**3GPP TSG RAN WG1 Meeting #103-e R1-20xxxxx**

**Oct 26th – Nov 13th, 2020**

**Agenda item: 8.2.2**

**Source: Moderator (Qualcomm Incorporated)**

**Title: FL summary for channel access mechanism for 52.6GHz-71GHz band**

**Document for: Discussion and Decision**

# Introduction

This paper summarizes the following email discussion

[103-e-NR-52-71-Channel-Access] Email discussion/approval on channel access mechanisms including aspects related to system level simulations until 11/3; address any remaining aspects by 11/11 – Jing (Qualcomm)

# Summary of contributions and discussions

The section summarises key proposals and observations from submitted contributions.

## Channel bandwidth, nominal bandwidth, and LBT bandwidth

A few papers discussed the definition of channel bandwidth, nominal bandwidth and LBT bandwidth.

### Nominal Bandwidth

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| **Company** | **Key Proposals/Observations/Positions** |
| Huawei, HiSilicon | Proposal 1: For operation in NR-U-60, multiple nominal channel BWs can be defined for a device as follows:  A) Single carrier operation with K BWPs: K nominal channels are defined each with a BW equal to that of the corresponding BWP.  B) CA with N non-contiguous CCs: N nominal channels are defined each with a BW equal to that of the corresponding CC.  C) CA with M contiguous CCs: Defined nominal channels correspond to every contiguous subset of the M CCs where each nominal channel BW is equal to the sum of the BWs of the CCs in the corresponding subset. |
| Ericsson | Proposal 1 The nominal channel bandwidth should map to the channel bandwidths supported by the UE/gNB. |
|  | OCB Requirements  Proposal 2: RAN1 shall further clarifies the OCB requirement as follows: For each declared nominal channel bandwidth,   * If the channel is used for DL transmission, RAN1 design should support at least one DL physical layer signal/channel transmission that occupies at least 70% of the nominal channel bandwidth. * If the channel is used for UL transmission, RAN1 design should support at least one UL physical layer signal/channel transmission that occupies at least 70% of the nominal channel bandwidth.   Proposal 3: RAN1 shall further clarifies that the “nominal channel bandwidth” in the OCB requirement refers to the channel bandwidths supported for each NR band, as defined in TS 38.101-X. |
| NTT Docomo | Observation 1: There has been no clear definition in NR which is well relevant to the Nominal Channel Bandwidth defined in BRAN.   * Although a unit of bandwidth for channel access (or a RB set) may be considered as the NCB, the unit of bandwidth for channel access (and channel access mechanism itself) is not clear at this stage. |
| Charter | Proposal 1: No special consideration is necessary for nominal channel bandwidth in EN BRAN 302 567 and mapping to NR bandwidth definitions. |

### LBT Bandwidth

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| **Company** | **Key Proposals/Observations/Positions** |
| Huawei, HiSilicon | Proposal 2: For operation in the 60 GHz band, the LBT BW can be greater than the carrier BW.  Proposal 3: For operation in NR-U-60, the EDT formula adopted from draft v2.1.20 of EN 302 567 as a baseline should be adjusted to account for an LBT BW other than 2 GHz. |
| Apple | Observation 2: The possibility of an CCA measurement bandwidth that is larger than the transmission bandwidth may require a change to the basic LBT mechanism. |
| CAICT | Proposal 4: One mode that aligns with or comparable WiFi 11ad channels of 2.16GHz bandwidth could be supported by CA and multiple LBT bandwidth.  Proposal 5: Multiple LBT bandwidth could be considered for unlicensed band operation within 52.6-71GHz. |
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### Channel bandwidth

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| **Company** | **Key Proposals/Observations/Positions** |
| Lenovo, Motorola Mobility | Observation 5: For NR unlicensed bands between 52.6 GHz and 71 GHz, applicability of DFS based channel access schemes is dependent up on the channelization bandwidth and corresponding availability of number of such channels in different regions  Proposal 5: For NR unlicensed bands between 52.6 GHz and 71 GHz, for further consideration of DFS as a potential channel access mechanism, either the channelization bandwidths need to be agreed first or BWPs switching could be considered to be associated with DFS |
| Nokia, Nokia Shanghai Bell | Proposal 3: Channelization based on 2.16 GHz is assumed in the channel access mechanism design.  Proposal 4: Transmissions with a (channel) bandwidth smaller than 2.16 GHz, such as 400 MHz, are also supported by the channel access mechanism design |
| ZTE, Sanechips | Proposal 2: The channel bandwidth supported by UE and defined in NR can be regarded as the nominal channel bandwidth.  Proposal 3: If coexistence with Wi-Fi is considered, or the absence of Wi-Fi node cannot be guaranteed, the following options can be further studied:   * Option 1: Align the channelization of Rel-17 NR with Wi-Fi design at least in unlicensed band (e.g. 57 GHz - 71 GHz) and support 2.16 GHz channel bandwidth * Option 2: No need to align the channelization of Rel-17 NR with Wi-Fi design. Study and evaluate how the coexistence is achieved between NR-U and Wi-Fi under different channel bandwidth. |
| Sonly | Proposal 1: NR devices support 2.16 GHz bandwidth in 60GHz spectrum as one of nominal channel bandwidths. |
| Apple | Proposal 3: Channel Access Mechanisms for single-carrier and multi-carrier modes should be supported.   * When LBT is used, study channel access mechanisms assuming CCA on a bandwidth greater than the operating bandwidth   + Allow support for multi-carrier CCA where each carrier is smaller than the CCA bandwidth.   + Allow support for single-carrier CCA which is smaller than the CCA bandwidth |
| CAICT | Proposal 4: One mode that aligns with or comparable WiFi 11ad channels of 2.16GHz bandwidth could be supported by CA and multiple LBT bandwidth. |
| NTT Docomo | Observation 7: Channel bandwidth and assignment for IEEE 802.11ad/ay may need to be considered for channel bandwidth and assignment for NR in 57 – 71 GHz |

### Heterogeneous Channel bandwidths

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| **Company** | **Key Proposals/Observations/Positions** |
| Nokia, Nokia Shanghai Bell | Proposal 9: Consider the need for LBT ensuring fairness between cells with different bandwidths while maintaining efficient spatial reuse between cells of same bandwidth |
| Intel | Proposal 7: When operating in unlicensed 60 GHz band, in order to allow fair coexistence among incumbent systems, the ED threshold calculation shall account not only for the maximum output power, but also at least for the bandwidth used. |

### Discussion

On the definition of nominal bandwidth, though it may not have any spec impact, but a common understanding of it may help clarify the OCB requirement

FL proposal:

It is RAN1 understanding that nominal bandwidth is equivalent to channel bandwidth supported by UE or gNB as defined if 38.101.

During the online session, the language is updated to the following

Proposal:

* RAN1 understanding is that nominal bandwidths at the UE are the subset of UL channel BWs supported by the UE from the set of channel BWs (carrier) to be defined in 38.101.
* RAN1 understanding is that nominal bandwidths at the gNB is the subset of DL channel BWs supported by the gNB from the set of channel BWs (carrier) to be defined in 38.104.

Alternate Proposal:

* RAN1 understanding is that nominal bandwidths at the UE is the maximum UL channel BW supported by the UE.
* RAN1 understanding is that nominal bandwidths at the gNB is the maximum DL channel BW supported by the gNB.

Please provide additional comments.

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| **Company** | **View** |
| Ericsson | Agree to FL proposal. channel bandwidth which is equivalent to the carrier bandwidth from RAN1 perspective |
| Huawei/HiSilicon | We could be flexible about this and agree in principle with the majority to base the “nominal channel BW” on the “channel BW” defined in 38.101. However, assuming similar principles as in 38.101-1 for FR1 and 38.101-2 for FR2 are followed to define “channel BW” for FR-X, there are two points that need to be clarified:   1. 38.101 define UE channel BWs only and, unlike what FL proposal suggests, are quiet about the channel BWs at the gNB side. Based on our understanding, these nominal channel BWs are defined mainly for spurious energy test and, as such, it seems necessary that they are also defined at the gNB side. However, defining nominal channel BWs at the gNB side seems to be out of RAN1 scope and whether and how to define nominal channel BWs at the gNB seems to be in RAN4 scope. Sending an LS to RAN4 regrading this issue may be required. 2. Not all defined channel BWs in 38.101-1 for FR1 and 38.101-2 for FR2 for UEs are actually supported by the UE. UE’s actual supported channel BWs can be a subset of the defined channel BWs in 38.101 and can be reported in UE capability signalling in *channelBWs-UL* and *channelBWs-DL*. For the nominal channels at the UE side, only *channelBWs-UL* wherein UE transmits are relevant.   To summarize, we can propose the following:  Proposal:   * RAN1 understanding is that nominal bandwidths at the UE side are the UE’s subset of supported UL channel BWs from the set of defined channel BWs in 38.101. * Send an LS to RAN4 requesting to define nominal channel BWs at the gNB side if necessary. |
| LG | Agree to the FL proposal. |
| Nokia, NSB | Agree with the FL proposal. |
| vivo | Our understanding is that nominal channel bandwidth should be equivalent to channel bandwidth supported by UE as defined by RAN#4. One UE can have multiple nominal channel bandwidths. If BWP is adopted, the bandwidth of each BWP equals to one of the nominal channel bandwidth. |
| Futurewei | Nominal channel bandwidth term is used in ETSI for two purpose: 1) to limit the spurious emission 2) to define OCB.  3GPP 38.101-1 defines the Channel related bandwidth as follows:    Figure 5.3.1-1: Definition of the channel bandwidth and the maximum transmission bandwidth configuration for one NR channel  Based on 38.101 language the Channel Bandwidth is equivalent to Nominal Channel Bandwidth. The OCB requirement should be interpreted (based on Figure 5.3.1-1) as the requirement on the Transmission Bandwidth with respect to Channel Bandwidth.  For the multi-carrier operation, we should consider the nominal channel bandwidth as the aggregated channel bandwidth (38.101), which is the bandwidth for intra-band contiguous carrier aggregation.  Nevertheless, we think that these definitions and understandings should be used just as working assumptions and there is no need to be captured in the TR. If necessary, they can be later refined in RAN4. |
| Charter Communications | Fine with the alternate proposal |

Discussion point:

Naturally we will support LBT bandwidth equal to channel bandwidth. Shall we further support

* LBT bandwidth narrower than the channel bandwidth
* LBT bandwidth wider than the channel bandwidth

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| **Company** | **View** |
| Ericsson | In our view, the LBT bandwidth is the minimum of the channel bandwidth and the transmission bandwidth. |
| Huawei/HiSilicon | In our view, two issues need to be clarified first:   1. Based on our reading of t-docs of different sources, we think it is necessary to clarify what we mean by “channel BW” here. Do we mean “transmission BW” (e.g., set of PRBs occupied by PDSCH or set of PRBs occupied by PUSCH) or the set of “UE channel BW” that are going to be defined in 38.101, or the “carrier BW” that is configured to the UE? 2. gNB may perform FDM transmission to multiple UEs. However, FDM transmission from a UE to two gNBs (in scenarios such as DAPS-HO) seems to be unlikely. Therefore, LBT bandwidth at the gNB side and the UE side may need to have two different treatments.   Considering the above two issues, we believe that LBT BW should be wider than the transmission BW and can be wider than the channel BW (as defined in 38.101) and carrier/cell BW (as configured to the UE). The reason for LBT BW being larger than transmission BW is clear. In our view, LBT BW can also be wider than the carrier BW and UE channel BW in the case of CA and when gNB serves multiple UEs in the FDM manner. In such scenarios, having a LBT BW larger than carrier BW/UE channel BW facilitates a single LBT mechanism instead of having multiple LBT mechanisms running in parallel in the frequency domain. |
| LG | We think that the LBT bandwidth can be configured based on the UE capability or by the gNB. Therefore, it can be larger than channel bandwidth or smaller than the channel bandwidth. |
| Nokia, NSB | We agree with the Ericsson proposal at least as the baseline. |
| vivo | Our preference is to have the LBT bandwidth equal to the bandwidth of BWP or the nominal channel bandwidth. |
| Futurewei | The answer to this question depends on the channel bandwidth definition. In the context of LBT we propose to define the channel bandwidth as the maximum channel bandwidth which is discussed in 8.2.1. and to agree that this is a supported LBT bandwidth.  The question of “LBT bandwidth wider than the channel bandwidth” can be interpreted as LBT necessary for multi-channel access operation as defined in the TS37.213, Section 4.1.6. In this case, the LBT should be done per each channel, and the multi-channel operation from TS 37.213 may be used as reference design.  For the question of “LBT bandwidth narrower than the channel bandwidth” we prefer to leave it for FFS. |

Discussion point:

Shall we support one mode to align the channelization between 11ad/ay and NR in 60GHz band

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| **Company** | **View** |
| Ericsson | No. Actually it is not clear what is meant by align the channelization, is it about (1) mandating same channel bandwidth (2.16 GHz) or only about (2) making sure that the NR channels is fully contained within .11ad channel and crosses the channel boundary ?  If its about (1) this is not the correct place to discuss this. The maximum carrier bandwith is discussed in the other email thread. And if it is about (2):  In our contribution (R1-2007982), we have provided an extensive analysis about the drawback of aligning the channelization with .11ad.  The main drawbacks are:   1. extensive evaluation results from different companies shows there are no coexistence issues even without deploying LBT 2. If NR adopts the same channelization design as IEEE 802.11ad/ay, large wastage of spectrum would occur in many regions:  * 240 MHz at the lower edge of the band is unused in all regions * 800 MHz at the upper edge of the band is unused in USA and Europe * 680 MHz of the 5 GHz allocation in China is unused   + In recognizing the need to have at least three channels for cell planning, IEEE 802.11aj standard defined four 1.08 GHz channels nested within the two 2.16 GHz channels for the 60 GHz band in China. As a result, the spectrum wastage issues are left unaddressed in the 802.11aj channelization. * 280 MHz of the 7 GHz allocation in Canada/Brazil/Mexico is unused * In the IMT (licensed) allocation in Europe, one out of the 2 available 2.16 GHz channels is unusable since it extends outside the IMT allocation  1. If .11ad channelization is used, only 2 non-overlapping 2.16 GHz channels are available, and 680 MHz would be wasted. Instead, NR can divide the 5GHz allocation into 3 non-overlapping 1.6 GHz nominal channels which (1) increase the number of available channels, and (2) full use of the allocation. 2. the 802.11ad standard itself supports partially overlapping channels for channel bandwidths >2.16 GHz 3. In R1-2007982, we demonstrate that misaligned channels do not create a coexistence problem either. We evaluated Coexistence scenario between two operators (a) both operators use aligned 2 GHz channels, and (b) Operator #2 uses three 1.6 GHz channels misaligned with the two 2 GHz channels used by Operator #1. We show that misaligned channels do not cause any coexistence issue. |
| Huawei/HiSilicon | We think it is better to first to clarify what we mean by aligning the channelization to 11 ad/ay. In our view two choices may be considered :   1. Supporting a 2.16 GHz single channel BW with the centre frequency located at one of the 6 locations {58.32, 60.48, 62.64, 64.80, 66.96, 69.12} GHz. 2. Supporting multiple channels with a smaller BWs nested inside one 2.16 GHz BW channel with a centre frequency located at one of the 6 locations {58.32, 60.48, 62.64, 64.80, 66.96, 69.12} GHz.   If the intention is 1 above, then this discussion needs to be made in another Email thread concerning 8.2.1 as it is directly related to the maximum supported channel BW. In any case, even if a 2.16 GHz single channel BW is agreed, we do not see such an alignment results in a noticeable inter-RAT interference reduction.  If the intention is 2 above, although we are in general supportive of the idea of having a few smaller BWs to cover a 2.16 GHz BW (using CA), we do not see such an alignment results in a noticeable inter-RAT interference reduction. |
| LG | No. Since, the regional regulatory does not mandate supporting the same bandwidth as in 802.11ad/ay, aligning the channelization with 11ad/ay cannot be justified. If performance requirements (such as BLER, system throughput, coexistence) can be met in a reasonable range, we think CA based approach could be sufficient to coexist with 11ad/ay. |
| Nokia, NSB | If aligning the channelization with 11ad/ay means that we support at least one mode where no NR-U channel overlaps with two 2.16 GHz 11ad/ay channels, we are ok. Note that this still allows for using for NR-U parts of the spectrum that 11ad/ay is currently not utilizing.  However, the exact channelization must obviously take into account the supported subcarrier spacings and channel bandwidths, and may need to be discussed jointly with AI 8.2.1. |
| vivo | Not clear about what does it mean by align the channelization of 11ad/ay.  If the intention is to have the exact same channel bandwidth and bonding as in 11ad/ay, we don’t think that’s necessary.  If the intention is to support large bandwidth similar to the channel bandwidth used in 11ad/ay, we are supportive. |
| Futurewei | The alignment of the channelization with 802.11ad/ay is not necessary. Whereby alignment we understand the same exact channel bandwidth as 802.11ad/ay (2.16GHz). Channel bandwidth of about same bandwidth as 802.11ad, for instance 2GHz, may be obtained through CA. |
| Charter Communications | We support defining large carrier bandwidths that allow a NR cell to operate with the same bandwidth (or greater) than an 802.11ad/ay system. This is motivated by a technology equivalence perspective, and does not necessitate the exact same channelization. |

## No-LBT

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| **Company** | **Key Proposals/Observations/Positions** |
| ZTE, Sanechips | Observation 1: According to regulation of ETSI EN 302 567 v2.1.20, at least LBT operation should be supported in Europe area for above 52.6 GHz. |
| Ericsson | Referring to Baseline LBT procedures based on 302567 v 2.1.20  Observation 1 LBT is not mandated by any regional regulations for 57-71 GHz frequency band.  Observation 2 In all three indoor scenarios (A, B and C), operating with LBT degrade the performance in terms of DL and UL throughput, as compared with operating without LBT.  Observation 3 Ideal receiver assisted LBT does not show performance improvement as compared to no LBT.  Observation 4 The effectiveness of LBT as medium access mechanism for co-existence in unlicensed spectrum in 60 GHz band is questionable.  Observation 5 Good link adaptation algorithm is sufficient to cope with occasional interference in 60 GHz band  Observation 6 In outdoor Scenario B, operating with LBT degrade the performance in terms of DL and UL throughput, as compared with operating without LBT.  Observation 7 ECC Report 288 concludes that in the 57-66 GHz band, system performance is reduced when LBT enabled, even with proper ED setting.  Observation 8 Inter-/intra technology network operating with LBT procedure as specified in EN 302 567 is not harmed by a coexisting NR-U network that access the channel without LBT  Observation 9 The benefit from directional LBT in 60GHz spectrum is not clear.  Proposal 3 For operation in 60GHz, it is not beneficial to mandate operation with LBT as a medium access mechanism. |
| Huawei/HiSilicon | Observation 7: When No-LBT is used in regions where LBT is not mandated by regulations, the hidden node issue would still persist.  Observation 8: Receiver-only directional LBT outperforms No-LBT in terms of both coverage and capacity across the different loading conditions in the indoor scenario. |

### No-LBT mode

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| **Company** | **Key Proposals/Observations/Positions** |
| FUTUREWEI | Proposal 1: The study should clarify the No LBT conditions of usage. |
| Lenovo, Motorola Mobility | Observation 8: For NR unlicensed bands between 52.6 GHz and 71 GHz, long-term channel sensing could be useful for both LBT and without LBT based channel access mechanism:  - For LBT based channel access mechanism, long-term sensing at the UE could be utilized for receiver assisted LBT at the gNB  - For no LBT based channel access mechanisms, long-terms sensing could provide interference statistics in terms of potential interference from WiFi as well as interference from other NR operators  Proposal 8: For NR unlicensed bands between 52.6 GHz and 71 GHz, long term sensing could be supported for both LBT based and without LBT based channel access mechanism to consider potential interference |
| Huawei, HiSilicon | Observation 7: When No-LBT is used in regions where LBT is not mandated by regulations, the hidden node issue would still persist. |
| CATT | Proposal 1: Only when the local regulation makes it clear that LBT is not mandatory, gNB /UE can initiate channel occupancy directly without LBT.  Proposal 5: The interference mitigation of beamforming based operation needs to be investigated in place of LBT based operation for distributed channel access scheme. |
| ZTE, Sanechips | Observation 3: No LBT can be considered to be used in COT sharing case and interference controlled environment.  Observation 4: No LBT should be workable only if some interference elimination mechanisms are applied on top of it. If no LBT is supported, the spec impact of introducing such enhancement should be further studied and evaluated.  Proposal 4: Release 17 NR-U should consider supporting different channel access modes for above 52.6 GHz, e.g., directional LBT and No LBT. |
| Samsung | Proposal 4: It is beneficial to support an implicit or explicit indication of the operation mode to the UE: either channel access is operated with LBT or without LBT |
| OPPO | Proposal 3: the enhancement of no LBT transmission, e.g., interference mitigation mechanisms should be studied. |
| Sony | Observation 1: In EU, no-LBT mode cannot be operated at least under the ‘C1’ for indoor and outdoor deployment.  Observation 2: No-LBT mode works in the uncongested environment.  Observation 3: Congestion could be measured by average RSSI and channel occupancy which have been already introduced in NR-U.  Proposal 6: No-LBT mode is configured in the environment where both average RSSI and channel occupancy are low. |
| Qualcomm | Observation 1: Shared spectrum operation with high directivity systems experiences low interference and good performance on the aggregate. Moreover, the gain of LBT schemes over no LBT schemes is minimal on the aggregate. |

### Long Term Sensing

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| **Company** | **Key Proposals/Observations/Positions** |
| FUTUREWEI | Proposal 11: The study should clarify the term of “long-term sensing” and its usage. |
| Lenovo, Motorola Mobility | Observation 8: For NR unlicensed bands between 52.6 GHz and 71 GHz, long-term channel sensing could be useful for both LBT and without LBT based channel access mechanism:  - For LBT based channel access mechanism, long-term sensing at the UE could be utilized for receiver assisted LBT at the gNB  - For no LBT based channel access mechanisms, long-terms sensing could provide interference statistics in terms of potential interference from WiFi as well as interference from other NR operators  Proposal 8: For NR unlicensed bands between 52.6 GHz and 71 GHz, long term sensing could be supported for both LBT based and without LBT based channel access mechanism to consider potential interference |
| Huawei, HiSilicon | Proposal 7：For operation in the 60 GHz band, in regions where LBT is not mandated, a gNB/UE can initiate a channel occupancy access using a channel access mechanism without LBT if it is used in conjunction with a short-term or a long-term interference mitigation scheme.  Observation 5：The long-term interference mitigation schemes such as ATPC or DFS would be implemented as specified by the region-specific regulations and do not need to be specified by 3GPP.  - Rel-16 NR-U specifications did not capture the DFS requirements and procedures specified by the ETSI BRAN HS for 5GHz (EN 301 893)  Proposal 8：For operation in the 60 GHz band, receiver-only directional LBT can be considered as an optional short-term interference mitigation scheme. |
| CATT | Proposal 2: To obtain channel occupancy condition which help Tx node to configure channel access mode , a periodic and long term RSSI or CCA measurements procedure can be introduced. |
| OPPO | Proposal 3: the enhancement of no LBT transmission, e.g., interference mitigation mechanisms should be studied. |
| Convida | Re: Exposed node issue : Proposal 5: Study methods to enhance resource utilization and interference in 52.6 GHz and above.  Proposal 6: Enhancement of beam operation should be investigated to mitigate interference |
| NTT Docomo | Observation 6: On mechanism to switch channel access mechanism, the following two options could be studied  • Option 1. To determine channel access mechanism by itself  o Indication of determined channel access mechanism to its communication partner(s) may be necessary  • Option 2. To follow indication/reporting from other devices  Proposal 1: On condition to switch channel access mechanism, even if LBT is not mandatory, at least long-term channel condition such as congestion situation should be considered.   * To observe the long-term channel condition, sensing the channel with longer periodicity such as RSSI/channel occupancy measurement could be possibility |
| Charter | Observation 1: Existing NR features appear to be sufficient for supporting ATPC, DFS, long-term sensing, etc. |
| Qualcomm | Proposal 3: Consider measurements intervals for long term sensing as designated transmission opportunities for detection of potentially interfered nodes and enabling collision resolution selectively. The collision resolution techniques can be per-COT LBT, TX power limitation, and/or duty cycle limitation. |

### DFS

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| **Company** | **Key Proposals/Observations/Positions** |
| Lenovo, Motorola Mobility | Proposal 5: For NR unlicensed bands between 52.6 GHz and 71 GHz, for further consideration of DFS as a potential channel access mechanism, either the channelization bandwidths need to be agreed first or BWPs switching could be considered to be associated with DFS |
| Huawei, HiSilicon | Observation 5：The long-term interference mitigation schemes such as ATPC or DFS would be implemented as specified by the region-specific regulations and do not need to be specified by 3GPP.  - Rel-16 NR-U specifications did not capture the DFS requirements and procedures specified by the ETSI BRAN HS for 5GHz (EN 301 893) |
| Nokia, Nokia Shanghai Bell | Proposal 2: Consider DFS as channel mechanism without LBT for use cases not limited to fixed network equipment but not requiring LBT either. |
| Charter | Observation 1: Existing NR features appear to be sufficient for supporting ATPC, DFS, long-term sensing, etc. |

### ATPC

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| **Company** | **Key Proposals/Observations/Positions** |
| Lenovo, Motorola Mobility | Observation 6: For NR unlicensed bands between 52.6 GHz and 71 GHz, in order to adopt ATPC as potential channel access mechanism, receiver feedback such as long-term sensing would be needed |
| Huawei, HiSilicon | Observation 6：The long-term interference mitigation schemes such as ATPC or DFS would be implemented as specified by the region-specific regulations and do not need to be specified by 3GPP.  - Rel-16 NR-U specifications did not capture the DFS requirements and procedures specified by the ETSI BRAN HS for 5GHz (EN 301 893) |
| CATT | Observation 2: APTC function for uplink and downlink transmission can be supported base on R15 power control/allocation frame work. |
| Nokia, Nokia Shanghai Bell | Proposal 1: NR for 60 GHz band shall be able to fulfil the EN 303 722 requirements for spectrum sharing based on automatic transmit power control and/or automatic link adaptation. Needed specification changes, if any, are to be studied along with EN 303 722 progress. |
| Spreadtrum Communications | Proposal 3: The medium access mechanism of ATPC and DFS should be studied in 60GHz unlicensed band. |
| Charter | Observation 1: Existing NR features appear to be sufficient for supporting ATPC, DFS, long-term sensing, etc. |

### No-LBT/LBT switching

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| **Company** | **Key Proposals/Observations/Positions** |
| FUTUREWEI |  |
| Xiaomi | Proposal 2: For CG-PUSCH, mechanism and condition(s) switching between LBT and LBT-free channel access should be studied. |
| CATT | Proposal 3: When initialing the channel occupancy, gNB shall determine the channel access mode according to the relationship between the result of measurements and configured threshold. |
| Nokia, Nokia Shanghai Bell | Proposal 15: Channel access mechanism is part of cell configuration.  Proposal 16: Flexible selection of channel access mechanism per gNB beam is considered. |
| Ericsson | Proposal 5 The condition to use/skip LBT is left for implementation. 3GPP needs to only design signaling to communicate the support of LBT |
| LG Electronics | Proposal #4: The channel access with LBT mechanism can be switched to a channel access mechanism without LBT during limited time only when the local regulation allows initiating channel occupancy without LBT and the specific conditions such as low interference environment are met. |
| Spreadtrum Communications | Proposal 3: The medium access mechanism of ATPC and DFS should be studied in 60GHz unlicensed band. |
| Samsung | Proposal 4: It is beneficial to support an implicit or explicit indication of the operation mode to the UE: either channel access is operated with LBT or without LBT |
| Sony | Observation 1: In EU, no-LBT mode cannot be operated at least under the ‘C1’ for indoor and outdoor deployment.  Observation 2: No-LBT mode works in the uncongested environment.  Observation 3: Congestion could be measured by average RSSI and channel occupancy which have been already introduced in NR-U.  Proposal 6: No-LBT mode is configured in the environment where both average RSSI and channel occupancy are low. |
| Apple | Proposal 1: The mechanism and condition(s) to switch between channel access with LBT and channel access without LBT should allow:   * Switching between LBT-based and non-LBT based access based on the regulatory environment only or based on the interference environment the UE(s) experience when regulation allows. * For LBT channel access, non-LBT transmission for specific channels (e.g. SSB) can occur in at most 10% of the COT. |
| NTT Docomo | Observation 5: Even if LBT is NOT mandatory to access channel, some operation restriction for channel access without LBT may be beneficial in some scenario  • However, unless LBT mechanism for 60 GHz is clarified, how much LBT is helpful in such scenario is unclear  Observation 6: On mechanism to switch channel access mechanism, the following two options could be studied  • Option 1. To determine channel access mechanism by itself  o Indication of determined channel access mechanism to its communication partner(s) may be necessary  • Option 2. To follow indication/reporting from other devices |
| Potevio | Proposal 4: At least network density and traffic load could be studied as conditions to switch between channel access with LBT and channel access without LBT. |
| Charter | Observation 2: The need to switch between channel access with LBT and channel access without LBT is not well motivated. |

### Discussion

For regions where LBT is not required, it has been discussed if additional conditions can be introduced in 3GPP spec to enable no-LBT mode and what are the conditions.

FL proposal:

gNB should indicate the system is operating in LBT mode or no-LBT mode as part of system information

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| **Company** | **View** |
| Ericsson | To start with, the formulation of this discussion is contradicting, for regions where LBT is not required, naturally no LBT is a default, and the discussion should be if LBT should be used in certain conditions.  We prefer to discuss the points below before agreeing to this proposal. |
| Huawei/HiSilicon | Agree. We think it needs to be clarified in the FL proposal that this is only applicable for regions that LBT is not mandated. |
| LG | We think that gNB can indicate the supported channel access mode of the system based on the local regulation as part of system information. For example, the gNB can indicate whether the no-LBT mode is supported or not by the SIB. |
| Nokia, NSB | It is yet premature to say whether the UE needs to know if the gNB performs LBT or not. |
| vivo | Even in regions where no-LBT mode is allowed, we think the channel access mode can be semi-statically or dynamically changed according to the interference at the receiver, the channel occupancy time at the transmitter, traffic priority, etc. And the channel access mode can be device-specific, e.g., if a UE suffers constant severe interference, gNB can operate in receiver-assisted LBT mode for that UE. For other UEs, gNB may operate in no LBT or non- receiver-assisted LBT mode |
| Futurewei | Where the indication would be used? If this is used in the LBT mandated region it could be simply signalled to UE whenever the situation dictates. For the No LBT region, it can be used as the default operation until instructed by gNB otherwise. |
| Charter Communications | Can be left to the WI phase based on SI conclusions. |

Discussion point:

For regions where LBT is not mandated, shall we introduce additional conditions for no-LBT to be used, or leave it for gNB implementation

* The condition can be based on DFS, long term sensing, etc

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| **Company** | **View** |
| Ericsson | It should be left for implementation. None of the evaluations showed coexistence issues in regular scenarios. In fact, LBT degraded the performance in most cases. Therefore, it should be left for implementation when it should be used.  Artificial restrictions should not be added to the specs unless there is a strong justification. FCC on the other hand does not mandate any Adequate spectrum sharing mechanism. The requirement by CEPT is to implement any Adequate spectrum sharing mechanism. Besides, CEPT recommends ATPC and DFS as the most effective and cost-efficient mechanisms. NR by design support power control schemes. and DFS can be done by implementation.  It is the operator’s responsibility to make sure that the regional regulations are fulfilled using any of the tools supported by the system. |
| Huawei/HiSilicon | Leave it to gNB implementation. However, some sensing/measurement can be defined to assist the gNB in deciding between LBT and no-LBT mode wherever LBT is not mandated. It is up to the NW how to use the reported sensing/measurement. |
| LG | Even for the regions where LBT is not required, the channel access with LBT can be the basic channel access mechanism. The channel access mechanism can be switched to the no-LBT mode based on the conditions when it can assume a low interference environment e.g., by estimating interference level or by using HARQ information of (consecutive) successful transmissions. |
| Nokia, NSB | It would be good to clarify how this question differs from the next one. It seems they are virtually the same. |
| vivo | Some conditions based on long term sensing/measurement or report can be used to determine the suitable channel access mode when LBT is not mandated. |
| Futurewei | Leave it for gNB implementation. |
| Charter Communications | We do not support having additional restrictions or conditions in the specification for no-LBT to be used. The existing NR framework with various measurements (e.g., RSSI) can be utilized for such a determination via implementation. |

Discussion point:

For regions where LBT is not mandated, shall we introduce additional restrictions when no-LBT is used, or leave it for gNB implementation

* Shall we design ATPC-like mechanism to be used in no-LBT mode
* Shall we design DFS-like mechanism to be used in no-LBT mode
* Shall we design long term sensing type mechanism to be used in no-LBT mode
* Shall we design duty-cycle restriction mechanism to be used in no-LBT mode
* Shall we design transmit power restriction mechanism to be used in no-LBT mode

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| **Company** | **View** |
| Ericsson | CEPT regulations requires Adequate spectrum sharing mechanism to be implemented. the regulations state: ”Among dynamic mechanisms, ATPC and DFS are the most effective and cost-efficient mechanisms. ATPC is particularly important as MGWS equipment are naturally motivated to implement ATPC to control self-interference.”  NR by design support power control schemes that can serve as “ATPC” mechanism. In additional, NR has link adaptation which also can serve as a “Adequate spectrum sharing mechanism” (e.g. in good link conditions, transmission time is reduced (higher MCS) which promotes for better coexistence)  DFS can be done by implementation, that has also been the case for sub-6GHz spectrum.  Therefore, we do not think more restrictions are needed specially that the interference at 60GHz is not expected to be critical. |
| Huawei/HiSilicon | We are in principal supportive of discussing additional restrictions when no-LBT is used. However, some of these restrictions may not have any specification impact. For instance, Rel-16 NR-U specifications did not capture the DFS requirements and procedures specified by the ETSI BRAN HS for 5GHz. Not specifying DFS in Rel-17 seems to be a reasonable approach as well. Current UL PC mechanism should be able to handle an ATPC-like mechanism at the UE side and we are not sure ATPC-like mechanism at the gNB side is within RAN1 mandate. |
| LG | No-LBT mode can be used along with ATPC or duty cycle restriction or transmit power restriction mechanism. The gNB can configure or indicate the mechanism to be used for UL transmission in combination with no-LBT mode. |
| Nokia, NSB | No. For now, we do not see a need to design specific RAN1 support for the aforementioned schemes. Naturally, if strict restrictions for the use of no-LBT are specified by a regulatory body, we can revisit this issue.  However, we may consider some definition for e.g. minimum antenna gain (including element and beamforming) or maximum TX power that is allowed in the case of no-LBT.  Possible RAN4 impact (e.g. power control range requirements, etc.) may be considered separately, if needed. |
| vivo | As we commented to the question above, some conditions based on long term sensing/measurement or report can be used to determine the suitable channel access mode when LBT is not mandated. Along with those conditions, we’re open to discuss potential restrictions but the questions on detail method are premature to answer right now. |
| Futurewei | We should not consider the region specific requirements unless they cannot be supported with the actual design. We should leave the features to the gNB implementation |
| Charter Communications | As noted in our contribution, existing NR features appear to be sufficient for supporting ATPC, DFS, duty-cycling, long-term sensing, etc. |

Discussion point:

For regions where LBT is not mandated, when operating in no-LBT mode, shall we further define mechanism for the system to fall back to LBT mode

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| **Company** | **View** |
| Ericsson | No. it should be left for implementation.  A smart gNB implementation should aim for a good performance. In the rare case of a device stuck in a severe interference situation, the gNB would of course try to resolve the issue. It could change the channel, adjust the Link adaptation parameters, change the RX-TX beam, etc…. Activating LBT does not necessarily solve the issue, specially if the interferer is not using LBT, or using LBT according to EN ETSI HS 302 567 with ED -47 dBm (which rarely backs off to any interference). The gNB is equipped with tools other than LBT to cope with interference. Which one of those tools (including LBT) is used as a fall back, should be left for implementation. |
| Huawei/HiSilicon | Leave it to gNB implementation. However, some sensing/measurement can be defined to assist the gNB to decide between LBT and no-LBT mode wherever LBT is not mandated. It is up to the NW how to use the reported sensing/measurement. |
| LG | As we mentioned in the above, the channel access with LBT mechanism can be switched to a channel access mechanism without LBT during limited time only when the local regulation allows initiating channel occupancy without LBT and the specific conditions such as low interference environment are met. Once the channel access mechanism is switched to one without LBT, the timer can be started and the channel access mode can be fallback to the channel access mode with LBT mechanism when the timer is expired or at least one of the specific conditions (e.g., when NACKs were received consecutively for the PDSCH/PUSCH transmitted without LBT) for switching the channel access mechanism is met. |
| Nokia, NSB | No. Regulations do not require this, and it is unclear if there would be any benefit in such fall-back. Moreover, it is important to support guaranteed no-LBT operation for e.g. fixed links. |
| vivo | Yes, mechanism fall back to LBT mode is necessary. Since the deployments in unlicensed band cannot be controlled, there may exist a scenario where some severe interference from other RATs or operators exist. LBT mode operation helps to enhance system performance. |
| Futurewei | Should be left for implementation. |
| Charter Communications | It is unclear if such a fall-back is always even feasible, for example, UEs deployed in a certain region may not support LBT functionality at all. |

## LBT Types and COT

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| **Company** | **Key Proposals/Observations/Positions** |
| CAICT | Proposal 1: CAT2 based directional LBT could be considered for 52.6-71GHz.  Proposal 2: The mechanism of CAT2 based directional LBT for DRS and data transmission within a COT could be different.  Proposal 3: The mechanism for CAT4 based directional LBT should be considered and the detail design could be FFS. |
| NTT Docomo | Observation 3: On sensing timing of LBT (event-driven manner such as LBE, or periodic manner such as FBE), following aspects need to be taken into account:   * Robustness against congestion with coexisting systems   + Event-driven sensing with random back-off has higher robustness, but highly congested situation in higher frequency may be a corner case   + Periodic sensing may cause potential unfairness issue in highly congested situation * Resource utilization efficiency   + Event-driven sensing would provide lower efficiency especially in case of less congested situation   + Periodic sensing would provide higher efficiency especially in case of less congested situation * Latency   + Event-driven sensing may lead larger latency at least in less congested situation   + Periodic sensing may lead smaller latency at least in less congested situation |

### LBT Parameters, COT duration, Gaps

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| **Company** | **Key Proposals/Observations/Positions** |
| FUTUREWEI | Proposal 2: For LBT channel access the maximum COT shall be 5ms.  Proposal 3: For LBT channel access the default maximum time gap between consecutive transmissions in the COT without additional LBT should be at least 13 us.  Proposal 4: NR should support configuration of larger gaps between consecutive transmissions in a COT without LBT required. |
| vivo | Proposal 2: The channel access mechanism can be selected based on the channel occupancy time, channel access rate, transmission priority, service requirement, or feedback information from the receiver, etc. |
| Nokia, Nokia Shanghai Bell | Proposal 11: gNB can serve multiple beams in TDM manner, resulting in transmissions gaps on a beam, within a COT after sensing the channel on the corresponding directions at the beginning of the COT. |
| Intel | Proposal 3: For a system operating in unlicensed 60 GHz band, the maximum channel occupancy time (MCOT) should never exceed 5 ms. |
| Sony | Proposal 5: Channel access parameters (such as LBT category, ED threshold, CWS adjustment, CAPC, etc.) need to be studied in order to fit with 60 GHz channel conditions. |

### ED threshold adaptation

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| **Company** | **Key Proposals/Observations/Positions** |
| FUTUREWEI | Proposal 7: The value of Pout in the CCA Check before initiating a COT should correspond to the maximum EIRP of the transmissions during that COT. |
| Intel | Proposal 8: When operating in unlicensed 60 GHz band, the ED threshold calculation shall account for the type of LBT mechanism used. |

### COT Sharing

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| **Company** | **Key Proposals/Observations/Positions** |
| Intel | Proposal 4: When a COT is acquired by an initiating device, this can be shared with any other device for which the transmission of the initiating device is targeted to.  Proposal 5: It is up to the gNB on whether to mandate or not the use of LBT before attempting any transmission from any device within an initiating device’s acquired COT |
| ZTE, Sanechips | Observation 3: No LBT can be considered to be used in COT sharing case and interference controlled environment. |
| LG Electronics | Proposal #6: It would be beneficial for coexistence that channel occupancy acquired by directional LBT is shared only for DL and UL signals/channels having spatial QCL relationship. |

### CWS and CAPC

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| **Company** | **Key Proposals/Observations/Positions** |
| Huawei, HiSilicon | Proposal 9：The procedures specified for CWS adjustment and multi-channel access in Rel-16 NR-U should be considered for operation in the 60 GHz band with necessary modifications when LBT is used.  Proposal 10：For operation in the 60 GHz band, when LBT is used within the COT, NR-U should consider to reuse the corresponding channel access procedures for 5/6GHz and modify the channel access parameters in accordance with the ETSI BRAN Harmonized Standard. |
| CATT | The LBT schemes studied in Rel-16 NR-U focusing in sub-6GHz frequency and included the following categories,  • Category 1(Immediate transmission after a short RX/TX switching gap),  • Category 2(LBT without random back-off, the duration time is more than 16us and less than 25us)  • Category 4( LBT with random back-off with a contention window of variable size)  Proposal 4: For NR operation in 52.6 - 71GHz, these three LBT categories can be considered as the starting points for proposal and evaluations. The setting of LBT parameters for NR operation in unlicensed spectrum should use those defined in 802.11ad as the reference for the study of the coexistence. |
| Intel | Proposal 6: RAN1 should discuss and identify the values Zmin and Zmax for the CCA procedure agreed and captured in TR 38.808 [5]. Further RAN1 should investigate on whether these values should depend on the type of transmission and physical channel that the device performs, and/or on the type of traffic and. |

### Discussion

EN 302 567 only defines the CCA check at the initiating device, which can be consider as a Cat 4 LBT type mechanism.

FL proposal:

Use the CCA check procedure in EN 302 567 (per RAN1 understanding as from RAN1 #102-e) as the baseline for the Cat 4 LBT design for 60GHz band.

* FFS: Any parameter change needed
* FFS: Do we need to introduce CAPC
* FFS: Do we need to introduce contention window adjustment

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| **Company** | **View** |
| Ericsson | CAT4, by definition, includes CW adjustment which is not part of the CCA check procedure in EN 302 567. So to avoid any confusion, we prefer not to refer to it as CAT4.  We disagree with the second and third FFSs. there is a justification for having CAPC, CWS adjustment in 5GHz because simply the propagation characteristics and coverage of this frequency range might result in interference issues. So it was important to make sure that high priority data is prioritized in this case (via CAPC) and collisions are resolved via CWS adjustment.  Now, the situation is very different in 60GHz. Most companies have shown that the LBT is inducing unnecessary deferral that reduces throughput performance. Differentiating between traffic types would mean inducing even larger unnecessary latencies.  In general, LBT in 60GHz may or may not bring gains for the 5th perc. UEs, but what all companies agree on is that it has a negative impact on the aggregated system performance. Therefore, there is no justification to increase the LBT overhead by introducing CAPC and CW adjustment, especially that they are not mandated by the HS. The work should be focused on what is needed to enhance the performance and not to re-specifying the 5GHz LBT aspects in 60GHz without a strong motivation. |
| Huawei/HiSilicon | We are OK to use the CCA check procedure in EN 302 567 as the baseline for the Cat 4 LBT design. However, we believe the following aspects related to CCA energy/EDT should be further discussed.   1. Dependency of EDT to LBT BW. 2. Aspects related to the sensing/Tx beam, e.g., how the CCA energy/EDT takes into account the sensing antenna gain, Receive (sensing) beamforming gain, and the beamforming gain of the subsequent transmission after acquiring the COT.   We are also supportive of discussing CAPC and CWS adjustment. However, we believe that CAPC and CWS are less essential discussions than the above two aspects. |
| LG | It was agreed in RAN1#102-e to use the CCA check procedure in EN 302 567 as the baseline for system evaluation with LBT. Therefore, it can be the baseline for the Cat-4 LBT design for 60GHz, and enhancements such as the introduction of contention window adjustment and CAPC can be considered. The procedure for CWS adjustment for the Type 1 channel access procedure in Rel-16 NR-U can be reused with modifications to the parameters. |
| Nokia, NSB | We agree with Ericsson on the terminology. Actually, the LBT scheme in EN 302567 is rather Cat3 than Cat4 (TS 36.889: *Category 3: LBT with random back-off with a contention window of fixed size*).  As for the FFS points, 3GPP should firstly aim at following ETSI’s definition. We do not see a need for the 2nd and 3rd FFS points. The first one we may keep open until the work item, e.g. depending on the exact decisions on directionality of LBT, channelization etc. |
| vivo | No further enhancement (all FFS) is necessary. |
| Futurewei | We agree to use the EN 302 567 as the baseline as it was agreed already in RAN#102, and we agree with the first bullet. We do not see the second and third bullet as necessary. |
| Charter Communications | The CCA scheme in EN 302 567 is a Cat-3 LBT mechanism. There is no need based on current simulation evidence to further enhance it into a pseudo-Cat-4 scheme. |

EN 302 567 defines the MCOT to be 5ms.

FL proposal:

MCOT is 5ms, including all the gaps inside

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| **Company** | **View** |
| Ericsson | Agree with FL proposal (we propose the additional wording for the proposal “when LBT is performed, MCOT is 5ms, including all the gaps inside”) |
| Huawei/HiSilicon | Agree. |
| LG | Agree with the FL proposal. |
| Nokia, NSB | Agree with the FL proposal. Ericsson’s clarification is also fine to us. |

The above discussion is agreed as follows:

Agreement:

At least when operating with LBT, MCOT is 5ms, including all the gaps inside

From online session, the following possible conclusion is discussed.

Possible Conclusion:

There is no maximum channel occupancy time defined when gNB and all UEs are operating without LBT.

Please provide view:

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| **Company** | **View** |
| vivo | Agree |
| Futurewei | We think that with this wording this conclusion is obvious as COT and MCOT were defined only for the LBT case. Maybe we could either remove the word “defined” or re-phrase it as a question “Do we need to define COT when no LBT is used for channel access?” |
| Charter Communications | Agree |

From online session, the following possible conclusion is discussed.

Possible Conclusion:

There is no COT sharing defined when gNB and all UEs are operating without LBT.

Please provide view:

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| **Company** | **View** |
| vivo | Agree |
| Futurewei | We think that with this wording this conclusion is obvious as COT sharing was defined only for the LBT case in 5GHz band. Maybe we could either remove the word “defined” or re-phrase it as a question “Do we need to define COT sharing when no LBT is used for channel access?” |
| Charter Communications | We understand the motivation here, but in RAN1#102-e agreements the notion of channel occupancy also covers the no-LBT case (“For gNB/UE to initiate a channel occupancy, both channel access with LBT mechanism(s) and a channel access mechanism without LBT are supported.”) So a more consistent phrasing would be:  There is no restriction on COT sharing when a channel occupancy is initiated without LBT. |

The EN 302 567 does not explicitly define the gap allowed for COT sharing. Shall we define maximum gap or allow any gap with the COT

Discussion point:

For COT sharing from an initiating node performed LBT to responding device without performing LBT, do we need to define a maximum gap between the initiating node transmission and responding node transmission?

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| **Company** | **View** |
| Ericsson | No. such restriction is not required by EN 302 567 and there is no coexistence issue. As long as there is no evidence that there is an issue to resolve, we do not accept adding those restrictions.  Besides, the gap is any way restricted since, unlike 5GHz, all the gaps are counted as part of the COT. Hence, a gap can never exceed 5ms. |
| Huawei/HiSilicon | We do not see a compelling reason to define a maximum gap within COT. |
| LG | The definition of the gap allowed for COT sharing without LBT can be discussed together with the type of channel access procedures (e.g., Type 2A/2B/2C in Rel-16 NR-U) even the restrictions are not specified in EN 302 567. |
| Nokia, NSB | No need to define such gap. |
| vivo | Maximum gap definition without LBT is not necessary. Any gap is applicable since the regulation does not have any restriction on this.  “*An equipment (initiating or not initiating transmission), upon correct reception of a packet which was intended for this equipment, can skip the CCA Check, and immediately proceed with the transmission in response to received frames. A consecutive sequence of transmissions by the equipment, without a new CCA Check, shall not exceed the 5 ms Channel Occupancy Time as defined in step 5) above*” |
| Futurewei | The maximum gap definition is not necessary. |
| Charter Communications | Any such maximum gap limit should be motivated based on simulation evidence. |

Discussion point:

Shall we introduce Cat 2 LBT for 60GHz band for responding device in COT sharing and/or initiating device transmits another burst in its own COT. If yes, how to define Cat 2 LBT.

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| **Company** | **View** |
| Ericsson | No.  EN 302 567 all transmissions within the COT (responding or initiating device) to be transmitted without any LBT. As long as there is no evidence that there is an issue to resolve, we do not accept complicating the procedure. |
| Huawei/HiSilicon | Not supportive. We don’t see any necessity to define Cat 2 LBT within COT. |
| LG | The introduction of Cat-2 LBT for COT sharing can be discussed and the initiating device can transmit other transmission in its own COT by supporting multiple switching points when the conditions such as the gap is met. For the definition of Cat-2 LBT, the Type 2 channel access procedure in Rel-16 NR-U can be reused with possible modifications to the parameters. |
| Nokia, NSB | We see no need for this as EN 302 567 does not mandate this (and other HS’s do not even require LBT) |
| vivo | Follow the regulation in EN 302 567, no need. |
| Futurewei | Not necessary. |
| Charter Communications | Same view as E//, Nok, vivo, etc |

Discussion point:

For COT sharing with LBT at responding device, do we need to define a maximum gap?

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| **Company** | **View** |
| Ericsson | We do not support LBT at responding device |
| Huawei/HiSilion | The discussion point is not very clear for us. It needs to be clarified which of the following scenarios (or any other scenario) is concerned in the question:   1. COT is acquired after a successful receiver assisted LBT (e.g., RTS/CTS-like mechanism) and is shared between the initiating device and the responding device. 2. COT is acquired by the initiating device and shared with a responding device. The responding device performs LBT during the COT before transmission.   If the intention is 1 above, we don’t see any reason defining a maximum gap.  If the intention is 2 above, we do not support LBT by the responding device during the COT. |
| LG | The definition of the gap allowed for COT sharing with LBT can be also discussed together with the type of channel access procedures (e.g., Type 2A/2B/2C in Rel-16 NR-U) even the restrictions are not specified in EN 302 567. |
| Nokia, NSB | As said above, we see no need for Cat 2 for the responding device |
| vivo | Our understanding is that any transmission within the COT can proceed immediately if COT sharing. |
| Futurewei | This is a re-phrase of a previous question. There is no need to define a maximum gap based on ETSI regulations. |
| Charter Communications | Same view as vivo |

Discussion point:

Should ED threshold be a function of LBT bandwidth

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| **Company** | **View** |
| Ericsson | ETSI BRAN EN 302 567 has been recently updated. The updates included changes related to the LBT procedures (CW, MCOT, etc..) but yet the ED threshold was not changed to reflect the LBT bandwidth. |
| Huawei/HiSilicon | Yes. One reason is that if two operators with different BWs interfere with each other, the one with a higher BW is in disadvantage if the EDT does not depend on the LBT bandwidth. |
| LG | It is necessary to enhance the method of determining the ED threshold with consideration of the maximum output power and the unit LBT bandwidth applied in NR for the fair coexistence with the incumbent system (e.g., WiGig). |
| Nokia, NSB | We are open to study this further once the channelization becomes more clear. ED threshold adaptation should be standardized only if meaningful benefits are shown. |
| vivo | The ED threshold for different LBT bandwidth can be further studied. |
| Futurewei | The PSD depends on the bandwidth therefore ED threshold should be adjusted accordingly. |
| Charter Communications | Open to study this further. |

## CET and short control signalling

### Short Control Signalling with CET

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| **Company** | **Key Proposals/Observations/Positions** |
| Ericsson | Proposal 2. When operating with LBT, a node can access the channel for up to 10% without LBT for control signal/channel transmission(s) |
| Apple | For LBT channel access, non-LBT transmission for specific channels (e.g. SSB) can occur in at most 10% of the COT. |
| Nokia | Proposal 6: LBT procedure for 60 GHz band supports channel access without channel sensing for UE responding within a gNB initiated shared COT.  Proposal 7: Support LBT exempt transmissions for SSBs and other reference signals critical for cell operation.  Proposal 8: Support LBT exempt UL transmissions with a low Tx power (e.g. 10 dBm or less) and with a certain minimum beamforming gain for better support of low latency PRACH, SR or CG-PUSCH |

### Discussion

Discussion point:

Shall we support short control signalling based contention exempt transmission in 60GHz band?

* Any restriction to the transmission, on duty cycle (10%?), content (control signalling only? SSBs? CSI-RS?), TX power

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| **Company** | **View** |
| Ericsson | Yes. Since there is no coexistence issue in majority of the scenarios, we think it is beneficial to assume that control signals (especially SSB and PRACH) can be send without performing LBT up to 10% of the time. Even if LBT is performed, it will rarely fail. we do not see the need to support any channel design changes to cope with the LBT procedure, if we know that LBT will rarely make difference. |
| Huawei/HiSilicon | We can accept such an exemption as long as the following conditions are met:   1. The exempted signal/channel has a low duty cycle. 10% can be a reasonable choice. However, it should be clarified the x% duty cycle only accounts for the amount of signal outside of COT or also includes the amount of signal inside COT. 2. The exempted signal/channel is unicast and not broadcast so it has a small “interference footprint” (e.g., only UCI or unicast DCI). |
| LG | The contention exempt for short control signalling can be considered based on the requirements described in EN 302 567. The type of short control signals (e.g., SSB, CSI-RS) and the requirements (e.g., TX power) for the transmission without contention can be determined through further discussion. |
| Nokia, NSB | Yes, we should plan for that. ETSI BRAN is expected to update EN 302 567 in this respect, and the NR-U design should make use of the allowance. |
| vivo | Some clarifications are needed.  1, what is a duty cycle? A COT or a constant time?  2, the restriction applies only to the short control signalling outside the COT or also inside a COT?  3. Shall we update the regulation regarding the short control signalling? Since there is no short control signalling in EN 302 567 now. |
| Futurewei | Same as Vivo mentioned. How a duty cycle is defined? It is not clear. Is it 10% of a COT duration or 10% of MCOT? How short the short control transmissions need to be? More details are necessary. In principle we are OK of having contention exempt transmissions. |

Discussion point:

If we support short control signalling based transmission, do we apply Cat 2 LBT or Cat 1 LBT?

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| **Company** | **View** |
| Ericsson | Can be performed without LBT as allowed by EN 302 567 (we prefer to avoid referring to CAT1 here since cat1 as specified for 5GHz has certain restrictions and requirements that are not applicable here) |
| Huawei/HiSilicon | If the exempted signal has a low duty cycle and is unicast, Cat 1 LBT seems to be sufficient. |
| Nokia, NSB | LBT is not required for Short Control Signaling transmissions. |
| vivo | If short control signalling based transmission is supported, Cat 1 LBT should be applied. |
| Futurewei | It depends on the definition of “short signalling”. In principle, we would prefer for shorter signalling shorter or no LBT. The actual CAT should be left to gNB decision and configuration based on deployment scenarios and traffic situations. |

## Directional LBT

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| **Company** | **Key Proposals/Observations/Positions** |
| FUTUREWEI | Proposal 9: The study should clarify the definition of “omni-directional LBT” or remove it. |
| Lenovo, Motorola Mobility | Observation 1: For NR unlicensed bands between 52.6 GHz and 71 GHz, for LBT based channel access mechanism, if only omni-directional LBT is supported, then the exposed node problem could result in reduce spatial reuse.  Observation 2: For NR unlicensed bands between 52.6 GHz and 71 GHz, for LBT based channel access mechanism, if only omni-directional LBT is supported, then the coverage of the beamformed transmissions/receptions could be limited for fair coexistence by having similar range as with omni-directional LBT  Observation 3: For NR unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, if directional LBT is agreed to be supported, then the beam-management and directional LBT procedures are expected to be tightly coupled or inter-dependent.  Observation 4: For NR unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, if directional LBT is supported, then performing LBT only at the transmitted side may not guarantee an interference-free reception due to hidden nodes to the transmitter  Proposal 1: For NR unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, directional LBT operation at both the gNB and UE should be supported  Proposal 2: For NR unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, if directional (beam-based) LBT operation is agreed to be supported, then the omni-directional LBT procedures and corresponding beam-based transmission and reception procedures specified for unlicensed bands in FR1 in NR Rel-16 should be enhanced to adapt accordingly for facilitating beam-based LBT operation |
| Huawei, HiSilicon | Observation 1: It should be clarified whether antenna gain is counted in the received energy when comparing with the EDT.  Proposal 4: For operation in NR-U-60, the EDT formula adopted from draft v2.1.20 of EN 302 567 as a baseline should be adjusted to account for the beamforming gain of the potential following transmission.  Observation 2: (Quasi-)omni-directional simplifies the implementation and allows for reusing Rel-16 NR-U LBT procedures but could lead to an ‘over protection’ problem and thus reduction of spatial reuse.  Observation 3: Directional LBT potentially improves the channel access probability and enhances the spatial reuse. However, when performed at the transmitter side, the hidden node problem could be more severe due to limited sensing direction.  Observation 4: Compared to (quasi)-omni-directional LBT, directional LBT increases complexity and overhead for gNB to serve multiple UEs in different directions.  Proposal 5：For operation in the 60 GHz band, in regions where LBT is mandated, transmitter side (quasi)-omni-directional LBT and directional LBT should be considered for different scenarios.  Observation 5：It should be clarified whether antenna gain is counted in the received -side LBT of the receiver-assisted LBT mechanism and provides an efficient tradeoff as it aims at increasing the spatial reuse while mitigating the hidden node issue. |
| Xiaomi | Proposal 1: Directional CCA can increase network efficiency compared to omnidirectional CCA. Directional CCA both at transmitter and receiver side should be studied. |
| vivo | Proposal 1: If directional LBT is used in 60 GHz band, the CCA energy should be calculated as one specific beamforming direction including beamforming gain. |
| Interdigital | Observation 1: Omni-directional LBT in unlicensed spectrum from 52.6GHz to 71GHz can under-represent interference in the direction of the associated transmission and over-represent interference in other directions.  Observation 2: Dynamic scenarios with some level of mobility increases the likelihood of transmitter-receiver pairs interfering with each other even when using narrowbeams.  Observation 3: Directional LBT provides benefits over no LBT for dynamic scenarios with some level of mobility, while reducing the drawbacks associated with omni-directional LBT.  Proposal 1: Directional LBT is supported for channel access from 52.6GHz to 71GHz.  Proposal 2: A single directional LBT process can be performed on a beam whose parameters are determined from the parameters of the Tx beam of one or more associated transmissions. |
| CATT | Observation 1: The energy detection algorithm of LBT based on the assumption of omni antenna is not feasible for the beamforming based Tx/Rx operation.  Proposal 6: The mechanism of LBT enhancement for beamforming operation in 52.6-71 GHz can be studied as follows,  • The procedure of directional LBT with same beamwidth of PDCCH/PDSCH. .  • The handshake mechanism (e.g. measurement and report) with UE feedback of channel status at the receiver in helping gNB in determining the clear channel status. |
| TCL | Proposal 1: RAN1 shall study channel access mechanisms based on directional LBT.  Proposal 3: RAN1 shall study solutions to mitigate the effect of LBT deafness, beam orthogonality and beam imbalance in order to enable directional LBT at UE side without harming NR-U channel access efficiency.  Proposal 4: RAN1 shall consider the usage of directional LBT at gNB side. |
| ATT | Support of directional LBT |
| Nokia, Nokia Shanghai Bell | Observation 1: Both omnidirectional and directional LBTs need to be considered on the channel access design.  (but prefer gNB implementation to choose which one)  Proposal 10: Beamforming for gNB’s LBT is left for implementation as much as possible and only necessary requirements are specified.  Proposal 11: gNB can serve multiple beams in TDM manner, resulting in transmissions gaps on a beam, within a COT after sensing the channel on the corresponding directions at the beginning of the COT. |
| Intel | Observation 1: Omni-directional LBT may act in many cases overprotectively and may prevent from fully exploiting spatial reuse under highly directional transmissions. This issue may be mitigated through directional LBT. However, directional sensing exacerbates the well-known hidden node issue, and leads to scenarios where the system could suffer from deafness.  Proposal 1: Both directional and omni-directional LBT are supported, and it may be up to the network which LBT to use based on the specific use case and scenario.  Observation 2: Receiver-aided LBT is able to mitigate the issues introduced by directional LBT and offers a mean to better assess the correct level of interference at the receiver  Proposal 2: If directional LBT is supported, a receiver-aided LBT should complement its CCA procedure. FFS: details on how to support this feature.  Proposal 8: When operating in unlicensed 60 GHz band, the ED threshold calculation shall account for the type of LBT mechanism used. |
| ZTE, Sanechips | Observation 2: Compared to omni-directional LBT, directional LBT is beneficial to increase the probability of channel access and the spatial reuse efficiency for NR-U, and the impact on the performance of the existed Wi-Fi system is negligible.  Proposal 4: Release 17 NR-U should consider supporting different channel access modes for above 52.6 GHz, e.g., directional LBT and No LBT. |
| Ericsson | Observation 9 The benefit from directional LBT in 60GHz spectrum is not clear. |
| LG Electronics | Proposal #3: If directional CCA procedure with beam based transmission is identified as beneficial, the followings for directional CCA procedure can be considered:   * CCA threshold setting * Relationship between transmission direction and CCA direction * Directional LBT for broadcast/unicast transmission * CWS management   Proposal #5: It should be studied that how to indicate the direction of LBT (e.g., omni-directional LBT or directional LBT) and the type of LBT (e.g., Type 1 or Type 2A/2B/2C channel access procedure in NR-U) when scheduling a UL transmission inside or outside of a channel occupancy.  Proposal #6: It would be beneficial for coexistence that channel occupancy acquired by directional LBT is shared only for DL and UL signals/channels having spatial QCL relationship. |
| Spreadtrum Communications | Proposal 1: The directional LBT should be studied in 60GHz unlicensed band. |
| Samsung | Proposal 5: RAN1 shall study the channel access mechanism with directional channel sensing.  Observation 1: Directional LBT performs better than omni-directional LBT.  Observation 2: Directional LBT performs better than no LBT in high load case, and performs worse than no LBT in low load case.  Observation 3: Directional LBT has higher performance gain for 5% tile UEs. |
| OPPO | Proposal 2: the feasibility of directional LBT should be studied. |
| Sony | Proposal 2: Directional LBT should be supported on 60 GHz unlicensed operation  Proposal 4: Relationship between the sensing beam and transmission beam should be considered if directional LBT is supported.   * Beam of all transmissions on a COT should be contained within the sensing beam used for acquiring the COT. |
| Apple | Observation 1: The large propagation losses in the 60 GHz range mandate the need for beam-based transmission and the need for LBT schemes that account for these beams.  Proposal 4: RAN1 to support directional LBT in scenarios where LBT is mandated. |
| CAICT | Proposal 2: The mechanism of CAT2 based directional LBT for DRS and data transmission within a COT could be different.  Proposal 3: The mechanism for CAT4 based directional LBT should be considered and the detail design could be FFS. |
| Convida | Proposal 1: Directional LBT and interference mitigation should be studied.  Proposal 2: Omni-directional LBT and directional LBT should be considered and supported. |
| NTT Docomo | Observation 2: On directivity of LBT, following aspects need to be taken into account:  • The different sensing area between omni-directional LBT and directional LBT would lead different sensitivity to presence/absence of transmission from surrounding device   Omni-directional LBT can only detect presence of transmission from surrounding device in proximity but in all directions so that unnecessary LBT failure may happen   Directional LBT can only detect presence of transmission from surrounding device in the transmission direction  • Appropriate approach could depend on types of the intended transmission in the acquired channel occupancy. |
| ITRI | Proposal 1: Directional LBT should be supported in R-17 NR-U. |
| Potevio | Proposal 1: For LBT based channel access mechanism in 60GHz unlicensed band, directional LBT combining with receiver-assisted LBT should be studied in comparison to no-LBT based access mechanism.  Proposal 3: For channel access mechanism with directional LBT, simultaneous LBT procedures for different directions should be studied to mitigate the transmission latency and increase channel access probability. |
| Qualcomm | Proposal 2: Consider the use of antenna gain of sensing beam and transmission beam to determine the suitability of using a given sensing beam in conjunction with another transmission beam. |

### Discussion

There is strong support to support or study directional LBT. On the other hand, in mmW system, likely there is no true “omni-directional” LBT in the beginning. When we discuss “directionality” of LBT, we should discuss its relationship with transmission beam.

Discussion point:

Should 3GPP spec defines the relationship between the LBT beam and the transmission beam or leave it as implementation. For example, should we define something like the LBT beam should “cover” the transmission beam?

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| **Company** | **View** |
| Ericsson | EN 302 567 does not define it, neither should 3gpp do that. It can be left to implementation. |
| Huawei/HiSilicon | 3GPP spec should define the relationship between the LBT beam and the transmission beam.  A relation between the LBT sensing beam and the transmission beam should be defined as simulations results of multiple companies show that directional LBT (at the receiver and/or transmitter) can improve coverage compared to omni-directional LBT.  From our perspective, an “ideal” directional LBT covers only a spatial continuum of the subsequent transmit beam(s) in the COT while an omni-directional LBT does not have any correspondence with the subsequent transmit beams(s) in the COT and, in particular, may be have a much wider beam width than the spatial continuum of the subsequent transmit beam(s) in the COT.  We understand that one beam covering a spatial continuum of multiple other beams is not defined in 3GPP so far. This is an exercise that seems necessary to do in WI. |
| LG | We should clarify the meaning of directional LBT and omnidirectional LBT first because the omnidirectional LBT can be seen as just a case of directional LBT. Moreover, we think the transmission beam should have a spatial relation with the LBT beam. |
| Nokia, NSB | To our understanding, although EN 302 567 does not have a related requirement, there is a test case that verifies that: “*The UUT may be connected to a companion device during the test. When performing this test of a UUT with directional antenna (such as array antenna system capable of beam-forming), the wanted communication link (between the UUT and the companion device) and the interference signal shall be aligned to the direction corresponding to the UUT's maximum EIRP.”*  One way or another NR-U devices will need to comply with the requirement, but that will likely not affect RAN1 standards (but possibly RAN4). |
| vivo | The directional LBT operation should be first discussed, in the case with beam correspondence, without beam correspondence, with a beam “cover” the transmission beams, etc. When we have clear view on the directional LBT, we can further discuss if there is spec impact. |
| Futurewei | We should study and define the relationship between sensing beam for LBT and transmission beam. We should consider the CCA ED adjustment based on the sensing beam and transmission beam imbalance. |

If we define the relationship between LBT beam and TX beam, another question to answer is if ED threshold should be adjusted by the LBT beam and TX beam choices. For example, given a fixed TX beam, using a pseudo-omni beam or the same TX beam for LBT will produce different LBT ED measurement given the same interference.

Discussion point:

If 3GPP spec defines the relationship between the LBT beam and the transmission beam ,shall we also define the impact to ED threshold given a certain LBT beam and transmission beam, or use a fixed ED threshold?

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| **Company** | **View** |
| Ericsson | Is the assumption to allow higher ED threshold than what BRAN allows if directional LBT is used? but then doesn’t that violate EN 302 567? |
| Huawei/HiSilicon | Both sensing (LBT) beamforming gain and subsequent transmission beamforming gain should be taken into account in the EDT threshold.  In our view, this is independent of whether or not 3GPP spec defines the relationship between the LBT beam and the transmission beam. |
| LG | The ED threshold for directional transmission may need to be different from the case of omni-directional transmission since the coverage and interference from a directional transmission will be different from an omni-directional transmission. Therefore, the ED threshold can be adjusted by the LBT beam and/or TX beam choices. |
| Nokia, NSB | This aspect will require further study during the WI. |
| vivo | If the LBT beam and the transmission beam are different, the ED threshold should take into account the different antenna gain. |
| Futurewei | Sensing and transmission beams, especially when a gNB serves multiple UEs in a COT may be quite different therefore the ED may require adjustments. |

## Rx Assisted LBT

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| **Company** | **Key Proposals/Observations/Positions** |
| FUTUREWEI | Proposal 10: Receiver assisted LBT is an LBT operation that relies both on channel measurements at the transmitter and on channel measurements at the receiver |
| Lenovo, Motorola Mobility | Observation 6: For NR unlicensed bands between 52.6 GHz and 71 GHz, in order to adopt ATPC as potential channel access mechanism, receiver feedback such as long-term sensing would be needed  Observation 8: For NR unlicensed bands between 52.6 GHz and 71 GHz, long-term channel sensing could be useful for both LBT and without LBT based channel access mechanism:  - For LBT based channel access mechanism, long-term sensing at the UE could be utilized for receiver assisted LBT at the gNB  - For no LBT based channel access mechanisms, long-terms sensing could provide interference statistics in terms of potential interference from WiFi as well as interference from other NR operators  Proposal 4: For NR unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, receiver assisted LBT could be supported along with directional LBT to take into account the potential interference at the receiver |
| Huawei, HiSilicon | Proposal 6：For operation in the 60 GHz band, receiver-side directional LBT should be supported.  Observation 8: Receiver-only directional LBT outperforms No-LBT in terms of both coverage and capacity across the different loading conditions in the indoor scenario  Observation 6: Receiver-assisted directional LBT is beneficial for cell-edge users in indoor scenario especially in medium and high traffic load. |
| Xiaomi | Proposal 1: Directional CCA can increase network efficiency compared to omnidirectional CCA. Directional CCA both at transmitter and receiver side should be studied. |
| vivo | Observation 1: For cell edge UEs, compared to no-LBT scheme, the ED-based LBT schemes cause some UPT performance loss when the traffic load is low. In high load, there’s some slight performance gain.  Observation 2: The receiver-assisted LBT is not observed with apparent gain compared with ED-based LBT for cell edge UEs but slight performance gain for average UPT in indoor scenario A.  Observation 3: The receiver-assisted LBT shows significant gain in severe interference scenarios.  Proposal 2: The channel access mechanism can be selected based on the channel occupancy time, channel access rate, transmission priority, service requirement, or feedback information from the receiver, etc. |
| CATT | Proposal 6: The mechanism of LBT enhancement for beamforming operation in 52.6-71 GHz can be studied as follows,  • The procedure of directional LBT with same beamwidth of PDCCH/PDSCH. .  • The handshake mechanism (e.g. measurement and report) with UE feedback of channel status at the receiver in helping gNB in determining the clear channel status. |
| AT&T | Enhancements for receiver assisted LBT |
| Nokia, Nokia Shanghai Bell | Observation 2: Considerable benefits from Rx assistance should be shown in a reasonable range of different situations and with realistic UE feedback delays given the considerable implementation effort involved.  Proposal 12: Rx assistance, if supported, should be configurable per UE, so that it could be used only with UEs frequently detecting high interference.  Proposal 13: If Rx assistance is supported, UE processing time similar to PDSCH processing time (N1) or CSI computation time (N2/Z1Z2) should be considered for providing Rx assistance.  Proposal 14: If Rx assistance is supported, Rx assistance should not be limited to the beginning of COT only. |
| Intel | Observation 2: Receiver-aided LBT is able to mitigate the issues introduced by directional LBT and offers a mean to better assess the correct level of interference at the receiver  Proposal 2: If directional LBT is supported, a receiver-aided LBT should complement its CCA procedure. FFS: details on how to support this feature. |
| Ericsson | Proposal 4. For operation in 60GHz, it is not beneficial to support receiver assisted LBT. |
| Spreadtrum Communications | Proposal 2: The receiver assisted LBT should be studied in 60GHz unlicensed band. |
| Samsung | Proposal 6: RAN1 shall study the channel access mechanism with handshake between transmitter and receiver. |
| Sony | Proposal 3: Receiver assisted LBT should be supported on 60 GHz unlicensed operation. |
| Apple | Proposal 5: RAN1 to support an RTS/CTS-like mechanism to help in mitigating directional interference or potential hidden node issues in scenarios where LBT is mandated. |
| Convida | Proposal 4: Receiver assisted LBT should be supported in 52.6 GHz and above.  Re: Exposed node issue : Proposal 5: Study methods to enhance resource utilization and interference in 52.6 GHz and above.  Proposal 6: Enhancement of beam operation should be investigated to mitigate interference |
| NTT Docomo | Observation 4: On receiver-assisted LBT,   * It is beneficial to detect channel condition at Rx device which would be more invisible from Tx device in higher frequency * It needs more procedure burden while how it is actually beneficial in higher frequency is questionable |
| Potevio | Proposal 1: For LBT based channel access mechanism in 60GHz unlicensed band, directional LBT combining with receiver-assisted LBT should be studied in comparison to no-LBT based access mechanism. |
| Qualcomm | Observation 2: Aggregate performance may not be representative of individual drops due to the highly directional nature of links. In the events where interference becomes an issue, Rx-assistance based LBT schemes outperform Tx-only LBT schemes as well as not doing LBT at all.  Observation 3: Under scenarios with low interference diversity, there can be scenarios (depends on locations of transmitters and receivers) persistent interferers present and cause significantly reduced SINR or outage. A receiver assisted LBT mechanism can help those scenarios.  Proposal 1. Consider receiver assisted LBT mechanism for scenarios with low interference variation. |

### Discussion

There is strong support to support or study RX assisted LBT, mainly to solve the hidden node issue. However, there may not be a common understanding on what is RX assisted LBT. Might be good to clarify the definition first

Discussion point

Receiver assisted LBT can the categorized into the following classes

* Class A. Receiver provides assistance information (signalling) to transmitter only, but does not provide information to other NR transmitter/receivers
  + Eg. UE provides information to serving gNB, and gNB provides information to COT initiating UE
  + In this case, cross link coexistence is based on ED.
* Class B. Receiver provides assistance information (signalling) to other NR nodes, including non-serving nodes
  + In this case, cross RAT coexistence is based on ED
  + Class B1. Intra-operator only
  + Class B2. Also including inter-operator signalling
    - In this case, cross operator coexistence is based on ED
* Class C. Receiver provides assistance information (signalling) to other NR nodes and nodes from other RAT

Note that for the case receiver provides long term measurement information, we can consider it in the no-LBT design.

Please provide your view on which class you are supporting, and please also comment on if there is better way to define classes.

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| **Company** | **View** |
| Ericsson | We agree with the moderator’s proposal to clarify companies’ expectation when it comes to receiver assisted LBT. Companies that evaluated Receiver assisted LBT are asked to indicate which RAL category did they evaluate.  In our view, we see benefits in providing long term measurement to assist the interference situation. We do not see the benefits or need to support a receiver assisted LBT with information exchange per COT. |
| Huawei/HiSilicon | Support Class A as it is more practical.  In our view, Receiver-only LBT as a simple yet effective sub-category of receiver-assisted LBT should be supported. Our simulations in our updated t-doc R1-2008976 show the performance of receiver-only LBT. |
| LG | We agree with the moderator’s proposal. In the actual implementation of the UE or gNB, the receiving direction and the transmitting direction may not match well. Moreover, applying the same spatial direction as transmission direction for CCA may not be effective since interference to the receiver will be estimated in the opposite direction to the transmission direction. In this sense, the receiver assisted LBT can be considered but there is a need to clarify which aspect is additionally required to support receiver assisted LBT in terms of above categorized class of receiver assisted LBT. |
| Nokia, NSB | First of all, in our view receiver assisted LBT schemes, if any, should be a complementary solution that can be used based on gNB discretion when benefits are there. There should be convincing simulation results with realistic assumption before such schemes are specified.  The practical feasibility of Class B and Class C schemes is questionable, while the gains are unclear.  Class A could in principle include schemes resembling existing CSI reporting mechanisms with some enhancements, and those may help the network in understanding the instantaneous interference conditions. Practical challenges related to e.g. UE processing times will still need to be considered, and related information should be provided along with the proposals and evaluation results. |
| vivo | As a starting point, we should focus on class A. All the UEs in the cell can detect the request sent from the gNB, but only the target UEs will feed back with response. In the case of UE-initiated COT, only gNB provides response to the initiating UE.  In the future, the scheme can be extended to class B if necessary. Class C should not be considered. |
| Futurewei | Use Class A as the starting point. For the benefits of Class B and Class C, it is not clear for instance, what type of signalling can be used between RAT and if this signalling is reciprocal between RAT. |

## Multibeam operation

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| **Company** | **Key Proposals/Observations/Positions** |
| Xiaomi | Proposal 3: Multi-beam transmission should be studied to fully take advantage of spatial diversity. |
| CATT | Proposal 7: For increasing the channel access opportunities, the scheme of multi-beam ED measurement in a sensing slot can be studied.  Proposal 8: In order to alleviate the hidden node problem in directional LBT, a method of Multi-DCI transmission in different beam direction for a PDSCH scheduling should be considered. |
| Nokia, Nokia Shanghai Bell | Proposal 11: gNB can serve multiple beams in TDM manner, resulting in transmissions gaps on a beam, within a COT after sensing the channel on the corresponding directions at the beginning of the COT. |
| ZTE, Sanechips | Proposal 5: For multiple transmission(s) with different beams case, channel condition difference for different beams should be considered when designing the channel access schemes for COT sharing in NR unlicensed spectrum. |
| Potevio | Proposal 3: For channel access mechanism with directional LBT, simultaneous LBT procedures for different directions should be studied to mitigate the transmission latency and increase channel access probability. |

### Discussion

Discussion point:

Within a COT, shall we support spatial multiplexing of multiple beams (MU-MIMO), and what is the LBT requirement?

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| **Company** | **View** |
| Ericsson | The support of LBT should not add restriction on gNB scheduling behaviour. EN 302 567 does not disallow spatial multiplexing of multiple beams (MU-MIMO) within a COT. Also, it does not require additional LBT requirements. |
| Huawei/HiSilicon | Support spatial multiplexing of multiple beams (MU-MIMO) as long as a directional LBT is used before COT that covers all the subsequent transmission beams in the COT. |
| LG | As we mentioned in 2.5.1, the transmission beam is closely related to the LBT beam. Therefore, if we want to support spatial multiplexing of multiple beams within a COT, the corresponding LBT should be performed for the multiple beams accordingly. |
| Nokia, NSB | MU-MIMO should be supported as long as requirements related to EIRP etc. are met. It is unclear if MU-MIMO puts any further requirements to the LBT design. |
| vivo | Spatial multiplexing of multiple beams should be supported. But the LBT requirements need further discussion. There are some options as below:   1. Perform LBT with a beam “cover” the transmission beams to obtain the COT    1. Transmit without further LBT in each transmission direction within the COT    2. Perform one-short LBT before each transmission within the COT 2. Perform LBT for each transmission beam immediately before the transmission and obtain COT for each beam.    1. Some rules should be considered to break LBT procedure if some beam direction is always detected as busy. The device can then switch to another beam to perform LBT and transmission. |
| Futurewei | Support spatial multiplexing. For the LBT requirement part , it may be related to the relation between sensing and transmission beams. CCA should cover the potential transmission area. |

Discussion point:

Within a COT, shall we support TDM multiplexing of multiple beams? If we do, shall we perform LBT at the beginning of the COT with no LBT in the middle, or shall we perform LBT at the beginning, and perform additional LBT for each beam switching in the middle?

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| **Company** | **View** |
| Ericsson | The support of LBT should not add restriction on gNB scheduling behaviour. EN 302 567 does not disallow TDM multiplexing of multiple beams within a COT. Also, it does not require additional LBT requirements. |
| Huawei/HiSilicon | Support TDM multiplexing of multiple beams as long as long as a directional LBT is used before COT that covers all the subsequent transmission beams in the COT. In such a case, there is no need to do an extra LBT within the COT by any of the responding nodes or initiating node. |
| LG | It is noted that the interference environment can be different for each beam direction. For example, if gNB’s transmission is beamformed to Beam A for the first three slots but the last slot is redirected to Beam B, it may collide with other nodes (e.g., WiGig AP) that has transmitted in the direction of beam B after the success of directional LBT to Beam B. Therefore, it should be further studied how to perform omnidirectional or directional CCA for multiple-beam sweeping transmission. |
| Nokia, NSB | TDM multiplexing of beams should be supported. The exact LBT schemes require further study. |
| vivo | Both options can be considered. If no LBT procedure fulfils the requirements of the regulation, it can be adopted for multiplexing of multiple beams within the COT. |
| Futurewei | The LBT during COT is not required as long the LBT that precedes COT covers the potential transmission area (solid angle) |

## SSB related

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| **Company** | **Key Proposals/Observations/Positions** |
| Convida | Proposal 8: Increasing the number of SSB candidate positions to above 64 to increase transmission opportunities to cope with LBT failure should be studied. |
| CATT | Proposal 9: The enhancement of LBT mechanism for SSB transmission shall be studied for narrow beamwidth beamformed operation up to 71 GHz. |
| NTT Docomo | Proposal 2: Regarding potential required changes considering NR operation in unlicensed band,   * LBT related issues, e.g. SSB candidate position and non-consecutive RO, may need to be discussed after the discussion on LBT mechanisms. |

### Discussion

Discussion point:

For SSB transmission, do we need to introduce additional candidate SSB positions?

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| **Company** | **View** |
| Ericsson | No.  First of all, the LBT failure is not a common issue in 60GHz. Hence, it is not justified to do PHY design changes to handle LBT failure. Besides, if short control signalling is supported, SSB can be transmitted without LBT even when operating with LBT. |
| Huawei/HiSilicon | Yes to handle the LBT failure. However, details should be discussed in 8.2.1 |
| Nokia, NSB | If Short Control Signaling is supported, SSBs should be transmitted preferably as SCS, and further candidate positions are not needed. |

## Misc issues

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| **Company** | **Key Proposals/Observations/Positions** |
| Lenovo, Motorola Mobility | Configured grant: Observation 7: Depending on the configuration, a collision on CG resources can cause systematic collisions between corresponding subsequent retransmissions causing transmission failure of affected packets.  Proposal 7: Adopt CG retransmission collision avoidance techniques such as retransmission deferral or additional retransmission resources. |
| Xiaomi | Proposal 2: For CG-PUSCH, mechanism and condition(s) switching between LBT and LBT-free channel access should be studied. |
| TCL | Coexistence: 11ad  Proposal 2: RAN1 shall study directional LBT at UE side to guarantee fair coexistence with 802.11ad. |
| ZTE, Sanechips | Proposal 1: The key regulation rules for above 52.6 GHz, including channel access mechanism, OCB, COT, EIRP and PSD should be supported and enhanced to achieve good spectrum sharing with other systems, especially for Wi-Fi 802.11ad/ay. |
| LG Electronics | Proposal #2: It is necessary to enhance the method of determining ED threshold with consideration of the maximum output power and the unit LBT bandwidth applied in NR and the fair coexistence with the incumbent system (e.g., WiGig) operating in frequency range from 52.6GHz to 71 GHz. |
| Samsung | Proposal 1: The design of channel access mechanism shall comply to the regulation requirement, if applicable, and guarantee fair coexistence with 802.11 ad operating on the 60 GHz unlicensed spectrum.  OCB Requirements  Proposal 2: RAN1 shall further clarifies the OCB requirement as follows: For each declared nominal channel bandwidth,   * If the channel is used for DL transmission, RAN1 design should support at least one DL physical layer signal/channel transmission that occupies at least 70% of the nominal channel bandwidth. * If the channel is used for UL transmission, RAN1 design should support at least one UL physical layer signal/channel transmission that occupies at least 70% of the nominal channel bandwidth. |
| Apple | Observation 3: Unlicensed access for NR operating between 52.6 GHz and 71 GHz in the unlicensed band will have to co-exist with existing RATs such as IEEE 802.11ad and IEEE 802.11ay that require an operating bandwidth of 2.16 GHz  Proposal 2: Support at least one mode that aligns with WiFi 11ad/11ay channels of 2.16GHz bandwidth   * Both single carrier and multi-carrier modes should be supported * Allow an operating channel BW < 2.16 GHz bandwidth |
| Convida | Proposal 7: Wideband operation and coexistence with other RAT should be investigated considering UE power consumption and complexity. |
| Convida | More SSB Candidates |
| LGE | LBT Mode indication |
| Intel, HW | Introduce CAPC and CW |
| AT&T | FBE |
| AT&T | Licensend CC assisted LBT |
| Lenovo | Observation 1: For NR unlicensed bands between 52.6 GHz and 71 GHz, for LBT based channel access mechanism, if only omni-directional LBT is supported, then the exposed node problem could result in reduce spatial reuse.  Observation 2: For NR unlicensed bands between 52.6 GHz and 71 GHz, for LBT based channel access mechanism, if only omni-directional LBT is supported, then the coverage of the beamformed transmissions/receptions could be limited for fair coexistence by having similar range as with omni-directional LBT  Observation 3: For NR unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, if directional LBT is agreed to be supported, then the beam-management and directional LBT procedures are expected to be tightly coupled or inter-dependent.  Observation 4: For NR unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, if directional LBT is supported, then performing LBT only at the transmitted side may not guarantee an interference-free reception due to hidden nodes to the transmitter  Directional LBT Coupled with Beam Management |
| FUTUREWEI | Multi-Channel Operation: Proposal 5: Consider the multi-channel operation described in TS 37.213 as the baseline multi-channel NR operation. |
| Interdigital | Configuration signaling: Proposal 6: The UE receives configuration and indication of the channel access mechanism to use (omni-directional, directional, receiver based, no LBT) from the gNB. FFS if configuration/indication is by RRC or L1 signaling.  Proposal 7: RAN1 to consider if a UE can select a channel access mechanism as a function of measurements or prior LBT success or failure |
| CATT | Proposal 8: In order to alleviate the hidden node problem in directional LBT, a method of Multi-DCI transmission in different beam direction for a PDSCH scheduling should be considered. |
| TCL | Beam Transition/Switching:  Proposal 5: It is proposed to investigate the mechanisms which can avoid collisions due to double ownership of the shared carrier at beam transition events. |
| NTT Docomo | OCB:  Proposal 2: Regarding potential required changes considering NR operation in unlicensed band,   * LBT related issues, e.g. SSB candidate position and non-consecutive RO, may need to be discussed after the discussion on LBT mechanisms. * Given the PSD and OCB related requirements and concluded interpretation, interlaced UL transmission in Rel.16 NR-U would not be needed. |

# Simulation study observatons

## System Level Simulation studies

Preliminary observations for system level studies are presented below.

* 8 companies have presented results for Indoor Scenario A, 6 companies for Indoor scenario C. 1 company has presented Indoor scenario B,
* 2 companies have presented results for Outdoor scenario B.

From the simulations submitted, we have the following (tentative) observations)

* Indoor Scenario A with 2 operators
  + Comparison of No-LBT with LBT
    - 6 Companies have compared No-LBT with Tx Side ED based Omni sensing LBT
      * (Vivo, show tail and median benefits of using omni LBT on DL, at high loading
      * (Ericsson, HW, Nokia show loss for omni LBT). Nokia shows median loss and tail gain for directional LBT for 100% DL
      * Samsung shows loss in median and tail for omni LBT. They also show gain in tail and median in medium and high loads for directional LBT
      * Intel shows mostly loss of omni and directional LBT over no LBT at high loads for a threshold of -48 dBm
  + Directional vs Omni LBT
    - For same threshold, directional LBT
      * Vivo shows loss relative to Omni LBT, using Tx side and Rx assisted LBT
    - ZTE shows that an operator using directional LBT benefits in the presence of an operator using Omni LBT
    - For 100% DL traffic, ZTE shows gains in directional LBT for tail users for high ED thresholds. The gains are for tail and median users for lower ED thresholds. The gains are also present in DL+UL Traffic
    - Samsung shows gain in tail and median in medium and high loads for directional LBT over no-LBT and omni-LBT variants
    - Intel shows directional LBT gains relative to omni LBT for low ED threshold ( -55 and -65 dBm) but loses for high thresholds (-48 dBm). The gain of directionality increases with more directional UE beams
    - Qualcomm simulations show largely a comparable performance for omni and directional sensing using equal threshold, with small benefit of directionality under gNBs with narrower beams
  + Rx-Assisted vs Tx Sensing LBT
    - HW, Qualcomm, show benefits for DL and UL in the tail and median, primarily at higher loding levels
    - Vivo shows benefits in the tail DL and UL users
    - Ericsson shows gains of Rx Assistance over Tx only sensing but both are shown to lose relative to no-LBT, at high loading levels
* Indoor Scenario C
  + No-LBT vs Omni LBT
    - Ericsson and HW show loss, Charter shows roughly comparable performance with minor losses in some metrics with omni-LBT.
  + Directional vs Omni
    - For equal ED threshold Directional sensing and omni sensing are comparable
    - ZTE show gains for directional LBT in median and tail for very low ED thresholds for 100% DL traffic
  + Rx Assistance
    - Shows benefits over omni LBT but loss relative to no-LBT
* Outdoor Scenario B
  + Ericsson shows loss for LBT schemes with respect to no-LBT, for two ED thresholds (-47 and -68 dBm) . -68 dBm ED has marginally better performance than -48 dBm
  + HW shows loss for LBT schemes with respect to no-LBT for 1-site and 7 -site scenarios. Directional and omni LBT are comparable.

Note that fair comparisons of LBT schemes, especially those comparing directional vs omni LBT, must be presented with the right ED threshold pairs. A collection of proposals for directional LBT propose to change the ED threshold with directivity of the sensing beams.

Please check the if the above observations are correct and provide your view below.

|  |  |
| --- | --- |
| **Company** | **View** |
| Ericsson | 1. Even though multiple companies submitted results for scenario A, not all of them assumed the same deployment assumptions. 2. The observations as they are written now highlight benefits shown by a certain LBT scheme in certain metrics, but fail to capture that the same LBT scheme causes losses in other metrics (e.g. Vivo’s results show improvement in DL, but also show degradation in UL). 3. Staying “benefit/gain/losses” is not accurate representation of the results. It is preferred that the gains and losses are quantified. 4. Question to ZTE: most of ZTE’s evaluations are done using an ED threshold below noise level. How can a device sense below the noise level? shouldn’t that mean that the device will never get the chance to transmit? 5. Ericsson’s Directional LBT, no LBT and omni directional LBT comparison are not captured 6. Ericsson’s result for dynamic enabling of LBT are not captured. 7. The evaluated Receiver assisted LBT by different companies is not explained. For example, none of the companies explain if realistic assumptions related to UE processing are assumed, and if the signalling of the handshake messages is explicitly modelled in the simulations. Qualcomm also assumes silencing of neighbouring nodes however it is not clear how that can be achieved. Our receiver assisted LBT assumed very idealistic setup and therefore the shown results represent an upper bound of achievable performance and not a realistic one. 8. Even though the main bullet says:” Comparison of No-LBT with LBT” , the sub-bullets are discussing the performance of directional LBT. It is preferred that each LBT scheme is discussed separately. 9. What we observed from the submitted results for scenario A is that:    * 6 Companies have compared No-LBT with Tx Side ED based Omni sensing LBT      + 5 out of 6 companies (Ericsson, HW, Nokia, Samsung, Intel) show loss for omni LBT for tail, median and mean at all load points in both DL and UL directions      + 1 out of 6 companies (Vivo) shows tail and median benefits of using omni LBT on DL, and tail benefit in UL high load. However, loss for omni LBT for all other UL metrics at all load points.    * Directional vs. no LBT      + 3 companies (HW, Ericsson, Intel) shows that no LBT outperforms directional LBT at all load points for tail, median and mean DL and UL      + 1 company (Nokia) shows that directional LBT provides benefits in the tail in a 100% DL only scenario. But also show losses in the median and mean as compared to no LBT in the same scenario      + 1 company (Vivo) shows directional LBT provides benefits at high load for DL, and losses at all loads in UL and low and medium load for DL      + 1 company (Samsung) shows that directional LBT provides benefit at medium and high load, but losses at low load.    * Directional vs. omni LBT      + 4 companies (Ericsson, HW, Intel, Qualcomm) marginal difference between omni- and directional LBT using same ED threshold.      + Vivo: omni-directional is better than directional LBT      + Nokia: in DL only scenario, directional outperforms omni-directional      + Samsung shows gain in tail and median in medium and high loads for directional LBT over omni-LBT variants      + ZTE: for appropriate ED threshold (higher than noise level) marginal gains are observed for load and medium load. Higher gains for high load. |
| Huawei/HiSilicon | A few comments regarding observations:   1. We are not sure why under the bullet “Comparison of No-LBT with LBT”, only the omni-directional LBT is compared to no-LBT. Based on our simulations, in most scenarios, omni-directional LBT provides the worst mean and tail UPT results among all LBT methods (omni, directional, receiver-assisted, and receiver-only). WE believe that this is also corroborated by the results of a few other companies. We think that to draw a conclusion in regards to no-LBT vs. LBT, the best (and not the worst) LBT method should be compared with no-LBT. 2. We have also simulated receiver-only LBT (where the directional sensing is performed only at the receiver side) in our updated t-doc R1-2008976 which show considerable performance gains in both UL and DL main and tail UPT compared to both receiver-assisted LBT and No-LBT. We would to request that this observation be included in the set of observations in Section 3. |
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## RSRP distribution from system simulations

To be added

## Delay spread from system simulations

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| **Company** | **Key Proposals/Observations/Positions** |
| Vivo  (R1-2007654) | DS distribution is generated for typical indoor scenes by using the SLS. We can see that the DS of almost 80% users are less than 30ns. |
| Ericsson (R1-2007982) | Proposal 7. In TR 38.808, change the system level evaluation assumption for Factory Scenario A from Dense Clutter & Low BS (InF-DL) to Dense Clutter & High BS (InF-DH) to be consistent with ceiling mounted gNBs.  Proposal 8. Capture the following observation in TR 38.808. Factory Scenario A (InF-DH) results in post-beamforming delay spreads that are a significant fraction of the CP duration for 960 kHz SCS.  Observation 3.For selection of suitable SCS for the 52.6 – 71 GHz frequency range, it is important to perform link level evaluations with sufficiently large post-beamforming RMS delay spreads that are representative of a suitable range of deployment scenarios including the indoor factory scenario analyzed above (e.g., up to at least 40 ns using the agreed TDL-A model). It is important to consider the margin left over for other sources of time synchronization error such as initial timing error, timing advance setting, timing advance adjustment granularity, and timing differences expected in multi-TRP deployments. |
| Intel (R1-2007943) | SIR as a function of maximum detected tap and offset for FFT window place wrt the tap is studied for multiple channels.  Proposal 1: Use root mean square effective channel delay spread at the receiver as a metric for system level evaluation of NR in 52.6–71GHz  Proposal 2:   * Use intersymbol interference signal to interference ratio as a metric for system-level evaluation of NR in 52.6–71GHz * Assume the acceptable intersymbol interference level criteria is having 80% of links with intersymbol of 30dB SIR or higher   Proposal 3: Assume the dynamic FFT window placement based on the 40% CP length offset from the detected CIR peak for intersymbol interference SIR calculation  Observation 4: 85% of UEs experience RMS delay spread smaller than SCS 1.92MHz CP length (36.6 ns). |
| Qualcomm (R1-2008615) | SINR caused by ISI is studied in SLS.  Observation: for small range indoor hotspot deployment, the channel delay spread is not an issue with NCP. For outdoor scenarios with larger ISD and at moderate to high SNR – this may be produced by higher EIRP or smaller BW – NCP demonstrates SINR degradation compared to ECP. However, for such large coverage, high EIRP, and small BW use cases, we can choose to use a small SCS, e.g., 120kHz, with NCP. |
| InterDigital (R1-2007790) | Shows the CDF of RMS delay spread for Indoor Factory B, Indoor Office C and Outdoor C based on the system level simulations with the agreed evaluation assumptions.  Observation 4: While each scenario experiences different amounts of RMS delay spread, regardless of scenarios, most of UEs experience smaller RMS delay spreads than normal CP of 960 kHz. |
| DCM (R1-2009062) | Reported the distribution of RMS delay spread (DS) of the channel for those UEs whose RSRP is larger than the specified threshold for outdoor-B scenario with the following observation.  Observation 8: The mean RMS DS of 60 GHz system in Outdoor-B scenario is about 23 ns and the 95%-tile DS value is about 80 ns.   * More than half of UE experiences channels with DS larger than 20 ns, which should be referred to in the link performance evaluation with large DS configurations. |
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These observations and proposals are related to SCS selection and CP length choices. These will be further discussed in 8.2.1 email discussion.

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