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| Proposed draft for a LS to 3GPP RAN4 related to LAA/802.11 coexistence tests |
| Name | Affiliation | Phone | Email |
| Vinko Erceg | Broadcom |  | vinko.erceg@broadcom.com |
| Thomas Derham | Broadcom |  | thomas.derham@broadcom.com |
| Michael Montemurro | BlackBerry |  | mmontemurro@blackberry.com |
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|  |  |  |  |
| Andrew Myles | Cisco |  | amyles@cisco.com |

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Abstract

This document contains a proposed draft for a Liaison Statement from IEEE 802 to 3GPP RAN4 related to LAA/802.11 coexistence tests

This version is unapproved

**TO:**

* Xutao Zhou, 3GPP TSG RAN WG4 Chair, xutao.zhou@samsung.com

**CC:**

* Susanna Kooistra, 3GPP Liaison Coordinator, susanna.kooistra@3gpp.org
* John D’Ambrosia, IEEE 802 Recording Secretary, JAmbrosia@gmail.com
* Steve Shellhammer, IEEE 802.19 Coexistence WG Chair, shellhammer@ieee.org
* Paul Nikolich, IEEE 802 LAN/MAN Standards Executive Committee p.nikolich@ieee.org

**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 from IEEE 802.11 Working Group is in relation to the definition of LAA/802.11 coexistence tests in 3GPP RAN4.

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. 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 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. 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. 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 concurrently, 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. IEEE 802.11 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, IEEE 802 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 parallel transmissions, all of these weak 802.11 links 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, parallel 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 parallel 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 parallel 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 would 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 parallel 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 model the complexity of spatial reuse in a deployed network, especially for a mixed technology LAA/802.11 network.
	3. The proposed SIR configurations must also be evaluated from the perspective of robustness to measurement uncertainty, test tolerances and variability in device performance. The SIR should be chosen such that it ensures a robust test for coexistence even in the presence of the largest probable error margin. For example, the proposed coexistence test and related tests in RAN4 have the following margins/uncertainties:
	* The test for LAA Energy Detection threshold specifies a signal margin of +4dB and a detection tolerance of 10% ([4]).
	* The LAA/802.11 coexistence tests have a tolerance of 10%.
	* Variation in calibrating the signal levels of the different links configured in the test.
	* The coexistence tests propose to use a multitude of 802.11 devices across different versions of 802.11 which can lead to further variations in test output.

All of the above can increase the SIR realized by the test to a value higher than the configured SIR. So, in case the configured SIR is already high, such errors can make the coexistence test more ineffective.

Considering the above, it is IEEE 802.11’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, IEEE 802.11 strongly recommends 3GPP RAN4 to consider an SIR level of 0 dB for the “Below ED” test configuration. Such a test will ensure that coexistence issues, if there are any, are detected and corrected at the test phase and do not arise in deployments. This will also assure the broader 802.11 and LAA community that LAA devices that pass the test will coexist fairly with deployed 802.11 networks and facilitate deployment of LAA devices without concern and to the benefit of both the LAA and 802.11 communities. On the contrary, a weaker test of coexistence will not provide such an assurance, and could result in 802.11 and LAA operators having to define their own tests outside the scope of RAN4 in order to address their requirements to ensure robust coexistence. This would defeat the very purpose of the tests being defined in 3GPP RAN4.

IEEE 802.11 looks forward to a continued and productive interchange between our two organizations on these and other issues during the development of LAA and beyond. The next two IEEE 802.11 meetings are scheduled for 9-14 July 2017 in Berlin, Germany and 10-15 September in Hawaii, USA.

Regards,

Adrian Stephens,
Chairman, IEEE 802.11 Working Group
adrian.p.stephens@ieee.org

# References

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4. 3GPP TS 36.141 V14.2.0 (2016-12), Base Station (BS) conformance testing