IEEE P802.11  
Wireless LANs

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| LS to 3GPP RAN4 on SIR for below ED tests | | | |
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Abstract

This document contains a Liaison Statement from IEEE 802 to 3GPP RAN4 related to LAA/802.11 coexistence tests. Version 02 of this document was approved by the IEEE 802.11 Working Group on Wednesday, 10 May 2017, with the IEEE 802.11 WG Chair given authority to make editorial changes. Version 03 contains a variety of minor editorial changes.

**TO:**

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**SUBJECT:** Open issues related to the definition of LAA/802.11 coexistence tests in 3GPP RAN4.

**DATE:** 10 May 2017

Dear Chairman of 3GPP RAN4,

This Liaison Statement (LS) from the IEEE 802.11 Working Group (WG) is in relation to the definition of LAA/802.11 coexistence tests currently being discussed in 3GPP RAN4.

The IEEE 802.11 WG has reviewed the outcome of the LAA/802.11 coexistence test discussions from the previous 3GPP RAN4 meeting (RAN4#82bis, 03-07/April/2017) as summarized in [1] and [2].

1. The IEEE 802.11 WG notes that 3GPP RAN4 has agreed on a configuration for the “Above ED” test - i.e. a configuration where the link between the 802.11 AP and the LAA eNB is above the LAA Energy Detection (ED) threshold of −72dBm. For this test, 3GPP RAN4 has specified the signal levels of the relevant links as follows: AP-client: −57dBm, AP-eNB: −67dBm, eNB-client: −67dBm.
2. The IEEE 802.11 WG also notes that 3GPP RAN4 has not yet agreed on a configuration for the “Below ED” test - i.e. a configuration where the link between the 802.11 AP and the LAA eNB is below the LAA ED threshold of −72dBm.
3. The IEEE 802.11 WG notes, based on the documentation in [1] and [2], that the following configurations have been proposed for the “Below ED” test:
   1. AP-Client: −70dBm, AP-eNB: −80dBm, eNB-Client: −80dBm
   2. AP-Client: −80dBm, AP-eNB: −80dBm, eNB-Client: −80dBm

In such case that the 802.11 and LAA systems interfere with one another by transmitting simultaneously, the first configuration would result in an SIR of 10 dB, while the second configuration would result in an SIR of 0 dB at the 802.11 client and the LAA UE.

1. The IEEE 802.11 WG requests 3GPP RAN4 to kindly consider the following comments in relation to the above mentioned “Below ED” test configurations:
   1. In order for the test to be sufficiently robust, the selected configuration must closely model the configuration of deployed 802.11 networks. In this respect, the IEEE 802.11 WG requests 3GPP RAN4 to kindly note the following:
      1. Both proposed configurations set the 802.11 AP-Client link at −70dBm or lower.
      2. It is known that in uncoordinated multi-operator environments typical of many public 802.11 deployments, a significant proportion of AP-Client links at levels at or around  
          −70dBm or lower operate with a geometry SIR < 0dB. Such 802.11 links are able to operate only due to 802.11 transmitters backing off and sharing the channel in an equitable manner. Had 802.11 transmitters not backed off and caused simultaneous transmissions, all of these weak 802.11 links likely would have been degraded to the point of being inoperable.
      3. Even in the case of highly managed 802.11 deployments, e.g. 802.11 networks that are RF planned and optimized by a single operator and are also largely free of external interference, there are a significant proportion of 802.11 links with SIR < 0dB. For example, measured network data presented to 3GPP RAN4 in [3] shows the following:
         1. Indoor Large Enterprise single operator network: All 802.11 links < −62dBm have a geometry SIR < 0dB. Further, such links comprise about half of all the 802.11 links in the network.
         2. Outdoor Large Stadium single operator network: The median 802.11 link is about −74dBm and all links below −72dBm have a geometry SIR < 0dB.
   2. The “Below ED” test represents a configuration where the LAA eNB and 802.11 AP might fail to sense transmissions from each other via energy detection. This is a “hidden node” scenario. In such scenarios, fair channel sharing might be achieved via other means, such as by contention window adaptation mechanism or by adapting transmissions based on channel occupancy or RSSI of the channel or by adapting the energy detection threshold. Such mechanisms are supported by both LAA and 802.11 specifications. Note that an LAA/802.11 configuration may have more hidden nodes than an 802.11/802.11 configuration due to LAA using an ED threshold of −72dBm and 802.11 using an ED threshold of −62dBm and a PD threshold of −82dBm. Therefore, it is essential to test LAA/802.11 coexistence in the presence of such hidden nodes.
      1. An SIR = 0dB will ensure that in such a hidden node scenario, simultaneous transmissions from LAA and 802.11 are highly likely to result in collisions that lead to packet errors that activate some or all of the mechanisms referred to above. For example, packet errors will cause both LAA and 802.11 to increase their respective contention windows which in in turn should exponentially reduce the probability of the next collision and can help in fair channel sharing between LAA and 802.11.
      2. On the contrary, SIR = 10dB will mask the effect of hidden nodes by artificially mitigating the effect of collisions and reducing packet errors. As a result, fair sharing mechanisms such as those described above that are designed for operation below the ED threshold will not be tested. Also importantly, any failure to share the channel fairly under such hidden node scenarios that are known to exist in deployed 802.11 networks and are expected to be much more common in LAA/802.11 networks would escape detection.
      3. An SIR = 10dB converts the coexistence test from a “hidden node” scenario into a “spatial reuse” scenario as collisions due to simultaneous transmissions from LAA and 802.11 are converted into a reuse configuration where both LAA and 802.11 links are able to support significant throughput even in the presence of simultaneous transmissions. Please note the following in this regard:
         1. It is critical to test the hidden node scenario for LAA/802.11 coexistence, since for reasons described above such configurations are expected to be common for LAA/802.11 networks. Not defining a test for such a scenario will mean that any failure to coexist fairly due to inadequate or improper implementation of the mechanisms designed for such a scenario, will not be detected and corrected in the testing phase and will rather arise in deployments with much more serious consequences.
         2. Spatial reuse is also a possible scenario in a network deployment. However, spatial reuse is not an unconditional scenario, since the benefit of spatial reuse is dependent on the transmitters being aware of the likelihood and level of cross-interference caused at the victim receivers. “Blind” spatial reuse, i.e. uncoordinated simultaneous transmission without any knowledge of the cross-interfering links at the victim receivers, as would happen in a mixed LAA/802.11 configuration, cannot be expected to be robust in deployed networks. Further, a simple two transmitter model, as has been defined for the coexistence tests in 3GPP RAN4 with spatial reuse induced artificially by means of a high SIR will not adequately model the complexity of spatial reuse in a deployed network, especially for a mixed technology LAA/802.11 network.

Considering the above, it is the IEEE 802.11 WG’s view that a coexistence test at SIR = 0dB more closely models the SIR configuration of deployed 802.11 networks, is able to more effectively exercise channel access mechanisms that are required to ensure fair channel access in the “Below ED” configuration and is more robust to errors, measurement uncertainty, test tolerances and variability in the test setup than a test at SIR = 10dB.

Given this, the IEEE 802.11 WG strongly recommends 3GPP RAN4 consider an SIR level of 0 dB for the “Below ED” test configuration. Such a test will increase the likelihood that coexistence issues, if there are any, are detected at the test phase and do not arise in deployments.

The IEEE 802.11 WG looks forward to a continued and productive interchange between our two organizations on these and other issues during the development of LAA and beyond.

**Action to 3GPP RAN4: the IEEE 802.11 WG recommends 3GPP RAN4 consider an SIR level of 0 dB for the “Below ED” test configuration.**

**Next IEEE 802.11 WG meetings:**

* 9-14 July 2017 in Berlin, Germany
* 10-15 September 2017 in Hawaii, USA.

Regards,

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# References

1. R4-1704409, WF on Multi-node tests for Rel-13 LAA
2. R4- 1704501 RAN4#82bis Meeting Report
3. R4-1701879, Further Implications of Wi-Fi Field Measurements for Multi-Node Testing
4. 3GPP TS 36.141 V14.2.0 (2016-12), Base Station (BS) conformance testing