### **IEEE P802.11Wireless LANs**

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| Comment Resolutions on MC-OOK On Symbols |
| Date: 2019-09-18 |
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**Abstract**

The document provides comment resolutions for CIDs: 3064, 3304, 3305 and 3383.

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| **CID** | **Clause** | **Page/Line** | **Comment** | **Proposed Change** | **Resolution** |
| 3064 | 30.3.4.1 | 139/139 | There is no requirement on tendency ON waveforms (in SYNC, HDR or LDR ON periods) to cause false preamble detections in 802.11a/n/g/ac/ax receivers. For example, Low Data Rate waveform Example 1 in Annex AC has a high 800ns autocorrelation peak. Autocorrelation is the prevalent method to detect OFDM waveforms. | Require that ON waveforms have autocorrelation metric of 0.5 or less. | **Revised**TGba Editor makes changes as shown in IEEE 802.11-19/1171r3 |
| 3304 | Annex AC | 180/18 | Recommended sequences for the 4us MC-OOK On Symbol are provided in Table AC-2. Recently it has been discovered that STAs operating in non-WUR mode will frequently falsely detect the LDR Data Field, constructed with any of these recommended sequences, as an L-STF causing the STA to think it has detected a non-WUR PPDU. This can have a negative impact on the STA operation. | I will prepare a presentation describing this issue in more detail and provide a recommended text change. | **Revised**TGba Editor makes changes as shown in IEEE 802.11-19/1171r3 |
| 3305 | Annex AC | 179/33 | Recommended sequences for the 4us MC-OOK On Symbol are provided in Table AC-2. Recently it has been discovered that STAs operating in non-WUR mode will frequently falsely detect the LDR Data Field, constructed with any of these recommended sequences, as an L-STF causing the STA to think it has detected a non-WUR PPDU. This can have a negative impact on the STA operation. | I will prepare a presentation describing this issue in more detail and provide a recommended text change. | **Revised**TGba Editor makes changes as shown in IEEE 802.11-19/1171r3 |
| 3383 | Annex AC | 179/15 | Receivers may false detect these WUR MC-OOK symbols as L-STF. | Update the WUR symbols to reduce false detection as L-STF. | **Revised**TGba Editor makes changes as shown in IEEE 802.11-19/1171r3 |

**Discussion**

In [1] we show that the narrowband portion of the WUR PPDU may falsely trigger the L-STF detector of STAs not operating in WUR mode. This was confirmed independently in [2].

We showed [1] that the MC-OOK On Symbols must be chosen so that the autocorrelation metric is sufficiently low to avoid this problem. We show that Examples 1 and 2 in Table AC-1, for 2 µs On Symbols, have low autocorrelation metric values while Example 3 does not. We also show that all three examples in Table AC, for 4 µs On Symbols, have high autocorrelation metric values. These high autocorrelation metric values cause high false alarm rates in the L-STF detector simulations.

Our proposal is to add a new transmitter specification based on the correlation metric to avoid false L-STF detection in a non-WUR receiver, due to an 802.11ba PPDU. We also propose to change some of the example MC-OOK symbols in Annex AC.

1. Steve Shellhammer, et. al., “False L-STF Detection Issue,” IEEE 802.11-19/1120r0, July 2019
2. Miguel Lopez and Leif Wilhelmsson, “Study of False L-STF Detections Triggered by MC-OOK,” IEEE 802.11-19/1178r0, July 2019

**Proposed Resolution**

TGba Editor make the following changes to Draft 3.1,

* WUR Basic PPDU waveform generation for WUR-Sync field and high data rate WUR-Data field

For the WUR-Data field, the sequence generation block generates the WUR encoded bits. For the WUR-Sync field, the sequence generation block outputs the WUR-Sync sequence.

For a single 20 MHz WUR channel, the 2 µs duration MC-OOK On symbol should be constructed by the On-WG using center 13 subcarriers of a 64-point IDFT, sampling at 20 MHz as follows:

* The six subcarriers with subcarrier indices *k* = (-6, -4, -2, 2, 4, 6) are used with non-zero input. Other subcarriers are null.
* The non-zero subcarriers are selected from any of the following constellations: BPSK, QPSK, 16-QAM, 64-QAM, and 256-QAM.
* The first 32 values of the 64-point IDFT output are selected.
* Those 32 values are processed by the Symbol Randomizer as described in 30.3.4.4 (Symbol Randomizer and Per-transmit chain Cyclic Shift).
* The last 8 samples of those 32 samples are prepended to the 32 samples generating 40 samples, representing the 2 µs duration MC-OOK On symbol. This step corresponds to the GI Insertion in Figure 30-6 (An example of an On-WG for the WUR-Sync and high data rate WUR-Data fields).

For a single 20 MHz WUR channel, the 2 µs duration MC-OOK Off symbol should be constructed by the Off-Waveform Generator (Off-WG) as zero for 2 µs.

With the 2 µs duration MC-OOK On and Off symbols the PPDU should meet the Correlation Test in Subclause 30.2.12.15

* WUR Basic PPDU waveform generation for low data rate WUR-Data field

For a single 20 MHz WUR channel the 4 µs duration MC-OOK On symbol should be constructed by the On-WG using center 13 subcarriers of a 64-point IDFT, sampling at 20 MHz as follows:

* The 12 subcarriers with subcarrier indices *k* = (-6, -5, … -1, 1, 2, … 6) are used with non-zero input. Other subcarriers are null.
* The non-zero subcarriers are selected from any of the following constellations: BPSK, QPSK, 16-QAM, 64-QAM, and 256-QAM.
* The 64 values from the 64-point IDFT are processed by the Symbol Randomizer as described in 30.3.4.4 (Symbol Randomizer and Per-transmit chain Cyclic Shift).
* The last 16 values of the 64-point IDFT output are prepended to the 64 samples generating 80 samples, representing the 4 µs duration MC-OOK On symbol. This step corresponds to the GI Insertion in Figure 30-7 (An example of an On-WG for the low data rate WUR-Data fields).

For a single 20 MHz WUR channel the 4 µs duration MC-OOK Off symbol should be constructed by the Off-Waveform Generator (Off-WG) as zero for 4 µs.

With the 4 µs duration MC-OOK On and Off symbols the PPDU should meet the Correlation Test in Subclause 30.2.12.15

TGba Editor, add a new section after subclause 30.3.12.4

**30.3.12.5 Correlation Test on MC-OOK Symbols**

We define an autocorrelation metric indicative of that used for L-STF detection in non-WUR receivers. The correlation metric is given in Equation (30-XYZ),

 $C\left(n\right)= \left|\left(\frac{N}{N-1}\right)\frac{\sum\_{k=0}^{M\left(N-1\right)-1}x\left(n+k\right)x^{\*}(n+k+M)}{\sum\_{k=0}^{MN-1}\left|x\left(n+k\right)\right|^{2}}\right|$ (30-XYZ)

Where $M = 16$, which is the number of samples in an 800 ns time period, sampled at 20 MHz. Also, $N=6$, which is the number of 800 ns time periods over which the correlation metric is calculated.

This metric is calculated over the WUR-Sync and WUR-Data fields, at a sampling rate of 20 MHz using the MC-OOK symbols. Hence the value of $n$ spans from the beginning of the WUR-Sync field to the end of the WUR-Data field. The PPDU should be tested for both the LDR and HDR with a 6-byte data field of random data. The maximum value of the correlation metric should be less than 0.4.