains and 2N sets of converters, so its complexity is actually comparable to 2N-SS 40 MHz, yet its spectral efficiency is only half as good. Thus 40+40 is not good direction for the industry  2) A 80/40+40-capable device will not be interoperable with an 80-only device. 40+40 is not an identical waveform to 80 when the two frequency segments are placed adjacent to each other, particularly at the mid-band. If a 40+40 device places its two 40 MHz wide RF chains adjacent to each other to communicate with an 80-only device, then it must use an 80 MHz PPDU, then effectively, each 40 MHz RF chain much operate with only 1 guard tone (corresponding to the 3 DC tones of 80).  This is not practical, and hence most 40+40 STAs would need a separate RF mode to support 80 MHz (since the existing contiguous 80MHz mode is mandatory): i.e. 40+40 or 80+off. This is a huge burden on implementation  Another option is to require 80 devices to support 40+40 tone allocation, but 40+40 devices would not have to support 80. But this is an additional burden on 80 devices and is a significant departure from the accumulated wisdom expressed by the SFD.  3) 40+40 (216 data tones) has lower throughput than 80 (234 data tones)  4) US has six 80 MHz channels. Japan has four 80 MHz channels, and we’ve recently discovered that Europe has five 80 MHz channels, and with modest regulatory changes, even six 80 MHz channels. (Albeit one 80 MHz channel is currently not available in some regulatory domains due to TDWR. TDWR is present in certain areas, but not everywhere, so a range of technical solutions may lead to mutually satisafactory sharing of this bandwidth in many areas). Even with three channels, we saw in 2.4 GHz that three channels works well.  5) 802.11ac offers 256QAM-rate5/6, up to 8 spatial streams, a single sounding protocol, and MU-MIMO. Each of these are important and valuable extensions to 802.11n, and deliver a capacity increase even in busy environments.  6) In several places in the draft, the bandwidth field is 2 bits and is optimized to carry up to 4 bandwidths (20, 40, 80, 160 and 80+80 where either 20 and 40 are lunped together or 160 and 80+80 are lumped together. How to retrofit additional bandwidth options to these fields is unknown in general, and certainly no proposal has been made. In particular, consider the problem of extending the CH\_BANDWIDTH\_IN\_NON\_HT field that is painfully inserted into 2 bits of the scrambling sequence of an 802.11a PPDU and consumes PAPR robustness for select MAC addresses.  In regards to 20+20 and 20+40, the same points apply, albeit to a slightly greater extent.  1) 20+20 is somewhat less spectrally efficient than 40 MHz, approaching twice as complex as an 802.11n implementation of the same spectral efficiency (due to the need to duplicate converters and RF chains), and slower than 802.11n, yet 802.11n does not suffer from a paucity of channels.  2) A feasible solution for how a 20+20, 20+40 and/or 40+40 device can interoperate with a mainstream 20/40/80 MHz device is unknown.  3) A feasible solution for how to signal the range of bandwidth modes proposed is unknown.  Commenter is invited to re-submit the comment if they can present a feasible solution for a 20+20,20+40 and/or 40+40 device that can interoperate with a mainstream 20/40/80 MHz device, and if they can also present a feasible solution for signalling a multitude of bandwidths across the range of 802.11ac frames and fields. |
| 5002 | my comments on previous ballot are not resolved , especially CID2125;PLEASE Cconsider2 non adjacent channels for 40 MHz ( 2X20 ) and 80(2X40)MHhzchannels . |  | CID2125 was resolved in 11/1479r2.  The 40+40 mode was addressed during SFD development, and the group decided that the value of 40+40 MHz did not merit inclusion in the SFD. With additional investigation, the reasons are more refined but the conclusion is the same, as follows:  1) Related docs 10/1159r1, 10/846r1, 10/1274r2 assume that the implementation cost of 40+40 is the same as 80, and find benefits for 40+40. However, this ignores the associated implementation costs. In particular, a STA with N spatial streams over 40+40 requires 2N RF chains and 2N sets of converters, so its complexity is actually comparable to 2N-SS 40 MHz, yet its spectral efficiency is only half as good. Thus 40+40 is not good direction for the industry  2) A 80/40+40-capable device will not be interoperable with an 80-only device. 40+40 is not an identical waveform to 80 when the two frequency segments are placed adjacent to each other, particularly at the mid-band. If a 40+40 device places its two 40 MHz wide RF chains adjacent to each other to communicate with an 80-only device, then it must use an 80 MHz PPDU, then effectively, each 40 MHz RF chain much operate with only 1 guard tone (corresponding to the 3 DC tones of 80).  This is not practical, and hence most 40+40 STAs would need a separate RF mode to support 80 MHz (since the existing contiguous 80MHz mode is mandatory): i.e. 40+40 or 80+off. This is a huge burden on implementation  Another option is to require 80 devices to support 40+40 tone allocation, but 40+40 devices would not have to support 80. But this is an additional burden on 80 devices and is a significant departure from the accumulated wisdom expressed by the SFD.  3) 40+40 (216 data tones) has lower throughput than 80 (234 data tones)  4) US has six 80 MHz channels. Japan has four 80 MHz channels, and we’ve recently discovered that Europe has five 80 MHz channels, and with modest regulatory changes, even six 80 MHz channels. (Albeit one 80 MHz channel is currently not available in some regulatory domains due to TDWR. TDWR is present in certain areas, but not everywhere, so a range of technical solutions may lead to mutually satisafactory sharing of this bandwidth in many areas). Even with three channels, we saw in 2.4 GHz that three channels works well.  5) 802.11ac offers 256QAM-rate5/6, up to 8 spatial streams, a single sounding protocol, and MU-MIMO. Each of these are important and valuable extensions to 802.11n, and deliver a capacity increase even in busy environments.  6) In several places in the draft, the bandwidth field is 2 bits and is optimized to carry up to 4 bandwidths (20, 40, 80, 160 and 80+80 where either 20 and 40 are lunped together or 160 and 80+80 are lumped together. How to retrofit additional bandwidth options to these fields is unknown in general, and certainly no proposal has been made. In particular, consider the problem of extending the CH\_BANDWIDTH\_IN\_NON\_HT field that is painfully inserted into 2 bits of the scrambling sequence of an 802.11a PPDU and consumes PAPR robustness for select MAC addresses.  Commenter is invited to re-submit the comment if they can present a feasible solution for a 40+40 device that can interoperate with a mainstream 20/40/80 MHz device, and if they can also present a feasible solution for signalling a multitude of bandwidths across the range of 802.11ac frames and fields. |
| 5396 | In draft 2.0, there is few chance to enjoy more than 1 Gbps transmission data rate due to not enough flexible frequency band usage. In addition, there are note effective methanisms to enhance the performance for OBSS scenario. |  | The 40+40 mode was addressed during SFD development, and the group decided that the value of 40+40 MHz did not merit inclusion in the SFD. With additional investigation, the reasons are more refined but the conclusion is the same, as follows:  1) Related docs 10/1159r1, 10/846r1, 10/1274r2 assume that the implementation cost of 40+40 is the same as 80, and find benefits for 40+40. However, this ignores the associated implementation costs. In particular, a STA with N spatial streams over 40+40 requires 2N RF chains and 2N sets of converters, so its complexity is actually comparable to 2N-SS 40 MHz, yet its spectral efficiency is only half as good. Thus 40+40 is not good direction for the industry  2) A 80/40+40-capable device will not be interoperable with an 80-only device. 40+40 is not an identical waveform to 80 when the two frequency segments are placed adjacent to each other, particularly at the mid-band. If a 40+40 device places its two 40 MHz wide RF chains adjacent to each other to communicate with an 80-only device, then it must use an 80 MHz PPDU, then effectively, each 40 MHz RF chain much operate with only 1 guard tone (corresponding to the 3 DC tones of 80).  This is not practical, and hence most 40+40 STAs would need a separate RF mode to support 80 MHz (since the existing contiguous 80MHz mode is mandatory): i.e. 40+40 or 80+off. This is a huge burden on implementation  Another option is to require 80 devices to support 40+40 tone allocation, but 40+40 devices would not have to support 80. But this is an additional burden on 80 devices and is a significant departure from the accumulated wisdom expressed by the SFD.  3) 40+40 (216 data tones) has lower throughput than 80 (234 data tones)  4) US has six 80 MHz channels. Japan has four 80 MHz channels, and we’ve recently discovered that Europe has five 80 MHz channels, and with modest regulatory changes, even six 80 MHz channels. (Albeit one 80 MHz channel is currently not available in some regulatory domains due to TDWR. TDWR is present in certain areas, but not everywhere, so a range of technical solutions may lead to mutually satisafactory sharing of this bandwidth in many areas). Even with three channels, we saw in 2.4 GHz that three channels works well.  5) 802.11ac offers 256QAM-rate5/6, up to 8 spatial streams, a single sounding protocol, and MU-MIMO. Each of these are important and valuable extensions to 802.11n, and deliver a capacity increase even in busy environments.  6) In several places in the draft, the bandwidth field is 2 bits and is optimized to carry up to 4 bandwidths (20, 40, 80, 160 and 80+80 where either 20 and 40 are lunped together or 160 and 80+80 are lumped together. How to retrofit additional bandwidth options to these fields is unknown in general, and certainly no proposal has been made. In particular, consider the problem of extending the CH\_BANDWIDTH\_IN\_NON\_HT field that is painfully inserted into 2 bits of the scrambling sequence of an 802.11a PPDU and consumes PAPR robustness for select MAC addresses.  Commenter is invited to re-submit the comment if they can present a feasible solution for a 40+40 device that can interoperate with a mainstream 20/40/80 MHz device, and if they can also present a feasible solution for signalling a multitude of bandwidths across the range of 802.11ac frames and fields.  The OBSS scenario is a very broad topic, and more guidance in the comment would be helpful. Given the context, assume this is the multi-channel OBSS scenario. Here, the available mechanisms include a) more sensitive mandatory secondaryX CCA (up to 13 dB better than 802.11n) for addressing OBSS at the individual PPDU timescale, b) RTS/CTS enhanced with bandwidth indication for addressing OBSS at the individual PPDU timescale, c) the VHT Operating Mode Notification frame as a low-overhead means to reduce bandwidth and avoid OBSS interference at the 100+ millisecond timescale and d) channel selection rules to avoid the secondary20 of an >=80 MHz BSS and the secondary40 of a 160/80+80 MHz BSS at the 1day++ timescale. These comprise a broad and thorough set of OBSS mechanisms. Other mechanisms have been considerd but proved not to be feasible.  Commenter is invited to re-submit the comment if they can present a feasible solution for an OBSS mitigation proposal. |