**3GPP TSG RAN WG1 #89 R1-1709854**

**May 15th to 19th 2017**

**Hangzhou, China**

**Title:** Response LS to IEEE 802 regarding LAA

**Release:** Release 13

**Work Item:** LTE\_LAA

**Source:** RAN1, RAN4

**To:** IEEE 802 LAN/MAN Standards Committee, RAN

**Cc:**

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**Attachments:**

**1. Overall Description:**

3GPP RAN1 would like to thank IEEE 802 LMSC for their LS (**IEEE EC-17-0065-00-00EC/R1-1706127**) on the following subject “Liaison Statement to 3GPP RAN/RAN1: IEEE 802 response to 3GPP RAN1 LS dated November 2016 (R1-1613770)”.

In response 3GPP RAN1 would like to provide the following information.

**IEEE Issue 1**:

IEEE 802 suggested in its Liaison Statement to 3GPP RAN1 dated 18 March 2016 (IEEE 802 19-16-0037-09-0000-laa-comments.pdf) that LAA should be modified to avoid sending energy for the primary purpose of blocking access to the channel to others. IEEE 802 continued to argue for this important principle in its Liaison Statement to 3GPP RAN1 dated 1 August 2016 (IEEE 802 EC-16-0140-01-00EC). In the same Liaison Statement, IEEE 802 suggested (Response 1.1) a compromise solution whereby the LAA Rel. 13 specification is modified to include a recommendation that implementations should avoid transmitting any signals in a channel between the time a device obtains access to the channel using LBT Category 4 and the time of the next subframe or partial subframe boundary. As an alternative, IEEE 802 suggested (Response 1.2) that 3GPP RAN1 define additional partial subframe starting positions in LAA Rel. 13, so that the need to send reservation signals is minimized.

3GPP RAN1 responded to IEEE 802 in its Liaison Statement to IEEE 802 dated November 2016 (3GPP R1-1613770). In the first part of its response, 3GPP RAN1 asserted that such reservation signals represent legitimate overhead. However, 3GPP RAN1 also notified IEEE 802 that there is discussion of adding a statement in 36.300 to minimize the transmission of such signals. In the second part of its response, 3GPP RAN1 noted that shortened TTI candidates may be incorporated into FS3 for LAA in the future as a follow on from the current work to add 2-symbol, 4-symbol and 1-slot TTI to Release 14 for FS1 and FS2.

IEEE 802 does not agree that reservation signals are legitimate overhead, at least partially based on 3GPP RAN1’s assertion in a previous Liaison Statement to IEEE 802 that deferring sending energy until a subframe boundary or partial subframe boundary provided good LAA performance. This assertion highlights the unnecessary nature of these reservation signals thus emphasizing their illegitimacy in unlicensed spectrum. However, IEEE 802 is pleased that 3GPP has decided (3GPP RP-170848) to adopt IEEE 802’s suggestions for a recommendation to avoid the use of reservation signals by making LAA to include more partial sub-frame starting positions (albeit not in LAA Rel. 13/14). IEEE 802 now believes that this issue is heading towards consensus based on 3GPP RAN1’s efforts to minimize the time between the time a device obtains access to the channel and the next sub-frame. In the meantime, IEEE 802 requests that:

* 3GPP RAN1 provide a copy of the proposed statement in 36.300 as soon as it is available for IEEE 802’s consideration and comment
* 3GPP RAN1 notify IEEE 802 on the progress of the work item to incorporate multiple starting positions for LAA along with the granularity of these positions
* 3GPP RAN1 confirm that the use of multiple starting positions by LAA will be made mandatory to minimize transmission of reservation signals
* 3GPP RAN1 reconsider fair coexistence with 802.11 if LAA systems are modified as part of this work item.

IEEE 802 also thanks 3GPP for clarifying that the usage of partial sub-frames does not make HARQ operation

inefficient.

**RAN1 response 1:**

As stated in the previous LS response to IEEE 802.11 (R1-1613770) as well and reiterated in this response, RAN1 views the transmission of signals transmitted between the time a device obtains access to the channel using LBT Category 4 and the time of the next subframe or partial subframe boundary as overhead. Any system has many different forms of overhead. While minimization of overhead is one of the design goals of any system, RAN1 also recognizes that there are many benefits to be obtained by a time synchronized transmission from a system performance perspective and leaves the flexibility and choice of transmission of such signals to an implementation in some operating conditions where its benefits can be overcome the costs of such a transmission.

RAN1 again reiterates that the LAA specification does not specify the transmission of such signals and defines the eNB Cat 4 LBT procedure so that the eNB may explicitly avoid the transmission of such signals by defining a self-deferral procedure to enable channel access exactly at the medium boundary.

Furthermore, RAN1 notes that RAN plenary has approved a new work item (RP-170848) on LAA in Rel-15 with the specific objective of specifying multiple start positions for initial and end partial subframes for both DL and UL to enable more efficient medium occupancy and reduce the overhead.

From RP-170848:

“… Further enhancements to efficiency of the LTE design for unlicensed spectrum should be addressed, including scheduling enhancements allowing for reduced control signalling overhead and more efficient channel occupancy.

……

The detailed objectives of the work item are to specify support for the following functionalities:

* Specify support for multiple starting and ending positions in a subframe for UL and DL on SCell with Frame structure type 3. [RAN1, RAN2, RAN4]

… “

Currently, the Rel-15 LAA work item is expected to be completed in RAN1 in Dec 2017 with RAN2 and RAN4 work to be completed within a few quarters thereafter. RAN1 has so far agreed to specify at least one additional UL start and at least one additional UL ending position (ending transmission at symbol 6 of a subframe) as well as not specifying any additional DL ending positions on top of the Rel-13 options of ending in symbol 3,6,9,10,11,12 and 14. For the UL partial subframes, it was agreed that two modes of operation would be supported: Mode 1 in which UE may decide on the starting point of transmission depending on the outcome of LBT and Mode 2 in which the UL grant indicates the start position to be the second slot of the subframe.

RAN1 notes that all the specified initial and end DL partial subframes in Rel-13 are optional for UE implementation. Rel-14 does not specify any UL end partial subframes. The discussion of mandatory and optional features for Rel-15 (and for any release in general) happens at the end of each release at which time further information could be provided on which start and end positions for DL and UL transmissions are mandatory for Rel-15 LAA capable UEs.

**IEEE Issue 2:** There is consensus on Issue 2: “Transmission of Discovery Reference Signals should be clearly bounded to avoid excess airtime overhead on unlicensed spectrum” but final resolution will depend on satisfactory field experience

IEEE 802 expressed a concern in its Liaison Statements to 3GPP RAN1 dated 18 March 2016 (IEEE 802 19-16-0037-09-0000-laa-comments.pdf) and 1 August 2016 (IEEE 802 EC-16-0140-01-00EC) that there was the potential for excessive DRS overhead with short LBT periods. IEEE 802 requested that 3GPP RAN1 define much tighter constraints on the DRS overhead in LAA Rel. 13.

3GPP RAN1 responded to this concern in its Liaison Statement to IEEE 802 dated November 2016 (3GPP R1-1613770). It noted that the DRS limit agreed in 3GPP RAN1 is only a strong upper bound for the amount of time to be used with 25us LBT, and that it is 3GPP RAN1’s expectation that most DRS will be transmitted using Cat 4 LBT access.

It appears there is consensus between IEEE 802 and 3GPP RAN1 that the use of 25us LBT access for DRS should be limited. IEEE 802 is willing to accept 3GPP RAN1’s expectation that it will be limited in practice, subject to satisfactory experience in field deployments.

**RAN1 response 2:**

RAN1 thanks IEEE 802 for its understanding.

**IEEE Issue 3:** There is not consensus on Issue 3: “Radio equipment in unlicensed spectrum should detect neighboring networks with sufficient sensitivity to ensure fair coexistence” but successful RAN4 testing before deployment may lead to resolution.

Issue 3 is addressed in a separate Liaison Statement from IEEE 802 (https://mentor.ieeeorg/802-ec/dcn/17/ec-17-0064-00-00EC-802-to-3gpp-ran-ran1-ran4-liaison-statement.pdf). There is not yet consensus on this issue, but resolution is possible based on the completion of suitable test plans by 3GPP RAN4 and the successful execution of those test plans on LAA systems with satisfactory results before their deployment.

**RAN1 response 3:**

RAN1 thanks IEEE 802 for its understanding.

RAN1 once again notes that ETSI BRAN with the active participation of several stakeholders from IEEE 802 and LAA communities and including regulatory bodies of several countries has also agreed to an ED threshold level -72dBm in the latest version of the harmonized standard EN 301 893 [3] applicable to all equipment transmitting in the 5GHz unlicensed spectrum including potentially 802.11ax devices.

RAN4 is currently expected to complete the TR on multi-node coexistence by June 2017.

**IEEE issue 4:** There is not consensus on Issue 4: “LAA and IEEE 802.11 slot boundaries should align as accurately as possible to preserve spectral efficiency in unlicensed spectrum” but resolution can result from satisfactory RAN4 testing before deployment.

IEEE 802 highlighted several issues related to slot synchronization in its Liaison Statement dated 1 August 2016 (IEEE 802 EC-16-0140-01-00EC). In particular, IEEE 802 noted that in the absence of slot synchronization the system will be more like ALOHA rather than slotted-ALOHA. IEEE 802 suggested that the situation would be improved by LAA detecting 802.11 preambles or finer grained energy detection. Finally, IEEE 802 explained why the SI simulations cannot reasonably be used to draw any conclusions about the details of LAA Rel. 13 coexistence with IEEE 802.11.

3GPP RAN1 responded in its Liaison Statement to IEEE 802 dated November 2016 (3GPP R1-1613770). 3GPP RAN1 noted that good slot synchronization between LAA and 802.11 is only possible if all systems transmit and receive 802.11 preambles and NAVs, but also notes that this would not be technology neutral. IEEE 802 agrees that this is best solution for slot synchronization and thus fair and efficient use of the spectrum. Further, IEEE 802 asserts such a solution is “technology neutral” if it is the only way to achieve these goals.

3GPP RAN1 also challenged IEEE 802’s comments about the efficacy of the SI simulations to prove LAA and 802.11 fairly coexist in any cases beyond the very simple indoor scenario with the known limitations of the chosen propagation model. IEEE 802 does not believe it is productive to argue further about simulations and associated assumptions at this point.

IEEE 802 notes that RAN4 has decided on the development of a set of coexistence test cases including multi-node tests to verify the coexistence between LAA and IEEE 802.11 devices in various scenarios. IEEE 802 requests that the question of the effect of lack of slot synchronization be examined in these coexistence tests, as well as in actual deployment scenarios. IEEE 802 requests that 3GPP define and perform the RAN4 tests to verify coexistence between LAA and IEEE 802.11, before deployment of any LAA systems.

**RAN1 response 4:**

RAN1 notes that in all the simulations that have been presented in 3GPP RAN1 as part of the LAA study item, Rel-13 and Rel-14 LAA and as part of ETSI BRAN 5GHz harmonization, any coexistence concerns that can be attributed to slot synchronization have not been identified. In addition, as RAN1 has already noted in its previous LS response (R1-1613770), transmitting and receiving 802.11 preambles requires the eNB to implement several aspects of the PHY and MAC processing chain of 802.11 devices and imposes an undue burden on the eNB.

RAN1 notes that the coexistence testing being studied in RAN4 already considers the effect of slot synchronization in the normal course of eNB operation and does not believe anything specific needs to be considered to test this aspect.

**IEEE issue 5:** There is not consensus on Issue 5: “LAA and 802.11 multi-channel aggregation schemes should align” issue with resolution waiting for 3GPP response.

IEEE 802’s Liaison Statement to 3GPP RAN1 dated 18 March 2016 (IEEE 802.19-16-0037-09-0000-laacomments.pdf) observed in relation to Issue 5 that non-contiguous and/or differently aligned use of spectrum causes each LAA eNB to impact multiple 802.11 networks. IEEE 802 suggested that LAA should align its multichannel aggregation scheme with 802.11.

3GPP RAN1’s response to this comment was included in 3GPP RAN1’s Liaison Statement dated 7 June 2016 (R1-166041). The response rejected IEEE 802’s request on the basis that its adoption would reduce LAA performance, as well as 802.11 performance.

In IEEE 802’s subsequent Liaison Statement to 3GPP RAN1 dated 1 August 2016 (IEEE 802 EC-16-0140-01-00EC) IEEE 802 pointed out that because 802.11 multi-carrier schemes follow channel bonding rules, while the LAA multi-carrier scheme can flexibly select any group of carriers for transmission, this additional channel access flexibility for LAA naturally means that LAA will gain higher channel access at the expense of co-channel 802.11. Citing this, IEEE 802 continued to argue for the need for LAA to align its multi-channel aggregation scheme with 802.11 in order to fairly share unlicensed resources between LAA and 802.11.

3GPP RAN1 responded to IEEE 802 in its Liaison Statement dated November 2016 (3GPP R1-1613770). The RAN1 response noted the following two points copied verbatim below:

* For UEs performing multi-carrier transmission on the uplink, it was also agreed that a UE that has received UL grants on a set of carriers scheduled with Cat 4 LBT with the same starting point in a subframe on all carriers can switch to 25us LBT, if Cat 4 LBT has been performed on a designated carrier in the set of carriers, where the set of carriers is specified according to the ETSI channel bonding rules.
* RAN1 notes that in multi-carrier access schemes that perform independent LBT per carrier, the whole Cat 4 LBT procedure has to be completed on each carrier before any given transmission and hence in principle each carrier waits for its fair share of time determined by congestion and collisions on that carrier before it accesses the medium.

IEEE 802 is pleased to note from the first point that 3GPP RAN1 has decided to align the uplink LAA (eLAA) multichannel aggregation scheme with 802.11, in the case where the multi-channel CCA scheme is similar to 802.11. IEEE 802 thanks 3GPP RAN1 for this positive development.

On the second point, 3GPP RAN1 has noted that downlink LAA multi-channel CCA schemes that perform an independent Cat 4 LBT procedure (i.e. CCA with exponential backoff on each carrier) and hence wait their “fair share of time” on each carrier, can be fair to 802.11.

However, IEEE 802 notes that this is not the only multi-channel CCA scheme allowed by downlink LAA. Downlink LAA is also allowed to flexibly select carriers for multi-channel transmission even in the case where it performs such Cat4 LBT on only one of the carriers and 25us LBT on the remaining carriers. The latter procedure (denoted as Type B multi-carrier access in the 3GPP LAA specifications) will naturally result in LAA getting a higher share of channel access relative to 802.11. In view of this, IEEE 802 requests that 3GPP RAN1 align the multi-channel aggregation scheme for this latter downlink channel access procedure with 802.11, the principle being that if the LAA multi-channel CCA scheme is similar to 802.11, it should also follow the multi-channel aggregation scheme of 802.11, in order for both technologies to share the spectrum fairly.

IEEE 802 also notes that updates to the 5 GHz harmonized standard EN 301 893 (ETSI EN 301 893 V2.0.7 (2016-11)) in ETSI-BRAN require that downlink LAA has to mandatorily follow a multi-channel aggregation scheme similar to 802.11 in the case where the multi-channel CCA scheme is similar to 802.11. IEEE 802 also notes that the above ETSI mandate together with the 3GPP goal of a “single global solution” for LAA should naturally imply that downlink LAA must always follow multi-channel aggregation scheme similar to 802.11 in the case where it uses multi-channel CCA similar to 802.11.

IEEE 802 also requests 3GPP to define and perform the RAN4 tests before LAA deployment to verify coexistence between multi-channel LAA and 802.11.

**RAN1 response 5:**

RAN1 notes that the following statement has already been added to TS 36.300 on multi-carrier transmission.

From TS 36.300, Section 5.7

“If the absence of IEEE802.11n/11ac devices sharing the carrier cannot be guaranteed on a long term basis (e.g., by level of regulation), and for this release if the maximum number of unlicensed channels that E-UTRAN can simultaneously transmit on is equal to or less than 4, the maximum frequency separation between any two carrier center frequencies on which LAA SCell transmissions are performed should be less than or equal to 62MHz.”

RAN1 notes that this significantly addresses the concerns pointed out by IEEE 802 on the selection of carriers for multi-carrier transmission as this strongly recommends the restriction of the choice of carriers to less than 80MHz bandwidth when the number of carriers is less than or equal to 4. This constraint is applicable globally to all the multi-carrier transmission schemes including the scheme in which all the carriers perform Cat 4 LBT and the scheme in which a group of carriers perform 802.11 like LBT.

RAN1 also notes that in the current ETSI BRAN specification there is no constraint on the choice of carrier placement if all the carriers perform Cat 4 LBT (looser specification than RAN1) and a strong constraint on the choice of carrier placement if the group of carriers perform 802.11 like LBT (stricter specification than RAN1).

RAN1 will further discuss alignment with various aspects of multi-carrier transmission and adopt the proposed scheme in ETSI BRAN if there is sufficient consensus.

**IEEE issue 6:** There is consensus on Issue 6: “Radio equipment in unlicensed spectrum should stop transmission as soon as transmission of useful data is complete” but final resolution is subject to use of multiple ending positions

IEEE 802 requested a confirmation in its Liaison Statement dated 1 August 2016 (IEEE 802 EC-16-0140-01-00EC) that a LAA Rel. 13 system is mandatorily required to end transmission at the shortest end partial sub-frame boundary when it has no more data to transmit of the appropriate channel access priority class(s). IEEE 802 thanks 3GPP RAN1 for the requested confirmation in its Liaison Statement to IEEE 802 dated November 2016 (3GPP R1-1613770).

IEEE 802 is pleased to note that 3GPP may be in a position to adopt IEEE 802’s suggestions for stopping LAA transmission as soon as transmission of useful data is complete once support for increased number of ending positions in an LAA sub-frame, as specified in 3GPP RP-170848, is enabled. IEEE 802 now believes that this issue is heading towards consensus. In the meantime, IEEE 802 requests that:

* 3GPP RAN1 notify IEEE 802 on the progress of the work item to incorporate multiple ending positions for LAA along with the granularity of these positions.
* 3GPP RAN1 confirm that LAA devices will support these multiple ending positions in a sub-frame in a mandatory way.

**IEEE issue 7:** There is consensus on Issue 7: “Channel access that is obtained using special access mechanisms for high priority data should not be used to transmit lower priority data” but final resolution is subject to the use of shorter sub-frames.

IEEE 802 requested in its Liaison Statement dated 1 August 2016 (IEEE 802 EC-16-0140-01-00EC) for LAA Rel. 13, the minimum duration be approximated to the next occurring (partial) sub-frame boundary (one of 3/6/9/10/11/12/14 OFDM symbols). IEEE 802 further requested, as a compromise, that for future releases of LAA (starting with Rel. 14), 3GPP should define partial sub-frames with a finer granularity including the provision for a sub-frame with 1 OFDM symbol.

3GPP RAN1 responded in its Liaison Statement to IEEE 802 dated November 2016 (3GPP R1-1613770) by noting that the choice of size of the partial subframes to be used is also a function of the specification impact for considering many different sizes, eNB and UE implementation complexity and also the incremental gains that can be obtained.

IEEE 802 is pleased to note that 3GPP has decided to specify support for multiple starting and ending positions in an LAA sub-frame, as specified in 3GPP RP-170848. IEEE 802 requests that 3GPP RAN1 not only use this feature but also define shorter sub-frames for LAA similar to what are defined for licensed LTE as part of 3GPP RP-161299. This will ensure that transmissions of finer granularity are possible for LAA, in order to better approximate the channel occupancy to the minimum time required to transmit higher priority data, in the case the channel has been obtained using the access mechanisms of the higher priority data and not allow transmission of lower

priority data.

In the meantime, IEEE 802 requests that:

* 3GPP RAN1 notify IEEE 802 on the progress of the work item to incorporate multiple starting and ending positions for LAA and specifically whether it will also provision shorter sub-frames for LAA.
* 3GPP RAN1 confirm that such multiple starting and ending positions and shorter sub-frames will be supported by LAA devices in a mandatory manner

**RAN1 response to issue 6 and 7:**

As noted in RAN1 response 1 previously, a new work item on LAA enhancements for Rel-15 (RP-170848) to specify the multiple starting and ending positions has already begun in RAN1 and it is expected that additional start and end positions for DL and UL transmissions would be specified. This work item is expected to end in Dec 2017 in RAN1 and in RAN2 and RAN4 a few quarters later. RAN1 has so far agreed to specify at least one additional UL start and at least one additional UL ending position (ending transmission at symbol 6 of a subframe) as well as not specifying any additional DL ending positions on top of the Rel-13 options of ending in symbol 3,6,9,10,11,12 and 14. For the UL partial subframes, it was agreed that two modes of operation would be supported: Mode 1 in which UE may decide on the starting point of transmission depending on the outcome of LBT and Mode 2 in which the UL grant indicates the start position to be the second slot of the subframe.

Both initial and end partial subframes are optional in Rel-13 and no new start/end positions were defined in Rel-14 for DL and UL transmissions.

The discussion on mandatory and optional features is discussed at the end of each release (June 2018 for Rel-15) and further information could be provided at that time. In addition, while multiple companies have proposed adopting sTTI compatible solutions for transmission on initial and end partial subframes, there is currently no consensus to do as part of Rel-15 LAA.

**IEEE issue 8:** There is not consensus on Issue 8: “The maximum continuous transmission time should be limited to avoid blocking latency sensitive traffic on coexisting networks”, but resolution can result from satisfactory RAN4 testing & deployment experience

IEEE 802 requested in its Liaison Statement dated 1 August 2016 (IEEE 802 EC-16-0140-01-00EC) that LAA Rel. 13 aligns with the agreement that was achieved at ETSI-BRAN for maximum TXOP. 3GPP RAN1 responded in its Liaison Statement to IEEE 802 dated November 2016 (3GPP R1-1613770) that while RAN1 may consider alignment with all aspects of the ETSI BRAN specification including MCOT limits it is the responsibility of the eNB to comply with any regional regulations.

IEEE 802 is disappointed with 3GPP RAN1’s position to not adopt the maximum TXOPs agreed in ETSI BRAN (EN 301 893) by stakeholders from both the 802.11 and LAA communities. The limits in EN 301 893 represent a compromise by all stakeholders that is likely to enhance fair sharing of the 5GHz band globally. Given these limits will be required in Europe and the many countries that align with European regulations, the adoption of these limits by 3GPP RAN1 into LAA has the added advantage for LAA of enabling a “single global solution” as mandated for LAA by 3GPP.

IEEE 802 also notes that 3GPP has already adopted the maximum TXOP limits agreed in EN 301 893 for uplink LAA (eLAA). In that case IEEE 802 is unable to understand the reluctance by 3GPP RAN1 to also adopt them as part of the LAA specifications for downlink LAA. IEEE 802 requests 3GPP RAN1 to clarify why it has decided to follow such different stances between downlink and uplink LAA. It strongly urges 3GPP to resolve this difference and hence adopt the maximum TXOP limits as specified in EN 301 893 for both downlink and uplink LAA.

IEEE 802 notes that RAN4 has decided on the development of a set of coexistence test cases including multi-node tests to verify the coexistence between LAA and IEEE 802.11 devices in various scenarios. IEEE 802 requests that the effect of maximum TXOP limits on LAA/802.11 coexistence be examined in these coexistence tests as well as actual deployment scenarios.

**RAN1 response 8:**

RAN1 will discuss whether to adopt the ETSI BRAN TxOP limits and mechanisms for increasing the TxOP length to 8ms and 10ms as specified in ETSI BRAN.

**IEEE recommendation 9:** There is not consensus on Issue 9: “Adjustment of channel access contention window should be based on comparable indicators of congestion to ensure fairness between technologies” but resolution can result from satisfactory RAN4 testing

IEEE 802 suggested in its Liaison Statement dated 1 August 2016 (IEEE 802 EC-16-0140-01-00EC) that extensive simulation and testing of LAA and 802.11 coexistence be conducted to determine whether fair sharing of the channel actually occurs in typical medium to high congestion environments. This recommendation was based on the difficulty of predicting the interaction LAA and 802.11 given the many differences (and similarities) in their medium access mechanisms.

3GPP RAN1 responded in its Liaison Statement to IEEE 802 dated November 2016 (3GPP R1-1613770) by addressing several technical sub-issues discussed in IEEE 802’s Liaison Statement, and finished by declining IEEE 802’s offer to work closely with 3GPP RAN1 on additional and extensive simulation and testing on the basis that such work is unnecessary. IEEE 802 disagrees that such testing is unnecessary and believes the 3GPP RAN4 testing activities provides a suitable forum for such work. IEEE 802 also believes that targeted simulation work may also provide value in some cases.

In addressing the differences between immediate ACKs in LAA and 802.11, 3GPP RAN1 noted that as part of a Rel-14 work item on shortened TTI and processing time, the minimum latency between the DL PDSCH and DL HARQ feedback for legacy 1ms TTI operation is to be reduced from the current 4ms for all frame structures (FS) including FS3 used for LAA. IEEE 802 requests that 3GPP RAN1 notify IEEE 802 on the progress of the work item. In view of the differences in medium access mechanisms between LAA and 802.11, IEEE 802also requests that 3GPP RAN4 define coexistence tests in medium and high congestion environments to determine whether the channel is fairly shared in such environments.

**RAN1 response 9:**

RAN1 once again notes that extensive simulations have been conducted in Rel-13 and Rel-14 LAA and the ETSI BRAN work item and no coexistence issues that can be attributed to the delay in the adjustment of the channel access window have been identified. Also, as RAN1 explained in detail in its previous response (R1-1613770), the LAA CW adjustment mechanism is conservative compared to the mechanism used by IEEE 802.11 in several aspects such as increasing the CW size to the next allowed value if 80% of the transmissions in the first subframe are in error (instead of 100% for IEEE 802.11).

RAN1 notes that the current testing framework as being discussed in RAN4 and further input on the test scenarios would be provided when fully available.

The work item to reduce the delay between DL transmission and corresponding ACK and the UL grant and the corresponding UL transmission including for FS3 is expected to be completed as part of Rel-15 LTE.

**IEEE issue 10:** There is consensus and resolution of Issue 10: “Adjustment of channel access contention window should be clearly defined”

**RAN1 response 10:**

RAN1 thanks IEEE 802 for its understanding.

**IEEE issue 11:** There is consensus and resolution of Issue 11: “The channel access state machine during channel sensing should be clearly defined”.

**RAN1 response 11:**

RAN1 thanks IEEE 802 for its understanding.

**IEEE recommendation 12:** There is consensus on Issue 12: “The use of the back off mechanism should be clearly defined” and it has been largely resolved.

IEEE 802 highlighted two issues related to the backoff mechanism in its Liaison Statement dated 1 August 2016 (IEEE 802 EC-16-0140-01-00EC). In relation to the first issue, IEEE 802 requested clarification that LAA maintained slot synchronisation in cases where the next transmission is ready after the post backoff is complete. 3GPP RAN1 responded in its Liaison Statement to IEEE 802 dated November 2016 (3GPP R1-1613770) that LAA can maintain slot synchronisation by continuously monitoring the channel. IEEE 802 agrees that this is an appropriate mechanism, and further requests confirmation that LAA actually undertakes this monitoring, at least most of the time.

In relation to the second issue, IEEE 802 noted an ambiguity in the way a station with a frame that becomes ready after a previous post transmission backoff is allowed to transmit. 3GPP RAN1 responded in its Liaison Statement to IEEE 802 dated November 2016 (3GPP R1-1613770) by noting a corresponding change to the LAA specification.

IEEE 802 agrees this modification appears to resolve the issue and thanks 3GPP RAN1 for their action.

**RAN1 response 12:**

RAN1 notes that in the presence of DL or UL traffic, while the exact details are up to implementation, an LAA eNB is reasonably expected to actively monitor the medium to obtain channel access and to serve traffic to the UEs at the earliest. If there is no traffic, an LAA eNB may transmit discovery reference signal (DRS) once in every configured period and go to sleep as a power saving measure and thus not monitor the medium. If there are no UEs associated with the LAA serving cells and on the corresponding licensed cell, an eNB may also choose to completely switch off transmissions on LAA serving cells to reduce interference as well as to save power.

On the second issue, RAN1 thanks IEEE 802 for its understanding.

**IEEE issue 13:** There is not consensus on Issue 13: “Issues related to ED threshold and coexistence between LAA and IEEE 802.11” but resolution can result from satisfactory RAN4 testing before deployment of LAA

Issue 13 is addressed in a separate Liaison Statement from IEEE 802 (https://mentor.ieeeorg/802-ec/dcn/17/ec-17-0064-00-00EC-802-to-3gpp-ran-ran1-ran4-liaison-statement.pdf). There is not yet consensus on this issue, but resolution is possible based on the completion of suitable test plans by 3GPP RAN4 and the successful execution of those test plans with satisfactory results before the deployment of LAA.

**RAN1 response 13:**

RAN1 thanks IEEE 802 for its understanding on the issue.

**IEEE issue 14:** Resolution of Issue 14: “Continued dialog towards a future framework for efficient sharing of the 5 GHz band” is waiting for a 3GPP RAN response.

IEEE 802 indicated an interest in a continued dialog towards a future framework for efficient sharing of the 5 GHz band in its Liaison Statement dated 14 November 2016 (IEEE 802 EC-16-0203-00-00EC). 3GPP RAN1 included a response to this request in its Liaison Statement to IEEE 802 dated November 2016 (3GPP R1-1613770), deferring the question to 3GPP RAN. IEEE is awaiting the response from 3GPP RAN.

**RAN1 response 14:**

RAN1 and RAN4 once again note that they welcome communication and continued dialog with IEEE 802 on coexistence between technologies sharing the 5GHz band and notes that 3GPP RAN may discuss any further response in upcoming plenary meetings.

**NR-based access to unlicensed spectrum:**

RAN1 notes that RAN plenary has been approved a new study item for NR-based access to unlicensed spectrum [2] with the following objectives and scenarios.

From RP-170848 [2], “

*This study item will include the following objectives*

* *Study NR-based operation in unlicensed spectrum (RAN1, RAN2, RAN4) including* 
  + *Physical channels inheriting the choices of duplex mode, waveform, carrier bandwidth, subcarrier spacing, frame structure, and physical layer design made as part of the NR study and avoiding unnecessary divergence with decisions made in the NR WI*
    - *Consider unlicensed bands both below and above 6GHz, up to 52.6GHz*
    - *Consider unlicensed bands above 52.6GHz to the extent that waveform design principles remain unchanged with respect to below 52.6GHz bands*
    - *Consider similar forward compatibility principles made in the NR WI*
  + *Initial access, channel access. Scheduling/HARQ, and mobility including connected/inactive/idle mode operation and radio-link monitoring/failure*
  + *Coexistence methods within NR-based and between NR-based operation in unlicensed and LTE-based LAA and with other incumbent RATs in accordance with regulatory requirements in e.g., 5GHz, 37GHz, 60GHz bands* 
    - *Coexistence methods already defined for 5GHz band in LTE-based LAA context should be assumed as the baseline for 5GHz operation. Enhancements in 5GHz over these methods should not be precluded. NR-based operation in unlicensed spectrum should not impact deployed Wi-Fi services (data, video and voice services) more than an additional Wi-Fi network on the same carrier;*

*The above study will address the following architectural scenarios (RAN2):*

* + *An NR-based LAA cell(s) connects with an LTE or NR anchor cell operating in licensed spectrum*
    - *The study assumes the techniques for linking between Pcell (LTE or NR licensed CC) and Scell (NR unlicensed CCs) according to the NR WI*
  + *An NR-based cell operating standalone in unlicensed spectrum, connected to a 5G-CN network with priority on frequency bands above 6GHz, e.g., for private network deployments;*
  + *Study how to ensure from a RAN level that connection and security management can be integrated with the E-UTRAN, NG RAN and 5G CN architecture, including service continuity requirements for users moving between cells of licensed and unlicensed frequency bands, liaising with SA2 as required*”.

RAN1 notes that several issues of current interest to IEEE 802 in the 5GHz band including smaller subframe durations, faster HARQ turnaround time etc. may also be directly addressed by utilizing NR-based transmissions in the unlicensed spectrum. Note that NR based LAA cell can connect to either an LTE or NR carrier in the licensed spectrum for licensed assisted access.

**2. Actions:**

**To IEEE 802 LMSC**

RAN1 requests IEEE 802 LMSC to consider harmonizing the ED threshold in 802.11ax and future 802.11 systems as specified in Option 2 of ETSI BRAN EN 301 893 v 2.1.0 [3]

## 3. References

[1] RP-170848, “Work Item on Enhancements to LTE operation in unlicensed spectrum”

[2] RP-170828, “Study on NR-based access to unlicensed spectrum”

[3] EN 301 893 v 2.1.0, “5GHz RLAN, Harmonized standard covering the essential requirements of article 3.2 of Directive 2014/53/EU

[4] R1-1613770, “Response LS to 802dot11 regarding LAA”, Approved in RAN1 #87, Nov 2016.

**4. Date of Next TSG-RAN WG1 Meetings:**

TSG RAN WG1 Meeting 90 21 – 25August 2017 Prague, CZ

TSG RAN WG1 Meeting 90bis 9 – 13 October 2017 Prague, CZ

**5. Date of Next TSG-RAN Plenary Meetings:**

TSG RAN WG1 Meeting 76 5 – 8 June 2017 Florida, USA

TSG RAN WG1 Meeting 77 11 – 14Sept 2017 Sapparo, Japan