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| On transmission of reservation signals by LAA |
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Abstract

The presentation discusses coexistence concerns due to the transmission of reservation signals in the downlink by an LAA eNB. The discussion reflects the status in 3GPP up to the latest 3GPP RAN1 meeting #90bis [1]. It also proposes a way forward for IEEE 802.11.

# Transmission of reservation signals in LAA

In Release 13 and 14 of LAA, an LAA eNB can acquire a Channel Access Time (COT) at any time instant based on the success of the CCA procedure. However, transmission of meaningful data is defined to start only at symbol #0 and symbol #7 of an LAA DL subframe. This means that an LAA eNB cannot transmit any meaningful data for an average duration of 250us and a maximum duration of 500us in the beginning of a COT

To take into account this initial gap in transmission, LAA implementations might use either of the following two schemes:

1. **Option 1**: Desist from any transmission in the time interval between the eNB winning the channel and the start the next valid transmission opportunity (either symbol 0 or symbol 7); subsequently perform a fixed defer just before the start of either of these two symbols. On success of the fixed defer, start valid transmissions from symbol 0 or symbol 7. On failure of the fixed defer, reattempt channel access with CAT4 LBT ([2]: section 15.1.1 of 3GPP TS 36.213 v 14.3.0). CAT4 LBT is the LAA equivalent of the 802.11 truncated exponential backoff channel access procedure.
2. **Option 2**: Transmit any energy (i.e “reservation signals” so called because they are used only to hold or reserve the channel) in the time interval between the eNB winning the channel and the start of either symbol 0 or symbol 7 in order to block any other node from accessing the channel; subsequently start valid transmissions from symbol 0 or symbol 7.
	* The transmission in the time interval between the eNB winning the channel and symbol 0 and 7 is not defined in the LAA specification. So, no exchange of useful data can happen in this interval since the UE is not expected to decipher any such transmission from the eNB.

Regarding Option 2, 3GPP RAN1 has taken the following positions regarding transmission of such reservation signals. The positions are contradictory; one denies the provision of reservation signals while another accepts the presence of such a provision and reasons that reservation signals constitute valid system overhead.

1. **There is no provision for transmission of reservation signals in LAA since the LAA specifications do not define it**: R1-1613770 [3] “*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*”
2. **Transmission of reservation signals constitutes valid LAA system overhead**. This is also captured in the following LS responses from 3GPP to IEEE 802.11:
	1. R1-1709851 [4]: “*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*”.
	2. R1-1613770 [3]: “*While RAN1 does not specify the transmission of any such signals, RAN1 recognizes the benefits of leaving the flexibility and choice of transmission of such signals as an implementation and operational choice*.”

# Arguments against the transmission of reservation signals by LAA

802.11 does not transmit reservation signals i.e. energy for the purpose of preventing another node from accessing the channel. For example, if 802.11 does not have data available for transmission on winning a COT, it does not start transmission till it has such valid data. Subsequently, on availability of valid data, it can start transmission upon the success of a fixed CCA defer [5]. This is similar to the transmission procedure described for LAA in **Option 1**. So, for fair coexistence with 802.11 it is necessary that the 802.11 and LAA channel access procedures be similar and that LAA not hold the channel via transmission of reservation signals.

Please also note the following:

1. 3GPP RAN1’s argument (as described above) that there is no provision for transmission of reservation signals in the LAA specification sidesteps the general understanding in RAN1 that an LAA eNB will transmit such reservation signals to hold the channel. This general understanding has been discussed in numerous documents submitted to RAN1 by different companies. Some of them have been cited below:
	* R1-1704297 ([6]): “*The duration from the time the eNB successfully accesses the unlicensed channel to the slot boundary the eNB starts control/data transmission should be reserved with useless signals*”
	* R1-1705293 ([7]): “*LAA SCell may access the channel at any time in a subframe, which may lead to transmission of unnecessary signal (e.g. reservation signal) to hold the channel until the starting position (e.g. next subframe boundary) where the control and/or data can be transmitted.*”
	* R1-1704837 ([8]): “*We understand that one motivation to allow multiple starting positions in a DL subframe is to reduce the potential reservation signal transmission. Then, one way could be to simply limit the maximum length of reservation signal (e.g., 1 symbol)*”
2. The second argument by 3GPP RAN1 that transmission of reservation signals constitutes valid system overhead doesn’t also seem appropriate.
* This is because by definition, LAA or any other system, can only be considered to constitute procedures that are defined in the corresponding specification of the system. So, procedures that are not defined in the specification cannot be included in the definition of such a system.
* Reservation signals (since they are not defined in the specification) may not be understood by the UE which will only look for transmissions beginning at the valid starting positions. So, reservation signals have no specific usage that a valid embedded signal must have, other than of blocking the channel.
1. In this regard, it should also be noted that the ETSI-BRAN harmonized standard EN 301 893 [9] specifies the following for transmissions of an Initiating device after winning a COT “*6)The Channel Access Engine may start transmissions belonging to the corresponding or higher priority classes, on one or more Operating Channels*”. This clause may rule out transmission of reservation signals by an LAA eNB within a COT since reservations signals are not specified in the LAA standards and hence cannot be classified as belonging to either any of the channel access priority classes 1 to 4 (defined in table 7 and table 8 of [9]) or being signals that are embedded into transmissions of any of these priority classes.

# Proposed next steps

It is important for 802.11 to understand whether use of reservation signals to guarantee medium access is an advisable practice, and if it is even acceptable under various regulatory domains. The following points should be noted in this respect:

1. 802.11 does not transmit reservation signals i.e. energy for the sole purpose of preventing another node from accessing the channel. For example, if 802.11 does not have data available for transmission on winning a COT, it defers transmission and can start transmission at a later time on availability of such data, depending on the success of a fixed CCA defer [5]. The LAA specification too contains a provision for doing so by defining a procedure [2] similar to 802.11. So, this procedure of self-deferral for both LAA and 802.11 is necessary for fair coexistence..

1. It appears that the ETSI harmonized standard EN 301 893 [9] allows the transmission within a COT of only data belonging to channel access priority classes 1 to 4. It may also allow transmission of standardized signals and other transmissions that may be embedded in such data. However, reservation signals as provisioned for LAA DL are not defined in the LAA specification and hence cannot be considered to constitute either data belonging to a channel access priority class or embedded signals and messages that aid the transmission or reception of such data. So, we may seek clarification and advice regarding this practice.
2. There is a Work Item on LAA enhancements [10] that was approved in the 3GPP RAN Plenary (RAN#75, March 2017) that included a goal of reducing the duration of transmission of reservation signals by specifying the support for multiple starting positions in a subframe for LAA DL. The documents [6], [7], [8] that refer to transmission of reservation signals had been submitted in relation to this Work Item. However, 3GPP has concluded in the latest RAN1 meeting (RAN1#90-bis, 09-13/Oct/2017) that there is no consensus in RAN1 on defining additional starting positions in an LAA DL subframe. This has happened despite multiple LSs from IEEE 802.11 and the support of many companies ([11], [12], [13], [14]).
3. The scope of the Work Item for the next version of ETSI EN 301 893 contains a topic to consider not allowing transmission of reservation signals “*Consider to make clear in the standard that transmissions, which have the purpose of preventing others to have access to the channel, are not allowed*”. Point 1 to 3 discussed above should be a part of any discussion on this scope.

# References

1. RAN1 Chairman’s Notes, 3GPP TSG RAN WG1 Meeting 90bis (9th – 13th, October 2017)
2. 3GPP TS 36.213 v 14.3.0 (2017-06)
3. R1-1613770, Response LS to IEEE 802.11 regarding LAA
4. R1-1709851, Response LS to IEEE 802 regarding LAA
5. IEEE 802.11 – 2016, Section 10.22.2.4 “Obtaining an EDCA TXOP”
6. R1-1704297, Support for multiple starting and ending positions in a subframe for DL on SCell with frame structure 3, Huawei
7. R1-1705293, Multiple starting and ending position for DL, Samsung
8. R1-1704837, Discussion on multiple starting and ending positions for LAA DL, LG
9. Draft ETSI EN 301 893 V2.0.7 (2016-11)
10. 3GPP RP-170848, “Work Item on Enhancements to LTE operation in unlicensed spectrum”, March 2017
11. R1-1715050, WF on additional DL and UL start and end positions in FeLAA, Broadcom, CableLabs, Brocade, BlackBerry, Comcast, Sequans
12. R1-1713024, Multiple starting and ending positions in a subframe in UL, Qualcomm
13. R1-1718015, Discussion on additional starting positions for DL in LA, Hewlett Packard Enterprises et al
14. R1-1718014, Discussion on multiple starting positions in a subframe for DL, NEC