**3GPP TSG RAN WG1 Meeting #106-e** **R1-2108223**

**August 16th – August 27th, 2021**

**Agenda item: 8.2.6**

**Source: Moderator (Qualcomm Incorporated)**

**Title: Contribution summary of channel access mechanism for 52.6GHz-71GHz band, ver01**

**Document for: Discussion and Decision**

# Introduction

This paper summarizes the channel access related proposals submitted to agenda item 8.2.6 in RAN1-106e.

# Summary of contributions

The section summarises key proposals and observations from submitted contributions. Discussion points arising from each group of topics are captured separately in subsections.

## ED Threshold computation FFS Items

Agreement:

The baseline ED threshold can be computed as

Where Pout is RF output power (EIRP) and Pmax is the RF output power limit, Pout≤Pmax.

* FFS: Further adjustment on ED threshold based on the sensing beam and the transmission beam (further adjustment should not violate EDT requirements as per regulations)
* FFS: If Pout is max output EIRP of the device or instantaneous output EIRP
* FFS definition of Operating Channel BW
* FFS: Whether ED threshold for NR-U and NR-U coexistence scenarios (eg, at regulation level) can be appropriately relaxed compared with the threshold of coexistence between NR-U and Wi-Fi.
* FFS: EDT when the COT has time varying transmission beams and varying EIRP

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | *Proposal 3: For operation in NR-U-60, the agreed baseline EDT formula should be adjusted such that, for a given RF output power (EIRP), the EDT proportionally increases with the effective beamforming gain of the potential following transmission(s) by the device. Proposal 4: For operation in NR-U-60, when LBT is used, adopt the following formula to capture the potential adjustment to the baseline EDT formula based on the transmit beamforming gain: EDT=-80 dBm+10\*〖log〗\_10⁡(Pmax/Pout)+10\*〖log〗\_10⁡(BW [MHz])+(1-a)(G\_TX -G\_(TX,max)) GTX is the effective transmit antenna gain at the potential transmitter [dBi] GTX,max is the maximum effective transmit antenna gain considered for the deployment [dBi] a is a scaling factor such that 0≤ a≤ 1 Proposal 5: For operation in NR-U-60, when LBT is used, the sensing beamforming gain of the LBT beam is deducted from the detected energy level before comparing it to the EDT.* |
| vivo | Proposal 10: The ED threshold for CCA check should consider the impact of beamforming gain of the directional sensing beams. |
| Spreadtrum Communications | Proposal 6: The formula of ED threshold should consider the LBT bandwidth and beamforming gain. |
| InterDigital Inc. | Proposal 12: Adapt EDT to account for beamforming gain of the sensing beam. |
| Samsung | Proposal 6: ED threshold should depend on: ·Whether other technology sharing the channel is absent or not on a long-term basis; ·LBT bandwidth (which is operation channel bandwidth in regulation); ·Beam parameters including beamforming gain and/or beam direction for transmission and/or receiving. |
| CATT | Proposal 7: Adjustment value should be considered for the baseline ED threshold.  Proposal 8: For adjustment value on baseline EDT, at least beamforming gain difference between the transmission beam and sensing beam should be considered. |
| ZTE Sanechips | Proposal 18: Considering potential mismatch between sensing beam and transmission beam, the ED threshold provided by the ETSI BRAN 302 567 can be modified to consider mismatching between sensing beam and transmission beam.  Proposal 19: For NR-U and NR-U coexistence scenarios, its ED threshold can be considered to be appropriately relaxed compared with the threshold of coexistence between NR-U and Wi-Fi. |
| Ericsson | *Observation 3 ED threshold defined in EN 302 567 v2.2.0 is a function of the transmission’s EIRP Pout, which includes the transmission beamforming gain. It does not include the sensing beamforming gain.*  *Proposal 3 Further adjustment on ED threshold based on the transmission and sensing beamforming gains could be up to implementation while not violating EDT requirements as per regulations.* |
| FUTUREWEI | Proposal 2: Utilize a separate EDT for each sensing beam. |
| Nokia, Nokia Shanghai Bell | Observation 3: Proposal 8 allows also for implementation according to RAN1#104bis working assumption.  Proposal 10: Further adjustment of EDT based on the sensing and transmission beams is not specified. |
| NEC | Proposal 1: The energy detection threshold adaptation for beam based channel access procedure should take into account the beamforming gain and mapping between transmission beam(s) and sensing beam(s). |
| Qualcomm Incorporated | Proposal 2: Support additional adjustment to Energy Detection computation/threshold to include the relationship between the transmit beamforming and sensing beam.  Proposal 3: If sensing beam is same as transmission beam, the beam based adjustment to the Energy Detection computation/threshold should be zero. |
| LG Electronics | Proposal #14: The ED threshold provided by the ETSI 302 567 can be enhanced considering the following points:   l  The size of LBT bandwidth   l  Transmit power of beam(s) in the COT   l  The beam correspondence capability/requirement of UE. |
| Intel Corporation | Proposal 4: When operating in unlicensed 60 GHz band, the ED threshold calculation shall account for the sensing beam used to perform the LBT procedure.  Proposal 5: In case the network is able to assess the absence of any other incumbent technology, the ED threshold value that a device may use during the LBT procedure is up to the gNB and may be configured via higher layer signaling. |
| AT&T | Proposal 2:   • The ED threshold can be adjusted based on the sensing beam and the transmission beam within any requirements per regulations   o FFS: ED threshold when the COT has time varying transmission beams and varying EIRP |

Working assumption:

* For Pout in EDT determination, define Pout as the maximum EIRP of the node determining EDT during a COT.

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | Observation 1: Adopting the “maximum of mean EIRP of each transmission burst” is not a practical solution as it requires the gNB to know all scheduling decisions for up to 320 slots at 960 kHz before acquiring the COT. Proposal 1: For operation in NR-U-60, confirm the working assumptions on the definition of Pout in the previously agreed baseline EDT formula. |
| vivo | Proposal 7: The transmission burst is a set of transmissions from gNB/UE from one or more transmission beams within a sensing beam without any gaps greater than [16us]. Proposal 8: For Pout in EDT determination, define Pout as the maximum of mean EIRP of transmission burst for the node determining EDT during a COT. |
| Ericsson | *Observation 1 According to the regulations it is sufficient to use only the initiating device’s Pout to determine EDT.*  *Observation 2 The argument to use both EIRPs from the initiating and responding devices to determine Pout for a node initiating a COT is insufficient as the responding device may also use a different bandwidth than the initiating device.*  *Proposal 1 Confirm that Pout corresponds to the maximum of the mean output power EIRPs of the transmissions or transmission bursts in a COT that may contain varying transmission beams and EIRPs.*  *Proposal 2 Confirm that Pout is estimated only based on the node initiating the COT even for COT sharing cases.* |
| FUTUREWEI | Proposal 1: Define a transmission burst to be a contiguous sequence of transmissions along any transmit beam.  Observation 1. Using common Pout (common EDT) for multiple sensing beams can limit spatial reuse. |
| Nokia, Nokia Shanghai Bell | Proposal 9: For Pout in EDT determination, define Pout as at least the maximum of mean EIRPs of the transmission bursts of the node initiating the COT during the COT. |
| Charter Communications | Proposal 1: Confirm the working assumption for the EDT definition: Pout is defined as the maximum EIRP of the node determining EDT during a COT. |

### First Round Discussion

Discussion 2.1.1-1

On further adjustment on ED threshold based on the sensing beam and the transmission beam (further adjustment should not violate EDT requirements as per regulations), please provide your view for the following

* Alt A: Support additional adjustment to Energy Detection computation/threshold to include transmit beamforming and/or sensing beam
* Alt B: No additional adjustment to Energy Detection computation introduced (Energy measurement directly compared with baseline EDT agreed no matter which transmit beamform(s) and sensing beam(s) are used

Summary of Positions:

* Alt A: HW, Vivo, Spreadtrum, InterDigital, Samsung, CATT, ZTE, FUTUREWEI, NEC, Qualcomm, Intel, AT&T. Samsung, LG, OPPO, Lenovo, Motorola Mobility, Xiaomi, Convida, Apple
* Alt B: Ericsson, Nokia, NTT DOCOMO, Charter

Please provide your position if not already captured above

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| Company | View |
| vivo | Since the ED threshold is defined assuming a 0 dBi receiving antenna. When directional LBT is applied, the beamforming gain for the receiving antenna is no longer 0 dBi, and the impact of the beamforming gain of the sensing beam should be counted in when calculating the ED threshold. |
| Charter Communications | Support Alt B, that is sufficient to satisfy ETSI requirements. |
| Intel | We support Alt. A. As it has been highlighted during the SI, when accounting for the specifics of the sensing and transmit beam within the ED threshold calculation, it is possible to achieve better system performance given that different level of protection may be offered when LBT is performed with a narrower or wider beam. In this matter, it may be beneficial within the ED threshold calculation to also account more specifically for the measurement and transmit beam used so that to exploit the advantage described above. |
| OPPO | Our position is added in the summary in RED |
| NEC | We support Alt. A. Different from NR-U, beamformed narrower transmission and corresponding directional LBT can be applied in 60GHz, the beamforming gain should be considered in EDT calculation to reflect system difference. |
| Lenovo, Motorola Mobility | Support Alt A |
| LG Electronics | We support Alt A.  The ED threshold can be further adjusted by reflecting the relationship between the sensing beam and transmission beam and it may be closely related to the beam correspondence between Tx/Rx beams. The beam correspondence requirements may be different depending on whether the UE capability supports *beamCorrespondenceWithoutUL-BeamSweeping* or not. A UE supporting this capability can satisfy requirements (for minimum peak EIRP and spherical coverage) without UL beam sweeping and beam management such as beam indication from gNB. On the other hand, for a UE not supporting the capability, the requirements (for minimum peak EIRP and spherical coverage) must be satisfied through the beam management procedure, and additionally, without beam management, a requirement relaxed by 3 dB must be satisfied. Therefore, it is necessary to adjust the ED threshold value differently depending on whether the UE supports *beamCorrespondenceWithoutUL-BeamSweeping* or not. To be specific, the ED threshold for a UE not supporting the capability can be lower than that for a UE supporting the capability. |
| Xiaomi | Support Alt A, we share the views from many other companies that the beamforming gain should be taken into account to ensure the fairness co-existence. |
| Nokia, NSB | We see that Alt B is sufficient and also complies with the ETSI HS. It is unclear what co-existence benefits the proposed modifications provide, and what is the associated implementation and specification complexity. |
| ZTE, Sanechips | As position listed in summary, we support Alt A. |
| DOCOMO | As Pout is defined as a value of EIRP, we think transmit beamforming is considered in EDT calculation defined in BRAN already. It implies that larger transmit beamforming gain results in lower EDT, meaning more severe threshold to access the channel. Assuming characteristics of transmit beam(s) would be reflected in the one of sensing beam, both beamforming gain of transmit/sensing beams are already considered in BRAN EDT equation. Added our view on Alt B. |
| InterDigital | Support Alt A. Not adjusting the EDT would result in biased LBT outcomes (unfairly biased against narrowbeam transmission when in reality narrowbeams are better for coexistence). |
| Ericsson | We support Alt B. The transmission beam’s EIRP is used in the EDT equation, which means that the beamforming gain of transmission beam is already included in the determination of EDT. Doing anything more would be a violation of the regulations. For e.g., if two antenna arrays have the same RF output power (EIRP), both the antenna array with the higher beamforming gain and the antenna array with the lower beamforming gain must have the same EDT according to regulations as it is based on the EIRP output power.   Regarding the sensing beam’s inclusion, we need to understand the reference point while testing the eCCA both in ETSI and 3GPP. Which value of received energies (before or after antenna BF gain) is compared with the EDT to determine channel idle/busy in 3GPP and ETSI? If they are the same (either both before or both after BF gain in 3GPP and ETSI), then there is no need to change the EDT based on sensing BF gain.In 5 GHz spec, it was explicitly specified that the RSSI at the antenna ports is compared with the EDT: “*the received power shall be measured at the interface between the equipment and the antenna assembly*”. For the testing, the antenna ports were connected via cables to perform the test, i.e. conducted tests were performed.  However, in EN 302 567, there are no conducted tests but only radiated tests where the energy estimated at the antenna is measured OTA parallelly by a separate oscilloscope and compared with the EDT to determine channel idle/busy. Therefore, we think that the sensing beamforming gain is already included in the EDT determination (in both 3GPP and ETSI) and nothing more needs to be done. |
| Futurewei | We believe the gain of the sensing beam (relative to an omni reference) should be considered at-least in the prominent directions in which intended transmit beam has high gain. This can be done by appropriately adjusting EDT. Alt-B does not even seem to allow adjusting the sensed energy before comparing to the baseline EDT. |
| CATT | Support of Alt A. |
| Samsung | We support Alt A as indicated in the summary. |
| Convida Wireless | We prefer Alt A for performance consideration. |
| Apple | Support Alt A. When EDT has transmission beamforming gain with omni receiving gain. When sensing beam has beamforming gain, the sensing beamforming gain should be counted to follow the same EDT by regulation. |

The following discussion points are for Companies in support of further adjustment of ED Threshold

Proposal 2.1.1-2

The value of the adjustment to ED threshold based on the sensing beam and the transmission beam should be zero if

* Alt 1. Same beam is used for transmission or reception.
  + Support: Oppo, NEC, Lenovo, LG, Xiaomi, ZTE, InterDigital, CATT, Samsung, Spreadtrum
* Alt 2. Pseudo-omni beam is used for sensing
  + Support: LG, Samsung, Apple, Futurewei
* Alt 3. When 0dBi sensing beam is used
  + Support: vivo, Intel, Futurewei, Apple
* Alt 4. When TX antenna gain matches max EIRP(?)
  + Support: HW

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| Company | View |
| vivo | Zero adjustment is feasible only for 0 dBi receiving antenna gain. |
| Intel | Same view as Vivo |
| OPPO | Alt-1 is our understanding, if the Tx and Rx antenna again is the same, there is no adjustment. |
| NEC | We prefer Alt. 1. |
| Huawei/HiSilicon | We do not support the proposal.  In our view, zero adjustment can be used when the effective transmit beam forming gain is equal to the maximum gain value considered for the deployment, e.g. 30dBi, to ensure that the adjustment does not violate the EDT requirements as per regulations. Our proposed EDT is as follows:  Where the red-marked term is the adjustment term. In our view, the amount of adjustment should be proportional to the beamforming gain. Also, the impact of the sensing beam and the impact of the transmission beam are decoupled. We propose that the sensing beamforming gain of the LBT beam is simply deducted from the detected energy level before comparing it to the EDT.  As for Alt 1 and Alt 2 above, we have some questions for clarification:   1. In Alt. 1, do you mean that the same LBT beam is used for Tx?   [Moderator] Yes   1. In Alt. 2, Pseudo-omni LBT beam is not defined. So, how the value of EDT adjustment could be determined based on an undefined parameter?   [Moderator] That is a good question. I guess this is why some companies are proposing the new Alt 3. |
| Lenovo, Motorola Mobility | Support Alt 1 |
| LG Electronics | We support both Alt 1 and Alt 2.  As we described in above, if a UE supporting the beam correspondence capability, the ED threshold can be determined by only Pout and the LBT bandwidth (operating bandwidth). For pseudo-omni beam, the adjustment to ED threshold is not necessary regardless of the beam correspondence capability. |
| Xiaomi | We share OPPO’s view |
| ZTE, Sanechips | Support Alt 1. |
| InterDigital | Alt 1. Though it should be rewritten as “Same beam is used for sensing or transmission/reception”. |
| Ericsson | We do not support this proposal without deciding on the previous Discussion 2.1.1-1. For a device operating according to EN 302 567, EDT should not be impacted by antenna beamforming gain. Both Alt 1 and Alt 2 adjustment should be zero according to the regulations. |
| Futurewei | We support Alt-3 (or Alt-2). We believe Alt-1 will make the EDT even more stringent since then using near omni (near 0 dBi) sensing will further lower the EDT and make access less likely compared to using omni sensing and original EDT. Making EDT more stringent would not be beneficial for NRU. |
| CATT | Support Alt 1. |
| Samsung | We support Alt 1 and Alt 2. |
| Apple | Alt 2 or Alt 3. EDT is calculated based on Pout, and Pout include transmission beam. |
| Spreadtrum | Support Alt 1. |
| Huawei, HiSilicon2 | Our preference for EDT adjustment is not accurately reflected in Alt 4. is the maximum transmit antenna gain considered by 3GPP. As a guideline, 30dBi may be considered as it is the maximum antenna gain below which the 40dBm Pmax EIRP and 23 dBm/MHz PSD are valid in ETSI BRAN 303 722 (See Tables 2 and 3 from ETSI BRAN 303 722 below  C:\Users\K00903651\AppData\Roaming\eSpace_Desktop\UserData\k00903651\imagefiles\C482FAAF-393A-43F1-A499-2501AACE50C8.png  C:\Users\K00903651\AppData\Roaming\eSpace_Desktop\UserData\k00903651\imagefiles\AA1EC9B8-9E79-4C7B-8D57-9638C8F16BBF.png  To properly reflect our preference, we made the following modification:  Proposal 2.1.1-2  The value of the adjustment to ED threshold based on the sensing beam and the transmission beam should be zero if   * Alt 1. Same beam is used for transmission or reception.   + Support: Oppo, NEC, Lenovo, LG, Xiaomi, ZTE, InterDigital, CATT, Samsung, Spreadtrum * Alt 2. Pseudo-omni beam is used for sensing   + Support: LG, Samsung, Apple, Futurewei * Alt 3. When 0dBi sensing beam is used   + Support: vivo, Intel, Futurewei, Apple * Alt 4. When TX antenna gain matches ~~max EIRP(?)~~  which is the maximum supported transmit antenna gain   + Support: HW |

Proposal 2.1.1-3

Confirm the working assumption on Pout definition in RAN1 #104bis-e with the following updates:

* For Pout in EDT determination, define Pout to be at least the maximum of mean EIRP of each transmission burst during the COT at the node initiating the COT.

Support: vivo, Charter, Intel, Oppo, NEC, Lenovo, Nokia, ZTE, DCM, InterDigital, Ericsson, CATT, Apple, WILUS, Spreadtrum

Support the original version (without the change): HW, LG, Futurewei, Samsung,

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| Company | View |
| vivo | We support the proposal. |
| Charter Communications | We support the proposal |
| Intel | We are Ok to confirm the working assumption. |
| OPPO | We are fine with the working assumption, but we would like to add an FFS:  FFS: whether the value of maximum of mean EIRP can be provided by network to UE when UE initiating the COT.  Moderator: This FFS can be discussed separately, and potentially can be covered by the “at least” part of the proposal. |
| NEC | We support the proposal. |
| Huawei/HiSilicon | Our preference is to confirm the original working assumption on the definition of Pout, i.e., “maximum EIRP of the node determining EDT during a COT”.  This is because adopting the “maximum of mean EIRP of each transmission burst” is not a practical solution as it requires the gNB to know all scheduling decisions for up to 320 slots at 960 kHz before acquiring the COT.  Moderator: gNB may not need to know all the scheduling decision. It only needs to make a decision on the maximum mean transmit power of all bursts in the COT. I don’t feel it is a difficult commitment.  Moreover, Proposal 2.1.1-3 requires to define transmission burst. |
| Lenovo, Motorola Mobility | We support the proposal |
| LG Electronics | We support the previous version of the working assumption without the updates (or just adopt the mean EIRP which is the definition in ETSI EN 302 567 as is).   * Original version: For Pout in EDT determination, define Pout as the maximum EIRP of the node determining EDT during a COT.   In addition, we should consider the following situation when the determining the EDT: If multiple UL transmissions are scheduled within a COT, the transmissions with an EIRP larger than the max EIRP used for the initial EDT calculation may be suddenly scheduled in the middle of the COT.  To reflect this situation, we can add the FFS points to the current working assumption or it can be handled by a new proposal. |
| Nokia, NSB | We support the proposal. We further note that the proposal also allows for operation according to the previous, more conservative, working assumption. |
| ZTE, Sanechips | We support the proposal. |
| DOCOMO | We are fine with the proposal. |
| InterDigital | We support the proposal |
| Ericsson | We support the proposal. |
| Futurewei | We believe there is some ambiguity in the modified working assumption. Firstly, there is no definition of a burst due to which an LBT initiator can assume entire COT to be one burst upon which Pout will reduce to the mean EIRP over all transmit beams and across entire COT duration. The latter was in-fact a drawback which the modification seeks to rectify. Defining a burst as a set of contiguous (up-to small gaps below a threshold) transmissions along any transmit beam can remove the ambiguity in the modified working assumption. In the absence of a proper definition of a burst we will prefer the original working assumption.  Moderator: In 37.213 section 4.0, there is already a definition of transmission burst. We can reuse that |
| CATT | We support the proposal. |
| Samsung | We prefer to confirm the working assumption without any change. |
| Apple | Support the proposal |
| WILUS | We support the proposal. |
| Spreadtrum | We support the proposal. |
| Futurewei-2 | Thanks for Moderator’s suggestion.  We believe the proposed modification should be more precise in terms of what are mean and max computed over?.  Our understanding is that the mean is over temporal dimension (duration of burst) and max is over both candidate bursts and over all directions.  We think this will be consistent with adaptivity test description in 5.3.8.2 of ETSI BRAN document which uses “maximum EIRP” to specify the angular direction in which the interference signal must be aligned. |

Proposal 2.1.1-4

Please provide your view if a node can initiate two (or more) (partially) overlapping COT in two different beams

Moderator: This effectively is a question if the COT is defined per initiating node, or per initiating node per beam.

Support: vivo, Intel, Oppo, NEC, Lenovo, Xiaomi, ZTE, DCM, Futurewei (with limit on total span), ITRI

Not support: Charter, HW, LG, Nokia, InterDigital, Ericsson, Samsung, Apple, WILUS, Spreadtrum

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| Company | View |
| vivo | From our point of view, the COT is defined per-sensing beam per initiating node. An initiating node may perform LBT for beam 2 during the COT of beam 1, and then perform MU-MIMO transmission. Therefore, the COT of beam 1 and beam 2 can overlap. |
| Charter | COT should be defined per initiating node. If a COT is defined per beam, then it seems a node can initiate one COT after another and transmit indefinitely. |
| Intel | In our view, the COT is initiated per initiating node per beam, and a device is indeed able to initiate two (or more) independent COTs through two (or more) different beams, which may partially overlap. |
| OPPO | We support that COT is defined per initiating node per beam. |
| NEC | We support the COT can be defined per initiating node and per beam. Based on two or more independent sensing beams, concurrent independent COTs could improve the system transmission efficiency. |
| Huawei/HiSilicon | We are not supportive of defining COT per initiating per beam.  Supporting such a notion contradicts the notion of ‘multi-beam COT’ still being discussed in discussion point 2.7 and compromises the progress made in the previous meetings for initiating a COT with SDM/TDM beams.  Therefore, we do not support that a node initiates two (or more) (partially) overlapping COT in two different beams. |
| Lenovo, Motorola Mobility | In our view, a node should be able to initiate multiple COTs that maybe partially or completely overlapping corresponding to different beams. |
| LG Electronics | We think that the COT should be defined per initiating node. It seems that this discussions are closely related to the multi-beam COT. If the transmissions in two different beams start at the same time, it corresponds to SDM transmission discussed in Section 2.7 Multi-beam COT. Otherwise, it should not be allowed if the transmission starts in two different beam directions by two (or more) (partially) overlapping COT. |
| Xiaomi | We support the COT is defined per-sensing beam per initiating node. The COT (s) can be (partially) overlapped in different beams. |
| Nokia, NSB | We are not supportive of any specific optimizations related to this case and prefer rather focusing on multi-beam COTs. It may be possible to operate the system with beam specific COTs in a transparent manner, without further specification effort. |
| ZTE, Sanechips | If the initiating node performs LBT and succeeds in different beams, then it is possible that multiple COTs corresponding to different beam may partially or completely overlap. |
| DOCOMO | Yes, we think it is possible, while agree it is related to multi-beam COT discussion. |
| InterDigital | We believe that a single COT can operate with multiple beams. Allowing multiple (partially) overlapping COTs initiated by a single node would require further study. |
| Ericsson | We do not support this proposal.   According to the regulations, only a single COT is awarded to an initiating device that performs eCCA. Multiple beams may be transmitted within this COT if the eCCA was performed quasi-omni/omni or in those beam directions. However, the MCOT limit applies entirely for the transmissions from the device and not per-beam. Is the intention to allow these partially overlapping COTs to have its own MCOT of 5ms? If yes, it would be in violation of the regulations. If no, it is already supported by the regulations and a device may transmit multiple beam directions already within a COT (that may overlap in time domain), there is no need to try to add restrictions or specify it and complicate the specification work. |
| Futurewei | We are open to this concept but potential further restrictions on the total time-span of all acquired COTs by an initiator might need to be discussed. |
| Samsung | In our understand, if directional LBT is supported, a node is able to initiate multiple COTs corresponding to different directions, but the starting time should be aligned. |
| Apple | the COT is defined per initiating node |
| WILUS | The COT should be defined per initiating node. |
| ITRI | In our view, the COT is initiated per initiating node per beam |
| Spreadtrum | Share the same view as Samsung. We are not supportive of initiating the COT per initiating node per beam. |

## LBT Bandwidth FFS Items

Agreement:

For LBT for single carrier transmission, consider the following alternatives

* Alt SC.1. gNB/UE performs LBT over the channel bandwidth (or BWP bandwidth)
* Alt SC.2. gNB/UE performs LBT over the transmission bandwidth (from the lowest RB to the highest RB used for the transmission)
* Alt SC.3. Define a unit of LBT bandwidth and gNB/UE performs LBT in all the LBT units (to be transmitted in) in the channel bandwidth

For LBT for multi-carrier transmission in intra-band CA, consider the following alternatives

* Alt CA.1. gNB/UE performs multiple LBT, one for each channel bandwidth separately
* Alt CA.2. gNB/UE performs single LBT over all CCs
* Alt CA.3. gNB/UE performs multiple LBT, one for each CC over the transmission bandwidth (from the lowest RB in to the highest RB used for the transmission in the CC)
* Alt CA.4. gNB/UE performs LBT over the transmission bandwidth over all CCs (from the lowest RB in the lowest CC to the highest RB in the highest CC used for the transmission)
* Alt CA.5. Define a unit of LBT bandwidth and gNB/UE performs LBT in all the LBT units (to be transmitted in) in the channel bandwidth in each CC

Note: supporting more than one alternative for at least multi-carrier transmission in intra-band CA is not precluded.

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | *Proposal 2: For operation in NR-U-60, the term ‘Operating Channel Bandwidth’ in the agreed baseline EDT formula is defined as the ‘LBT Bandwidth’ or the ‘bandwidth on which a channel access procedure is performed in shared spectrum’.*  Proposal 9: For a single-carrier transmission in NR-U-60, support performing a single LBT over the channel/BWP bandwidth, i.e. Alt SC.1. Proposal 10: For a multi-carrier transmission in intra-band CA in NR-U-60, support both performing a single LBT over all CCs, and performing multiple LBTs, one for each channel bandwidth separately, i.e., Alt CA.2 and Alt CA.1, respectively. |
| vivo | Proposal 1: Both Alt SC.1 and Alt SC. 3 are supported for single carrier transmission. With Alt SC 3, gNB performs multi-channel LBT in all the LBT units to be transmitted in, and the UE performs wideband LBT over the active BWP or over all the LBT units to be transmitted in. Proposal 2: Both Alt CA.1 and Alt CA. 5 are supported for multi-carrier transmission. With Alt CA 5, gNB performs multi-channel LBT in all the LBT units to be transmitted in, and the UE performs wideband LBT over the active BWP or over all the LBT units to be transmitted in in each carrier. Proposal 3: The LBT unit can be indicated via RRC signalling.  Proposal 9: The LBT bandwidth should be used as the operating channel bandwidth for EDT evaluation. |
| Spreadtrum Communications | Proposal 1: Regarding LBT bandwidth, at least Alt SC.1 and Alt CA.1 should be supported  • For single carrier transmission, at least gNB/UE should perform LBT over the channel bandwidth (or BWP bandwidth) • For multi-carrier transmission, at least gNB/UE should perform multiple LBT, one for each channel bandwidth separately |
| InterDigital Inc. | Proposal 13: The Operating Channel BW used in the EDT formula is equivalent to the LBT BW.  Proposal 15: For single-carrier transmission, support Alt SC.3.  Proposal 16: For multi-carrier transmission, support Alt CA.5.  Proposal 17: Support a set of units of LBT BWs and LBT is performed in each CC on one or more adjacent LBT BWs that covers at least the transmission BW. |
| Lenovo Motorola Mobility | Proposal 1: For NR unlicensed bands between 52.6 GHz and 71 GHz, for LBT based channel access mechanism, there is no need to specify the nominal bandwidth in 3GPP and it is up to devices’ implementation on how to meet the OCB requirements  Proposal 2: For NR unlicensed bands between 52.6 GHz and 71 GHz, for LBT based channel access mechanism:- For single carrier transmission defining a unit of LBT bandwidth where gNB/UE performs LBT in all the LBT units (to be transmitted in) in the channel bandwidt- For multi-carrier transmission in intra-band CA, support defining a unit of LBT bandwidth where gNB/UE performs LBT in all the LBT units (to be transmitted in) in the channel bandwidth in each CC- Defined LBT bandwidth value is fixed for both cases |
| Samsung | Proposal 2: For LBT bandwidth, support Alt SC.1 + CA.1 + CA.2 as the first preference, and SC.3 + CA.5 as the second preference. |
| CATT | Proposal 6: For LBT bandwidth, Alt SC.1 and Alt CA.1 should be supported. |
| ZTE Sanechips | Proposal 2: The nominal bandwidth can be defined as follows:   • Nominal bandwidths for the purpose of OCB requirements at the UE are the channel BWs for transmission supported by the UE from the set of channel BWs (carrier BWs) to be defined in 38.101.   • Nominal bandwidths for the purpose of OCB requirements at the gNB are the channel BWs for transmission supported by the gNB from the set of channel BWs (carrier BWs) to be defined in 38.104.  Proposal 3: Support Alt SC.3 that “Define a unit of LBT bandwidth and gNB/UE performs LBT in all the LBT units (to be transmitted in) in the channel bandwidth” and Alt CA.5 that “Define a unit of LBT bandwidth and gNB/UE performs LBT in all the LBT units (to be transmitted in) in the channel bandwidth in each CC”, considering channel access probability and spectrum utilization.  Proposal 4: If Alt SC.3 and Alt CA.5 are supported, it is not necessary to separately define LBT bandwidth for single carrier and multi-carrier cases, just a LBT bandwidth unit needs to be defined.  Proposal 5: If Alt SC.3 and Alt CA.5 are supported, it is recommended that the unit of LBT bandwidth is defined as a fixed value such as the minimum channel bandwidth from the perspective of implementation complexity.  Proposal 6: Considering Alt SC.1 and Alt CA.1 can be seen as the special cases of Alt SC.3 and CA.5 respectively, Alt SC.1 and Alt CA.1 can be also supported only if the channel bandwidth is configured as the unit of LBT bandwidth. |
| Ericsson | *Observation 4 In EN 302 567, the nominal channel bandwidth and at least one transmission mode with occupied channel BW 70% of NBW is defined for spurious out-of-band emissions and not for LBT purposes.*  Observation 5 The relationship between the LBT bandwidth and the channel bandwidth is not specified in EN 302 567 for the sake of technology-neutrality and flexibility.  Observation 6 Operating channel BW defined in EN 302 567 is the LBT BW in RAN1 which is already defined in 37.213 as a “channel”  Observation 7 Alt SC3/CA5 poses an artificial restriction to insert guard bands at the end of the LBT units  Observation 8 For SC3, LBT failure for a node within a LBT unit is complex and not discussed.  Observation 9 Definitions in EN 302 567 and TS 37.213 at least covers Alt SC1.  *Proposal 4 Support Alt SC1/Alt CA1 for LBT in single carrier and multi-carrier operation. Other options are not precluded by implementation.* |
| FUTUREWEI | Proposal 5: In LBT for single carrier transmission gNB/UE performs LBT over the channel bandwidth (or BWP bandwidth).  Proposal 6: In LBT for multi carrier transmission gNB/UE support:   • gNB/UE performs multiple LBT, one for each channel bandwidth separately,   • gNB/UE performs single LBT over all CCs. |
| Nokia, Nokia Shanghai Bell | Proposal 12: Support Alt SC.1 for single carrier transmission and both Alt CA.1 and Alt CA.2 for multiple carrier transmission.  Proposal 13: For multiple carrier transmission, how to perform LBT is left to implementation and there is no motivation to indicate the LBT bandwidth adopted by gNB/UE. |
| Charter Communications | Proposal 3: For LBT bandwidth, support at least Alt SC.1: gNB/UE performs LBT over the channel bandwidth (or BWP bandwidth). A transmission is initiated only if the entire LBT bandwidth is found to be unoccupied. FFS: If minimum BWP bandwidth used for LBT is the same as the minimum channel BW for a SCS.  Proposal 4: For multi-carrier LBT, support Alt CA.1: gNB/UE performs multiple LBT, one for each channel bandwidth separately. gNB/UE can transmit on any channel bandwidth(s) that pass LBT, adjacent or non-adjacent. |
| CAICT | Proposal 1: For LBT for single carrier transmission, Alt SC.1 should be supported as baseline.  Proposal 2: For LBT for multi-carrier transmission, Alt CA.1 and Alt CA.2 should be supported. |
| OPPO | Proposal 1: support both Alt SC.1 and Alt SC. 3.  Proposal 2: support both Alt CA.1 and Alt CA.5. |
| Qualcomm Incorporated | Proposal 4: For a single carrier transmission, enable mechanism that permits access to part of the carrier based on LBT success in that part of the carrier.  Proposal 5: For single carrier LBT, support both Alt SC.1 and Alt SC.3 as implementation choices, as long as the aggregated LBT bandwidth covers the transmission bandwidth.  Proposal 6: If Alt SC.3 is supported, for UL to DL COT Sharing, the LBT bandwidth adopted is indicated to gNB via UE capability signaling.  Proposal 7: For multi-carrier transmission in intra-band CA, Alt-CA.1, Alt-CA-2, and Alt CA.5 are made implementation choices, the aggregated LBT bandwidth covers the transmission bandwidth. |
| LG Electronics | Proposal #3: UE can be configured with one of multiple LBT bandwidth values which at least include carrier bandwidth as the minimum value and 2.16 GHz. |
| MediaTek Inc. | Proposal 1:RAN 1 should discuss the relation between sensing result and permissible transmission of each LBT bandwidth for DL and UL transmissions before finalizing the LBT bandwidth for 60 GHz.  Proposal 2:Support SC. 1 and CA. 1 as the baseline LBT bandwidth. If UL in 60 GHz can only begin the transmission when all LBT bandwidth has “idle” sensing results as in sub-6 NR-U, CA. 2 can be considered. |
| Intel Corporation | Proposal 6: In single carrier transmission, a gNB/UE performs LBT over the channel bandwidth.  Proposal 7: For carrier aggregation, a gNB/UE performs multiple LBTs and one over each channel bandwidth. |
| Apple | *Proposal 2: LBT bandwidth is channel bandwidth or BWP bandwidth for single carrier.*  *Proposal 3: If LBT unit based sensing is supported, enable LBT unit based sensing only at the gNB.* |
| NTT DOCOMO INC. | * Proposal 1: * For LBT for single carrier transmission and multi-carrier transmission in intra-band CA, support either of the following: * Alt.A: Adopt Alt SC.1 (gNB/UE performs LBT over the channel bandwidth (or BWP bandwidth)) for single carrier transmission and Alt CA.1 (gNB/UE performs multiple LBT, one for each channel bandwidth separately) for multi-carrier transmission in intra-band * Alt.B: Adopt Alt SC.3 (Define a unit of LBT bandwidth and gNB/UE performs LBT in all the LBT units (to be transmitted in) in the channel bandwidth) for single carrier transmission and Alt CA.5 (Define a unit of LBT bandwidth and gNB/UE performs LBT in all the LBT units (to be transmitted in) in the channel bandwidth in each CC) for multi-carrier transmission in intra-band CA   ²  Minimum CBW can be considered as the unit of LBT bandwidth |
| Xiaomi | *Proposal 1: Support Alt SC.3* *for LBT for single carrier transmission, and Alt CA.5 for multi-carrier transmission in intra-band CA*. |
| Convida Wireless | *Proposal 13: To down-select the options of LBT BW with single carrier and multi-carrier operation for supporting NR form 52.6 GHz to 71 GHz, co-existence of single carrier and multi-carrier operation within a same channel BW should be studied.* |
| WILUS Inc. | *Proposal 1: We support   Alt SC.3 for LBT on single carrier transmission.   At least Alt CA.1 or Alt CA.5 for LBT on multi-carrier transmission in intra-band CA.* |

### First Round Discussion

Summary of Positions

* For LBT with single carrier transmission, at least Alt SC.1 should be supported
  + HW, Vivo (both), Spreadtrum, Samsung (first preference), CATT, Ericsson, FUTUREWEI, Nokia, Charter, CAICT, OPPO(both), Qualcomm (both), MediaTek, Intel, Apple, DOCOMO (both), Convida
* For LBT with single carrier transmission, Alt-SC.3 should be supported
  + Vivo, InterDigital, Lenovo, Samsung (second preference), ZTE, OPPO, Qualcomm, LG, (MediaTek), DOCOMO, Xiaomi, WILUS

Discussion 2.2.1-1 (closed)

For single carrier transmission or multi-carrier transmission, should we support the functionality to access a carrier if there is interference in part of the carrier?

* Support: vivo, Intel, Lenovo, LGE, Xiaomi, ZTE, DCM, InterDigital, CATT, Samsung, WILUS
* Not support: Ericsson, MTK, Nokia, HW, Futurewei,

Moderator: To add a clarification to this discussion, I feel we need to agree on supporting this functionality or not first, before discussing the LBT bandwidth. If we don’t have this functionality, then I believe explicitly define multiple LBT subband in a BWP/channel is not needed anymore. Of course, by implementation, multiple LBT subbands can still be measured, but the energy measurement results will be added together to compare with ED threshold.

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| Company | View |
| vivo | Yes, with this feature, gNB or UE can perform LBT only on the bandwidth with scheduled resources, the interference on the part of channel where no data is scheduled will not affect the channel access. Alt SC 1 is a little bit over protection if the transmission is not spreading over the whole channel. And for DL transmission, same as in NR-U, if part of the channel is occupied, gNB can still use the other part of the channel for DL transmission. |
| Charter Communications | ‘Part’ of the carrier needs to be properly defined. The behavior to define is, for example, if the node is sensing over 400 MHz and a chunk of 50 MHz in the middle is occupied, can the node transmit non-contiguously in the two unoccupied 175 MHz chunks on the LBT BW edges? |
| Intel | As long as the level of interference is below a certain threshold, and fairness is guaranteed we should indeed support this functionality. In this matter, it is important to note that the ED threshold calculation already accounts for the operating BW, which could be simply defined as the channel BW. |
| OPPO | If only Alt SC.1 is supported, we wonder whether it would raise issue for ANR mechanism, which was agreed to reuse legacy mechanism. Note that the legacy mechanism is based on Alt-SC.3 concept. |
| Huawei/HiSilicon | First, we would like to note that the above quoted agreement at the top of Section 2.2 is not the latest relevant agreement for this discussion point. In the latest agreement from RAN1#104bis-e, only SC1 and SC3 are available alternatives for SC transmission, and only CA1, CA2 and CA5 are available alternatives for the multi-carrier transmission:   |  | | --- | | Agreement:  For LBT for single carrier transmission, continue down selection between   * Alt SC.1. gNB/UE performs LBT over the channel bandwidth (or BWP bandwidth) * Alt SC.3. Define a unit of LBT bandwidth and gNB/UE performs LBT in all the LBT units (to be transmitted in) in the channel bandwidth   For LBT for multi-carrier transmission in intra-band CA, continue down selection between   * Alt CA.1. gNB/UE performs multiple LBT, one for each channel bandwidth separately * Alt CA.2. gNB/UE performs single LBT over all CCs * Alt CA.5. Define a unit of LBT bandwidth and gNB/UE performs LBT in all the LBT units (to be transmitted in) in the channel bandwidth in each CC |   Second, although may be useful in some scenarios, we still do not see a strong justification to support the proposed functionality in 2.2.1-1. In our view, supporting this functionality is possible only if we define unit of LBT BW that is smaller than the carrier (we need to support Alt SC.3 and Alt CA.5). Defining such LBT units are not supported by regulation and, further, are not well-justified due to running multiple parallel LBT processes which would be unnecessarily complex and energy wasteful. |
| Lenovo, Motorola Mobility | Yes, partial access to a carrier should be supported when there is interference on some other part of the carrier |
| LG Electronics | If we adopt Alt SC.3, there is no need to differentiate the single-carrier and multi-carrier transmission. Regardless of single-carrier or multi-carrier transmission, the UE can access the channel if the performing LBT on the unit LBT bandwidth is successful. For the unit LBT bandwidth, the UE can be configured with one of multiple LBT bandwidth values which at least include carrier bandwidth as the minimum value and 2.16 GHz. |
| Mediatek | We don’t support Alt SC. 3, so the summary above has been modified a little bit. As long as the interference power level does not exceed the energy detection threshold, a carrier should be accessible. In addition, we would like to confirm whether “access a carrier” in the proposal means partial access or full access. Since we support Alt SC. 1, we are ok with the proposal as long as it means full access instead of partial access. |
| Xiaomi | Yes, this feature is already supported in NR-U. we think it is valid to support this to effectively utilizing the spectrum. |
| Nokia, NSB | The benefits of Alt SC.3 are unclear, while the added complexity is non-negligible. Given the little time we have left in this WI, we prefer to focus on Alt SC.1 only. |
| ZTE, Sanechips | We support Alt SC.3 and Alt CA.5. the introduction of the concept of LBT bandwidth unit is beneficial to increase the chance of accessing channel and decrease unnecessary resource waste due to multiple LBTs are performed and non-occupied bandwidth can be used to transmit. |
| DOCOMO | * For single carrier transmission, when alt SC.1 is adopted, there is no need to consider the functionality since there is no sensitivity for “part of the carrier” only in SC.1. * For single carrier transmission, when alt SC.3 is adopted, we agree it is beneficial to support the functionality. * For multi-carrier transmission, when alt CA.1 or CA.5 is adopted, we support to introduce the functionality * For multi-carrier transmission, when alt CA.2 is adopted, as well as the 1st bullet, we do not think it should be considered. |
| InterDigital | Yes. Otherwise to mitigate bursty interference in a portion of a carrier would either require smaller BWPs or require rapid BWP reconfiguration, which would increase signaling. |
| Ericsson | No, we do not support this functionality. The regulations do not support such functionality and we do not see a benefit in defining stricter rules for operation in the band. If this were to be allowed, how will the gNB decide which part of the carrier needs to be unused? IF fixed BW units are defined as LBT BW units, the issue of how to determine guard bands between these bands only complicates the spec. |
| Futurewei | While we see the reuse benefits of this more granular sensing functionality, however, to enable this we require several decisions such as configuring LBT bandwidth units, accommodating guard-bands, potentially optimizing coresets. Moreover, EDT increases with bandwidth for a given interference power/spectral confinement, which implies that the access likelihood with full channel sensing is not always overtly pessimistic. Overall enabling this feature requires larger optimization/specification effort. |
| CATT | We support Alt SC.1 and support the functionality to access a carrier with interference as long as the EDT regulation is met.  The Alt SC.1 is the gNB/UE performs LBT over the channel bandwidth (or BWP bandwidth) in the agreement of RAN1#104b. We believe that the granularity of BWP is small enough to address the concerns of over protection and resource waste as mentioned by the companies who support Alt SC.3.  In addition, Alt SC3 will introduce the discussion about how to define bandwidth of LBT unit and how to configure the LBT unit for the UE. We share the same view with Nokia that the time left in this WI is little, and we suggest only focus on Alt SC.1 during this WI. |
| Samsung | We didn’t see regulation forbids this functionality. Hence, as long as the LBT procedure can be passed, the carrier can be accessed without further restriction. |
| Convida Wireless | For single carrier transmission or multi-carrier transmission, we are ok to support the functionality to access a carrier if there is interference in part of the carrier. |
| Apple | Need clear definition of “part of” the carrier. Is it LBT unit?  Moderator: At least one example is LBT unit. The discussion is motivated by the SC.1 vs SC.3 discussion. If we don’t support partial BWP/channel signal, I feel there is no point discussing defining subband LBT anymore. |
| WILUS | We support the functionality to access a carrier if there is interference in part of the carrier for both single and multiple-carrier transmission. However, it seems the question from the moderator is belonging to the only single carrier transmission.  Moderator: Yes I was talking about within a CC. |

Proposal 2.2.1-2 (on hold)

For LBT for multi-carrier transmissions in intra-band CA, support Alt CA.1, Alt CA.2, and Alt CA.5, and leave the choice to gNB/UE implementation.

* FFS if and how gNB indicates the LBT bandwidth adopted to UE
* FFS if and how UE indicates the LBT bandwidth adopted to gNB

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| Company | View |
| vivo | We only support Alt CA.1 and Alt CA.5.  The application of Alt CA.2 should be FFS since the over protection will reduce the performance of CA. For example, is it feasible/desirable to perform a single LBT covering say 5 CC each with around 2 GHz channel bandwidth?  For Alt CA1, there is no need to indicate LBT bandwidth other than the BWP configuration. The LBT bandwidth of UE is the UL BWP. The LBT bandwidth of gNB is the channel bandwidth.  For Alt CA 5, the LBT bandwidth adopted by UE will be indicated by gNB, it is not determined by UE. gNB and UE will use the same LBT bandwidth. |
| Charter Communications | Support the proposal for the sake of progress |
| Intel | We do not support this proposal, and we believe this would really be not a good design choice, since this may lead to coexistence issues among different vendors, which may effectively perform differently the LBT measurements. Therefore, we would prefer to converge toward a single solution and preferably to Alt CA.1 and Alt. SC.1. |
| OPPO | If different UEs are not aligned with a same LBT bandwidth, then what is the point to perform LBT? The resulting LBT success does not guarantee an interference free environment. |
| Huawei/HiSilicon | We support CA.1 and CA.2.  For CA.2, we think it is important to have the option of performing single LBT over all CCs to reduce the eCCA complexity procedure associated with performing N parallel eCCAs of N CCs especially in low to moderate traffic where the chance of LBT failure is low. *For companies that are against CA.2, please note that we do not believe that CA.2 should be the only mode or default mode of supporting LBT over multiple CCs and that is why we also support CA.1 as well.*  Alt CA.5 may significantly increase the complexity/energy consumption due to running potentially many parallel eCCA processes, especially if a small fixed LBT BW unit, e.g. 100 MHz, is defined to suit different channel and CC BWs (ranging from 100 MHz to up to N\*2GHz where N is the number of CCs). Defining unit of LBT BW may be considered only if the unit size is configurable. |
| Lenovo, Motorola Mobility | We support Alt CA. 5. We would also be fine to support Alt CA. 1, but we cannot support Alt CA. 2 at least for a UE as it will allow transmission only when LBT is successful across all the CCs |
| LG Electronics | On the proposal structure, the main bullet (leave to gNB/UE implementation) is not matched with the sub-bullet (regarding on the indication of LBT bandwidth). Therefore, we suggest the following simple modification on the Proposal 2.2.1-2:  Proposal 2.2.1-2  For LBT for multi-carrier transmissions in intra-band CA, support Alt CA.1, Alt CA.2, and Alt CA.5, ~~and leave the choice to gNB/UE implementation.~~   * FFS if and how gNB indicates the LBT bandwidth adopted to UE * FFS if and how UE indicates the LBT bandwidth adopted to gNB |
| Mediatek | For multi-carrier operation in sub-6 NR-U, the UL data can not be transmitted unless all carriers are sensed to be idle. However, the data for DL can be transmitted in CC, where LBT results indicate channel to be idle. In our view, it should be clarified that whether this property is reused in 60 GHz or not. If it’s reused, Alt CA. 5 can be supported for UL but not for DL since it lacks the flexibility for accessing the channel. Alt CA. 1 can be supported as the baseline scheme for DL in our view. |
| Xiaomi | It is not good to leave the LBT choice up to the implementation. A unified design should be specified to ensure the fairness co-existence. |
| Nokia, NSB | We support Alt CA.1 and Alt CA.2 Similarly as with Alt SC.3, we see that Alt CA.5. complicates thing unnecessarily, while the benefits are unclear. |
| ZTE, Sanechips | We think Alt CA.2 should be further discussed, due to Alt CA2 requires only a LBT procedure for the whole bandwidth to be intended for the transmission, which may result in that all the intended transmissions would need to be postponed even if an interference is detected at a partial LBT bandwidth/CC. |
| DOCOMO | Fine to leave the choice to implementation, while our preference is Alt SC.1 and CA.1. |
| InterDigital | Support. Our proposal is to allow a set of units of LBT BWs. This can in effect support Alt CA.1, Alt CA.2 and Alt CA.5, depending on how the units are defined. |
| Ericsson | We support Alt CA1 as baseline that could go into the specification. Alt CA2 can be left to implementation.  For CA5, we do not support leaving the choice to gNB/UE implementation. Unlike 5 GHz, there are no fixed channel BWs in 60 GHz. It is not clear to us how Alt SC3 and corresponding CA5 can be supported when the channels may not be aligned. It also poses another issue in determining guard bands for these channels that may be nested, which is complex. In addition, the behavior of the node when the LBT in a LBT BW unit fails is also not clear nor discussed nor specified in ETSI TC BRAN.  We also think that gNB needs to control or indicate the UE’s LBT BW. This, for instance, could be the active BWP bandwidth that is configured.  **Question to the proponents:** For CA5, is the intention only to use LBT BW units as chunks of BW on which LBT is performed, and not define guard bands for ndicate channel bandwidths or have any spec impact? If yes, we do not object the proposal to leave CA5 to implementation. However, it must be clearly mentioned in the agreement that it requires no spec. impact, specifically no CORESET duplications or guard bands necessary and that LBT BW unit is only intended as units on which LBT is performed and can be left to implementation. |
| Futurewei | We support Alt CA.1 and are open to Alt CA2. Coexistence issues with configurable adopted LBT bandwidth choices must in addition be considered for Alt CA.5. |
| CATT | More discussion and clarification are needed for this proposal.   * We don’t support Alt CA.3 as mentioned in Proposal 2.2.1-1. The benefit of Alt CA.3 is not clear and it will introduce many new problems. * We would like to firstly discuss whether Alt CA.1 can be the supported as the baseline scheme for the LBT for multi-carrier transmissions in intra-band CA. * Then we may have chance to discuss whether Alt CA.2 can be supported in addition to Alt CA.1. If Alt CA.2 is must be supported inevitably, how to ndicate the LBT bandwidth can be further studied.   Hence, we would like to suggest modify the proposal as following  Proposal 2.2.1-2   * For LBT for multi-carrier transmissions in intra-band CA, whether support Alt CA.1as the baseline scheme. |
| Samsung | Should be make an agreement for single carrier case first and then discuss the multi-carrier case? From this proposal, it seems implying both Alt SC1 and SC3 are supported? |
| Convida Wireless | We are fine with the proposal. |
| Apple | Support Alt CA1. Should decide SC first whether LBT unit is adopted here. |
| WILUS | We support the Alt CA1 and Alt CA5. But we do not support Alt CA2 which allows transmission only when LBT is successful across all the CCs. |
| Spreadtrum | We are fine with the proposal. |

### Second Round Discussion

From discussion in 2.2.1-1, it seems that the majority view is to support the functionality of accessing a carrier if there is interference in part of the carrier. Given there are companies with concerns, the moderator would like to propose supporting the functionality but introduce capability for that

Proposal 2.2.2-1

For single carrier transmission or multi-carrier transmission, support the functionality to access a carrier if there is interference in part of the carrier. However, this is under gNB and UE capability

* gNB indicates if it supports the functionality
  + FFS how
* Introduce UE capability on if it can perform separate LBT for different parts of a carrier
  + FFS details

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| Company | View |
| vivo | We support the intention of the 1st sentence in the main bullet.  However, we are not sure that means we have to define gNB/UE capability for this.  As we explained, for Alt CA1, there is no need to indicate LBT bandwidth other than the BWP configuration. The LBT bandwidth of UE is the UL BWP. The LBT bandwidth of gNB is the channel bandwidth. If UE can support UL BWP, it should be able to support LBT on a part of carrier. Does that require a UE capability?  Similarly, for Alt CA 5, the LBT bandwidth adopted by UE will be indicated by gNB, and is not determined by UE. gNB and UE will use the same LBT bandwidth. Same question here: why introduce UE capability for this case?  We’d like to get clarification on the proposed gNB/UE (channel access) capability. |
| Intel | We share same concerns as Vivo, and we are not in favour of defining gNB/UE’s capability for this. Also as mentioned we cannot support multiple alternatives, and we believe this would really be a bad design choice, since this may lead to coexistence issues among different vendors, which may effectively perform differently the LBT measurements. Therefore, we would prefer to converge toward a single solution and preferably to Alt CA.1 and Alt. SC.1 |
| Futurewei | We are concerned with coexistence issues as pointed by Intel. Our understanding on UE capability was that it represented the number of bandwidth chunks (LBT units) it could simultaneously perform LBTs over. Is this capability same as that or is it just doing one LBT over any part/portion of BWP?. The latter seems already doable. With multiple LBTs at the UE, there is the contiguity issue. |
| Huawei, HiSilicon | Not supportive of the proposal  Due to its complexity of implementation and quite a few detailed design (UE Capability, gNB signalling, possible rate matching behaviour if only a part of a CC is available) that have to be addressed specially since, at this point, more basic LBT functionalities are not agreed yet (eg. LBT per CC). If the proposal is to motivate defining LBT BW unit, as we discussed before, we are against the fixed bandwidth unit. We can consider configurable LBT BW unit if more basic LBT functionalities are already agreed. |

## Sensing Structures FFS Items

Agreement:

For energy measurement in 8us deferral period, down-select from the following:

* Alt 1. Two energy measurements are required
* Alt 2. One measurement is required
* Alt 3. Extend the 8us to 10us and perform two measurements, one in each 5us segment

For energy measurement in 5us observation slot, perform single measurement

* FFS minimum duration of the measurement
* FFS location of the measurement

Working assumption:

* For energy measurement in 5us observation slot, when performing single measurement, the location of the measurement within the 5us is left for implementation, i.e., anywhere within the 5us.FFS location of the measurement

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | Proposal 8: For operation in NR-U-60, when LBT is used, support one energy measurement in the 8us deferral period. T\_d consists of a T\_f duration of 3us immediately followed by a 5us observation slot duration T\_f may include an additional measurement duration by implementation. |
| Spreadtrum Communications | Proposal 7: Two energy measurements are required for 8us deferral period. |
|  | Proposal 8: The duration of the measurement should be 3us for 5us observation slot. |
| Samsung | Proposal 3: For sensing structure, confirm the working assumption from RAN1#104b-e, and support single energy measurement within the 8 us deferral period. |
| CATT | Proposal 2: It is recommended that one measurement is located in the last 5us of the deferral period. Additional energy measurement in the first 3us is FFS. |
| ZTE Sanechips | Observation 10: Current CCA check procedure in EN 302 567 can be regarded as “Cat 4” rather than “Cat3”.  Observation 11: Energy measurement is performed in 3us observation slot and one or more consecutive 5us observation slot(s), respectively.  Observation 12: For deferral period and 5us observation slot, the length of energy measurement can be further discussed. |
| Ericsson | Observation 28 IEEE 802.11ad and IEEE 802.11ay do not perform two energy measurements in the 8 µs deferral period  Observation 29 ETSI HS does not require two energy measurements in 8 µs deferral period.  Observation 30 No simulation studies to suggest that two energy measurements are needed in an 8us deferral period for good coexistence.  Proposal 21 For energy measurement in 8 µs deferral period, Alt2 is preferred.  Proposal 22 The minimum duration of energy measurement within 5 µs can be left for implementation.  Proposal 23 Confirm the working assumption that the location of the energy measurement in 5us can be left for implementation. |
| FUTUREWEI | Proposal 4: For energy measurement in 8us deferral period one measurement is required   FFS where the measurement is located and its minimal duration. |
| Nokia, Nokia Shanghai Bell | Proposal 4: For energy measurement in 8us deferral period, one measurement according to 5 us observation slot is required. |
| Charter Communications | Proposal 2: For energy measurement in a 8us deferral period, support Alt 2 with a single measurement period located in the last 5us of the period. |
| CAICT | Proposal 3: One measurement for energy measurement in 8us deferral period is proposed.  Proposal 4: the measurement within 8us deferral period could be located in the middle of 8us or leave it for implementation. |
| OPPO | Proposal 3: support Alt 1 for energy measurement in 8us deferral period.  Proposal 4: a minimum measurement duration of 2us can be considered.  Proposal 5: confirm the following working assumption   Working assumption:   For energy measurement in 5us observation slot, when performing single measurement, the location of the measurement within the 5us is left for implementation, i.e., anywhere within the 5us.  Proposal 6: the EDT value should be adjusted: smaller value is applied when sensing beam is narrower. |
| Qualcomm Incorporated | Proposal 8: For energy measurement in 8us deferral period, performs a single measurement within 8us, the measurement duration is chosen as at least Y+X us, such that at least Y us of the measurements take place in the first 3 us and Y us of the measurement takes place in the last 5 us. The value of Y is FFS and less than or equal to 3us. |
| MediaTek Inc. | Proposal 3:For sensing structure within a 8 us deferral period, support only Alt 2. |
| Intel Corporation | Proposal 1: Alt-1 is supported and the 8us observation period is divided into two slots of 3 and 5us, respectively. For the energy measurement in the 3us observation slot, the location of the measurement is left up to implementation. |
| Apple | *Proposal 8: Confirm the working assumption* *that within the 5us slot, when performing single measurement, the location of the measurement within the 5us is left for implementation, i.e., anywhere within the 5us.*  *Proposal 9: Only one sensing is required in 8us initial sensing period. It is up to implementation to perform two sensing, or longer sensing time for better accuracy.* |
| WILUS Inc. | *Proposal 2: We propose to support Alt-2 that one measurement is required for energy measurement in 8us deferral period.   Option 1: For the sensing structure within 8us deferral period, the regulation does not specify anything which is left to the implementation at the device. Regardless of one or two energy measurements are required, it seems reasonable to be left to the implementation aspects.   Option 2: Similar to the definition of performing one energy measurement for 16us Cat-2 LBT in Rel-16 NR-U considering to actually miss the channel busy within a 16us, the 8us deferral period includes an observation slot that occurs within the last 5us of 8us deferral period. The channel is considered to be idle within the duration of the 8us deferral period if the channel is sensed to be idle for a total of at least (5us or 4us) with at least 3us of sensing occurring in the observation slot.   Option 3: Similar to the definition of performing one energy measurement for 16us Cat-2 LBT in Rel-16 NR-U considering to actually miss the channel busy within a 16us, the channel is considered to be idle within the duration of the 8us deferral period if the channel is sensed to be idle for a total of at least 5us with at least 3us of sensing occurring in the deferral period.* |

### First Round Discussion

Summary of positions:

* For energy measurement in 8us deferral period, performs single measurement within 8us,
  + Huawei, Samsung, CATT (in last 5us), Ericsson,  ~~OPPO (atleast 2us)~~ FUTUREWEI, Nokia, Charter, CAICT, Qualcomm (Y us in first 3 us), Apple. WILUS, MediaTek
* For energy measurement in 8us deferral period, performs at least 2 measurements within 8us,
  + Spreadtrum, Intel, OPPO

Proposal 2.3.1-1 (closed)

For energy measurement in 8us deferral period, performs single measurement within 8us, the measurement duration is selected from one of the following alternatives:

* Alt 1: At least 3+X us (FFS X, such as X=1).
  + Support: Charter, Lenovo, ZTE
* Alt 2: At least X us, where X is the same as the minimum measurement duration in a 5 us observation slot
  + Support: Charter, HW, LG, Nokia, MTK, Ericsson, WILUS
* Alt 3: At least X+Y us where Y us measurements are done in first 3 us and X is the same as the minimum measurement duration in a 5 us observation slot
  + Support: Charter, Intel,

|  |  |
| --- | --- |
| Company | View |
| Charter Communications | OK with any of the alternatives as long as a single measurement is performed. |
| Intel | As a compromised solution, we are Ok with the proposal if Alt.3 is adopted. |
| OPPO | From WIFI spec IEEE 802.11-2021 page 730, it defines the aCCATime, which is the maximum time that the CCA mechanism is used to determine CCA status. The CCA execution time for etermining CCA status depends on DMG PHY mode, e.g. either DMG SC mode with 1 us duration or DMG control mode with 3 us.    In IEEE 802.11-2021 page 2978, it defines the following for DMG control mode    In IEEE 802.11-2021 page 2992, it defines the following for DMG SC mode    It is noted that WIFI only specifies when the received level greater than threshold, the CCA status is busy. It means that if DMG PHY mode is DMG SC mode, only single CCA within 1 us is not enough, but needs to ensure during aCCATime, all the 1 us CCA status are idle. For this reason, we think only defining single measurement in deferral time is risky. |
| Huawei/HiSilicon | We support the proposal and our preference is Alt 2.  In our understanding, 8 us Td consists of a Tf duration of 3us immediately followed by a 5us observation slot duration in which X us of sensing is performed, whereas Tf may or may not include an additional measurement duration by implementation (such an additional measurement is not specified).  Nevertheless, it is not clear to us how Alt 3 achieves a single measurement within the 8us. It seems that in Alt 3, a special structure is imposed on the 5us observation slot such that the duration X+Y is contiguous and counted as one measurement, which is only possible if the location of the X us is always at the beginning of the 5us observation slot. However, this would go against the following WA agreed in RAN1#104bis-e  **Working assumption:**  For energy measurement in 5us observation slot, when performing single measurement, the location of the measurement within the 5us is left for implementation, i.e., anywhere within the 5us. |
| Lenovo, Motorola Mobility | We support the proposal, and our preference is Alt 1 |
| LG Electronics | Support Alt 2 and we prefer to keep the same design as possible with WiGig’s. |
| Nokia, NSB | It seems some words are missing form the proposal, should it be e.g.:  *For energy measurement in 8us deferral period, when a UE or a gNB performs single measurement within 8us, the measurement duration is selected from one of the following alternatives:*  …  Assuming this was the intention, we are ok with the proposal. For the three alternatives, our slight preference is Alt 2. |
| ZTE, Sanechips | We are fine with the proposal and prefer Alt 3 to reduce the likelihood of possible miss-detection. Besides, we are also okey to Alt 1. |
| Mediatek | Support Alt 2 |
| Ericsson | We support Alt 2 with the 5us observation slot at the end of the 8us deferral period.  This is the intended behaviour from regulations that mimic IEEE 802.11ad specs.  8us deferral period already contains 3us to allow SIFS duration (time gap between two transmissions, usually DL and UL, in 802.11 realm) in 802.11ad/ay and a 5us observation slot.  **Response to OPPO’s comments:**  The referral in that section corresponds to preamble detection in WiGig. In DMG SC mode , 90% probability within 1us again refers to preamble detection.(which is why the threshold is -68 dBm over 2.16 GHz).  **There is no 8us deferral time in WiGig standards.** In other words,8us was derived as aSIFSTime (3us) + aSlotTime (slot time in EN 302 567 also)(5us). WiGiG standards do not perform two sensing in the 8us period. As can be seen from the equations below, there is no energy measurement time/CCA time in the 3us aSIFSTime. aCCATime within aSlotTime is defined as implementation dependent. This is what we should do too instead of adding unnecessary restrictions.  **802.11-2021, page 1680**    **802.11-2021, page 3007**    aCCATime in 802.11ad-2012, page 493 was mentioned as <3us. |
| Futurewei | We prefer Alt-2. Expanding sensing duration in the first 3us can be up-to implementation. |
| CATT | We can support the proposal with some modifications. The following update is suggested.  Proposal 2.3.1-1  For energy measurement in 8us deferral period, performs *at least one* measurement within 8us, the measurement duration is selected from one of the following alternatives:   * Alt 1: At least 3+X us (FFS X, such as X=1). * Alt 2: At least X us, where X is the same as the minimum measurement duration in a 5 us observation slot * Alt 3: At least X+Y us where Y us measurements are done in first 3 us and X is the same as the minimum measurement duration in a 5 us observation slot |
| Samsung | We are ok with the proposal, and we prefer Alt 2. Alt 1 and Alt 3 can be achieved by implementation if one prefers. |
| Convida Wireless | We are ok with the proposal. |
| Apple | Support Alt 2. |
| WILUS | We support Alt-2 |

### Second Round Discussion

We have the following agreement

Agreement:

For energy measurement in 8us deferral period, at least a single measurement within 8us is performed, and the measurement duration is selected from one of the following alternatives:

* Alt 1: At least 3+X us (FFS X, such as X=1).
* Alt 2: At least X us, where X is the same as the minimum measurement duration in a 5 us observation slot and is within the 5 us observation slot.
* Alt 3: At least a contiguous duration of X+Y us where the Y us part of the measurement is done at the end of the first 3 us and X is the same as the minimum measurement duration in a 5 us observation slot and is at the beginning of the 5 us duration.

The next question is how to down-select.

Discussion 2.3.2-1 (closed)

Here is what I collected so far on support from earlier discussions

* Alt 1: Charter, Lenovo, ZTE
* Alt 2: Charter, HW, LG, Nokia, MTK, Ericsson, Apple, WILUS, Futurewei, Samsung, CATT, Spreadtrum
* Alt 3: Charter, Intel, Qualcomm, ZTE

Please add if your view is not captured

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| --- | --- |
| Company | View |
| Apple | Alt 2 |
| Intel | As correctly captured by the FL, we support Alt -3 and we believe by spanning the measurement window across the first 3us and the first observation slot may help reducing false detection issues. |
| Qualcomm | Alt 1 or Alt 3. Our view is, if we don’t measure any part of the first 3us, the measurement of 8us initial deferral will be exactly the same as a 5us observation slot. Ideally Alt 1 can help the node to avoid sampling in a WiFi SIFS of 3us. As a compromise, Alt 3 works for us as well. |
| LG Electronics | We support Alt 2. |
| WILUS | We support Alt 2 with the 5us observation slot at the end of the 8us deferral period. The location of the measurement within the 5us observation slot should be left for implementation. |
| ZTE, Sanechips | Either Alt 1 or Alt 3 is ok for us, because they can reduce the likelihood of possible mis-detection issue. |
| Futurewei | Support Alt-2 |
| Samsung | We support Alt 2. Alt 1 and Alt 3 can be left for implementation if benefit is found. |
| Ericsson | We support Alt 2. Alt1 and Alt 3 can be left to implementation if companies feel the need to do it.   **Response to Qualcomm’s comment:** WiGig does not do sensing in the 3us SIFS, so why should 3GPP specs be restrictive? If the node samples in a WiGig SIFS , it will continue to do CCA idle/busy check in the next 5us slot, so we do not see any issue here. |
| Spreadtrum | It seems that Alt 1 and Alt 3 are more restrictive than Alt 2. It is better to adopt Alt 2 as baseline and leave Alt 1 and Alt 3 for implementation. |
| CATT | We support Alt 2. |

Given the feedback, Alt 2 has clear majority. Moderator would recommend to agree to Alt 2 and leave Alt 1 and Alt 3 as implementation.

Proposal 2.3.2-2

For energy measurement in 8us deferral period, Alt 2 is supported while Alt 1 and Alt 3 can be considered as gNB/UE implementation

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| Company | View |
| Intel | For the sake of progress, we would be OK to Alt2, if X is at least 3us long. |
| Futurewei | Support |
| Huawei, HiSilicon | We support Proposal 2.3.2-2 |

## COT Sharing

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| --- |
| Agreement:  On maximum gap within a COT to allow COT sharing without LBT, down-select from   * Alt 1. No maximum gap defined. A later transmission can share the COT without LBT with any gap within the maximum COT duration * Alt 3. Define a maximum gap Y, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, an one-shot LBT is needed to share the COT   + FFS: Value for Y   + FFS:  How to define the one-shot LBT * FFS location of the measurement |

|  |  |
| --- | --- |
| Company | Key Proposals/Observations/Positions |
| vivo | Proposal 4: No maximum gap is defined for COT sharing. A later transmission can share the COT without LBT with any gap within the maximum COT duration. |
| Spreadtrum Communications | Proposal 9: Regarding COT sharing, NO maximum gap is needed. |
| InterDigital Inc. | Proposal 18: When COT sharing, a UE determines whether to use LBT based on the gap duration Y between the upcoming transmission and a previous transmission on the same beam (Alt 3). |
| Lenovo Motorola Mobility | Proposal 16: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, define a maximum gap Y, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, one-shot LBT is needed to share the COT  Proposal 17: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, COT sharing between the initiating device and responding device should be supported with at least Cat 2 LBT: - If the responding device is capable of beam correspondence and it is expected to use only any of the Rx beam(s) as Tx beam(s) for its transmission that have been used to receive at least one of the transmissions from the initiating device within the same COT - If the responding device determines at least one suitable beam on which it is allowed to transmit within the same COT, where the suitable beam can be determined as follows: o UE can be configured with a mapping table for determining suitable transmit beams for UL transmissions based on the receive beam(s) which the UE used to receive the prior DL transmissions in the same COT  Proposal 18: For NR unlicensed bands between 52.6 GHz and 71 GHz with directional LBT based channel access mechanism, multiple COT sharing indicators and their corresponding association to different beams can be signaled in a group common DCI and the association of COT sharing indicator to transmission is semi-statically signaled |
| CATT | Proposal 4：When the later transmission starts after the defined maximum gap from the end of the earlier transmission, whether a one-short LBT needs to be performed can be decided by gNB. |
| ZTE Sanechips | Proposal 8: From the perspective of fair and friendly coexistence with other nodes from same/different system, it is recommended that Alt 3: “Define a maximum gap Y, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, an one-shot LBT is needed to share the COT” should be supported.   Proposal 9: No LBT can be considered to be used in the following cases:   • COT sharing case only if the later transmission starts within the maximum gap Y from the end of the earlier transmission.   • Specific areas such as ITU region 2 and 3.   • Interference controlled environment.   • The transmission beams of nodes of different operators in the same system (e.g., NR-U) have little interference with each other. |
| Ericsson | Observation 27 ETSI BRAN regulations do not specify a minimum or maximum gap in the 60 GHz HS.  Proposal 19 Support Alt 1 for gaps in COT sharing. |
| FUTUREWEI | Proposal 8: Define a maximum gap Y, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, a one-shot LBT is needed to share the COT:   • FFS: Specific value of Y. |
| Nokia, Nokia Shanghai Bell | Proposal 11: CG PUSCH configuration shall include indication of whether the CG PUSCH configuration is used inside or outside of a gNB initiated COT, or both.  Proposal 27: On maximum gap within a COT to allow COT sharing without LBT, we support Alt. 1.  Proposal 28: In case of Alt. 3 for COT sharing without LBT, the maximum time gap X is at least longer that PDSCH processing time and PUSCH preparation time. |
| NEC | Proposal 3: A maximum gap Y should be defined, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, an one-shot LBT is needed to share the COT. |
| CAICT | Proposal 5: Alt.3 should be supported for COT sharing. |
| OPPO | Proposal 10: define a maximum gap Y, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, an one-shot LBT is needed to share the COT. The value of Y is 8us or 13us. |
| Qualcomm Incorporated | Proposal 9: If Cat 2 LBT is defined, for COT Sharing, define a configurable maximum gap Y, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, a one-shot LBT is needed to share the COT.  Proposal 17: For UL to DL COT sharing with CG-PUSCH, the Time and Frequency resources for RSSI measurement and the reporting can accompany CG-UCI sent on the uplink. |
| LG Electronics | Proposal #6: Since the collision-free transmission is not guaranteed for the gap larger than 3us (i.e., SIFS), the maximum gap within a COT to allow COT sharing without LBT and the Cat-2 LBT should be defined even though they are not specified in the regulation. |
| MediaTek Inc. | Proposal 4: For COT sharing aspect in 60 GHz, support Alt 2. |
| Apple | *Proposal 10: Regulation does not define max gap duration in COT sharing without LBT. Since any gap is counted into 5ms COT, no gap limitation needs to be specified.* |
| Convida Wireless | *Proposal 3: For COT sharing consider Alt 3. Define a maximum gap Y, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, an one-shot LBT is needed to share the COT.* |
| WILUS Inc. | *Proposal 3: We support Alt-1 since it seems that there is no need to define a maximum gap for COT sharing within the maximum COT duration from the ETSI regulation perspectives.* |

### First Round Discussion

Summary of Positions

Issue: Maximum gap before COT Sharing without LBT

* No Maximum Gap: Vivo, Spreadtrum, Ericsson, Nokia, ~~NEC~~, Apple, WILUS, Intel, CATT
* Define a max gap of Y before LBT recording: InterDigital, Motorola, CATT, ZTE, FUTUREWEI, OPPO, Qualcomm, LG, Convida, Intel, NEC

Proposal 2.4.1-1 (closed)

On maximum gap within a COT to allow COT sharing without LBT, down-select or support both of the following two alternatives

* Alt 1. No maximum gap defined. A later transmission can share the COT without LBT with any gap within the maximum COT duration
* Alt 3. Define a maximum gap Y, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, an one-shot LBT is needed to share the COT

Alt 3 is a use case for defining Cat 2 LBT procedure.

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| --- | --- |
| Company | View |
| vivo | Alt-1 is supported. According to the ETSI BRAN regulation, no maximum gap is specified. Therefore, we prefer not to impose additional constrains. |
| Charter Communications | Agree with vivo |
| Intel | We have added our support for both options, since we prefer to introduce both procedures (both Alt.1 and Alt.3). One-shot LBT should be used in a configurable manner up to gNB. When the one-shot LBT is not used, Alt.1 is used, which is consistent with the minimum requirements mandated by the ETSI BRAN. However, when one-shot LBT is configured, Alt-3 is used, and the concept of maximum gap could be used to discern the case when no-LBT or one-shot LBT is used. |
| OPPO | We support Alt-3 |
| NEC | We support defining a maximum gap Y, namely Alt 3, and fixed the typo in Summary of Positions. |
| Huawei/HiSilicon | We support Alt 1.  In our view, COT sharing for transmission(s) by a responding device as specified in the HS EN 302 567 does not require additional LBT within the COT. Furthermore, no requirement on a max gap between transmissions within the COT has been stated.  We could also consider Alt 3 if it has a majority support. |
| Lenovo, Motorola Mobility | We support Alt 3, especially considering the case where different beams might be used within the same COT.  As a compromise, we would be okay to support both the alternatives as well. |
| LG Electronics | Alt 3 should be supported.  Even in WiGig (i.e., 802.11ay/ad), if the gap length between transmissions exceeds SIFS, the LBT should be performed again to obtain the COT since the collision-free transmission is not guaranteed for the gap larger than 3us (i.e., SIFS). Therefore, ), the maximum gap within a COT to allow COT sharing without LBT and the Cat-2 LBT should be defined even though they are not specified in the regulation. The definition of Cat-2 LBT can be reused with possible modifications to the parameters such as the gap duration for each type of LBT.  If the later transmission share the COT without Cat-2 LBT, the duration of transmission may need to be limited, similar to the Cat-1 LBT in the NR-U (up to 584us). |
| Xiaomi | We support alt 1. |
| Nokia, NSB | We support Alt-1. |
| ZTE, Sanechips | We support Alt3 to avoid the impact of some burstiness interference. |
| DOCOMO | Agree with Intel to introduce both procedures (Alt 1 and Alt 3). As no sensing at responding device is defined in BRAN only, LBT at responding device needs to be considered. In this case, there would be no need to have random back-off. Thus we support alt 3. Configurability between Alt 1 and Alt 3 mentioned by Intel is also fine since we agree there is no need in BRAN. |
| InterDigital | Support Alt.3. The Y should be defined as the end of an earlier transmission on the beam and the start of a next transmission on the same beam. Otherwise, there is no guarantee that another interfering transmission using directional LBT on the beam will not have started during the gap. |
| Mediatek | Support Alt 1. |
| Ericsson | We support Alt 1. |
| Futurewei | Alt-3 is supported. We are open to making one-shot LBT requirement configurable. |
| Samsung | We prefer Alt 3 to be consistent with Rel-16 NR-U. |
| Convida Wireless | We support Alt 3. We are open for Alt 1. Alt 1 may be considered as well in addition to Alt 3. Which to use may be configured. |
| Apple | Support Alt 1 |

Consider the feedback and the local regulation from ETSI and Japan, I believe it is only fair to support both. Here is updated proposal. This also implies one-shot LBT is introduced.

Proposal 2.4.1-2 (closed)

On maximum gap within a COT to allow COT sharing without LBT, support both of the following two alternatives

* Alt 1. No maximum gap defined. A later transmission can share the COT without LBT with any gap within the maximum COT duration
* Alt 3. Define a maximum gap Y, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, an one-shot LBT is needed to share the COT

The usage of the two alternatives are gNB choice and depends on local regulations

|  |  |
| --- | --- |
| Company | View |
| FW | We can support this proposal. |
| CATT | We support this proposal.  Our position in the summary is wrong. I have corrected our position in the Summary of Positions. |
| Samsung | We are ok with the proposal. |
| Convida Wireless | We are ok with the proposal. |
| Apple | Need Y value. We cannot support Alt 3 without Y value. |
| Huawei, HiSilicon | We can support this proposal |
| WILUS | We support this proposal. |

### Second Round Discussion

After online discussion, the proposal 2.4.1-2 is updated to following

Proposal 2.4.2-1

On maximum gap within a COT to allow COT sharing without LBT, support both of the following two alternatives

* Alt 1: No maximum gap defined. A later transmission can share the COT without LBT with any gap within the maximum COT duration
* Alt 3: Define a maximum gap Y, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, an one-shot LBT is needed to share the COT.
  + Option 1: Y=8 us (motivated by need to operate in all regions)
  + Option 2: Y=a multiple number of OFDM symbols
  + Option 3: gNB determines Y (for example, according to local regulation)

Note: The usage of the two alternatives is a gNB choice and depends at least on local regulations

Please provide your view and suggestions on how to modify

|  |  |
| --- | --- |
| Company | View |
| Qualcomm | Consider for 60GHz band, we don’t need to control the gaps accurately, we feel we may not need a lengthy discussion on CP extension. We prefer Y=8us. However, the gap does not need to be exactly 8. Any gap larger than Y=8us can work with Cat 2 LBT before it. The transmission can start at symbol boundary. |
| Lenovo, Motorola Mobility | We prefer Alt 3 and we would suggest following updates to the proposal:  On maximum gap within a COT to allow COT sharing without LBT, support both of the following two alternatives   * Alt 1: No maximum gap defined. A later transmission can share the COT without LBT with any gap within the maximum COT duration * Alt 3: Define a maximum gap Y, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, an one-shot LBT is needed to share the COT.   + ~~Option 1: Y=8 us (motivated by need to operate in all regions)~~   + ~~Option 2: Y=a multiple number of OFDM symbols~~   Note: The usage of the two alternatives is a gNB choice and corresponding value(s) for the gap depends on local regulations |
| DOCOMO | Thanks to Moderator for taking into account other regional regulations.  To clarify, in Japan, sensing is always necessary to initiate any transmission with power above 10 mW, while no clear definition of “sensing” in the regulation, including whether COT sharing without sensing is allowed or not and how long gap is allowed for the COT sharing without sensing. Therefore, even if max. gap is defined for COT sharing without sensing, it does not comply with current Japanese regulation for transmission with power above 10 mW. Thus, we prefer to see the progress about whether to support Cat-2 LBT in 2.5.1 which is beneficial to achieve COT sharing with complying current Japanese regulation.  On the other hand, we think a regional regulation could be changed to follow 3GPP specification in some cases. For example, Japanese regulation could possibly introduce detailed rules to make channel access more reasonable for a responding device (e.g., allow channel access without sensing within a certain gap before responding transmission). Given this, to unlock Alt 3-like approach in 60 GHz in 3GPP is worth considering in our view since this is something available in Rel-16 NR-U and Wifi already to mitigate collision or interference.  With above, we support both Alt 1 and Alt 3. |
| vivo | We prefer Alt 1.  We can accept this proposal with the modification from Lenovo. |
| Apple | Prefer Alt 1.  Based on Docomo’s explanation, there is no COT sharing in Japan based on current regulation. All transmission should start with CCA with transmission power >= 10mW.  If we follow NR-U or WiFi approach, where SIFS time is used between COT sharing without LBT, SIFS=3us in 802.11ad.  Moderator: If we set Y=3us, then we will need to introduce a Cat 2 LBT of 3us, which might be hard. |
| Intel | We are fine with the proposal, and support both Alt.1 and Alt.3. Also we are fine with Lenovo’s edits and to leave the value of the gap completely as FFS rather than listing multiple options. |
| LG Electronics | We support Alt 3.  Even in WiGig (i.e., 802.11ay/ad), if the gap length between transmissions exceeds SIFS (i.e., 3us), the LBT should be performed again to obtain the COT since the collision-free transmission is not guaranteed for the gap larger than SIFS. Therefore, the maximum gap within a COT to allow COT sharing without LBT and the Cat-2 LBT should be defined even though they are not specified in the regulation and the same sensing structure as the 8 us initial deferral period can be used.  For options in Alt 3, we prefer to at least Y > 3us but it is fine to leave the value of the gap completely as FFS rather than listing multiple options. |
| WILUS | We prefer Alt 1, but we are fine with the proposal to support both. We are fine with a modification of Alt-3 by Lenovo. |
| ZTE, Sanechips | We prefer Alt3.  For this proposal, we’re a little confused about “Note: The usage of the two alternatives is a gNB choice and depends on local regulations”, current note seems to imply that gNB chooses to use Alt 1 or Alt 3, but choice is based on whether the maximum gap and/or LBT is required/mandatory in a region regulation. In our understanding, Alt3 can also be applied in region where LBT and/or the maximum of gap is not required.  Further question: if gNB chooses Alt1, and maximum gap is not defined in local regulation, for this case, how to ensure co-existence fairness and guarantee that channel is still available without LBT operation after a long gap.  Moderator: From evaluation, due to narrow beam nature of transmission, it is very unlikely there will be any performance difference with or without LBT. More precisely, it is very unlikely for a jammer to receive both the COT initiator and COT sharer above ED threshold, so the jammer will transmit in the gap. |
| Futurewei | We can support this proposal with the modification from the FL. Our preference is Alt-3. |
| NEC | We prefer Alt 3. Regarding Y value, we think it is not necessary to restrict Y to a single value because according to DOCOMO’s comment even if max. gap(such as 8 us) is defined, it does not comply with current Japanese regulation. A configurable Y with multiple candidate values may be more reasonable, even a wider Y than that of NR-U, namely 16us, also could be considered. |
| Nokia, NSB | We prefer Alt 1. According our understanding of the Japanese regulation, even Alt 3 is not aligned with the local requirements there, but channel sensing is required in every case. It is therefore premature to agree on Alt 3 and a gap duration. If local regulations change, 3GPP specs can of course be later updated as necessary. |
| OPPO | We support Alt 3. |
| Samsung | We are ok with the proposal.  One clarification, for Option 1, does Y=8 us imply the duration for Cat2 LBT is also 8 us? We don’t have strong view on the gap duration, but it should be aligned with or larger than the duration of Cat2 LBT in Option 1. |
| Ericsson | We support Alt 1.   A DL- UL switching time gap is about 7us. Considering other processing delays and additional 8us for CAT2 sensing, the gap is large enough that it is as good as doing a CAT3 LBT within the gap for the specific UE. It might also be worthy to note that IEEE 802.11ad/ay do not mandate the use of CAT2 LBT or any LBT for the UEs in the gap for COT sharing/long pauses in a COT but fills the gap with other transmissions.  Regarding regional regulations, CAT3 LBT could be used and there is no need to introduce CAT2 LBT which does not seem to have any benefits. LBT itself does not have any benefits in this regime. |
| Convida Wireless | We are ok with the proposal. |
| Spreadtrum | We are ok with the proposal and supportive of Alt 1. |
| CATT | We are generally OK with the proposal. |
| Huawei, HiSilicon | We can support Proposal 2.4.2-1 |

## Cat 2 LBT

Agreement:

For Cat 2 LBT, down-select from the following alternatives

* Alt 1: Do not introduce Cat 2 LBT for 60GHz unlicensed band operation
* Alt 2: Introduce Cat 2 LBT for 60GHz unlicensed band operation

Agreement:

If Cat 2 LBT is introduced, the following use cases can be further studied:

* Resume transmission after a gap Y:  Cat 2 LBT may be used to resume transmission by the initiating device within the COT after a gap Y (FFS the value of Y)
* COT sharing: Cat 2 LBT may be used before transmission by a responding node sharing a COT
* Multi-Beam LBT:  Cat 2 LBT may be used before switching to a new transmission beam (not used in earlier part of the COT) in a COT with TDM beams, or resume a previously used transmission beam after a gap Z (FFS the value of Z)
* Rx-Assistance:  Cat 2 LBT may be used for sensing at the receiver as a responding device for Rx-Assistance measurements and associated signalling

Other use cases not precluded.

FFS if Cat 2 LBT is mandated for each use case or not.

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | Proposal 20: Support introducing CAT2 LBT for the 60GHz unlicensed band operation.  Proposal 21: The following use cases of CAT2 LBT related to COT initiation should be prioritized in the discussion due to the low complexity and overhead of CAT2 LBT compared to Ecca: - Starting transmission on a secondary channel in Type B multi-channel access, if supported - Energy measurement and reporting of Rx-assistance information by the receiver in Rx-assisted LBT, if supported |
| vivo | Proposal 5: The Cat 2 LBT can be used before switching to a new beam in a COT with TDM beams, before response with assistant information at the receiver, and in the Type B multi-channel access scheme. |
| Spreadtrum Communications | Proposal 10: Cat 2 LBT should be supported for 60GHz unlicensed band operation.  Proposal 11: Cat 2 LBT may be used in case of directional LBT. |
| InterDigital Inc. | Proposal 19: Introduce CAT 2 LBT for 60GHz unlicensed band operation. |
| Sony | Proposal 4: Introduce Cat 2 LBT for 60 GHz unlicensed band operation |
| Samsung | Proposal 4: Support the following types of channel access procedures for 60 GHz unlicensed band: ·Type 1 channel access procedure without CWS adaptation; ·Type 2 channel access procedure with zero and positive fixed sensing duration. |
| CATT | Proposal 3: Cat 2 LBT should be introduced for 60GHz NR-U. |
|  | Proposal 12: Performing Cat 2 LBT before beam switching within the COT could be supported, and it can be decided by Gnb. |
| ZTE Sanechips | Proposal 16: Cat 2 LBT should be supported at least for COT sharing case for NR above 52.6GHz. |
| Ericsson | Observation 24 Cat2 LBT is not specified in HS EN 302 567  Observation 25 Simulation studies show that there is no gain using Ca2 LBT compared to no LBT for the proposed used cases.  Observation 26 It is not precluded to do Cat2 LBT in addition to the Cat3 LBT equirement. There is no motivation to specify it in the 3GPP RAN1 standard.  Proposal 18 Do not specify Cat2 LBT for NR operation in 52.6 GHz to 71 GHz. |
| FUTUREWEI | Proposal 7: Introduce Cat 2 LBT for 60GHz unlicensed band operation. |
| Nokia, Nokia Shanghai Bell | Proposal 5: Decide on Cat-2 LBT support separately for Gnb and UE.  Proposal 6: Decide on Cat-2 LBT support together with the specific Cat-2 LBT use case(s).  Proposal 7: Do not support Cat-2 LBT at the UE side.  Proposal 8: Do not support Cat-2 LBT at the Gnb side.  Observation 5: Short contention window of [4] observation slots facilitates flexible LBT timing for SSB transmissions.  Observation 7: Use of LBT provides mostly loss in median throughput compared to no-LBT mode  Observation 8: Use of LBT reduces throughput for cell edge Ues  Observation 9: Simulation results do not show any gain from introduction of additional Cat-2 LBT at Gnb beam switch during COT. |
| Charter Communications | Proposal 5: Do not introduce Cat 2 LBT for 60GHz unlicensed band operation. |
| NEC | Proposal 4: Cat 2 LBT for 60GHz unlicensed band operation should be introduced for resuming transmission by the initiating device within the COT after a gap Y.  Proposal 5: Cat 2 LBT for 60GHz unlicensed band operation should be introduced for COT sharing at least when transmission by responding node is transmitted after a gap Y.  Proposal 6: Cat 2 LBT for 60GHz unlicensed band operation should be introduced for channel sensing of receiver assistance measurements.  Proposal 7: Cat 2 LBT for 60GHz unlicensed band operation should be introduced for Type B multi-channel access. |
| CAICT | Proposal 6: Cat2 LBT should be studied and supported case-by-case. |
| OPPO | Proposal 11: introduce Cat-2 LBT with a sensing duration of 13us, which further consists of an 8us duration followed by a 5us sensing slot. |
| Qualcomm Incorporated | Proposal 10: Define Cat 2 LBT as sensing with X us duration. Suggested candidate values for X are 8 us or 13 us. The sensing structure can reuse Cat 4 LBT with n=0 or 1 respectively.  Proposal 11: Introduce Cat 2 LBT as an optional/configured and triggered component of COT Sharing, Multi-Beam LBT, and transmission with a gap. |
| Intel Corporation | Proposal 8: Cat-2 LBT is introduced for 60 GHz unlicensed band operation.  Proposal 9: Both Alt.1 and Alt.3 are supported, and 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. |
| Apple | *Proposal 11: No CAT-2 LBT needs to be defined for COT sharing.* |
| NTT DOCOMO INC. | Proposal 2: Cat 2 LBT, i.e., LBT with fixed sensing duration, should be introduced for 60 GHz unlicensed band operation, at least to support COT sharing.   l  Other use cases can be studied further |
| WILUS Inc. | *Proposal 5: We support Alt-2 to introduce Cat 2 LBT for 60GHz unlicensed band operation.* |

### First Round Discussion

Summary of Positions:

* Alt 1: Do not introduce Cat 2 LBT in 60GHz
  + Support: Ericsson, Nokia, Charter, Apple
* Alt 2: Introduce Cat 2 LBT for 60GHz unlicensed band operation
  + Support: HW, Vivo, Spreadtrum, Sony, Samsung, CATT, ZTE, FUTUREWEI , NEC CAICT, OPPO, Qualcomm, Intel, DOCOMO, WILUS,

Discussion 2.5.1-1: (closed)

Please provide your position if not captured in the above, and check if Alt 3 below can be considered as a compromise.

* Alt 1: Do not introduce Cat 2 LBT for 60GHz unlicensed band operation
* Alt 2: Introduce Cat 2 LBT for 60GHz unlicensed band operation for one or more of these use cases
  + A) Gap > X ms in a transmission
  + B) Gap > X ms for COT Sharing ( Cat 2 LBT is performed at the sharing node):
    - With a view towards NR unlicensed operations in other regions requiring sensing e.g. Japan
  + C) Before Beam Switching
  + D) For Rx –Assistance LBT
  + E) For Multi-Beam TDM COT
  + F) For Multi-channel (Type B) LBT based channel access
* Alt 3: Instead of introducing Cat 2 LBT, use a special Cat 4 LBT with n=[0 or 1] for one or more of the use cases summarized in Alt 2.

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| Company | View |
| vivo | The Cat 2 LBT should be supported for use cases C), D), E), F). Furthermore, we would like to know the difference between case C) and case E). |
| Charter Communications | Alt 1. A device can always perform Cat-3 LBT by implementation if it desires. |
| Intel | Definition/use of a different type of LBT, aka Cat-2 LBT, is preferred, but either Alt-2 or Alt-3 are also fine. As for the use case, we support B-C-D and E. |
| OPPO | We support Alt-2 |
| NEC | We support Alt 2 and corresponding use cases A), B), D) and F) at least, and be open to discuss the other cases. |
| Huawei, HiSilicon | We support Alt 2, at least for the use cases related to COT initiation such as D and F for which the benefit of replacing the Ecca procedure by a one-shot LBT is obvious. We are open to discuss other use cases as well if Alt 2 is agreed.  We do not support Alt 3, however, since CAT4 even with a deterministic number of observation slots cannot replace the one-shot LBT as in CAT2. This is due to the fact that the Ecca procedure is meant to be a persistent sensing procedure that continuously senses the channel for another deferral period if the channel is sensed to be busy. Even if n=0, channel is sensed persistently for as many deferral periods as in which channel is sensed busy until the channel is sensed idle in the last deferral period. |
| Lenovo, Motorola Mobility | We support Alt 2 and all the listed use cases. |
| LG Electronics | We support B) C) D) E) F) in Alt 2. Furthermore, we do not support Alt 3 and would like to know the use case of A) in Alt 2. The definition of Cat-2 LBT can be reused with possible modifications to the parameters such as the gap duration for each type of LBT. |
| Xiaomi | We support alt 2 at least for D) and F) |
| Nokia, NSB | We support Alt 1. As Charter commented, the Gnb may anyhow perform additional channel sensing, if beneficial, and indicate the UE to perform Cat 3 LBT prior to any UL transmission. |
| ZTE, Sanechips | At least Alt 2 B) should be supported. Besides, we can also observe from our simulation result that performance of the Cat2 directional LBT is better than the performance of no LBT for high load case for COT sharing case. |
| DOCOMO | We prefer to introduce Cat-2 LBT while either Alt 2 or 3 is fine. For Alt 2, we support at least B, C and E, and open to discuss the others. For Alt 3, we think it could minimize the spec effort. |
| InterDigital | Support Alt.2, at least for beam switching with a gap (B, C and E) |
| Ericsson | We support Alt 1.  For A) and B): Do we envisage gaps in the order of ms? If the gap is big CAT3 (upto 23 us sensing) is acceptable as few companies commented. If the gap is small, we don’t see the need to introduce a specific CAT2 LBT (8us) as it is not supported by EN 302 567.  Furthermore, the gap in a DL-UL will be dependent on DL-UL switching time, and this could take at least upto 7us.   For C) D) E): Our simulation results show no benefit in using CAT2 LBT for any of these cases.   For F) Type B channel access is not supported by EN 302 567. Moreover, Type B channel access relies on an assumption of a fixed channelization and channel bonding with same channel bandwidth, which is not the case for operation in 60 GHz where different channel BWs are supported. |
| Futurewei | We support Cat 2 LBT and support all use-cases and are open to making Cat-2 LBT requirement configurable in first 2 use-cases. We believe Cat-4 LBT flow may still not reduce to Cat-2 even if the randomness in number of selected observation slots is removed. |
| Convida Wireless | We prefer Alt 2. |
| Apple | Support Alt 1 |
| WILUS | We support Alt 2 at least for beam switching © and B), D), E), F) use cases. |

There is slightly majority view to support introducing Cat 2 LBT. Consider we have been discussing this for quite a while, the moderator recommend to have online discussion on the following

Proposal 2.5.1-2:

Introduce Cat 2 LBT in 60GHz band operation.

* The Cat 2 LBT uses the same sensing structure as the 8 us initial deferral period as in Ecca
* FFS use cases.

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| Company | View |
| Samsung | We support the proposal |
| Huawei, HiSilicon | We support the proposal |
| Intel | We support this proposal |
| WILUS | We support the proposal |
| OPPO | We support this proposal. |
| Spreadtrum | We support this proposal. |
| Futurewei | Support |
| vivo | support |
| Huawei, HiSilicon 2 | We support the proposal. |

## Rx Assistance

Agreement:

For receiver to provide assistance, channel sensing and reporting need to be performed. The following set of tools can be considered for further discussion

* Alt 1. Legacy RSSI measurement and reporting with possible enhancements
* Alt 2. AP-CSI report with possible enhancements
* Alt 3. LBT at receiver
  + Alt 3.1 eCCA
  + Alt 3.2 Cat2 LBT

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | Observation 3：A COT initiated using receiver-assisted LBT is not limited to the maximum number of PDSCHs that can be scheduled by a single DCI. Subsequent scheduling PDCCHs and their respective PDSCHs can be further transmitted within the remaining MCOT duration to any of the UEs that reported idle channel. Observation 4：Receiver-only directional LBT saves the LBT overhead associated with the transmitter-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. Observation 8: Compared to No-LBT, substantial coverage gains are achieved using Receiver-assisted LBT/Receiver-only LBT in the indoor scenario, especially at medium and high traffic load. - Even higher gains are realized when wider beams are used for directional transmissions  Observation 9: For Receiver-assisted LBT/Receiver-only LBT, if a high EDT\_Rx threshold is used, the DL cell-edge performance degrades if only CTS/idle indication is fed back when interference level is lower than the EDT\_Rx threshold. Observation 5：Enhancements and specification effort required to introduce L1-RSSI on AP-CSI feedback are substantial compared to those required to introduce receiver assistance based on receiver-side LBT.  Proposal 22：For UE to provide receiver-assistance when gNB intends to transmit in the DL, consider the following Alt 3.1C in FL Proposal 2.6.3-1 from RAN1#105-e to clarify Alt 3.1 based on eCCA at the receiver: • Alt 3.1C: gNB schedules or triggers UL transmission (PUCCH, PUSCH, SRS etc) as CTS/Receiver-assistance information with the DL assignment DCI and indicating Cat 4 LBT in the DCI. UE performs Cat 4 LBT and if LBT passes, transmits the CTS/Receiver-assistance information to explicitly indicate the LBT outcome. gNB detects the CTS/Receiver-assistance information to identify if the UE passed Cat 4 LBT. After detecting the CTS/Receiver-assistance information, the data transmission happens  Proposal 23：For operation in the 60 GHz band, receiver-side LBT should be supported (Alt 3 in the agreement made in the RAN1#104-e). |
| vivo | Proposal 17: LBT at receiver is supported and Cat 2 LBT should be applied.  Proposal 18: PDCCH can be used to send the transmitter request, and PUCCH can be used to send the assistant information.  Proposal 19: Each transmitter request monitoring occasion corresponds to a receiver feedback transmission opportunity. |
| Spreadtrum Communications | Proposal 5: Regarding receiver assisted LBT, at least the method of Legacy RSSI measurement and reporting with possible enhancements (Alt 1) and the method of AP-CSI report with possible enhancements (Alt 2) should be supported for further study. |
| InterDigital Inc. | Observation 4: In a beam-based environment, LBT (omni-directional or directional) can fail to detect hidden nodes if the interference is only in the direction of the receiving node.  Proposal 5: Receiver assistance should be considered for both omni-directional and directional LBT.  Proposal 6: Directional receiver assistance is supported.  Proposal 7: A single directional receiver assistance process can be performed on a beam whose parameters are determined from the parameters of the Rx beam of one or more associated transmissions.  Proposal 8: To enable directional receiver assistance, support at least Alt 1 (Enhance legacy RSSI measurements) and Alt 2(AP-CSI reporting). |
| Sony | Observation 4: If per-beam LBT sensing is introduced, per beam COT indication may be needed.  Proposal 11: Receiver assisted LBT should be supported in 60 GHz unlicensed operation.  Observation 5: For RSSI measurement and reporting with possible enhancements, L1-RSSI carried in CSI needs to be considered.  Observation 6: For AP-CSI report with possible enhancements, fast and low complexity measurement/reporting may be required.  Observation 7: For LBT at receiver, PDCCH transmission corresponds to RTS-like signal and PUCCH corresponds to CTS-like signal.  Proposal 10: For reporting receiver assistance information, CSI reporting mechanism should be a baseline. |
| Lenovo Motorola Mobility | Observation 2: For NR operation in 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 5: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, long-term channel sensing could be useful for both LBT and no-LBT based channel access mechanism:- For LBT based channel access mechanism, long-term sensing at the UE could be utilized for receiver assistance LBT at the gNB- For no LBT based channel access mechanisms, long-term sensing could provide interference statistics in terms of potential interference from WiFi as well as interference from other NR operators  Proposal 23: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, receiver assistance should be supported for both LBT and no-LBT based channel access mechanisms to avoid potential interference at the receiver.  Proposal 25: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, only class A receiver assistance should be supported where the assistance information is sent only to the transmitter.  Proposal 27: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, for receiver to provide assistance, channel sensing and reporting need to be performed and following enhancements to legacy RSSI measurements should be supported: - for long term sensing to measure interference statistics from WiFi systems or other NR operators, a new category of ZP CSI-RS should be supported where the UE is not expected to receive any channel/signal (including NZP CSI-RS for interference measurement) and only measure potential interference from WiFi nodes or other NR operators and report back corresponding measurements.  Proposal 28: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, for receiver to provide assistance, channel sensing and reporting need to be performed and eCCA should be supported as follows: - Signaling mechanism similar to RTS/CTS should be considered for receiver assistance o Short transmission using control channels (such as with 1-bit) or reference signals for before the actual transmission could be supported |
| Samsung | Proposal 11: Support dynamic RX-assistant channel access mechanism with handshake between transmitter and receiver: ·the channel access request is based on DCI and channel access response is based on UCI in a downlink scenario. ·the assistant information is based on CCA.  Proposal 12: Support RSSI measurement outside the active BWP and in non-serving cell. |
| CATT | Proposal 13：The receiver assistance channel access mechanism can be designed based on the A-CSI feedback framework. |
| ZTE Sanechips | Proposal 17: For receiver assisted channel access and interference management,   l If existing L1 and L3 measurement mechanism is supported to obtain assistance information, some enhancements may need to be considered for using the measurement results timely and effectively to guide the subsequent transmission.   l If LBT is supported to obtain assistance information, assistance information can be considered to be obtained within COT in addition to the beginning of COT.   n If Cat2 LBT is used for receiver, then Cat4 LBT should be used for transmitter to initiate a COT. |
| Fujitsu | Observation 1: For receiver assistance, what is concerned is L1 measurement and report. The three alternatives could be concluded as possible enhancements for the current CSI report with respect to quantity and content for CSI report, e.g. · For Alt 1 and Alt 2, L1-RSSI report is a possible enhancement for the current CSI report. · For Alt 3, indication of whether a LBT at the UE side is successful is a possible enhancement for the current CSI report. Proposal 1: For less standardization work, take the current CSI report as a starting point for further discussion on receiver assistance.  · FFS whether and how to support L1-RSSI report and indication of whether a LBT at the UE side is successful. Proposal 2: To reduce latency and signaling overhead of CSI report for receiver assistance, support AP-CSI report triggering directly by the DCI with DL grant, regardless of enhancements on quantity and content for CSI report. |
| Ericsson | Observation 18 Receiver assisted LBT does not show consistent performance improvement as compared to no LBT operation.  Observation 19 Receiver assistance LBT involves RTS/CTS-like handshaking in every data transfer procedure, which significantly increases data transfer latency, reduces spectrum efficiency and system capacity.  Observation 20 The standardization and implementation technical complexity and cost for receiver assistance LBT should not be under-estimated.  Observation 21 A new L1 report quantity of L1-RSSI can be introduced for UE to report interference level to gNB.  Observation 22 Enhancement to enable aperiodic CSI reporting to be triggered by DL DCIs and to be transmitted on PUCCH as being discussed in the URLLC WI can be reused to communicate receiver assistance information to gNB.  Observation 23 Current processing delay requirement for CSI reporting in NR can be reduced for L1-RSSI reporting, to make the receiver assistance mechanisms more efficient.  Proposal 15 Do not support receiver assisted LBT (Alt-3) in Rel-17.  Proposal 16 Support Alt-1 and Alt-2 for receiver assistance mechanisms that are based on the existing RSSI and CSI reporting and decoupled from data transmission procedure.  Proposal 17 The following enhancements on the current AP-CSI reporting can be considered to better support receiver assistance information reporting: |
| FUTUREWEI | Proposal 11: For receiver assisted LBT, support NR CSI-IM based reporting for the clear channel assessment at the receiver. |
| FUTUREWEI | Proposal 12: For receiver assisted LBT, the receiver shall report the resource availability prior to the transmission. The RSSI measurement definition may be extended to assess the resource availability, where the resources, type of measurement (for instance Cat2 LBT) shall be provided by the transmitter. |
| Nokia, Nokia Shanghai Bell | Proposal 30: Employ existing RSSI measurements and CSI reporting as the receiver assistance.  Proposal 31: Deprioritize introduction of new mechanisms for receiver assistance until more essential parts of the channel access solution have been agreed.  Observation 11: Any Rx assistance scheme should be configurable per UE, so that it could be used only with UEs frequently detecting high interference.  Observation 12: For any new Rx assistance schemes, UE processing time similar to PDSCH processing time (N1) or CSI computation time (N2/Z1Z2) should be considered when providing Rx assistance.  Observation 13: Rx assistance should not be limited to the beginning of COT only. |
| OPPO | Proposal 16: RTS-like signal can be carried in a PDCCH and CTS-like signal can be carried in a PUCCH. |
| Qualcomm Incorporated | Proposal 12: Beam Specific L1-RSSI measurement and reporting should be supported.  Proposal 13: Consider the use of RSSI compared to a configurable threshold as part of the L1-RSSI report  Proposal 14: Consider use of UL grant DCI for trigger of Beam Specific L1-RSSI measurement and reporting for enhanced AP-CSI in PUSCH.  Proposal 15: Consider use of PUCCH for sending Beam Specific L1-RSSI measurement and reporting for enhanced AP-CSI.  Proposal 16: Use Rel. 16 AP-CSI timelines as baseline for enhanced AP-CSI reporting with L1-RSSI and study further possible tightening of the timelines. |
| LG Electronics | Proposal #8: For the receiver to provide assistance, the feedback mechanisms already supported by the current specification (with possible enhancements) can be considered but it is not preferred introducing the additional or new mechanism (such as new RTS/CTS-like signalling). |
| Intel Corporation | 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. |
| AT&T | Proposal 3:   • Receiver assistance in Rel. 17 is limited to measurement enhancements   • Message based schemes similar to RTS/CTS signalling can be addressed in a later release targeting Class B scenarios   • Hand shaking is not supported   • Transmission should be allowed before the receiver assistance is received   • Receiver assistance can equally be useful, and should be allowed, for the no-LBT mode of transmissions   • Receiver assistance is a fast, low complexity feedback mechanism to convey to the transmitter the interference environment at the receiver |
| Apple | *Proposal 13: Consider using omni and directional RSSI and channel occupancy report, including regions where LBT is not mandated.*  *Proposal 14: L1-RSSI can be used to part of AP-CSI enhancement.* |
| NTT DOCOMO INC. | Proposal 3: For Rx assistance, support Alt 1 (Legacy RSSI measurement and reporting with possible enhancements) and/or Alt 2 (AP-CSI report with possible enhancements):   l  Alt 1 with enhancements to consider beam-related aspects should be a starting point at least for the support of long-term Rx-assistance   l  Alt 2 should also be considered if the need of short-term Rx-assistance is observed |
| Xiaomi | *Proposal 4: Conditions about whether to enable/disable receiver assisted LBT can be studied.*  *Proposal 5: How to design a receiver assisted LBT with a simpler flow and little spec impact should be considered.*  *Proposal 6:* *For receiver to provide assistance, the Rx side can report its detected interference level periodically to Tx. And Tx can determine whether to occupy the channel based on the interference level values previously received from Rx side.* |
| Convida Wireless | *Proposal 8: Receiver assisted LBT and channel access should be supported in 52.6 GHz to 71 GHz.*  *Proposal 10: For receiver to provide assistance, the following can be further discussed: legacy RSSI measurement and reporting with possible enhancements, AP-CSI report with possible enhancements and LBT at receiver using eCCA or Cat2 LBT.* |

### First Round Discussion

For receiver to provide assistance, the following positions are collected

* Alt 1. Legacy RSSI measurement and reporting with possible enhancements
  + Support: Spreadtrum, InterDigital, CATT, ZTE, Fujitsu, Ericsson, Nokia, FUTUREWEI, NOKIA, Qualcomm, LG, ATT, DOCOMO
* Alt 2. AP-CSI report with possible enhancements
  + Support: Spreadtrum, InterDigital, CATT, ZTE, Fujitsu, Ericsson, Nokia, FUTUREWEI, NOKIA, Qualcomm, LG, ATT, DOCOMO
* Alt 3. LBT at receiver
  + eCCA based
  + CCA based
  + Support: HW, Vivo, Samsung, ZTE, FUTUERWEI, Intel, Xiaomi, Convida

Proposal 2.6.1-1 (closed)

As a receiver assistance technique, introduce L1-RSSI measurement to be sent as part of an enhanced AP-CSI report

* FFS: Timeline of measurement, reporting and trigger
* FFS: Measurement configuration/resource of L1-RSSI
* FFS: ZP-CSI-RS based measurement
* FFS: Beam specific RSSI measurement and reporting
* FFS: What is included in the L1-RSSI report, such as the value of RSSI measurement, comparison outcome with Energy Detection threshold, etc
* FFS: CCA/eCCA based receiver assistance

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| Company | View |
| vivo | We think details such as timeline, measurement configuration etc. should be clarified before we make an agreement. We want to make sure that the enhancement is feasible for receiver assisted technique. |
| Charter Communications | Agreeable if this is the only Rx assistance technique that is introduced |
| Intel | We are generally OK with the proposal, but we would like to further discuss the details before making an agreement. |
| Huawei/HiSilicon | We cannot support this proposal.  It should be noted that introducing L1-RSSI would require defining a new measurement quantity in L1 along with designing and specifying its measurement configuration, resources, trigger and associated timelines. In particular, we cannot accept L1-RSSI measurement based on ZP CSI-RS. Similar to NR-U, if a L1-RSSI is defined, it should be based on energy measurement over the whole operating bandwidth.  Besides, the current AP-CSI reporting mechanism by itself needs several enhancements to resolve the issues listed below:   * An AP CSI-RS would have to be triggered first by each scheduling DL assignments for measurement, then followed by some processing delay before reporting CSI on PUCCH resources from all the candidate K UEs. * During such a processing time the UE needs to perform a more complex measurement procedure, e.g. including FFT due to the sparse nature of the CSI-RS measurement resource in the frequency domain. This is in contrast with the simple ED as part of LBT, * Based on the discussion on required synchronization accuracy in higher numerologies, CSI-RS detection is not immune to such requirement. However, energy detection as in receiver-side LBT does not nearly need such a level of timing accuracy. * As acknowledged by the proponents of enhancing the legacy AP-CSI mechanism, current processing delays for CSI reports in NR are rather long. Moreover, the latency between CSI-RS reception and CSI-RS report is a UE capability and it may be too long so that the reported CSI is not actually a representative of the experienced interference during the data reception. * Finally, in terms of specification effort, there is no advantage of AP CSI reporting on PUCCH as compared to LBT at the receiver since AP CSI reporting on PUCCH is not a legacy mechanism supported in Rel15/16. |
| Lenovo, Motorola Mobility | We support the proposal. |
| LG Electronics | We do not prefer to introduce L1-RSSI measurement which is not defined in the current specification. We believe that the benefits of L1-RSSI should be identified first (e.g., how small the delay is) compare to other CSI reports. |
| Nokia, NSB | We are fine with the proposal, but for L1-RSSI to be introduced still in Rel-17, further details on e.g. processing timelines should be fixed asap. Otherwise, it may be too late to include it into Rel-17 anymore as many of the essential channel access features (required by local regulators) are still unresolved. |
| ZTE, Sanechips | We are fine with the proposal. |
| DOCOMO | Support the proposal. Ok to discuss the details. We think 4th FFS is important since omni-directional sensing may not be sufficient to correctly observe the channel condition, which is the motivation to support directional sensing in our view. It may rely on the discussion about the relation between sensing beam and transmit beam. |
| InterDigital | Support the proposal. We believe that beam specific RSSI measurement and reporting is beneficial to directional operation. We also believe that comparison of an RSSI-like measurement to an EDT can be used as a proxy to CCA based receiver assistance. |
| Ericsson | **General Comment to Moderator:** Notwithstanding the FFS points in the proposal, we think that Alt 1 (Legacy RSSI measurements) can be achieved with the current timeline under consideration. The three alternatives are not contradictory, and each has its merits/demerits, so we propose to accept each alternative separately instead of doing it together. We think Alt 1 can be agreed with minimal changes. |
| Futurewei | We agree with Vivo on need to examine details before supporting L1-RSSI. |
| CATT | We are OK with the proposal. |
| Samsung | We don’t agree with the proposal. We have expressed our concern many times – what’s the fundamental difference between L1-RSSI and CCA? Since we already have CCA well defined, then why not directly using CCA based receiver assistance to avoid further specification impact? Meanwhile, the configuration and reporting of RSSI is semi-static, then how a semi-static procedure can help with dynamic channel access is questionable. |
| Convida Wireless | We are ok with the proposal. |
| Apple | OK with the proposal. |

Discussion 2.6.1-2 (closed)

For receiver to provide assistance Alt 3.1 (eCCA based) or Alt 3.2 (CCA based), when gNB is the initiating device (UE is providing assistance), what is your view on the schemes

* Alt 3.1A: gNB schedules or triggers UL transmission (PUCCH, PUSCH, SRS etc) with DCI and indicating CCA or eCCA in the DCI. UE performs CCA or eCCA for the scheduled UL transmission. gNB detects the scheduled UL transmission to tell if UE passes the CCA or eCCA
* Alt 3.1B: New RTS/CTS-like signaling introduced. gNB sends RTS-like signaling to UE. UE performs CCA or eCCA and if LBT passes, transmits CTS-like signaling to explicitly indicate the LBT outcome. gNB detects the CTS-like signaling to identify if the UE passed CCA or eCCA. After detecting the CTS-like signal, the data transmission happens

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| Company | View |
| vivo | We slightly prefer Alt 3.1B. However, it is not necessary to introduce new RTS/CTS-like signalling. The legacy DL grant, GC-PDCCH, etc. can be used to trigger the assistance information. And PUCCH or other UL signals/channels can be used to transmit the assistant information after a successful Cat 2 LBT. |
| Intel | We prefer Alt. 3.1.A and we would refrain from introducing new signalling. We believe that the RX assistance should be developed based on current NR framework. |
| OPPO | We are fine with Alt3.1A and Alt3.1B, we think either one can resolve the issue of hidden node. |
| Huawei, HiSilicon | First, we note that since this discussion addresses both Alt 3.1 (eCCA based) and Alt 3.2 (CCA based), which is a good approach in our view, it would be more appropriate to label the alternatives as Alt 3A and Alt 3B instead of Alt 3.1A and Alt 3.1B, respectively.  Second, Alt 3.1B is a closer mechanism to Receiver-assisted LBT than current Alt 3.1A. However, we note that the CTS/RTS may not be new signal/channels and could be similar to those described in Alt 3.1A.  For example, when the target transmission is DL and UE is the receiver, the scheduling DL assignment itself resembles an RTS and triggers the LBT at the UE and the UL transmission of PUCCH (as CTS/receiver-assistance information) or SRS (as idle indication CTS only). The UE transmits that triggered UL only after the LBT has passed. This does not require introducing a new DCI format unless there is a consensus to support as well performing the triggering separately from the DL scheduling, e.g., using a group common DCI, which can be discussed later on.  Therefore, a more accurate description in our view could be as suggested Alt 3C below:   * Alt 3C: gNB schedules or triggers UL transmission (PUCCH, ~~PUSCH,~~ SRS ~~etc)~~ as CTS/Receiver-assistance information with the DL assignment DCI and indicating CCA or eCCA in the DCI. UE performs CCA or eCCA for the scheduled UL transmission and if LBT passes, transmits the CTS/Receiver-assistance information to explicitly indicate the LBT outcome. gNB detects the scheduled UL transmission to tell if UE passes the CCA or eCCA. After detecting the CTS/Receiver-assistance information, the data transmission happens.   Note that setting the context of the discussion based on the target transmission direction provides more clarity than “gNB/UE is initiating device”. This is due to the fact that the DL assignment DCI could be transmitted, for instance, in a previous gNB/UE COT. |
| LG Electronics | We do not prefer to introduce new RTS/CTS-like signalling for the receiver-assisted LBT other than the mechanisms that are already supported by the current specification. |
| Nokia, NSB | We note that Alt 3.1A can be supported with Cat 3 LBT without any specific standards impact. We are not in favour of defining RTS/CTS-like procedures. |
| ZTE, Sanechips | We tend to support Alt 3.1B, but also open to Alt 3.1A |
| DOCOMO | Agree with Intel. Prefer Alt 3.1A. |
| InterDigital | We believe that Alt.3 should be agreed upon before working on different flavours. |
| Futurewei | Our preference is for Alt 3.1B, signalling details can be discussed further. |
| Samsung | We support both Alt 3.1A and 3.1B with the consideration that CTS/RTS are NR existing signal/channel (i.e., no new signal/channel introduced). |
| Convida Wireless | Some clarification may be needed. It seems Alt 3.1A is only for UL while Alt 3.1B is for DL and UL. Can it be made more clear in proposal if Alt 3.1A also applicable for DL? |
| Apple | Alt 3.1A is UL, where gNB is the receiver. DCI is kind of assisted information since gNB sensed channel clear. Supported already via cross TxOP scheduling.  Alt 3.1B is DL, where UE is the receiver. |

Discussion 2.6.1-3 (closed)

For receiver to provide assistance Alt 3.2 (CCA based), when gNB is the initiating device (UE is providing assistance), please provide your views on :

* Duration of CCA at the UE
* Procedure for channel access based on outcome of CCA
  + E.g. Procedure identified in Alt 3.1.A where Cat 2 LBT is used instead of Cat 4 LBT

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| Company | View |
| vivo | We prefer Cat 2 LBT at the UE side since it is not necessary to perform Cat 3 LBT (LBT with random back-off with a contention window of fixed size). The assistant nformation is usually very short and comparable to short control signalling. If a LBT is required for the transmission of the assistant information, Cat 2 LBT is enough. |
| Intel | Our view is that the procedure of Alt 3.1.A and 3.2 should be equivalent with the distinction that in Alt 3.1.A we perform eCCA and in Alt. 3.2 CCA is used, where the duration of the CCA could be as short as possible (preferably 8 us). |
| OPPO | We think Cat2 LBT is better than Cat 4 LBT.  The duration of CCA at UE can be 8 us or 8+5 us.  Regarding the procedure, we think Alt3.1A or Alt3.1B both can be considered. |
| Huawei, HiSilicon | In terms of the duration of CCA at the UE, it should be the duration of a one-shot LBT as in CAT2. Some reasonable values are 8us and 13us.  The procedure based on the outcome of CCA is rather similar to our clarified Alt 3C provided in the above discussion point.  The following example provides more details    For DL transmission, gNB performs CAT4 LBT to send DL assignments to K Ues out of M intra-cell Ues, e.g., based on the status of their respective buffers. As discussed in Section 2.3.3, this can be done using one sensing beam or multiple beams covering the transmission beams of the respective PDCCHs. Each DL assignment triggers an UL transmission of an idle indication (CTS) signal/channel on indicated resources upon a successful LBT by the intended receiving UE. The CTS could further include receiver-assistance information such as the interference level measured by the UE during LBT. In order to ensure no interference during PDSCH reception from other nodes, the UE could perform a directional LBT for a deterministic duration, i.e. CAT2 LBT in the direction of PDSCH reception as, e.g., indicated by PDCCH. As such, the gNB receives the CTS/receiver-assistance information from N (<=K) Ues to which it proceeds with the transmission of their respective PDSCHs. |
| LG Electronics | The Cat-2 LBT can be used instead of Cat-4 LBT to provide assistance information by the receiver, and the duration can be adopted if we will agree on the sensing structures in Section 2.3. |
| ZTE, Sanechips | Cat2 LBT is preferred at UE side if Cat4 LBT is performed by gNB that initiates a COT. |
| DOCOMO | For duration, we are open to discuss, while prefer to minimize. No need to consider random back-off.  For procedure, we think it could be up to gNB. |
| InterDigital | Same as Discussion 2.6.1-2, we believe that Alt.3 should be agreed upon before working on the details. |
| Futurewei | We believe that timelines for reporting useful assistance information need to be short and Cat-2 LBT is appropriate. |
| Samsung | If Cat2 LBT is supported, the duration of CCA can be same as Cat2 LBT. |
| Convida Wireless | Cat2 LBT is preferred. |
| Apple | CAT2 LBT |

### Second Round Discussion

From the feedback collected so for, the moderator feels it will be beneficial to list the detailed schemes we are considering for receiver assisted LBT for comparison and down-selection

Proposal 2.6.2-1

For receiver to provide assistance in channel access, channel sensing and reporting need to be performed. The following schemes can be further considered

* Scheme 1: L1-RSSI based receiver assistance
  + ZP-CSI-RS is configured for RSSI measurement
    - FFS: any enhancement needed for ZP-CSI-RS for this purpose (eg., ZP-CSI-RS over all REs in BWP).
  + L1-RSSI is reported in an AP-CSI report
  + L1-RSSI trigger in UL grant
    - FFS if L1-RSSI trigger can also be carried in DL grant
  + Timeline for L1-RSSI reporting is at least equal to AP-CSI reporting and RAN1 strives to tighten the timeline
  + FFS: How to indicate the measurement beam for L1-RSSI
  + FFS: What is included in the L1-RSSI report, such as the value of RSSI measurement, comparison outcome with Energy Detection threshold, etc
* Scheme 2: CCA or eCCA based receiver assistance with existing phy channel/signals
  + gNB schedules/triggers UL transmission PUCCH/SRS with the DL assignment DCI and indicates CCA or eCCA in the DCI. UE performs CCA or eCCA for the scheduled/triggered UL transmission and if LBT passes, transmits the CTS/Receiver-assistance information (implicitly or explicitly) in the PUCCH (or SRS in the case of 1-bit Rx-assistance) to indicate the LBT outcome. gNB detects the scheduled UL transmission to tell if UE passes the CCA or eCCA. After detecting the CTS/Receiver-assistance information, the data transmission happens.
  + gNB schedules/triggers UL transmission PUSCH with the UL assignment DCI and indicates CCA or eCCA in the DCI. UE performs CCA or eCCA for the scheduled/triggered UL transmission and if LBT passes, transmits the CTS/Receiver-assistance information (implicitly or explicitly) in the PUSCH to indicate the LBT outcome. gNB detects the scheduled UL transmission to tell if UE passes the CCA or eCCA. After detecting the CTS/Receiver-assistance information, the data transmission happens.
  + Note: There may not be any spec impact, especially if the CTS/Receiver-assistance information is carried implicitly by the scheduled UL transmission
* Scheme 3: CCA or eCCA based receiver assistance with new RTS/CTS type transmission
  + New RTS/CTS-like signaling introduced.
  + gNB sends RTS-like signaling to UE. UE performs CCA or eCCA and if LBT passes, transmits CTS-like signaling to explicitly indicate the LBT outcome. gNB detects the CTS-like signaling to identify if the UE passed CCA or eCCA. After detecting the CTS-like signal, the data transmission happens
* Scheme 4 (from DCM): LegacyL3-RSSI with enhancement on supporting gNB indicating the beam used for UE RSSI measurement.
* Other schemes?
  + Ericsson mentioned legacy RSSI with minimum change. Can you provide some details?

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| Company | View |
| Huawei/HiSilicon | We suggest the following modifications:  Proposal 2.6.2-1  For receiver to provide assistance in channel access, channel sensing and reporting need to be performed. The following schemes can be further considered   * Scheme 1: L1-RSSI based receiver assistance   + RSSI measurement is performed based on one of the following alternatives:     - Measurement on configured ZP-CSI-RS     - Energy measurement on operating BW   + ~~ZP-CSI-RS is configured for RSSI measurement~~     - ~~FFS: any enhancement needed for ZP-CSI-RS for this purpose~~   + L1-RSSI is reported in an AP-CSI report   + L1-RSSI trigger in UL grant     - FFS if L1-RSSI trigger can also be carried in DL grant   + Timeline for L1-RSSI reporting is at least equal to AP-CSI reporting and RAN1 strives to tighten the timeline   + Note: Alternative assistance approaches supported if the timeline of L1-RSSI reporting is deemed too long to be a representative of the experienced interference during the subsequent data reception   + FFS: How to indicate the measurement beam for L1-RSSI   + FFS: What is included in the L1-RSSI report, such as the value of RSSI measurement, comparison outcome with Energy Detection threshold, etc * Scheme 2: CCA or eCCA based receiver assistance with existing phy channel/signals   + gNB schedules or triggers UL transmission (PUCCH, PUSCH, SRS etc) with DCI and indicating CCA or eCCA in the DCI. UE performs CCA or eCCA for the scheduled UL transmission. gNB detects the scheduled UL transmission to tell if UE passes the CCA or eCCA * Scheme 3: CCA or eCCA based receiver assistance with new RTS/CTS type transmission   + New RTS/CTS-like signaling introduced.   + gNB sends RTS-like signaling to UE. UE performs CCA or eCCA and if LBT passes, transmits CTS-like signaling to explicitly indicate the LBT outcome. gNB detects the CTS-like signaling to identify if the UE passed CCA or eCCA. After detecting the CTS-like signal, the data transmission happens * Scheme 4: gNB schedules/triggers UL transmission PUCCH/SRS with the DL assignment DCI and indicates CCA or eCCA in the DCI. UE performs CCA or eCCA for the scheduled/triggered UL transmission and if LBT passes, transmits the CTS/Receiver-assistance information in the PUCCH (or SRS in the case of 1-bit Rx-assistance) to indicate the LBT outcome. gNB detects the scheduled UL transmission to tell if UE passes the CCA or eCCA. After detecting the CTS/Receiver-assistance information, the data transmission happens. * Other schemes?   + Ericsson mentioned legacy RSSI with minimum change. Can you provide some details?   Moderator:   * For energy measurement on operating BW, I can add it in ZP-CSI-RS enhancement. I assume you are not talking about time domain measurement. * Not clear to me what the note means. Can you make it more concrete? * For the proposed scheme 4, I see it is very similar with scheme 2, with some details. The only part missing from scheme 2 is using PUSCH for LBT passing indication. In that case. I modified scheme 2 to include scheme 4. |
| Lenovo, Motorola Mobility | We support the proposal and would prefer to support all the three schemes |
| vivo | We’re okay to further study. But have a clarification to scheme 1. Can the proponent explain the procedure of the receiver assistance technique? How L1-RSSI is used as the assisted information? Will UE perform LBT before reporting L1-RSSI? Will gNB perform DL transmission if no L1-RSSI is reported?  We support scheme 3 or scheme 4 in Huawei’s modification..  Moderator: What I have in mind is not LBT. It is simple RSSI measurement and reporting, just faster. So the gNB knows the interference level at receiver for data transmission. |
| Intel | We support the proposal and Huawei’s edits and prefer only scheme 2, and 4. We are also OK to further discuss scheme 1 and have a better understanding on its general procedure. |
| LG Electronics | We are not preferred introducing the additional or new mechanism such as scheme 2 and scheme 3 (i.e., new RTS/CTS-like signalling) other than the feedback mechanisms already supported by the current specification (with possible enhancements).  For scheme 1, since the L1-RSSI measurement is not defined in the current specification, the benefits of L1-RSSI should be identified first (e.g., how small the delay is) compare to other CSI reports. |
| Lenovo, Motorola Mobility2 | We also support updates from HW to the proposal including further details to scheme 2 based on their scheme 4. |
| ZTE, Sanechips | We slightly tend to scheme 2 from FL proposal or scheme 4 from HW’s proposal, these two schemes is very similar. For other schemes, we are also fine to further discuss and clarify. |
| DOCOMO | While we are ok with supporting L1-RSRP measurement and reporting based on ZP-CSI framework, we also think legacy (L3-)RSRP measurement and reporting should also be reused since it works as long-term Rx assistance. One aspect which should be enhanced is beam related aspects. For example, QCL/TCI/spatial relation for beam used for L3 RSSI measurement and reporting can be considered. This can be added as another scheme. |
| Nokia, NSB | On Scheme 1, as said we are ok to introduce L1-RSSI reporting, but there are still a number of questions to resolve. To us this is not a top priority item in this WI.  For Scheme 2, we see that this kind of operation can already be applied without any further changes in a fully standards transparent manner. There is no need to agree anything as such, and we fail to see the need for lengthy description of gNB scheduling choices in this context.  For Scheme 3 or any new RTS/CTS like signaling, it is unclear what benefits that would bring compared to Scheme 2. |
| OPPO | We support the proposal. |
| Samsung | We are ok with the direction of the discussion, and ok with the proposal in general, including Option 4 added by Huawei.  One question for Option 1, why ZP-CSI-RS has to be configured for RSSI measurement? In our understanding, RSSI measurement doesn’t rely on any detection of RS, and only needs information on time and frequency resource.  Moderator: I am trying to capture that in the enhancement to ZP-CSI-RS (time/freq resource for measurement) |
| Ericsson | Regarding Scheme 1: In our view, with so little time left we think that its best if we reuse the existing measurement and reporting mechanisms already supported in 3GPP NR specification. Measurement and reporting of receiver assistance information could be incorporated into the existing L3 measurement framework (legacy RSSI measurement).  **To Moderator:** In our initial access contribution paper, we provided detailed analysis on what needs to be done to support RSSI and CO measurement. The proposal is copied below:  “Proposal 15 The current RSSI and CO measurement in Rel-16 should be enhanced to support NR unlicensed operation in the spectrum beyond 52.6 GHz in Rel-17. The enhancement at least includes extension of reference SCS and indication of channel bandwidth. The enhancement details of the RRC configuration for RSSI and CO measurement should be decided by RAN2”  We propose to add Scheme 4: Legacy RSSI measurements  We do not support Scheme 2 and 3, as there are no significant benefits to motivate this option.  Moderator: Added a scheme 4 from DCM. If it is purely legacy RSSI, don’t think we need to list it. |
| CATT | Regarding to Scheme 2, we still have some concerns.  How to indicate UE to perform CCA/eCAA for Rx-assistance? In Rel-16, the ‘ChannelAcess-CPext-CAPC’ is used for indicate the channel access type and CP extension before the UL transmission. If Scheme 2 is supported, should we want to introduce a new field indicating the CCA/eCCA for Rx-assistance in the DCI 0\_1/DCI 0\_0?  Moderator: I am thinking reusing the field, but possibly adding more functionalities. I suspect this is what the proponent of scheme 2 has in mind  How does the UE know the time domain resource measured by CCA or eCCA used for Rx-assistance?  Moderator: I assume this is the time resource before the scheduled UL transmission.  Furthermore, how does the UE know the frequency domain resource measured by CCA or eCCA used for Rx-assistance?  Moderator: Details are to be further discussed. In general, this will depends on the freq domain resource for UL transmission, and also depends on the discussion on LBT bandwidth in 2.2.2  We prefer to support the scheme that has less impact on the current spec.  Therefore, the scheme 1 is our first choice. |
| Futurewei | We are OK with the overall proposal and prefer scheme-1 and scheme-2. In scheme-2 we prefer to remove “CTS” and use just Receiver-assistance. Also, please clarify the phrase “data transmission happens”. Is this a restriction on gNB scheduling behaviour? |
| Huawei, HiSilicon 2 | We thank our feature lead for his comments/questions on our earlier input above. Below, are our answers to his comments followed by further suggested modifications on the updated proposal Proposal 2.6.2-1   * For energy measurement on operating BW, I can add it in ZP-CSI-RS enhancement. I assume you are not talking about time domain measurement.   + We mean a “L1 version” of the RSSI measurement that is supported in Rel-16 NR-U based on energy measurement on the operating BW over certain time interval or number of symbols. The time interval or number of symbols may be specified or configured. * Not clear to me what the note means. Can you make it more concrete?   + Modified by adding a note. * For the proposed scheme 4, I see it is very similar with scheme 2, with some details. The only part missing from scheme 2 is using PUSCH for LBT passing indication. In that case. I modified scheme 2 to include scheme 4.   + Thank you for your comment. We have further clarified our Rx-assistance scheme for DL transmission as Scheme 2-1. The difference between our proposed scheme and the original Scheme 2 (we renamed the original Scheme 2 as Scheme 2-2) is that in Scheme 2-1 (our preference), the same DL assignment DCI schedules(triggers) UL transmission PUCCH(SRS) for CTS/Receiver-assistance information, indicates CCA or eCCA, and schedules PDSCH to the target UE. However, Scheme 2-2 requires two DCIs, one DCI to schedule PUSCH that carries Rx-assistance information after CCA/eCCA and a second DCI to schedule PDSCH to the target UE. We find Scheme 2-2 inefficient in that regard and we suggest to remove it (unless there is another company that supports Scheme 2-2 in which case please include it back). Further, we don’t believe that scheme 2-1 or (scheme 2-2) can have no specification impact since eCCA/CCA should be indicated in DCI and the scheduled PUCCH should carry the Rx-assistance info (in the case other than 1-bit Rx-assistance which may be alternatively and implicitly be communicated using SRS transmission). Further, note that in scheme 2-2, PUCCH that carries Rx-assistance info is scheduled prior to the PDSCH.   + Finally, we are not sure about the necessity of inclusion of Scheme 3 as, in our view, it is conceptually the same as Scheme 2-1 (just without mentioning how CTS and RTS are scheduled or which PHY channel carries them). Therefore, we also removed Scheme 3 for the sake of clarity as we find it redundant. However, if there is any company that specifically supports Scheme 3, please include it back to the proposal.   Proposal 2.6.2-1  For receiver to provide assistance in channel access, channel sensing and reporting need to be performed. The following schemes can be further considered   * Scheme 1: L1-RSSI based receiver assistance by down selecting between one of the two following alternatives   + Alt 1) ZP-CSI-RS is configured for RSSI measurement     - FFS: any enhancement needed for ZP-CSI-RS for this purpose (eg., ZP-CSI-RS over all REs in BWP).   + Alt 2) Energy measurement on operating BW over indicated or specified number of symbols or time interval   + L1-RSSI is reported in an AP-CSI report   + L1-RSSI trigger in UL grant     - FFS if L1-RSSI trigger can also be carried in DL grant   + Timeline for L1-RSSI reporting is at least equal to AP-CSI reporting ~~and RAN1 strives to tighten the timeline~~     - Note: RAN1 shall discuss if such timeline is tight enough to adequately represent experienced interference at the time of data reception. If RAN1 concludes that such timeline is not tight enough and cannot be further tightened such that L1-RSSI can adequately represent experienced interference at the time of data reception, Scheme 1 is not further considered.   + FFS: How to indicate the measurement beam for L1-RSSI   + FFS: What is included in the L1-RSSI report, such as the value of RSSI measurement, comparison outcome with Energy Detection threshold, etc * Scheme 2: CCA or eCCA based receiver assistance with existing phy channel/signals   Scheme 2-1) gNB schedules~~/~~(triggers) UL transmission PUCCH~~/~~(SRS) with ~~the~~ a DL assignment DCI and indicates CCA or eCCA in the DCI (see Figure). UE performs CCA or eCCA ~~for the scheduled/triggered UL transmission~~   * ~~then, and~~ if LBT passes, UE transmits the CTS/Receiver-assistance information ~~(implicitly or explicitly)~~ in the PUCCH (or SRS in the case of 1-bit Rx-assistance) to indicate the LBT outcome. gNB ~~detects~~ receives CTS/Receiver-assistance information ~~the scheduled UL transmission to tell if~~ and concludes that UE passes the CCA or eCCA. After detecting the CTS/Receiver-assistance information, the gNB transmits DL data ~~transmission~~ scheduled in the DL assignment DCI ~~happens~~. * if LBT does not pass, UE does not transmit the CTS/Receiver-assistance information and the gNB does not transmit DL data scheduled in DL assignment DCI.   Note: The same DL assignment DCI schedules (triggers) UL transmission PUCCH (SRS) for CTS/Receiver-assistance information, indicates CCA or eCCA, and schedules the PDSCH to the target UE.     * + ~~Scheme 2-2) gNB schedules/triggers UL transmission PUSCH with the UL assignment DCI and indicates CCA or eCCA in the DCI. UE performs CCA or eCCA for the scheduled/triggered UL transmission and if LBT passes, transmits the CTS/Receiver-assistance information (implicitly or explicitly) in the PUSCH to indicate the LBT outcome. gNB detects the scheduled UL transmission to tell if UE passes the CCA or eCCA. After detecting the CTS/Receiver-assistance information, the data transmission happens.~~   + ~~Note: There may not be any spec impact, especially if the CTS/Receiver-assistance information is carried implicitly by the scheduled UL transmission~~ * ~~Scheme 3: CCA or eCCA based receiver assistance with new RTS/CTS type transmission~~   + ~~New RTS/CTS-like signaling introduced.~~   + ~~gNB sends RTS-like signaling to UE. UE performs CCA or eCCA and if LBT passes, transmits CTS-like signaling to explicitly indicate the LBT outcome. gNB detects the CTS-like signaling to identify if the UE passed CCA or eCCA. After detecting the CTS-like signal, the data transmission happens~~ * Scheme 4 (from DCM): LegacyL3-RSSI with enhancement on supporting gNB indicating the beam used for UE RSSI measurement. * Other schemes?   + Ericsson mentioned legacy RSSI with minimum change. Can you provide some details? |

## Multi-Beam COT

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| Agreement:  For a COT with MU-MIMO (SDM) transmission, further consider the follow alternatives (down-select or support both)   * Alt 1: Single LBT sensing at the start of the COT with wide beam ‘cover’ all beams to be used in the COT with appropriate ED threshold * Alt 2: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT   Agreement:  Within a COT with TDM of beams with beam switching, down-select one or more of the following LBT operations   * Alt 1: Single LBT sensing with wide beam ‘cover’ all beams to be used in the COT with appropriate ED threshold   + FFS: Details on the definition of “cover” * Alt 2: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT * Alt 3: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT with additional requirement on Cat 2 LBT before beam switch   Agreement:   * SSB transmission with LBT is supported, at least when the conditions for contention exempt short control signalling based SSB transmission is not met   + Note the channel access for SSB with LBT may not be different from a normal COT with multiple beams   + FFS: If any difference from a multi-beam COT LBT needs to be introduced   Agreement:  For a COT with MU-MIMO (SDM) transmission, when independent per-beam LBT sensing at the start of COT is performed for beams used in the COT (Alt 2 in earlier agreement) is considered, the following alternatives are further considered   * Alt A: The per-beam LBT for different beams is performed in TDM fashion   + Alt A-1: The node completes one eCCA on one beam, and directly move on to the eCCA on the other beam, with no transmission in the middle   + Alt A-2: The node completes one eCCA on one beam, start transmission with the beam to occupy the COT, then move on to the eCCA on the other beam   + Alt A-3: The node performs eCCA of the different beams simultaneous, round robin between different beams * Alt B: The per-beam LBT for different beams is performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams   Agreement:  Within a COT with TDM of beams with beam switching, when independent per-beam LBT sensing at the start of COT is performed for beams used in the COT (Alt 2 or Alt 3 in earlier agreement) is considered, the following alternatives are further considered   * Alt A: The per-beam LBT for different beams is performed one after another in time domain   + Alt A-1: The node completes one eCCA on one beam, and directly move on to the eCCA on the other beam, with no transmission in the middle   + Alt A-2: The node completes one eCCA on one beam, start transmission with the beam to occupy the COT, then move on to the eCCA on the other beam   + Alt A-3: The node performs eCCA of the different beams simultaneous, round robin between different beams * Alt B: The per-beam LBT for different beams is performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams |

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| Company | Key Proposals/Observations/Positions |
| Samsung | Proposal 9: Support directional channel sensing in multi-beam operation: ·For multi-beam SDM scenario, both Alt 1 and Alt 2 can be supported. ·For multi-beam TDM scenario, Alt 1 can be supported as baseline, and selection between Alt 2 and Alt 3 depends on whether sensing is required for switching beams within a COT.  Proposal 10: For per-beam LBT for different beams, ·Support both Alt A and Alt B, and up to implementation to choose between Alt A and Alt B. ·Within Alt A, support Alt A-1 as the baseline. |
| CATT | Proposal 9：Consider supporting both of single LBT sensing with wide beam and independent per-beam LBT sensing for all beams to be used within the COT at the start of the COT.  Proposal 10: If supporting Alt A-1 or Alt A-2, the ‘blocking issue’ (failure of previous beam LBT causes subsequent beams unable to perform LBT) should be addressed.  Proposal 11: Alt A-3 of which node performs eCCA round robin between different beams should be supported to increase the multi-beam LBT efficiency. |
| ZTE Sanechips | Proposal 13: Considering transmission opportunity and utilization of resource, Alt2 that “multiple per-beam LBT that cover multiple transmission beams used in COT” should be considered for the transmission with multiple beams in spatial domain multiplexing if directional LBT is supported.  Proposal 14: Considering LBT overhead and transmission delay, Alt B that“The per-beam LBT for different beams is performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams” should be considered for the transmission with multiple beams in spatial domain multiplexing if Alt 2 is supported.  Proposal 15: Considering transmission opportunity and unnecessary interference to other device that is going to transmit transmission, Alt-3 that “Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT with additional requirement on Cat 2 LBT before beam switch” can be considered for the transmission with multiple beams in time domain multiplexing, if directional LBT is supported.   l Considering LBT overhead and transmission delay, Alt B that“The per-beam LBT for different beams is performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams” should be considered if Alt-2 or Alt-3 is supported |
| Ericsson | Observation 17 All alternatives agreed to be considered for a COT with TDM and SDM of beams, depends solely on how directional LBT for a single beam would be specified.  Proposal 13 If any enhancements to better enable multiple beam transmissions within a COT when LBT mode is used can be agreed now, it is to support Alt 1 in principle for TDM and SDM case where a single LBT at the beginning of the COT is performed with the definition of “cover” meaning omni-directional or quasi-omni-directional. |
| FUTUREWEI | Proposal 9: When independent per-beam LBT sensing at the start of COT is performed for beams used in the COT, an additional requirement on Cat 2 LBT before switching to new beam during the COT should be specified if the time duration from that beam’s LBT sensing exceeds a threshold. |
| Nokia, Nokia Shanghai Bell | Proposal 19: COT initiating LBT with multiple independent per-beam LBT sensing should be ppropriated while completing the design for baseline channel access procedures.  Proposal 21: For a COT with MU-MIMO (SDM) transmission, support both Alt 1 and Alt 2.  Proposal 22: Within a COT with TDM of beams with beam switching, support both Alt 1 and Alt 2 for LBT operations.  Proposal 23: For a COT with MU-MIMO (SDM) transmission, support Alt B.  Proposal 24: Alt A-1 is modified as: The node completes one eCCA on one beam, and directly moves on to the eCCA on the other beam, with no transmission in the middle. After completing eCCA on all beams, a further round robin CCA check is carried out in all beams (except the last beam).  Proposal 25: Alt A-3 is modified as: The node performs eCCA of the different beams simultaneous, round robin between different beams.   • single contention window is shared by beams or each beam has a separate contention window.   • the last CCAs shall indicate vacant channel on all beams that are part of the COT  Observation 10: It is important to maintain flexibility of gNB implementation for multi-beam COT  Proposal 26: For a COT with TDM transmission, support the modified Alt A-1 and Alt A-3. |
| NEC | Proposal 8: For a COT with SDM transmission, when independent per-beam LBT sensing at the start of COT is performed and the node does not has the capability to simultaneously sense in different beams, at least the following LBT operations should be supported:   Ÿ The node performs eCCA of the different beams simultaneous, round robin between different beams.  Proposal 9: Within a COT with TDM of beams with beam switching, when independent per-beam LBT sensing at the start of COT is performed for beams used in the COT and the node does not has the capability to simultaneously sense in different beams , the following LBT operations should be supported:   • The node completes one eCCA on one beam, start transmission with the beam to occupy the COT, then move on to the eCCA on the other beam.   • The node performs eCCA of the different beams simultaneous, round robin between different beams. |
| CAICT | Proposal 7: Both single LBT sensing with wide beam and independent per-beam LBT sensing should be supported for COT with MU-MIMO transmission. Alt. B for per-beam LBT should be supported.  Proposal 8: For LBT within a COT with TDM of beams with beam switching, Alt 1 and 3 should be supported. |
| OPPO | Proposal 12: for COT containing multiple beams, including MU-MIMO (SDM) and TDM of beams, Alt A-2 is not supported. Alt A-1 and Alt A-3 can be left for implementation. |
| Qualcomm Incorporated | Proposal 18: For SDM transmission, support both (Alt1) single LBT sensing with wide beam covers all beams used in the COT and (Alt 2) independent per beam sensing.  Proposal 19: For a COT with MU-MIMO (SDM) transmission if independent per beam LBT is supported, and if the node has the capability to perform simultaneous sensing in different beams, simultaneous per-beam LBT for different beams is supported.  Proposal 20: Within a COT with TDM of beams with beam switching, if independent per beam LBT is supported, and if the node has the capability to perform simultaneous sensing in different beams, simultaneous per-beam LBT for different beams is supported.  Proposal 21: Within a COT with TDM of beams with beam switching, when independent per-beam LBT sensing at the start of COT is performed for beams used in the COT (Alt 2 or Alt 3 in earlier agreement is considered), select, Alt A-2, namely, the node completes one eCCA on one beam, start transmission with the beam to occupy the COT, then move on to the eCCA on the other beam.  Proposal 22: Within a COT with TDM of beams with beam switching, down-select to the following LBT operations   Alt A: Support both Alt-1 and Alt-2, where Alt-1 and Alt -2 are part of earlier agreement as follows:   ·         Alt 1: Single LBT sensing with wide beam ‘cover’ all beams to be used in the COT with ppropriate ED threshold   o    FFS: Details on the definition of “cover”   Alt 2: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT. |
| Panasonic | Proposal 1: Agree on Proposal 2.7.1-1 in Feature Lead Summary [1].  Proposal 2: Agree on Proposal 2.7.1-2 in Feature Lead Summary [1].  Proposal 3: Agree on Proposal 2.7.1-3 in Feature Lead Summary [1], and further select Alt B by recognizing that it is a valid use case for introducing Cat-2 LBT.  Proposal 4: Agree on Proposal 2.7.1-4 in Feature Lead Summary [1].  Proposal 5: Support A-1 and A-3 in the discussion 2.7.1-5 in Feature Lead Summary [1]. |
| LG Electronics | Proposal #13: For a COT with MU-MIMO (SDM) and TDM of beams transmission, adopt Alt A-1 (the node completes one eCCA on one beam, and directly move on to the eCCA on the other beam, with no transmission in the middle) when independent per-beam LBT sensing at the start of COT. |
| Intel Corporation | Proposal 10: For a COT with MU-MIMO, both Alt-1 and Alt-2 are supported. As for Alt-2 both Alt-A-2 and Alt-B could be considered.  Proposal 11: For a COT with beam switching, both single LBT sensing with wide beam and independent per-beam LBT sensing at the start of the COT are supported. |
| AT&T | Proposal 1:   • Within a COT with TDM of beams with beam switching, independent per-beam LBT sensing at the start of COT is performed for beams used in the COT with additional requirement on Cat 2 LBT before beam switch   • The per-beam LBT for different beams is performed one after another in time domain. The node completes one eCCA on one beam, and directly move on to the eCCA on the other beam, with no transmission in the middle |
| NTT DOCOMO INC. | Proposal 4:   l  For LBT initiating a COT with SDMed multiple transmissions, support a single LBT at the start of COT, covering all the SDMed beams.   l  For LBT initiating a COT with TDMed multiple transmissions, support independent per-beam LBT at the start of COT (Alt A-1) or at the start of transmission with changed beam within a COT (Alt A-2). |
| Xiaomi | *Proposal 7: Multi-beam transmission should be studied to fully take advantage of spatial diversity.*  *Proposal 8:* *Support independent per-beam LBT sensing at the start of COT* *for a COT with TDM of beams with beam switching.* |
| ITRI | *Proposal 2: For a COT with MU-MIMO (SDM) transmission, the per-beam LBT for different beams is performed simultaneously in parallel.*  *Proposal 3: For a COT with TDM transmission, the per-beam LBT for different beams is performed one after another in time domain.* |
| Convida Wireless | *Proposal 4: For a COT with MU-MIMO (SDM) transmission, support both single LBT sensing at the start of the COT with wide beam ‘cover’ all beams to be used in the COT with appropriate ED threshold and independent per-beam LBT sensing at the start of COT performed for beams used in the COT.*  *Proposal 5: Within a COT with TDM of beams with beam switching, support both single LBT sensing with wide beam ‘cover’ all beams and independent per-beam LBT sensing at the start of COT performed for beams used in the COT. Further discuss independent per-beam LBT sensing at the start of COT for beams used in the COT with additional requirement on Cat 2 LBT before beam switch.*  *Proposal 6: For a COT with MU-MIMO (SDM) transmission, consider both per-beam LBT for different beams performed in TDM fashion and per-beam LBT for different beams performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams.*  *Proposal 7: Within a COT with TDM of beams with beam switching, consider both per-beam LBT for different beams performed in TDM fashion and per-beam LBT for different beams performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams.* |
| Huawei/HiSilicon | *Proposal 14: For initiating a COT with SDM or TDM of different beams, support multiple independent per-beam LBTs, i.e. Alt 2.*  *Proposal 15: When gNB performs multiple independent per-beam LBTs, the spatial domain sensing filter for an LBT beam is the same as the spatial domain filter used for the corresponding transmission beam.*  *Proposal 16: For initiating a COT with SDM or TDM of different beams, support one LBT beam covering all transmission beams (Alt 1) as a fallback mechanism when the one-to-one correspondence between the LBT beams and transmission beams cannot be established.*  *Proposal 17: For initiating a COT with SDM or TDM of different beams using a single LBT beam that “covers” all the subsequent DL transmission beams, gNB selects a spatial sensing filter that minimizes the resulting [3]dB sensing beamwidth which at least contains all beam peak directions of the subsequent DL transmission beams within the COT.*  *Proposal 18: For initiating a COT with SDM or TDM of different beams, when independent per-beam LBT sensing at the start of COT is performed for beams used in the COT, support performing the per-beam LBTs simultaneously in parallel (Agree to FL Proposals 2.7.1-2 and 2.7.1-4 from RAN1#105-e).*   * *FFS: How to coordinate these parallel LBTs to align the start times of the SDMed transmissions, and how to determine the COT start time in the TDM case.* * *If the node is incapable of sensing simultaneously in different beams, a single LBT beam covering the multiplexed transmission beams should be used.* |

### First round discussion

Proposal 2.7.1-1

For a COT with MU-MIMO (SDM) transmission, support both Alt 1 and Alt 2 below:

* Alt 1: Single LBT sensing at the start of the COT with wide beam ‘cover’ all beams to be used in the COT with appropriate ED threshold
* Alt 2: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT

Summary of Positions:

* Support both Alt 1 and Alt 2: Samsung, CATT, FUTUREWEI, CAICT, Qualcomm, Intel, Huawei/HiSilicon (Alt1 as a fallback mechanism), ITRI, Spreadtrum
* Decide single beam sensing first, deprioritize independent per beam sensing: Ericsson, Nokia

|  |  |
| --- | --- |
| Company | View |
| vivo | We support both Alt 1 and Alt 2. |
| Intel | As well summarized by the FL, we support both Alt.1 and Alt.2 and leave up to the device capability which alternative to use. |
| NEC | We support both Alt 1 and Alt 2. |
| Huawei/HiSilicon | We support Alt 2 as the first choice if all per-beam LBTs can be done simultaneously in parallel. If the node is incapable of sensing simultaneously in different beams, Alt 1 can be used as a fallback mechanism |
| Lenovo, Motorola Mobility | We support the proposal to have both the alternatives |
| ITRI | Support Alt 1 and Alt 2 |
| LG Electronics | We support both Alt 1 and Alt 2. |
| Nokia, NSB | We are in principle ok with both alternatives, but should firstly focus on single beams sensing. |
| ZTE, Sanechips | we support Alt 1 and Alt2, which alternative is applied can be determined based on Capability, or interference state and so on. |
| DOCOMO | Ok to support both and leave it up to capability. |
| InterDigital | We support the proposal. Independent per beam sensing is especially beneficial if the beams to be used in the COT are not adjacent and therefore a sensing beam “covering” all beams would be unnecessarily wide. |
| Ericsson | We support Alt 1 as the baseline mechanism with omni-directional/quasi-omnidirectional beam as the wide beam. Alt 2 need not be precluded by implementation and device capability.  However, we do not want to agree to anything on this topic without agreeing on how to do sensing for a single beam case. |
| Futurewei | We support both Alt 1 and Alt 2. We would like to clarify what is the EDT used for each separate per-beam LBT sensing in Alt 2. Is it a common EDT considering all beams in SDM transmission or a beam-specific separate EDT? This needs to be consistent with the choice of Pout and its further adjustment. |
| CATT | We support both Alt 1 and Alt 2. |
| Samsung | We support both alternatives, and up to implementation to choose one. |
| Convida Wireless | We support both Alt 1 and Alt 2. |
| Apple | Support Alt 1 and 2. Up to implementation |
| Spreadtrum | We support both Alt 1 and Alt 2. |

Proposal 2.7.1-2

For a COT with MU-MIMO (SDM) transmission if Alt 2 is supported (independent per beam LBT), and if the node has the capability to perform simultaneous sensing in different beams, simultaneous per-beam LBT for different beams is supported.

Summary of Positions as of RAN1-105e:

* Stable with wide support except Ericsson

|  |  |
| --- | --- |
| Company | View |
| Intel | Ok with proposal |
| Huawei/HiSilicon | Support |
| Lenovo, Motorola Mobility | We support the proposal |
| ITRI | Support |
| LG Electronics | We are fine with the proposal. |
| ZTE, Sanechips | Support |
| DOCOMO | Ok with proposal |
| InterDigital | We support the proposal. |
| Ericsson | As we mentioned in 105-e, we support the proposal in principle, but it is not clear to us what will be specified. It is best to leave it to implementation and device capability.  However, we do not want to agree to anything on this topic without agreeing on how to do sensing for a single beam case. |
| Futurewei | Support this proposal |
| CATT | Support |
| Samsung | We support the proposal. |
| Apple | OK with the proposal |
| WILUS | We support the proposal |
| NEC | We support the proposal. |
| Spreadtrum | We support the proposal. |

Proposal 2.7.1-3

Within a COT with TDM of beams with beam switching, at least support Alt 1

* FFS: If Alt 2 or Alt 3 are additionally supported. The decision can be made after we decide if Cat 2 LBT is introduced

|  |  |
| --- | --- |
| Company | View |
| vivo | We agree with proposal 2.7.1-3. Regarding the per-beam LBT, Alt 3 is preferred. A Cat 2 LBT is necessary since the channel for the newly switching beam has not been occupied during the past transmission with other Tx beams. |
| Intel | As mentioned above, we would prefer to leave up to the device capability which alternative to use, and we do not support agreeing on Alt.1 only. |
| NEC | We support moderator’s Proposal 2.7.1-3. |
| Huawei/HiSilicon | We support Alt 2. We also support and Alt 1 as a fallback mechanism if the COT initiating node does not support Alt 2 mechanism.  We do not see how the support of Alt 2 would depend on whether or not CAT2 LBT is supported. None of the alternatives to support Alt 2 (that is, Alt B and Alt A, including Alt A-1, Alt A-2, and Alt A-3) depend on CAT2 LBT.  Similar to the SDM cases, we believe that, if possible, simultaneous per beam LBTs should be performed at the start of the COT for beams used in the COT. If the node is incapable of sensing simultaneously in different beams or theone-to-one correspondence between the LBT beams and transmission beams cannot be established, Alt 1 can be used as a fallback mechanism.  How to support Alt 2 can be down-selected from Alt B, Alt A-1, Alt A-2, and Alt A-3. |
| Lenovo, Motorola Mobility | We support the proposal and strongly prefer to introduce Cat 2 LBT to allow CCA when switching to new beams within the same COT |
| ITRI | Support |
| LG Electronics | Alt 2 should be supported in addition to Alt 1. For Alt 3, the single wide beam or omnidirectional Cat-2 LBT can be used before the start of transmission when the amount of time to perform independent per-beam sensing is larger than the specified value. |
| ZTE, Sanechips | This proposal can be discussed after there is a conclusion on whether Cat 2 LBT is supported and Alt 2 or Alt3 is supported. At present, it is difficult to determine whether only Alt 1, or Alt 2/3, or both are supported. |
| DOCOMO | In Proposal 2.7.1-1, wider beam or per beam is left up to device capability, which is fine for us. We believe same concept should be applied here. Thus, we agree with Intel and not support agreeing on Alt 1 only. With Alt 2 or 3, we are fine with support Alt 1. |
| InterDigital | We do not support the proposal as currently worded. We wish to support Alt 1 and Alt 2 or Alt 3, and the decision on further narrowing the number of supported alternatives can be made after CAT2 LBT is decided to be introduced. |
| CATT | Support. |
| Samsung | Our understanding is at least supporting one of Alt 2 and Alt 3, and depending on whether Cat2 LBT is supported to choose. |
| Apple | Support the proposal |
| WILUS | Support the proposal |
| Futurwei | We prefer to discuss this proposal after Cat-2 decision has been made. |
| Spreadtrum | We support the proposal. |

Proposal 2.7.1-4

Within a COT with TDM of beams with beam switching, if Alt 2 or Alt 3 is supported (independent per beam LBT), and if the node has the capability to perform simultaneous sensing in different beams, simultaneous per-beam LBT for different beams is supported.

Summary of Positions as of RAN1-105e:

* Stable with wide support except Ericsson

|  |  |
| --- | --- |
| Company | View |
| Intel | We are Ok with the proposal |
| Huawei/HiSilicon | Support |
| Lenovo, Motorola Mobility | We support the proposal |
| LG Electronics | We are fine with the proposal. |
| ZTE, Sanechips | Support |
| DOCOMO | We are ok with the proposal. |
| InterDigital | We support the proposal |
| Ericsson | As we mentioned in 105-e, we support the proposal in principle, but it is not clear to us what will be specified. It is best to leave it to implementation and device capability. If the device is capable of simultaneous sensing in different beams, it is as good as a sensing with a wider beam. There is no need to specify it in our opinion.  However, we do not want to agree to anything on this topic without agreeing on how to do sensing for a single beam case. |
| Futurewei | Support |
| CATT | Support |
| Samsung | We support the proposal. |
| Apple | Support |
| WILUS | We support the proposal |
| NEC | We support the proposal. |
| Spreadtrum | We support the proposal. |

## Multi-Channel channel access

Agreement:

Define Type A and Type B multi-channel channel access as:

* Type A: Perform independent eCCA for each channel
* Type B: Identify a primary channel and perform eCCA on the primary channel, while perform Cat 2 LBT for other channels in the last observation slot

Down-selection between

* Alt1: Support Type A multi-channel channel access only
* Alt2: Support both Type A and Type B multi-channel channel access.

Note: How eCCA is performed on each channel, and the BW of the channels over which eCCAs are performed are separately discussed

|  |  |
| --- | --- |
| Company | Key Proposals/Observations/Positions |
| Ericsson | Observation 10 ETSI regulation for 60 GHz bands do not support Type B multi-channel access.  *Proposal 5 Support Alt1 in the agreement that allows only Type A multi-channel access from 37.213.*  *Proposal 6 Do not support Type B multi-channel access for NR operation in 52.6 GHz to 71 GHz.* |
| Nokia, Nokia Shanghai Bell | Proposal 14: Only Type A multi-channel access procedure (i.e. Alt.1 defined in RAN1#104-e meeting) shall be supported in NR-U on 60GHz band. |
| CAICT | Proposal 9: Support both Type A and Type B multi-channel channel access. |
| Qualcomm Incorporated | Proposal 23: Adopt Alt-1 for multi-channel access, *i.e.* support Type A multi-channel access only. |
| WILUS Inc. | *Proposal 6: At least Type A multi-channel access which performs independent clear channel assessment (CCA) for each channel should be supported. For support of the Type B multi-channel access, it should be further discussed after the decision on support of Cat-2 LBT including the definition of Cat-2 LBT.* |
| Huawei/HiSilicon | *Proposal 11: For multi-channel access in NR-U-60, support both Type A and Type B procedures.* |

### First Round Discussion

Define Type A and Type B multi-channel channel access as:

* Type A: Perform independent eCCA for each channel
* Type B: Identify a primary channel and perform eCCA on the primary channel, while perform Cat 2 LBT for other channels in the last observation slot

Summary of Positions based on contribution proposals:

* Alt1: Support Type A multi-channel channel access only
  + Ericsson, Nokia, Qualcomm, Huawei/HiSilicon, ~~vivo,~~ Intel, DCM, CATT, Apple
* Alt2: Support both Type A and Type B multi-channel channel access.
  + CAICT, WILUS (reconcile as a use-case of Cat 2 LBT), Huawei/HiSilicon, vivo, Lenovo, LG, ZTE, ~~vivo,~~ Samsung, Convida,

Proposal 2.8.1-1:

Please provide your view below on Alt 1 or Alt 2 if not captured above:

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| --- | --- |
| Company | View |
| vivo | We support both Type A and Type B multi-channel channel access. |
| Intel | We support Alt.1 and added our preference above. While we support the introduction of Cat-2 LBT, we do not support type B since this violates ETSI BRAN rules. |
| Huawei/HiSilicon | We support both Type A and Type B. |
| Lenovo, Motorola Mobility | We have preference to support Alt 2 i.e., support both Type A and Type B multi-channel access |
| LG Electronics | We support the Alt 2. |
| Nokia, NSB | We support Alt 1. Alt 2 does not comply with the ETSI 302 567, and would more over require a common channelization scheme (like channel bonding at 5 GHz) to work properly. |
| ZTE, Sanechips | We support Type A and Type B. |
| DOCOMO | Support Alt 1 with the same understanding as Intel. |
| Ericsson | We support Alt 1.  Type B channel access is not supported by the regulations in EN 302 567. Moreover, Type B channel access relies on an assumption of a fixed channelization and channel bonding with same channel bandwidth (for e.g., 20 MHz in 5 GHz), which is not the case for operation in 60 GHz where different channel BWs are supported. |
| CATT | Support with Type A multi-channel channel access, and open to discuss Type B multi-channel channel access if the benefit can be provided. |
| Samsung | We support both alternatives, and didn’t see the reason to exclude a supported alternative in the spec. |
| Convida Wireless | We prefer Alt 2. We support both Type A and Type B. |
| Apple | Support Alt 1 |
| WILUS | We support the Alt 2. |

## Directional LBT

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| --- | --- |
| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | Proposal 12: For operation in the 60 GHz band, support FL Proposal 2.9.4-1 from RAN1#105-e to specify the spatial relation between the LBT beam and the transmission beam(s).  Proposal 13: For a COT with a single transmission beam, the spatial domain sensing filter for the LBT beam at the beginning of the COT can be configured to be the same as the spatial domain filter used for the transmission during the COT.   * FFS: Further extending the framework to indicate a different spatial domain sensing filter to the UE   Proposal 17: For initiating a COT with SDM or TDM of different beams using a single LBT beam that “covers” all the subsequent DL transmission beams, gNB selects a spatial sensing filter that minimizes the resulting [3]dB sensing beamwidth which at least contains all beam peak directions of the subsequent DL transmission beams within the COT. |
| Vivo | Proposal 16: The “cover” for sensing beam is defined as: the angle included in the [3] dB beam width of the transmission beam(s) is included in the [X] dB beam width of the sensing beam. |
| Spreadtrum Communications  Spreadtrum Communications | Proposal 2: The directional LBT should be supported in 60GHz unlicensed band.  Proposal 3: The relationship between all the LBT beams and the transmission beam should be defined and at least LBT beam “covers” the transmission beam.  Proposal 4: The beam correspondence framework or QCL/TCI framework can be extended to define “cover”. |
| InterDigital Inc. | 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 at least for medium to high loads and especially for tail Ues, while reducing the drawbacks associated with omni-directional LBT.  Proposal 1: Directional LBT is specified in Rel-17.  Proposal 2: The relationship between the LBT beam and the transmission beam should be specified.  Proposal 3: 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.  Proposal 4: Support Alt 2 for the definition of the relationship between sensing beam(s) and transmission beam(s). |
| Sony | Proposal 5: Directional LBT should be supported in 60 GHz unlicensed operation.  Proposal 6: For definition of the relative relationship between applicable sensing beams and the transmission beam(s), extending the beam correspondence and/or QCL/TCI framework to define and/or indicate “cover” is considered from the RAN1 perspective. |
| Lenovo Motorola Mobility | Observation 4: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, when directional LBT is applied, then performing LBT only at the transmitted side may not guarantee an interference-free reception due to hidden nodes to the transmitter  Proposal 3: For NR unlicensed bands between 52.6 GHz and 71 GHz, with directional LBT based channel access mechanism, configuration and/or indication of multiple sensing beams to UE should be specified for beam-based UL transmission  Proposal 4: For NR unlicensed bands between 52.6 GHz and 71 GHz, with directional LBT based channel access mechanism, explicit mapping between sensing beam(s) and UL transmit beam should be specified based on extension of TCI framework, where the association between the sensing and transmission beams can be configured based on the TCI association between to be: - One-to-one mapping between sensing beam and transmission beam - One sensing beam to many transmission beams mapping- Many sensing beams to one transmission mapping  Proposal 5: For NR unlicensed bands between 52.6 GHz and 71 GHz, with directional LBT based channel access mechanism, following two aspects should be specified:- Definition of cover could be such that the angle included in the [3] dB beamwidth of the transmission beam(s) is included in the [3] dB beamwidth of the sensing beam(s)- Indication/configuration of association between sensing beam(s) and transmission beam(s) according to extension of TCI framework  Proposal 6: For NR unlicensed bands between 52.6 GHz and 71 GHz, with directional LBT based channel access mechanism, for UL transmissions on CG resources, time-based autonomous switching of UL Tx beam should be supported, where the switching can be based on a timer within which the UE is expected to receiver HARQ-ACK feedback  Proposal 15: For NR unlicensed bands between 52.6 GHz and 71 GHz with directional LBT based channel access mechanism, within a COT, PDCCH monitoring is not supported in the CORESETs corresponding to other COTs (PDCCH monitoring restricted to monitoring corresponding to only one COT at a time)  Proposal 29: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, potential enhancements related to periodic transmission of DRS such as SSB/PBCH/CORESET#0 are needed including: - performing directional LBT prior to the transmission of SSB according to the ssb-PositionsInBurst - directional LBT on multiple beams at the same time at the beginning of the DRS window - Cat 2 LBT (depending on the gap) before actual transmission |
| Samsung | Proposal 8: ·Support extending the beam correspondence framework and/or QCL/TCI framework to define “cover” (Alt 2); ·Support a new type of QCL assumption to define the sensing beam covering the transmission beam. |
| ZTE Sanechips | Proposal 12: If directional LBT is supported, it is necessary to further define the relationship between sensing/receiving beam(s) and transmission beam(s):   l Under the assumption of channel reciprocity between transmission beam and sensing/receiving beam, sensing/receiving beam and transmission beam are actually equivalent.   l Without the assumption of channel reciprocity between transmission beam and sensing beam, when sensing beam (e.g., reception beam) is wider than the transmission beam and/or partially overlapping with each other, certain method need to be further considered, e.g.,extend SpatialRelationInfo/QCL/TCI framework to define the relationship between transmission beam and sensing/receiving beam. |
| Ericsson | Observation 13 Common understanding in ETSI and IEEE 802.11ad and IEEE 802.11ay specs are omni-directional LBT or quasi-omnidirectional LBT  Observation 14 Simulation studies in general indicate no significant gain from using directional LBT.  Observation 15 Directional LBT is currently not precluded in the existing regulations. EN 302 567¨s tests intrinsically ensure sensing beam is in the direction of the transmission beam for devices equipped with directional antenna systems.  Observation 16 Notion of “beams” for sensing/LBT is non-existent in 37.213.  Proposal 10 Support omni-directional LBT or quasi-omni-directional LBT as the baseline LBT procedure for 60 GHz band.  Proposal 11 Support Alt 1 (with FFS options) that have less RAN1 specification impact for specifying the relationship between sensing beam and transmission beam.  Proposal 12 Do not support Alt.2 on extending the beam correspondence framework and/or QCL/TCI framework to define “cover”.  Proposal 14 RAN1 needs to decide on whether and how to specify directional LBT for single sensing beam case before further discussing multiple sensing beams. |
| FUTUREWEI | Proposal 3: Consider cover relation based on the following relation between a sensing beam and each one of its intended transmit beams:   • The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak transmission beam EIRP. The sensing beam gain measured along the chosen directions is at least X [FFS] dB of the transmission beam gain in those directions. |
| Nokia, Nokia Shanghai Bell | Proposal 20: Leave the relationship between gNB LBT sensing beam(s) and transmission beam(s) to vendor-specific implementations. Vendors can use different beamforming techniques for their LBT procedures, as long as global or region and deployment specific requirements (i.e., ETSI EN 302 567) are fulfilled.  Observation 6: Generic requirements may be considered, e.g., that the beam(s) used in the LBT contain the transmission direction(s) intended to be used during the COT. However, that should be done in RAN4, not in RAN1. |
| NEC | Proposal 2: For LBT based channel access in mmWave unlicensed band, the relationship between LBT beam and transmission beam should be defined to reduce the complexity of channel access for different nodes. |
| OPPO | Proposal 7: consider using QCL/TCI framework to define ‘cover’. |
| Qualcomm Incorporated | Proposal 24: Adopt Alt 1 and specify requirement/test procedure to guarantee sensing beam “covers” the transmission beam.  Proposal 25: If Alt 1 is chosen, consider the following criterion for eligibility of sensing beam. The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP and the sensing beam gain measured along the chosen directions is at least X [FFS] dB of the transmission beam gain in those directions.  Proposal 26: If Alt 1 is chosen, consider the following criterion for eligibility of sensing beam. The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP and the sensing beam gain measured along the chosen directions is at least X [FFS] dB of the *sensing* beam gain in peak transmission directions. |
| LG Electronics | Proposal #7: The directional CCA and the receiver assisted LBT can be beneficial to increase cell coverage and spatial reuse, and whether or not the receiver assisted LBT can have an impact on specification except for indicating LBT type to responder should be first investigated.  Proposal #9: If the directional CCA procedure is introduced the followings points can be considered:   l  How to perform the CCA procedure for multiple-beam sweeping transmission   l  How to define CWS management (e.g., per-direction or across-direction management)   l  How to manage the back-off counter value  Proposal #10: The relationship between the LBT beam with a specific direction to acquire the COT and the transmission beam(s) allowed to transmit in that COT should be defined considering the relationship between the CCA range of the LBT beam and the interference range of the transmission beam(s).  Proposal #11: 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.  Proposal #12: For the directional LBT, the relationship between the sensing beams and the transmission beam(s) can be defined by extending the beam correspondence framework and/or QCL/TCI framework. |
| Intel Corporation | 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 12: Both omni-directional and directional LBT are supported. When directional LBT is used, a receiver-aided LBT should complement its CCA procedure where a short LBT is performed at the receiver.  Proposal 13: When directional sensing is performed, the COT should be considered to be acquired only in the transmission beams for which the LBT is performed and the LBT measurements have indicated that the channel is idle.  Proposal 14: When directional sensing is performed, and multiple concurrent COTs are acquired, these should be independently treated unless LBT measurements have overlapping beams. In this case, RAN1 should define some rules on how to handle these cases.  Proposal 15: RAN1 should further study how to efficiently allow beam-pairing due to LBT success.  Proposal 16: For all devices operating in above 52.6 GHz unlicensed band the beam correspondence mandatory capability signaling is set to 1 for all supported unlicensed bands above 52.6 GHz.  Proposal 17: For gNB, RAN1 should leave the relationship between the received beams used for LBT measurements, and the transmit beam to be used after LBT success up to implementation and let regulatory requirements constrain it.  Proposal 18: For UE, RAN1 to define relationship between the received beams used for LBT measurements, and the transmit beam to be used after LBT success.  Proposal 19: RAN1 should extend the QCI or Spatial Relation Info framework to define and ndicate the sensing beam associated with a transmission beam. FFS: Details on how to extend the beam correspondence framework and/or QCL/TCI/ Spatial Relation Info framework. |
| Apple | *Proposal 7: Extend the TCI framework to signal the COT directivity based on sensing directivity. COT directivity can be signaled in DCI format 2-0 for gNB initiated COT, and CG-UCI for UE initiated COT.* |
| Xiaomi | *Proposal 2: Both Omni-directional LBT and directional LBT should be supported.*  *Proposal 3: Alt 1 is supported to define the relationship between sensing beam(s) and the transmission beam(s).* |
| ITRI | *Proposal 1: In order to avoid resource wastage and hidden node problem, the LBT beam should be the same as the transmission beam.* |
| Convida Wireless | *Proposal 1: Both omni-directional LBT and directional LBT should be supported for frequency range of 52.6GHz to 71GHz.* |
| WILUS Inc. |  |

### First Round Discussion

Discussion 2.9.1-1 (closed)

3GPP specification defines at least the relative relationship between all applicable sensing beam(s) and the transmission beam(s) to define sensing beam for LBT, where at least sensing beam(s) “covers” the transmission beam(s), considering following alternatives

* Alt 1: Specify necessary requirement/test procedure to guarantee sensing beam “covers” the transmission beam
  + FFS: This is handled in RAN1 and/or RAN4
  + [a] FFS: the angle included in the [3] dB beamwidth of the transmission beam is included in the [X, FFS] dB beamwidth of the sensing beam.
  + [b] FFS: the sensing beam gain measured along the direction of peak transmission direction is at least X [FFS] dB of the transmission beam gain
  + [c] FFS: The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak transmission beam gain. The sensing beam gain measured along the chosen directions is at least X [FFS] dB of the transmission beam gain in those directions.
  + [d] FFS: Sensing beam has the minimum [3]dB beamwidth which at least contains all beam peak directions of transmission beams
  + Other mechanisms not precluded
* Alt 2. Extending the beam correspondence framework and/or QCL/TCI/SpatialRelationInfo framework to define “cover” and to indicate sensing beam(s) associated with a transmission beam(s)
  + FFS: Details on how to extend the beam correspondence framework and/or QCL/TCI/ SpatialRelationInfo framework

Summary of Positions:

* Companies that support primarily Alt 1 approach:
  + Vivo, Ericsson, FUTUREWEI, Qualcomm, Xiaomi, Nokia, Huawei/HiSilicon
  + Concern: Vivo: Specifying ‘Requirements/Test Procedures’ not sufficient
* Companies that support Alt 2 approach:
  + Spreadtrum, InterDigital, Sony, Leveno, Samsung, ZTE, OPPO, LG, Intel, Apple, Huawei/HiSilicon, ITRI
* For gNBs, leave the issue to implementation: Nokia, Lenovo

For decision between alt 1 and 2, we will need some better understanding on what exactly they mean. The following discussions are meant to clarify the justifications for undertaking each approach and go to next level of detail in the understanding.

Discussion 2.9.1-2 (closed)

For companies that support Alt-1: If Alt 1 is chosen, consider the following modified set of options for eligibility of sensing beam for transmission beams

* Alt-1-A: the angle included in the [3] dB beamwidth of the transmission beam is included in the [X, FFS] dB beamwidth of the sensing beam.
* Alt-1-B: the sensing beam gain measured along the direction of peak transmission direction is at least X [FFS] dB of the transmission beam gain
* Alt-1-C: The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak transmission beam gain. The sensing beam gain measured along the chosen directions is at least X [FFS] dB of the transmission beam gain in those directions.
* Alt-1-D: The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP and the sensing beam gain measured along the chosen directions is at least X [FFS] dB of the sensing beam gain in peak transmission directions.
* Alt-1-E: Sensing beam has the minimum [3] dB beamwidth which at least contains all beam peak directions of transmission beams. [ Alt-1-E is a special case of Alt-1-D where A=0 dB and X=3dB].

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| Company | View |
| vivo | Alt-1-A is preferred. |
| Huawei/HiSilicon | We prefer Alt-1-E. Intuitively, minimizing the sensing beamwidth of the selected LBT beam as in Alt-1-E is motivated by increasing the channel access probability and/or spatial reuse opportunities. Compared to Alt-1-A to Alt-1-D, specifying that the sensing [3]dB beamwidth at least contains all beam peak directions of the subsequent DL transmission beams within the COT would simplify specifying the necessary RAN4 requirement/test procedure to guarantee that the sensing beam “covers” the transmission beam. For instance, a margin, , for the selected sensing beamwidth angle can be defined as an absolute or a relative sensing beamwidth accuracy requirement.  Alt-1-A to Alt-1-D, in contrast, involve measuring/testing the XdB beamwidth for each of the potential DL transmission beam in addition to the sensing beam, and/or measuring/testing the beamforming gain in these multiple directions.  Finally, we do not think that, Alt-1-E is the special case of Alt-1-D (or any other alternatives) at least in its current form. To our understanding, an omni-directional LBT beam would not be excluded in any Alt-1-A to Alt-1-D. So, if we agree with any of Alt-1-A to Alt-1-D in their current form, in fact omni-directional LBT can be used instead of a directional LBT. In turn, Alt-1-E minimizes the 3 dB LBT beamwidth and, as such, excludes omni-directional LBT.  We are open to discuss other alternatives Alt-1-A to Alt-1-D if somehow the element of minimizing or reducing LBT beamwidth would be taken into account in their description. |
| Nokia, NSB | In our view, RAN4 is in the best position to design the relationship between the sensing and the transmitting beams, as well as the associated requirements and tests. This should be considered as a further sub-alternative for Alt 1 e.g. Alt 1-F. |
| Ericsson | We also support the view that RAN4 is in best position to define requirements and testing for the relationship between sensing and transmission beams.  However, we are open to discussing the feasibility of testing and requirements for the options in Alt 1-A to Alt 1-E.  We do not support Alt 2 as it requires a lot of specification effort both in RAN1 and RAN4. |
| Futurewei | Our preference is for **Alt1-C** followed by **Alt1-A.** Our concern with Alt1-D and to some extent also on Alt 1-A is that there is no lower bound on the sensing gain which can be problematic. For instance, in Alt 1-D the sensing beam can have a null in a transmit beam peak direction. Similarly, for Alt1-A there has to be an additional requirement that peak sensing beam gain is at-least [S FFS] dBi. We are open to further consider these alternatives with the suggested modifications:  **Alt-1-A (modified):** the angle included in the [3] dB beamwidth of the transmission beam is included in the [X, FFS] dB beamwidth of the sensing beam. The peak sensing beam gain is at-least [S FFS] dBi.  **Alt-1-D (modified):** The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP and the sensing beam gain measured along the chosen directions is at least S [FFS] dBi.  Regarding **Alt-1-E:** we understand the motivation but would like to see a fully specified formulation which ensures there is always a feasible sensing beam solution. We also point out that it would be in the initiating device’s interest to reduce sensing gain in any directions wherever a minimum requirement not enforced. One alternate formulation towards similar objective we had suggested is: “minimum white noise gain (i.e., minimum L2 norm) sensing beam under the constraints that sensing beam gain measured along the chosen directions is at least S [FFS] dBi”. |
| CATT | We share same view with Nokia. |
| Samsung | One clarification, does Alt 1 imply the specification impact is only for RAN4? We don’t think the language in the alternatives is from RAN1. |
| Apple | Seems to be RAN4 OTA requirement and test. |

Discussion 2.9.1-3 (closed)

For companies that support Alt-2: Beam Correspondence notion describes the UE capability to identify an uplink transmission beam with a DL reception beam without UL beam sweep. Please provide your view on the following questions.

1. Do we require beam correspondence capability to support directional LBT? What happens if there is no beam correspondence.
2. Assuming analogous beam correspondence on gNB side, what would be the way to describe relationship for sensing and transmission beams.
3. Assuming beam correspondence on UE side, what would be the way to describe relationship for sensing and transmission beams

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| Company | View |
| Intel | Our view in this matter is that the beam correspondence mandatory capability signalling should be set to 1 for the unlicensed operation in 60GHz.  As for the gNB, our view is that the relationship could be left up to implementation and let regulatory requirements constraint it. However, for the UE RAN1 should define a relationship between sensing and transmit beam, which could be defined by extending either the QCI or the Spatial Relation Info framework. |
| OPPO | 1. Beam correspondence can be assumed. 2. We don’t need to describe the relationship for gNB, it is up to network implementation. 3. The relationship is that the sensing beam and transmission beam are QCL’ed with a same reference signal, e.g. the sensing beam is QCL’ed with SSB1 meaning that UE uses a same RX filter for sensing as it receives the SSB1. The transmission beam is QCL’ed with SSB1 is similar to what we have in PUCCH-SpatialRelationInfo IE in R15/R16. |
| Huawei/HiSilicon | 1. We think beam correspondence is required which, in our view, is a mandatory capability. 2. The correspondence should be maintained at the initiating equipment without specifying whether the equipment is gNB or UE. 3. LBT beam should use the same spatial filter for the subsequent transmission. Spatial filter of Tx beam is specified using QCL/TCI framework. |
| Lenovo, Motorola Mobility | Although we think that beam correspondence is also one method for directional LBT in additional to QCL/TCI framework extension, but with extended QCL/TCI framework, beam correspondence capability is not a mandatory requirement to support directional LBT |
| LG Electronics | 1. In our understanding, the beam correspondence capability is a mandatory feature and there are two types of UE depending on whether or not to support *beamCorrespondenceWithoutUL-BeamSweeping*. 2. We think that the beam correspondence on gNB side could be left up to gNB implementation. 3. A UE supporting this capability can satisfy requirements (for minimum peak EIRP and spherical coverage) without UL beam sweeping and beam management such as beam indication from gNB. On the other hand, for a UE not supporting the capability, the requirements (for minimum peak EIRP and spherical coverage) must be satisfied through the beam management procedure, and additionally, without beam management, a requirement relaxed by 3 dB must be satisfied. Therefore, it is necessary to adjust the ED threshold value differently depending on whether the UE supports *beamCorrespondenceWithoutUL-BeamSweeping* or not. To be specific, the ED threshold for a UE not supporting the capability can be lower than that for a UE supporting the capability. In addition, for the UE without this capability, the ED threshold value can be adjusted depending on the presence or absence of a beam management procedure. |
| ZTE, Sanechips | 1. Beam correspondence is required and a mandatory capability. 2. It can be left up to gNB implementation, but some restriction on BC is needed to specified in RAN4 3. Specify some restriction to define the relationship between sensing beam and transmission beam in RAN4. |
| DOCOMO | Share Intel’s view. |
| InterDigital | We agree with Intel’s views |
| Ericsson | **Question:** Beam correspondence currently is not a mandatory feature and is based on UE capability. The testing for beam correspondence in RAN4 also is very loose. What is the motivation to enable such a mechanism which incurs a lot of specification effort for no clear benefit? Furthermore, beam correspondences will not be tested for gNBs, if its left to implementation, we are enabling a mechanism that is not even tested. The whole purpose of this relation between sensing beam and transmission beam is to ensure devices do not cheat , sense in one direction and transmit in other? If we are not going to test it, why spend so much time and effort writing some spec text that wont be tested for gNBs? |
| Samsung | 1. Yes, it should assume UE have beam correspondence capability at 60 GHz unlicensed band. 2. For gNB, it seems there is no spec impact. It can be up to gNB implementation. 3. While the current TCI framework can also define the relationship between LBT beam and transmission beam, the current framework may have shortcoming when we want to define a wider sending beam by potentially grouping multiple ‘known’ transmission beams such as SSB beams. On top of that, the current spec does not have a mechanism of specifying LBT beam to be used for the corresponding transmission. One way is to introduce a new QCL type E (or extended definition of QCL type D). This QCL type is essentially to indicate the set of transmission beams that are “covered” by an LBT sensing beam.   The way how QCL-E would be used is as follows: in the tciState, the following can be defined:  *qcl-TypeX*  *{*  *bwp-Id b,*  *referenceSignal  {csi-rs : 1, csi-rs : 2, csi-rs : 3 }*  *qcl-Type type E*  *}*  In the above example, the transmission beams with the QCL-D source RS (CSI-RS1, CSI-RS2, CSI-RS3) are indicated as “covered” by the LBT sensing beam.  In other words, the sensing beam has the qcl type E source reference signals with (CSI-RS1, CSI-RS2, CSI-RS3).  While the QCL-E shall be introduced for defining the new spatial relation between sensing beam and transmission beam, we can either introduce this new QCL-E by changing the TCI state definition (applies to DL) or by changing *spatialrelationinfo* (applies to UL). |
| Convida Wireless | Whether beam correspondence capability is a mandatory feature should be clarified first. |
| Apple | Yes. Beam correspondence is needed for directional sensing. If beam correspondence is not supported by capability, quasi-omni sensing is always the default option.  For gNB, gNB implementation ensures sensing beam cover transmission beam. This is required regulation test anyway.  For UE, sensing beam/transmission beam can QCLed one DL RS TCI state. |

Discussion 2.9.1-4 (closed)

For companies that support Alt -2: Extending notions of QCL/TCI states for relating transmission beams with sensing beams, is primarily motivated by signaling considerations and capability considerations.

Please provide your view on the following questions.

1. QCL relationship and TCI states relate two reference signals in the same direction (e.g. SSB and CSI-RS). What is the envisioned way to extend it to describe the relationship between transmission beam and sensing beam. Assuming ‘beam correspondence’ on gNB side, are the following statements accurate?

A1. For a beam corresponding to TCI state A, the gNB can use the same beam for sensing and transmission

A2. If TCI B is used as QCL source (Type D) for TCI A, then gNB transmission beam corresponding to TCI B can be used as the sensing beam for transmission with TCI A.

A3. If TCI C is NOT used as QCL source (Type D) for TCI A, then gNB cannot use the transmission beam corresponds to TCI C as the sensing beam for transmission with TCI A.

1. How and if to support sensing with a beam without corresponding RS sent? For example, how to use quasi-Omni beam for sensing if there is no SSB transmitted with quasi-omni beam.

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| Company | View |
| Intel | A2 is preferred.  As for Question B, this would be left up to UE implementation if we use QCL framework, as the QCL framework does not preclude UE to use different set of Rx beams entirely. The QCl type D indication only lets the UE know same Rx beams can be used to measurement/reception for two pair of RS (source and target). As to how UE formulate the Rx beam such that it can receive the signal well is somewhat left up to UE implementation.  In case spatial relation info framework is leveraged, UE must use a specific beam for LBT measurements, and therefore it would not be able to use quasi-omni beam unless it was used for uplink transmission as well.  So there would be some trade-off on which framework to leverage for the UE directional LBT design. |
| OPPO | We think a simply way is to describe the beam correspondence is to set transmission beam and sensing beam (receiver beam) to be QCL’ed with a same reference signal. |
| Huawei/HiSilicon | 1. A1, A2, A3 are aligned with our understanding. 2. If a corresponding RS is not sent or configured or unknown, LBT beam direction would not be specified and may be selected based on implementation. |
| Lenovo, Motorola Mobility | The statements in A) seem to be fine, but they are just one example with the TCI/QCL framework extension for indicating relationship between transmission and sensing beams  Not fully sure if we understand question B) For the purpose of even transmission beam (regardless of sensing beams), TCI state will need to indicate a source RS. So not sure, if this is a valid questions |
| LG Electronics | For A), A2 and A3 can be a way to extend the QCL/TCI framework. However, A2 and A3 seem to be the same to us and A1 needs more clarification.  For B), the quasi-omni beam sensing could only be allowed on broadcast signals/channels, such as SSB. In this case, the COT acquired by quasi-omni sensing beam may not be allowed COT sharing with other nodes. |
| ZTE, Sanechips | We think it seems that Alt A1 is a relatively simple way. |
| DOCOMO | Our intention is actually to leverage spatial relation info framework. In case QCL/TCI is leveraged, A1 and/or A2 could be possibility.  As for B, when more beams than a certain number are intended, then to mandate omni-directional LBT can be considered. |
| InterDigital | We agree with the statements in A)  We are unclear as to why the UE would need to know the beam used for the transmission of the SSB for use in UL LBT? It is up to UE implementation which Rx beam it uses to receive a DL transmission. The QCL indication only informs the UE that it may reuse the same Rx beam. |
| Samsung | 1. A1, A2, A3 are accurate. 2. Could you clarify what is the meaning of “corresponding RS”? If it means   QCL-d source RS, then our understanding is that, with current TCI/QCL framework, UE cannot sense with a beam in the absence of its QCL type D source RS being sent. For example, quasi-Omni beam for sensing cannot be supported if there is no SSB transmitted with quasi-omni beam.  However, with the introduction of a new QCL type E (or extended definition of QCL type D) described above in Discussion 2.9.1-3, we can support sensing with a beam without corresponding RS sent. For example, we can support the quasi-Omni beam for sensing even if there is no SSB transmitted with quasi-omni beam. One example is as follows: In the tciState, the following can be defined:  *qcl-TypeX*  *{*  *bwp-Id b,*  *referenceSignal  {SSB : 1, SSB : 2, SSB : 3 }*  *qcl-Type type E*  *}*  In the above example, the transmission beams with the QCL-D source RS (SSB1, SSB2, SSB3) are indicated as “covered” by the quasi-Omni LBT sensing beam, without the SSB transmitted with quasi-omni beam.  In other words, the sensing beam has the qcl type E source reference signals with (SSB1, SSB2, SSB3). |
| Apple | A1, A2 and A3 aligned with our understanding.  If no association of the COT to any TCI state, UE or gNB performs omni sensing. |

Discussion 2.9.1-5 (closed)

For companies that support Alt -2: Regarding extending the notions of QCL/TCI states for relating transmission beams with sensing beams for UEs, please provide your view on the following question.

1. Assuming beam correspondence at the UE, if the UE is indicated to transmit with a beam corresponding to a certain SRI, the UE can use the same beam for sensing
2. Assuming beam correspondence at the UE and assuming Rel.17 unified TCI framework, if the UE is indicated to transmit with a beam corresponding to a certain unified TCI, the UE can use the reception beam corresponds to the TCI for sensing
3. Assuming beam correspondence at the UE, how can a wider sensing beam be identified to be used for a narrower transmission beam under QCL/TCI framework

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| Company | View |
| Intel | 1. and (B) are somewhat alternatives. We think we should pick either (A) spatial relation info framework or (B) QCL framework for directional LBT.   As for question ©, this would depend on whether state UE should use the same spatial filter for LBT measurement as the transmission spatial filter for uplink channel/signal (which is more aligned with (A)) or we state UE may assume same QCL type D assumption for LBT measurement as some source reference signal (which is more aligned with (B)).  For spatial filter assumption approach, there would be no possibility for the UE to use wide sensing beam. It would only simply follow gNB scheduling. For the QCL framework, we think it is still possible for the UE to use wide beam, as long UE has sufficient confidence that by using wider beam it is still able to capture the signal well as QCL does not necessarily restrict how the UE performs Rx beam selection. The QCL would simply provide guidance on the general directivity of the signal such that UE knows to make sure it needs to capture energy from that direction. |
| OPPO | 1. Agree 2. Agree 3. For this case, sensing beam and transmission beam can be QCL’ed with different RS, e.g. sensing beam is QCL’ed with SSB beam, and transmission beam is QCL’ed with CSI-RS beam. |
| Huawei/HiSilicon | 1. Aligned with our view 2. This needs to be further clarified once the unified TCI framework is completed. 3. Such a wider LBT beam based on QCL/TCI framework does not need to be specified. In Rel-15/16 wider/narrower Tx/Rx beam corresponding to a narrower/wider QCL sourcebeam is not specified. We don’t see why such relation between a QCL source and a LBT beam should be specified. |
| Lenovo, Motorola Mobility | 1. Yes, this is one method of direct one-to-one mapping between sensing and transmission beams based on SRI. However, LBT success probability can be further ncreasing with one transmit to multiple sensing beam mapping that can be supported based on extension of TCI/QCL framework as described in our reply to 2.9.1-6 2. Similar view as for A) 3. We would rather think that multiple narrower sensing beams could be used for a wider transmission beam. A wide sensing beam can be used for multiple transmission beams, if needed |
| LG Electronics | In our understanding, the sensing beam for a UE can be indicated by A) or B).  For C), the wider sensing beam can be explicitly indicated by DCI among the preconfigured sensing beam under the QCL/TCI framework. |
| ZTE, Sanechips | Basically agree A), for B), it needs to further clarify what is exactly Rel.17 unified TCI framework. For C), I am not sure whether this case will happen if beam correspondence has been assumed and per-beam LBT is used |
| DOCOMO | Agree with Intel that (A) and (B) are the alternatives. To support wider beam, (B) is required, with which we are fine. If it is deemed too much impact, we are also fine with (A) assuming simple relationship between sensing beam and transmission beam. |
| InterDigital | We agree with A) and B)  For C), we are unclear as to the motivation for using a wider beam. Would it be to cover multiple transmission beams with a single LBT procedure? If so, the transmission beam can be considered the aggregate of transmission beams. |
| Samsung | 1. Agree 2. Agree 3. In the current spec of TCI In the current RAN1 specification, implicitly, the source RS signal in a QCL-D relationship either has the same or broader beamwidth than the target RS signal. In particular, in the current spec, SSB is not explicitly defined in UE specific RRC since initial access SSB is reused. The only thing additionally defined are TCI states having SSB as QCL-D source, and this is for further processes like P2 and P3 procedure of NR beam management. While the current TCI framework can also define the relationship between LBT beam and transmission beam, the current framework may have shortcoming when we want to define a wider sending beam by potentially grouping multiple ‘known’ transmission beams such as SSB beams.   One way is to introduce a new QCL type E (or extended definition of QCL type D). This QCL type is essentially to indicate the set of transmission beams that are “covered” by an LBT sensing beam.  The way how QCL-E would be used is as follows: in the tciState, the following can be defined:  *qcl-TypeX*  *{*  *bwp-Id b,*  *referenceSignal  {csi-rs : 1, csi-rs : 2, csi-rs : 3 }*  *qcl-Type type E*  *}*  In the above example, the transmission beams with the QCL-D source RS (CSI-RS1, CSI-RS2, CSI-RS3) are indicated as “covered” by the LBT sensing beam.  In other words, the sensing beam has the qcl type E source reference signals with (CSI-RS1, CSI-RS2, CSI-RS3).  While the QCL-E shall be introduced for defining the new spatial relation between sensing beam and transmission beam, we can either introduce this new QCL-E by changing the TCI state definition (applies to DL) or by changing *spatialrelationinfo* (applies to UL). |
| Apple | Agree with A and B.  There is no issue sensing beam is wider with current specification. |

Discussion 2.9.1-6 (closed)

For companies that support Alt -2: Please provide your views on how to extend the notions of QCL/TCI and beam correspondence for relating transmission beams with sensing beams to UEs for:

1. Single sensing beam for single transmission beam in a COT
2. Single sensing beam for multiple transmission beams in a COT
3. Independent per beam LBT

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| Company | View |
| Intel | Prefer to support only case a) since we envision defining this relationship only from the UE’s point of view where a single transmit beam is used. |
| OPPO | a/c) We can use discussion 2.9.1-5 A) or B)  b) We can use discussion 2.9.1-5 C), where single sensing beam is a wider beam and multiple transmission beams are narrow beam |
| Huawei/HiSilicon | 1. Sensing beam uses the same spatial filter as the Tx beam. Spatial filter of Tx beam is specified using QCL/TCI framework. 2. This needs to be further discussed. For instance we can define a new extended TCI state that corresponds to multiple TCI states currently supported in Rel-15/16. 3. In our view, independent per beam LBT is a straightforward extension of the mechanism a) where there is one-to-one correspondence between sensing and transmission beams. Once one-to-one correspondence between one (Tx beam, LBT beam) pair is specified, extending it to multiple (Tx beam, LBT beam) pairs is trivial. |
| Lenovo, Motorola Mobility | In our understanding, for UL, the QCL relation and TCI states can have a source RS from DL direction and target RS from UL direction. Also, for UL transmission, UL RS such as SRS could be used as source RS. Therefore, the TCI/QCL framework can be used regardless of beam correspondence.  As we have discussed in previous meeting, the TCI/QCL framework can be extended as follow to indicate the relationship between transmission beam(s) and sensing beam(s)  Step 1: UE is configured up to 128 TCI states by RRC  Step 2: MAC CE activates TCI table with up to 8 TCI states for transmitting UL from the 128 configured TCI states  Step 3: MAC CE activates a new TCI table where each of the 8 activated TCI states (transmission beam based on QCL Type-D assumption with respect to source RS) from the previous step are mapped to one or more TCI states (sensing beam(s) based on QCL Type-D assumption with respect to source RS(s)) from the 128 TCI states.    Step 4: DCI indicates one of the activated TCI states from Step 2 to be used for reception of DL  Step 5: Once the TCI state is indicated in Step 4, then the corresponding sensing beam(s) are looked up in the table activated in Step 3.  So, the notion of sensing is established based on the mapping table activated in Step 3, where the sensing beam is based on one or more of the beams that have been used by UE to receive the source RS(s).  Moreover, the association between sensing beam(s) and transmission beam(s) doesn’t need to be dynamically indicated in the DCI.  In our view, this provides a fully flexible and quite clear approach on defining relationship and handling it in RAN1. Based on this mechanism, all the following associations can be supported:   1. Single sensing beam for single transmission beam in a COT 2. Single sensing beam for multiple transmission beams in a COT 3. Independent per beam LBT |
| LG Electronics | We think that all cases a), b), and c) can be supported by extending the notions of QCL/TCI and beam correspondence framework as mentioned in 2.9.1-3 through 2.9.1.-5.  Furthermore, the sensing beam can be explicitly indicated by DCI among the preconfigured sensing beam under the QCL/TCI framework. |
| ZTE, Sanchips | Issues raised in discussion 2.9.1-6 are related to discussion 2.9.1-5, e.g., a) can be handled by discussion 2.9.1-5 A). |
| DOCOMO | We view only a) would be sufficient. C) can be covered by a), by applying “each single sensing beam” for each independent per beam LBT. |
| InterDigital | We believe that (a) and (c) are well served with Alt-2. For (b), further discussion is necessary on how to handle multiple simultaneous TCI states. |
| Samsung | 1. Support 2. Support 3. Support |
| Convida Wireless | All cases a), b) and c) can be supported |
| Apple | All cases can be supported. |

### Second Round Discussion

From the inputs collected from the first round of discussion, the following details are added to the alternatives.

Proposal 2.9.2-1

3GPP specification defines at least the relative relationship between all applicable sensing beam(s) and the transmission beam(s) to define sensing beam for LBT, where at least sensing beam(s) “covers” the transmission beam(s), considering following alternatives

* Alt 1: Specify necessary requirement/test procedure to guarantee sensing beam “covers” the transmission beam
  + Some methods to define “cover” have been discussed in RAN1 (may further down select the list) and are considered as acceptable from RAN1 perspective
    - Alt-1A: the angle included in the [3] dB beamwidth of the transmission beam is included in the [X, FFS] dB beamwidth of the sensing beam.
    - Alt-1B: the sensing beam gain measured along the direction of peak transmission direction is at least X [FFS] dB of the transmission beam gain
    - Alt-1C: The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP. The sensing beam gain measured along the chosen directions is at least X [FFS] dB of the transmission beam gain in those directions.
    - Alt-1D: The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP and the sensing beam gain measured along the chosen directions is at least X [FFS] dB of the sensing beam gain in peak sensing ~~transmission~~ directions.
    - Alt-1E: Sensing beam has the minimum [3] dB beamwidth which at least contains all beam peak directions of transmission beams.
  + Sending LS to RAN4 and inform them the above and request them to make the final choice
    - RAN4 choice may not be limited by the list above, but if different method is selected, RAN1 would like to have an opportunity to check as well
* Alt 2. Extending the beam correspondence framework and~~/or~~ QCL/TCI/SpatialRelationInfo framework to define “cover” and to indicate sensing beam(s) associated with a transmission beam(s)
  + On gNB side sensing beam selection for a DL transmission beam,
    - Option 1: The selection of eligible sensing beam for a transmission beam is left for gNB implementation
      * Question: In this case, how to test and enforce? Is it safe not testing?
    - Option 2: Beam correspondence at gNB side is assumed. Supporting one or more of the following behaviors
      * A1. For a gNB transmission beam corresponding to TCI state A for a certain UE, the gNB can use the same beam for sensing
      * A2. If TCI B is used as QCL source (Type D) for TCI A for a certain UE, then gNB transmission beam corresponding to TCI B can be used as the sensing beam for transmission with TCI A.
      * A3. If TCI C is NOT used as QCL source (Type D) for TCI A for any UE, then gNB cannot use the transmission beam corresponds to TCI C as the sensing beam for transmission with TCI A.
      * FFS: How and if to support sensing with a beam without corresponding RS sent? For example, how to use quasi-Omni beam for sensing if there is no SSB transmitted with quasi-omni beam
  + On UE side sensing beam selection for a UL transmission beam
    - Beam correspondence is assumed at UE
      * FFS: What if beam correspondence is not supported at UE.
    - Supporting one or more of the following behaviors
      * If the UE is indicated to transmit with a beam corresponding to a certain SRI, the UE can use the same beam for sensing
      * Assuming Rel.17 unified TCI framework, if the UE is indicated to transmit with a beam corresponding to a certain unified TCI, the UE can use the reception beam corresponding to the TCI for sensing
      * FFS: How and if to support a wider sensing beam (such as pseudo-omni beam, which is supported in WiFi) to be used for a narrower transmission beam under QCL/TCI framework
        + Option 1: UE implementation.

How to test and enforce?

* + - * + Option 2: gNB indication.

How does gNB know which UE sensing beam is eligible?

RAN1 to make a down-selection by 106b-e.

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| --- | --- |
| Company | View |
| Huawei/HiSilicon | We support the proposal |
| Lenovo, Motorola Mobility | We do not support Alt 1  We can support Alt 2 with following updates:   * Alt 2. Extending the beam correspondence framework and~~/or~~ QCL/TCI/SpatialRelationInfo framework to define “cover” and to indicate sensing beam(s) associated with a transmission beam(s)   + On gNB side sensing beam selection for a DL transmission beam,     - Option 1: The selection of eligible sensing beam for a transmission beam is left for gNB implementation     - Option 2: Beam correspondence at gNB side is assumed. Supporting one or more of the following behaviors       * A1. For a gNB transmission beam corresponding to TCI state A for a certain UE, the gNB can use the same beam for sensing       * A2. If TCI B is used as QCL source (Type D) for TCI A for a certain UE, then gNB transmission beam corresponding to TCI B can be used as the sensing beam for transmission with TCI A.       * A3. If TCI C is NOT used as QCL source (Type D) for TCI A for any UE, then gNB cannot use the transmission beam corresponds to TCI C as the sensing beam for transmission with TCI A.       * FFS: How and if to support sensing with a beam without corresponding RS sent? For example, how to use quasi-Omni beam for sensing if there is no SSB transmitted with quasi-omni beam   + On UE side sensing beam selection for a UL transmission beam     - Beam correspondence is assumed at UE       * FFS: What if beam correspondence is not supported at UE.     - Supporting ~~one or more of~~ the following behaviors       * If the UE is indicated to transmit with a beam corresponding to a certain SRI, the UE can use the same beam for sensing       * Assuming Rel.17 unified TCI framework, if the UE is indicated to transmit with a beam corresponding to a certain unified TCI, the UE can use the reception beam corresponding to the TCI for sensing       * FFS: How and if to support a wider sensing beam (such as pseudo-omni beam, which is supported in WiFi) to be used for a narrower transmission beam under QCL/TCI framework         + Option 1: UE implementation.   How to test and enforce?   * + - * + Option 2: gNB indication.   How does gNB know which UE sensing beam is eligible?  For example, explicit association between a TCI state for transmission beam and the TCI state for transmission beam can be configured/indicated   * + - * FFS: If beam correspondence is not supported at UE, then the above behaviors can still be used for sensing beam selection for UL transmission beam   Moderator: The problem with gNB indication is gNB needs to know the UE sensing beam to choose them. Currently gNB does not know that. gNB only knows UE can use that beam to receive certain DL transmission, but does not know what the beam looks like, such as where it points to and how wide it is.  Moderator: If UE does not support beam correspondence, I don’t understand how the behavior can be supported. The description of the behavior uses beam correspondence.  Our further preferences and comments for Alt 2 are:   * **For gNB side sensing beam, option 1 is preferred** as we don’t see the need to indicate any relationship for DL Tx beam and DL sensing beam at the gNB. It can be handled by gNB implementation. * **For UE side sensing beam, indicating relationship between wider sensing beam and narrower transmission beam, we support option 2** where gNB can explicitly indicate the association between the TCI state for transmission beam and the TCI state for sensing beam. Option 1 should not be supported as it cannot be ensured/enforced if UE uses the appropriate sensing beam * We would like to raise another case of indicating multiple sensing beams corresponding to a single transmission beam. We think that this case should also be considered to allow sensing on multiple narrower beams corresponding to wider transmission beam. This would ensure increased probability of LBT success and transmission on at least one of the narrower sensing beam. This can be supported with similar mechanism as for indicating association between wider sensing beam and narrower transmission beam. Basically, this mechanism can allow any sort of mapping by gNB |
| vivo | We’re okay to further study. We support Alt1.  Alt2 is not preferred since it is based on the assumption of beam correspondence, which is not a mandatory feature for UE. |
| Apple | Support the proposal |
| Intel | We support the proposal |
| LG Electronics | We support Alt 2. In the case of Alt2, the specification impact is not considered to be significant because the same spatial filter is used to the sensing beam when receiving the signal configured with the QCL source.  In our understanding, the beam correspondence capability is a mandatory feature and the ED threshold can be further adjusted based on whether a UE support *beamCorrespondenceWithoutUL-BeamSweeping* or not. A UE supporting this capability can satisfy requirements (for minimum peak EIRP and spherical coverage) without UL beam sweeping and beam management such as beam indication from gNB. On the other hand, for a UE not supporting the capability, the requirements (for minimum peak EIRP and spherical coverage) must be satisfied through the beam management procedure, and additionally, without beam management, a requirement relaxed by 3 dB must be satisfied. Therefore, it is necessary to adjust the ED threshold value differently depending on whether the UE supports *beamCorrespondenceWithoutUL-BeamSweeping* or not. To be specific, the ED threshold for a UE not supporting the capability can be lower than that for a UE supporting the capability. In addition, for the UE without this capability, the ED threshold value can be adjusted depending on the presence or absence of a beam management procedure.  For quasi-omni beam sensing, it could only be allowed on broadcast signals/channels, such as SSB. In this case, the COT acquired by quasi-omni sensing beam may not be allowed COT sharing with other nodes. Furthermore, the sensing beam can be explicitly indicated by DCI among the preconfigured sensing beam under the QCL/TCI framework. |
| Lenovo, Motorola Mobility2 | @Moderator:  Through SRI in Rel-15/16 or unified TCI framework in Rel-17 (including SRS as source RS), gNB can indicate the UL Tx beam based on SRS measurements. Once the gNB knows which UL Tx beam is indicated, then it should also be able to indicate sensing beam(s) that maybe effectively wider than the UL Tx beam. gNB can infer the direction and width of UL beams based on how it has received them based on its Rx beams. For example, if UE has beam sweeped its UL Tx beams using SRI1, SRI2, SRI3 and correspondingly gNB identifies that SRI2 is the suitable Tx beam, and SRI1 and SRI3 are neighbouring beams. Then for the purpose of sensing, for UL Tx beam corresponding to SRI2, gNB can indicate sensing beams on all SRI1, SRI2 and SRI3 – effectively these beams can be considered as pseudo-wider beams. The above indications based on SRS measurements should be possible without beam correspondence.  In case of beam correspondence, for quasi-omni beam sensing, it will be allowed on wider beams based on SSB or multiple continuous CSI-RS beams.  I hope it further clarifies our understanding and proposed changed to the proposal in our previous comment.  Moderator: Do you mean for a UE beam to be used as a sensing beam, the gNB has to schedule/configure the beam to be used as one of the transmission beams (for SRI or something else)? In other words, if a beam is not used as a transmission beam, the UE cannot use it for sensing? Additionally, how does gNB know one beam is wider than another? The gNB can schedule two beams to be transmitted and try to measure them, but how does gNB know which one “covers” the other? Does UE provide the information somehow? |
| ZTE, Sanechips | We support FL proposal, but prefer Alt2. for gNB side, we tend to support A1 and A3 of Option2. for UE side, we are open to all candidate methods |
| DOCOMO | We are fine with capturing the alternatives with more detail to be down-selected in the future. |
| Futurewei | We noticed the following typo in option-C of Alt-1:  Alt-1C: The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP ~~transmission beam gain~~. ~~t~~The sensing beam gain measured along the chosen directions is at least X [FFS] dB of the transmission beam gain in those directions.  With this correction we are fine with the proposal and our preference is Alt-1.  Question to the moderator: We understand the motivation of Alt-1D but do we need to also impose an additional minimum threshold constraint on the sensing beam gain along each peak transmission direction? Otherwise, it seems a sensing beam with arbitrarily small gain along a peak transmission direction could still be feasible.  Moderator: Yes that is actually the intention. This allows (pseudo)-omni sensing to be used. |
| Nokia, NSB | We support the proposal, and in particular Alt-1. We see that this discussion should be taken to RAN4 as soon as possible to ensure timely completion of the WI. |
| OPPO | We support the proposal and we prefer Alt-2. |
| Samsung | We prefer Alt.2 over Alt.1.  Regarding Alt.2, Option 1 of Alt 2 would require the gNB sensing behavior to be specified, since any transmitter node (gNB or UE) which initiate the COT should be subject to the regulation test as described in EN 302.567 below:  5.3.8.2 Test method  The principle is to establish a communication between UUT and companion device, and then check the behaviour of UUT in the presence of an interferer. 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.”  Therefore, the gNB sensing behaviour also needs to be specified.  In addition, the ‘and if’ of the FFSs are to be removed: otherwise, the sensing device is left with two choices: either very narrow beam or quasi-omni, which is clearly too limiting  FFS: How ~~and if~~ to support sensing with a beam without… (note: this applies for both FFSs: the one in the gNB and the one in the UE)  We are okay to discuss the ‘how’ in a second stage, hence the FFS is fine for us. However, the sensing beam cannot be left to UE implementation, since any transmitter node (gNB or UE) which initiate the COT should be subject to the regulation test as described in EN 302.567 above, the same as gNB. The gNB indication is preferable and can be standardized relatively easily e.g., either through the definition of a new QCL type or through the extension of the existing QCL-D.  Moderator: This “and if” is added in case we don’t support sensing with a beam that has no corresponding transmission. |
| Ericsson | We support the proposal with minor modifications. We support Alt.1, and we think it is a feasible to way to test directional LBT with reasonable specification effort. We also support the view that this discussion needs to be taken to RAN4, especially to discuss the testing feasibility for all the sub-alternatives in Alt 1.  Considering that we do not have much time remaining for the WI and many complex schemes are still being discussed, we may not have enough time to reach consensus or finalize the details for supporting directional LBT. Therefore, it is better to have agreement on “considers defining” instead of “defines” so that we do not need to reverse the agreement later. We could use omni LBT (which is simple and already compliant with the regulation) as the baseline LBT to close the WI if we could not finalize this topic in time.  **Response to LG:** Beam correspondence is not a mandatory feature. That is why there could be UE that does not supports this capability as you mentioned. However, your proposal on adding 3dB requirement to devices that do not support beam correspondence is not reasonable.  Why would a device without beam correspondence get penalty for performing a more friendly LBT (omni LBT or wider beam LBT) compared to other devices?  **Response to Lenovo:** We think you are describing the procedure for UL beam management, where the UE performs beam sweeping using 3 SRIs. Then, the gNB could only know and indicate to the UE which beam/SRI is best for **transmitting in UL**. gNB cannot "indicate sensing beams on all SRI1, SRI2, SRI3" because those SRIs correspond to 3 **UL transmit beams, and NOT receiving/sensing beams**. One could propose the UE to derive the receiving/sensing beams from the corresponding UL tx beams. However, the feasibility and requirement for this procedure is not defined in 3GPP as far as we know.  In our view, before extending any 3GPP tool for directional LBT, we need to stick to the fundamental target: The beam relation needs to be **between transmission beam(s) and receiving/sensing beam(s) in the same device**. From our understanding, currently in 3GPP, only beam correspondence (and possible new UL QCL/TCI framework from unified QCL/TCI framework in rel-17) is close to that concept.  However, it is only for single beam relation in UL transmissions and is not a mandatory feature for UEs currently and is not tested for gNBs. It is important to note that a gNB probably would transmit multiple beam directions with higher power than a UE, and hence if we want to add this to the specification, it must be able to be tested for gNBs. It also would require a lot of specification effort. |
| Convida Wireless | We are ok with the proposal. |
| Lenovo, Motorola Mobility | **Response to Ericsson:** Maybe I was not clear. But yes, we described the UL beam sweeping procedure. Based on this, UE can derive the sensing beams corresponding to UL Tx beams. This is somewhat the opposite of what UE does to determine UL Tx beams based on DL Rx beams. Although, this could be case of beam correspondence as well. We don’t see this as a big impact in terms of specification, but just to allow UL RS as source for the sensing beams  In our view, these are not complex schemes (under Alt. 2) – these are simple and straightforward extension of the QCL/TCI framework. The key point of discussion here is just to indicate the source for the sensing beam(s) corresponding to the Tx beams indicated by gNB. In our view, both DL RS and UL RS could be indicated as the source RS for signalling the QCL assumption of sensing beam(s) corresponding to indicated Tx beams.  **Further, we think that we need to decide in this meeting to allow sufficient time to work out further details in the remaining meetings. Maybe a compromised/constructive approach could be to agree on support of Alt 2 when beam correspondence is supported, and if beam correspondence cannot be supported, then Alt 1 is applied.** |
| ITRI | We support the proposal and we prefer Alt-2. |
| Spreadtrum | We support the proposal and we prefer alt-2. |
| CATT | Given the limited time left for WI, we prefer Alt 1. We recommend sending LS to RAN 4 for more information, so that we can further down-selection a reasonable method. |
| LG Electronics | **Response to Ericsson:** In our understanding, beam correspondence is a mandatory feature in Rel-15. There are two types of UEs: one is a UE that satisfies the beam correspondence without the beam management procedure, and another is a UE that can satisfy the beam correspondence with the beam management procedure. It depends on whether a UE support *beamCorrespondenceWithoutUL-BeamSweeping* or not. Regarding the penalty on the ED threshold for a UE not supporting the capability, it can be applied when performing directional LBT, not when performing omni LBT or wide beam LBT. In other words, the further adjustment on the ED threshold can be applied to a UE when performing the directional LBT without the beam correspondence capability. Alternatively, for this type of UE, the UE may only be allowed to perform Omni LBT instead of adjusting the ED threshold. |
| Futurewei-2 | We thank moderator for additional details but still have some concern.  Regarding Alt-D we see its motivation and ease of testing but think it still needs some additional condition.  To illustrate, consider the case there is one intended transmit beam and we have the peak direction in set of chosen directions.  Here it seems Alt-1D might declare this quite mis-aligned directional sensing beam to also be a valid cover. Please clarify.  Directional  Sensing-beam  Tx-beam  Very small directional sensing gain along peak TX direction (much smaller than omni)  in peak TX direction  Omni  Sensing-beam  Based on Ericsson comment and also our previous Round-1 comment we think an alternative is:  **Alt-1-F:** The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP and the sensing beam gain measured along the chosen directions is at least S [FFS] dBi.  This alternative could be a fall-back alternative which is just saying that the sensing beam has sufficient gain in the directions of interest. Pseudo-omni will satisfy this in chosen directions but even in directions which are not chosen (i.e., even in directions in which intended transmit beams do not have relatively high gain)**.**  Moderator: Now I see what you mean. However, I feel it is restrictive to define something with dBi. Can you check if the modified Alt-1D works?  **FW-3: Response to moderator:** Yes, this seems to be a neat fix.  We believe **“**the sensing beam gain in peak sensing ~~transmission~~ directions” could be changed to “peak sensing beam gain”. |
| Intel | Our preference is Alt 2.  For the gNB aspects, we believe option 1 is the most reasonable choice. For gNB, it is going to be considerably difficult to precisely define the directional LBT behaviour, especially for those associated with multi-beam operations. We think MU-MIMO operation will be a key feature for 60 GHz band operations and trying to support various gNB measurement behaviour associated for various cases, while meaningful would be difficult to converge quickly.  Moreover, gNB scheduling decisions and beamforming selection are quite critical for network performance, and we do not wish to impact system performance potentially negatively by limiting how gNB can perform scheduling and beamforming decisions. Therefore, it would be best if the gNB conformance to regulatory domain is left to RAN4/5 requirement/testing methods or left to regulatory conformance testing to resolve.  However, for the UE side, it is quite different story. In most typical cases, UE would be using a single beam for communication with gNBs and given that there are more UEs compared to gNB, having a well understood and predictable behaviour for UEs is critical for network optimization.  As for requiring beam correspondence not strictly being mandatory for the UEs, we acknowledge that this case is for FR2-1. However, we believe there is value, and it is needed from regulatory requirements to make sure UEs operating in unlicensed within FR2-2 are required to support this functionality. This would be far simpler from specification perspective, as the beam correspondence is a “mandatory capability with capability signalling”, meaning specification simply needs to state that this capability is enabled for UEs supporting unlicensed bands in FR2-2, which is anyway band specific. This is not the same as enforcing a “optional” feature to be now a “mandatory” feature. We would be enforcing a “mandatory” feature that was allowed temporarily to be optional to be now a “mandatory” feature.  Of course, beam correspondence feature would be also needed for gNB. However, the current specification does not have/contain the requirements nor testing related to gNB beam correspondence. Whether such requirement and testing definitions should be defined can be decided by RAN4 and RAN5. We don’t think RAN1 needs to decide this. |
| Huawei, HiSilicon | We support the proposal where we added a note to Alt1-E for a better understanding of this Option in RAN1 and RAN4 for possible performance requirement:  Proposal 2.9.2-1  3GPP specification defines at least the relative relationship between all applicable sensing beam(s) and the transmission beam(s) to define sensing beam for LBT, where at least sensing beam(s) “covers” the transmission beam(s), considering following alternatives   * Alt 1: Specify necessary requirement/test procedure to guarantee sensing beam “covers” the transmission beam   + Some methods to define “cover” have been discussed in RAN1 (may further down select the list) and are considered as acceptable from RAN1 perspective     - Alt-1A: the angle included in the [3] dB beamwidth of the transmission beam is included in the [X, FFS] dB beamwidth of the sensing beam.     - Alt-1B: the sensing beam gain measured along the direction of peak transmission direction is at least X [FFS] dB of the transmission beam gain     - Alt-1C: The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP. The sensing beam gain measured along the chosen directions is at least X [FFS] dB of the transmission beam gain in those directions.     - Alt-1D: The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP and the sensing beam gain measured along the chosen directions is at least X [FFS] dB of the sensing beam gain in peak sensing ~~transmission~~ directions.     - Alt-1E: Sensing beam has the minimum [3] dB beamwidth which at least contains all beam peak directions of transmission beams.       * Note: To support “minimum” [3] dB beamwidth requirement, the [3] dB beamwidth of the selected LBT beam may not exceed β+θ where β is the angular spread of the transmit beam peak directions and θ is an absolute or a relative sensing beamwidth accuracy requirement.   + Sending LS to RAN4 and inform them the above and request them to make the final choice     - RAN4 choice may not be limited by the list above, but if different method is selected, RAN1 would like to have an opportunity to check as well * Alt 2. Extending the beam correspondence framework and~~/or~~ QCL/TCI/SpatialRelationInfo framework to define “cover” and to indicate sensing beam(s) associated with a transmission beam(s)   + On gNB side sensing beam selection for a DL transmission beam,     - Option 1: The selection of eligible sensing beam for a transmission beam is left for gNB implementation       * Question: In this case, how to test and enforce? Is it safe not testing?     - Option 2: Beam correspondence at gNB side is assumed. Supporting one or more of the following behaviors       * A1. For a gNB transmission beam corresponding to TCI state A for a certain UE, the gNB can use the same beam for sensing       * A2. If TCI B is used as QCL source (Type D) for TCI A for a certain UE, then gNB transmission beam corresponding to TCI B can be used as the sensing beam for transmission with TCI A.       * A3. If TCI C is NOT used as QCL source (Type D) for TCI A for any UE, then gNB cannot use the transmission beam corresponds to TCI C as the sensing beam for transmission with TCI A.       * FFS: How and if to support sensing with a beam without corresponding RS sent? For example, how to use quasi-Omni beam for sensing if there is no SSB transmitted with quasi-omni beam   + On UE side sensing beam selection for a UL transmission beam     - Beam correspondence is assumed at UE       * FFS: What if beam correspondence is not supported at UE.     - Supporting one or more of the following behaviors       * If the UE is indicated to transmit with a beam corresponding to a certain SRI, the UE can use the same beam for sensing       * Assuming Rel.17 unified TCI framework, if the UE is indicated to transmit with a beam corresponding to a certain unified TCI, the UE can use the reception beam corresponding to the TCI for sensing       * FFS: How and if to support a wider sensing beam (such as pseudo-omni beam, which is supported in WiFi) to be used for a narrower transmission beam under QCL/TCI framework         + Option 1: UE implementation.   How to test and enforce?   * + - * + Option 2: gNB indication.   How does gNB know which UE sensing beam is eligible? |

## No LBT

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| Agreement:  For regions where LBT is not mandated, gNB should indicate to the UE this gNB-UE connection is operating in LBT mode or no-LBT mode   * Support both cell specific (common for all Ues in a cell as part of system information or dedicated RRC signalling or both) and UE specific (can be different for different Ues in a cell as part of UE-specific RRC configuration) gNB indication |

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | Proposal 25: For operation in the 60 GHz band, in regions where LBT is not mandated, indication of the decision on applying LBT mode or no-LBT mode per beam is not supported. Proposal 26: For operation in the 60 GHz band, in regions where LBT is not mandated, indication of the decision on applying LBT mode or no-LBT mode using L1 signaling is not supported. Proposal 27: For operation in the 60 GHz band, in regions where LBT is not mandated, the serving cell may enable Rx-side LBT using a higher layer configuration to mitigate high levels of interference experienced from hidden nodes.  Observation 6: When network allows enabling/disabling the LBT mode, coexistence issues would arise as the performance of the nodes operating with LBT mode would be adversely impacted by the nodes operating with No-LBT on the channel without a time limit . Proposal 28: For operation in the 60 GHz band, in regions where LBT is not mandated, COT should be limited when No–LBT is used. |
| Vivo | Proposal 20: Per-beam based channel access mode indication is not necessary.  Proposal 21: The channel access mode can be selected based on the channel occupancy time, channel access rate, transmission priority, service requirement, or feedback information from the receiver, etc. |
| InterDigital Inc. | Proposal 9: The UE receives indication of the channel access mode (omni-directional, directional, receiver assistance, no LBT) from the gNB.  Proposal 10: The indication of channel access mode is received per cell and per beam.  Proposal 11: L1 signaling can be used for UE specific indication, at least for initial access. |
| Sony | Observation 1: In EU, no-LBT mode cannot be operated at least under the ‘C1’ mode 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 already been introduced in NR-U.  Proposal 1: No-LBT mode is configured by the network based on measurement results of RSSI and channel occupancy. |
| Lenovo Motorola Mobility | Proposal 22: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, UE assistance information to indicate whether and which UL Tx beams can be used with no-LBT mode as initiating and/or responding device should be supported |
| Samsung | Proposal 1: For regions where LBT is not mandated, ·the cell-specific indication is a group of mode pairs, wherein each mode pair defines the modes of gNB and UE for a particular beam; ·the UE-specific indication is a mode pair; ·gNB determines its operation mode up to implementation. |
| CATT | Proposal 1: During the initial access procedure before RRC\_CONNETED state, the LBT/No-LBT mode indication can be transmitted by MIB or reserved bits in DCI format 1\_0 scrambled by SI-RNTI. |
| ZTE Sanechips | Observation 8: 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 10: Similar restriction as defined in Type 2C channel access procedure in TS 37.213 can also introduced in above 52.6GHz NR-U frequency band but the length of a transmission can be relaxed.  Proposal 11: Conditions for No LBT fallback to LBT should be further studied, e.g., based on the interference level or correctly decoding rate. |
| Ericsson | Proposal 24 Cell-specific system information indication of LBT ON/OFF is included in SIB1. i. Define same DCI\_1\_0 sizes for both licensed and unlicensed operation |
| FUTUREWEI | Proposal 13: For regions where LBT is not mandated, indication of UE specific per-beam LBT/no-LBT indication from the gNB is not supported.  Proposal 14: In deployments without LBT consider specification of channel vacation policies accounting for disparity among co-existing devices. |
| Nokia, Nokia Shanghai Bell | Proposal 29: Ues without LBT functionality are supported.  Observation 14: Channel access mechanism without LBT should fulfil the expected requirements of EN 303 722 but also possibly EN 303 753.  Observation 15: 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.  Proposal 32: Leave any additional conditions/mechanisms/restriction/fallback modes on the no-LBT channel access mode for gNB implementation.  Proposal 32: Leave any additional conditions/mechanisms/restriction/fallback modes on the no-LBT channel access mode for gNB implementation. |
| NEC | Observation 1: Based on long term measurement, the channel assessment in statistic could be considered to determine or switch the operation mode.  Proposal 10: For regions where LBT is not mandated, the mechanism and conditions for LBT mode and no-LBT mode switching should be specified to simplify the system implement. |
| OPPO | Proposal 8: support gNB and UE having different modes.  Proposal 9: support LBT mode per beam indication. |
| Qualcomm Incorporated | Proposal 27: Do not support per beam indication of the decision on applying LBT mode or no-LBT mode. |
| LG Electronics | Proposal #1: For regions where LBT is not mandated, the mechanism for switching between the no-LBT mode and LBT mode should be supported and specified at least for UL, and the channel access mode switching between no-LBT mode and LBT mode can be determined e.g., based on the consecutive decoding success or failure or interference measurement. |
| Apple | *Proposal 12: 1 bit in DCI to indicate whether eCCA or no LBT before UL transmission. No CP extension is needed.* |
| Convida Wireless | *Proposal 2: Adaptation for LBT modes and LBT sub-modes for system performance optimization should be considered.* |

### First Round Discussion

Discussion 2.10.1-1

If UE specific gNB indication on using LBT mode or no-LBT mode is adopted, please provide your view whether the indication of the decision on applying LBT mode or no-LBT mode is per beam (can be different for different Ues in different beams or can be different for different beam pairs between gNB and the UE) or not

* Support per beam indication of the decision on applying LBT mode or no-LBT mode
* Do not support per beam indication of the decision on applying LBT mode or no-LBT mode:

Summary of current positions:

* Support Per Beam indication: InterDigital, Lenovo (for UE), Samsung (gNB and UE), OPPO, NEC, ZTE,
* Do not support per beam indication: Huawei, Vivo, Qualcomm, FUTUREWEI, LG, Charter, Intel, DCM, Ericsson, Apple, Convida, CATT, WILUS , Spreadtrum

Please provide your view if not already captured above

|  |  |
| --- | --- |
| Company | View |
| vivo | The beam pair link quality is changing due to UE moving or rotation. In general, TCI states are updated dynamically based on beam report, e.g. the gNB activates a set of TCI states via MAC CE or indicates TCI state by DCI. Therefore, per-beam channel mode indication by RRC will not adapt to the change of the TCI state. |
| Charter Communications | Do not support per beam indication |
| Intel | We have updated our preference, and we do not see the need to support this indication in terms of beams. |
| NEC | We updated our preference of supporting per beam indication. |
| Huawei/HiSilicon | Even though it was agreed to support the flexibility of UE-specific indication, in our view, if two Ues in the same cell operate with two different channel access modes, the UE operating with LBT is consistently at a disadvantage compared to the UE operating without LBT. We thus think that further indicating the LBT/No-LBT mode in per-beam granularity would overcomplicate the signaling without a clear benefit to the system performance.  Moreover, for a COT with multiplexed beams, a transmission on beam indicated with No-LBT would have to be deferred to allow for sensing by the same device before transmitting on another beam indicated with LBT mode; hindering as such the benefit of No-LBT. |
| Lenovo, Motorola Mobility | Based on the discussion in ETSI BRAN, the requirements related to No-LBT are dependent upon beamforming gain, therefore, it makes sense to have the support per beam indication. Further details should be discussed on how to indicate which beams are suitable for no-LBT |
| LG Electronics | We added our position in above summary. We do not see the necessity of per beam indication. |
| ZTE, Sanechips | In principle, we are open to discuss this issue, but by comparison, we slightly prefer per beam indication of the decision on applying LBT mode or no-LBT mode, that is, on which type LBT mode can be used for beam according to demand. |
| DOCOMO | Not support per beam indication. |
| InterDigital | We support per beam indication. This can be beneficial if multi-TRP or CoMP is used. |
| Ericsson | We do not support per beam indication. |
| Futurewei | We do not support per beam indication. |
| CATT | Given that UE-specific LBT has been supported, we see no need to support per-beam indication. |
| Samsung | We have another clarification question to the FL regarding the understanding of previous agreement. Let’s assume first there is no beam-based indication supported, then the cell-specific indication is for both gNB and its Ues (e.g. gNB and UE have same mode), or for gNB only (e.g. no information on UE mode), or for UE only? The UE-specific indication is for UE only (e.g. after UE receives the UE-specific indication, the UE only overrides its own mode without any change to gNB’s mode?). We guess there is still some confusion on the understanding.  Moderator: Cell specific indication will be overwritten by UE specific indication if they are different. What is the implication of the indication may need further discussion (I guess that is the confusing part). At least for the case of non-fallback DCI, if there is no LBT, we may not need the channel access control field. |
| Convida Wireless | Complexity associated with per beam indication should be considered. |
| Apple | Do not support per beam indication |
| WILUS | We do not support per beam indication |
| Spreadtrum | We do not support per beam indication. |

Discussion 2.10.1-2

For regions where LBT is not mandated, please provide your view if L1 signalling is be introduced for gNB to indicate to the UE if the operation is in LBT mode or no-LBT mode. Note this is different from the DCI field indicate the LBT type for UL transmission.

Summary of current positions:

* L1 Signaling for No-LBT mode should be supported: InterDigital, CATT, Apple, vivo (if there is benefit), Oppo, Lenovo, ZTE, NEC
* L1 Signaling for No-LBT mode should not be supported: Huawei, Intel. Charter, LG, Nokia, DCM, Ericsson, WILUS, Spreadtrum

Please provide your view if not already captured above

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| --- | --- |
| Company | View |
| vivo | We are ok to support L1 signalling if clear motivation or benefit can be provided. |
| Charter Communications | No L1 signaling is needed |
| Intel | We have updated our preference, and we do not support L1 signalling for this purpose. |
| OPPO | Following legacy design principle, where gNB can indicate the UE to omit LBT. |
| Huawei/HiSilicon | Not support. We do not see the need for dynamic switching between LBT and No-LBT modes. So, the support for L1 signalling is not clearly motivated for us. |
| Lenovo, Motorola Mobility | We support L1 signalling for No-LBT mode |
| LG Electronics | We do not see the necessity of L1 singaling but the GC-PDCCH may be used to trigger the switching between the operating modes. |
| Nokia, NSB | In our view cell-common signaling is sufficient. |
| ZTE, Sanechips | Support L1 Signaling for No-LBT mode |
| DOCOMO | No L1 signalling is needed. |
| InterDigital | Support L1 signaling for No-LBT mode. |
| Ericsson | We also do not see a need to support L1 signalling. Cell-specific signalling is sufficient. |
| Futurewei | Do not support such dynamic L1 signalling |
| CATT | Before RRC connection, L1 signalling can be used to indicate cell-specific LBT/No LBT mode indication. |
| Samsung | To clarify, if the assumption is different from the DCI field indicating LBT type for UL transmission, is the proposal only applicable for DL transmission? |
| Apple | OK to support |
| WILUS | We do not see the necessity of L1 signalling for No-LBT mode. |
| Mediatek | We are open to discuss its benefit and motivation. However, we don’t see strong need for this feature. |
| NEC | We support L1 signalling for No-LBT mode. |
| Spreadtrum | We do not see the necessity of dynamic indicating the LBT modes. |

## Short Control Signaling and Contention Exempt Transmission

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| Agreement:   * Contention Exempt Short Control Signaling rules can be applicable to the transmission of SS/PBCH.   + FFS: What are the other DL signals and channels that can be multiplexed with SS/PBCH transmission under Contention Exempt Short Control Signaling rule   + FFS: Whether this can be applied to all supported SCS or specific SCS.   + FFS: Extension to discovery burst if it is defined including signals other than SS/PBCH   + Note: Restriction for short control signalling transmissions apply (10% over any 100ms interval) * FFS: Other DL signals/channels can be transmitted with Contention Exempt Short Control Signaling rule, such as PDCCH, broadcast PDSCH, PDSCH without user plain data, CSI-RS, PRS, etc   Agreement:  For contention exemption short control signalling based DL transmission of SS/PBCH, further consider if the following signals/channels can be multiplexed with SS/PBCH block transmission.   * RMSI PDCCH and RMSI PDSCH * Other broadcast PDSCH * PDSCH without user-plane data * PDCCH * CSI-RS * PRS * Other signals/channels contained in Discovery Burst (i.e., exemption applies to Discovery Burst)   Note: Total exempted signals/channels should meet the restriction of 10% over any 100ms interval.  FFS: If contention exemption short control signalling based DL transmission is allowed when not multiplexed with SS/PBCH block transmission. |

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| Agreement:   * Contention Exempt Short Control Signaling rules apply to the transmission of msg1 for the 4 step RACH and MsgA for the 2-step RACH for all supported SCS.   + Note restriction for short control signalling transmissions apply (10% over any 100ms intervals)   + Alt 1: The 10% over any 100ms interval restriction is applicable to all available msg1/msgA resources configured (not limited to the resources actually used) in a cell   + Alt 2: The 10% over any 100ms interval restriction is applicable to the msg1/msgA transmission from one UE perspective * FFS: Other UL signals/channels can be transmitted with Contention Exempt Short Control Signaling rule, such as msg3, SRS, PUCCH, PUSCH without user plain data, etc |

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | Proposal 29: In regions where LBT is mandated, only channels/signals that can be multiplexed within the DB as defined for Rel-16 NR-U should be supported for contention exemption short control signaling based DL transmission. Proposal 30: In regions where LBT is mandated, contention-exempt short control signaling rules apply to the transmission of msg1 for 4 step RACH and msgA for 2-step RACH such that the 10% over any 100ms interval restriction is applicable to all available msg1/msgA resources configured in a cell (Alt 1). Proposal 31: In regions where LBT is mandated, contention-exempt short control signaling based transmission is not supported for UL signals/channels other than msg1/msgA. Observation 7: When No-LBT is used in regions where LBT is not mandated by regulations, the hidden node issue would still persist. |
| vivo | Proposal 22: The contention exempt short control signaling can be extended to discovery burst with duration at most 1ms.  Proposal 23: The contention exempt short control signaling based SS/PBCH can be multiplexed with RMSI PDCCH, RMSI PDSCH and CSI-RS.  Proposal 24: The 10% over any 100ms interval restriction is applicable to the msg1/msgA transmission from one UE perspective. |
| Sony | Proposal 2: Contention exempt short control signalling should be adopted for transmission of RMSI PDCCH, RMSI PDSCH, and/or CSI-RS contained in Discovery Burst. |
| Samsung | Proposal 7: For “short control signalling”: ·support at least discovery burst as part of the short control signalling; ·support limitation on the duty cycle to use “short control signalling”, wherein the duty cycle are defined from the perspective of a node. |
| CATT | Proposal 14: The 10% over any 100ms interval restriction should be applicable to all Contention Exempt Short Control Signals from cell perspective.  Proposal 15: For UL signal, the Contention Exempt Short Control Signaling rules can be applied to the PUCCH and PUSCH without user plane-data.  Proposal 16: The Contention Exempt Short Control Signaling can be applied to any signaling without user-plane data multiplexed with SS/PBCH block transmission.  Observation 1: When the periodicity of SS/PBCH block is 20msec and the number of SSB beams is 64, the total duration of SSB transmission is more than 10% within 100ms.  Proposal 17: In order to meet the rule of less than 10% duty cycle within 100ms, the Contention Exempt Short Signaling rules shall be applied to limited number of SSB beams for 120 kHz SCS. |
| ZTE Sanechips | Observation 2: Other channel/signal is allowed to be multiplexed with a channel/signal that has been regarded as Short Control Signalling only if their total transmission time does not exceed 10ms limitation within 100ms observation period.  Observation 3: If channel(s)/signal(s) is not regarded as Short Control Signalling and not multiplexed with any Short Control Signalling, it is a natural way that such channel(s)/signal(s) cannot apply Contention Exempt Short Control Signaling rule.  Observation 4:   l For 120 kHz SCS SS/PBCH, transmitted 64 SS/PBCH with 20ms SS/PBCH period exceeds 10ms limitation within a 100ms observation period required for short control signalling.   l For larger SCS (e.g., 240/480/960kHz) SS/PBCH, transmitted 64 SS/PBCH with 20ms SS/PBCH period does not exceed 10ms limitation within a 100ms observation period required for short control signalling.  Observation 5: As long as total time corresponding to all available UL resources that be used to transmit Short Control Signalling (e.g., Msg1/Msg A/potential Msg 3 ) meets 10ms limitation within a 100ms observation period, Contention Exempt Short Control Signaling rule can be applied.   Another issue on the situation that the transmission of DL/UL channels/signals considered as Short Control Signalling exceeds 10ms limitation, we think it is a natural way to switch from No LBT mode to LBT mode.  Observation 6: Once the transmission of DL/UL channels/signals considered as Short Control Signalling exceeds 10ms limitation, it is a nature way to switch from No LBT mode to LBT mode.  Besides, if the transmission of DL/UL channels/signals considered as Short Control Signalling is in a COT initiated by gNB or UE and LBT is performed before Short Control Signalling transmission, in our understanding, it should not be counted into 10ms limitation within the 100ms observation period.   Observation 7: For the case of the transmission of DL/UL channels/signals considered as Short Control Signalling is in a COT initiated by gNB or UE and LBT is performed before Short Control Signalling transmission, it is suggested that such transmission should not be counted into 10ms limitation within the 100ms observation period. |
| Ericsson | Observation 11 In HS EN 302 567, SCS transmissions have a duty cycle requirement but no limitations on the number of SCS transmissions within the observation period.  *Proposal 7 Support extending the Short control signalling transmissions exemption to Discovery Burst.*  *Proposal 8 Support Alt2 in which the short control signalling transmissions requirement of 10ms over 100ms duration is applicable to control and management transmissions from a single UE perspective*  *Proposal 9 Consistent with EN 302 567, a node can access the channel without LBT for control signal/channel transmissions, the total duration of which shall not exceed 10 ms within an observation period of 100ms. The following signals/channels shall be classified as short control signaling transmissions:*  1 msg3 for the 4 step RACH and MsgB for the 2-step RACH |
| FUTUREWEI | Proposal 10: The 10% over any 100ms interval restriction is applicable to all available msg1/msgA resources configured (not limited to the resources actually used) in a cell. |
| Nokia, Nokia Shanghai Bell | Observation 4: EN 302 567, v2.2.0 allows for Short Control Signalling transmissions for up to 10% of time within an observation period of 100 ms.  Proposal 15: NR-U design for 60 GHz bands supports transmission of the following DL and UL control and management signals as short control signalling without LBT:   • Downlink: SS/PBCH blocks (already agreed), PDCCH, CSI-RS and other reference signals, e.g., for beam management, SIBs, Paging   • Uplink: HARQ-ACK feedback on either PUCCH or PUSCH, Scheduling Request, CSI feedback, Sounding RS, e.g., for beam management, RACH related transmissions  Proposal 16: For the UL transmissions, the 10% short control signaling allowance is shared by all the UEs in the cell.  Proposal 17: One-shot LBT within COT is not required before gNB beam switch between SSBs.  Proposal 18: Use of short control signal contention exemption and use of LBT for SSBs is predetermined or semi-statically determined, distributing the channel access uncertainty over the SSBs. |
| OPPO | Proposal 13: PUCCH carrying HARQ-ACK information belong to short control signaling.  Proposal 14: msg3, SRS, and PUSCH without user plain data should not belong to short control signaling.  Proposal 15: restriction for short control signalling transmissions is applicable to all available msg1/msgA resources configured in a cell. |
| Qualcomm Incorporated | Proposal 28: Support Alt 2. Contention Exempt Short Control Signaling rules apply to the transmission of msg1 for the 4 step RACH and msgA for the 2-step RACH for all supported SCS. The 10% over any 100ms interval restriction is applicable from the perspective of the UE in accordance with per device requirement set by regulation.  Proposal 29: SRS should be included towards contention exempt transmissions.  Proposal 30: PUCCH should be included towards contention exempt transmissions.  Proposal 31: PUSCH without user plane data, such as CSI or Ack/Nack, and msg3 should be included towards contention exempt transmissions.  Proposal 32: Under the restrictions of duty cycle for short control signaling, allow SS/PBCH, PDCCH, CSI-RS and PRS for contention exempt transmission. |
| LG Electronics | Observation #1: The interpretation of regulation for 10% over any 100ms interval restitution from one UE perspective (Alt-2) is likely to cause coexistence problems with the incumbent system operating in the same band.  Proposal #2: Whether a short control signing rule is applicable or not to the configured msg1/msgA resources can be explicitly indicated by the gNB or can be implicitly determined by the UE. |
| Intel Corporation | Proposal 20: It is left up to gNB to decide and apply SSE to any signals/channels which are additionally multiplexed with SS/PBCH, as long as when it does the 10% duty cycle over a 100ms observation period is met.  Proposal 21: SSB transmission with no LBT is supported at least for 960 kHz and type0-PDCCH.  Proposal 22: It is up to the gNB to decide and apply SSE to the discovery burst, as long as when it does the 10% duty cycle over a 100ms observation period is met.  Observation 3: The contention exempt control signaling rules is interpreted as if the 10% over any observation period of 100ms is applicable per device.  Proposal 23: The 10% over any observation period of 100ms is applicable to the msg1/msgA transmission from one UE perspective.  Observation 4: For 120 kHz, 480kHz, and 960 kHz PRACH transmission, UE does not exceed total transmission duration of 10 msec for PRACH within a 100 msec observation period.  Proposal 24: Contention Exempt Short Control Signaling rules apply to the transmission of msg3 for the 4-step RACH for all supported SCS.  Proposal 25: It is up to the UE to decide and apply SSE to SRS and PUCCH, as long as when it does the 10% duty cycle over a 100ms observation period is met. |
| Apple | *Proposal 4: Other DL signals and channels for control, management and beamforming RS that is FDMed together in the SSB symbol can be transmitted together with SSB under short control signaling rule.*  *Proposal 5: Transmission of SSB as short control signaling can be applied to 120KHz, 480KHz and 960KHz SCS. It is up to gNB implementation to ensure short control signaling regulation limitation is met.*  *Proposal 6: Enable UE specific RRC signaling to indicate which DL/UL channel/signals can be transmitted with contention exempt short control signaling rule.* |
| NTT DOCOMO INC. | Proposal 5: *Contention Exempt Short Control Signaling rules can be applicable to the transmission of SS/PBCH and multiplexed signals/channels within a same transmission burst irrespective of SCS*  Proposal 6: *Support Alt 2 on the interpretation of Contention Exempt Short Control Signaling rules, i.e., the 10% over any 100ms interval restriction is applicable to the msg1/msgA transmission from one UE perspective* |
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### First Round Discussion

Summary of Current Positions:

Contention Exempt Short Control Signaling rules apply to the transmission of msg1 for the 4 step RACH and MsgA for the 2-step RACH for all supported SCS.

* Note restriction for short control signalling transmissions apply (10% over any 100ms intervals)
* Alt 1: The 10% over any 100ms interval restriction is applicable to all available msg1/msg3/msgA resources configured (not limited to the resources actually used) in a cell
  + Huawei, CATT, ZTE, FUTUREWEI, Nokia, OPPO, LG,
* Alt 2: The 10% over any 100ms interval restriction is applicable to the msg1/ /msgA transmission from one UE perspective
  + Vivo, Ericsson, Samsung, Qualcomm, Intel, DOCOMO, Charter, Intel, Lenovo, Nokia,
* FFS: Other UL signals/channels can be transmitted with Contention Exempt Short Control Signaling rule, such as msg3, SRS, PUCCH, PUSCH without user plain data, etc

Proposal 2.11.1-1:

Contention Exempt Short Control Signaling rules apply to the transmission of msg1 for the 4 step RACH and MsgA for the 2-step RACH for all supported SCS. Restriction for short control signalling transmissions apply (10% over any 100ms intervals). Down-select from the following alternatives

* Alt 1: The 10% over any 100ms interval restriction is applicable to all available msg1/msgA resources configured (not limited to the resources actually used) in a cell
  + Support: Oppo, HW, LG, Nokia (though regulation allows Alt 2), ZTE, Futurewei, CATT, Spreadtrum
* Alt 2: The 10% over any 100ms interval restriction is applicable to the msg1/msgA transmission from one UE perspective
  + Support: vivo, Charter, Intel, Lenovo, DCM, InterDigital, Ericsson, Samsung, Convida, Apple, Nokia

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| --- | --- |
| Company | View |
| vivo | From our point of view, the regulation regarding short control signalling is for the actually transmitted signals, not the configured resources. Only when the signal is transmitted, it is considered as a short control signalling and the signal duration is counted in. If the signal is not transmitted, no transmission duration should be counted in the total short control signalling transmission time. Therefore, Alt 2 is supported for msg 1 and Msg A transmission when they are considered as short control signalling. |
| Charter Communications | Agree with vivo |
| Intel | Our preference is Alt.2, which we believe is more in line with the ETSI BRAN description, which refers with “equipment” to an individual device. |
| OPPO | Alt 1 is our understanding |
| Huawi/Hisilicon | We support Alt 1.  If it is left to each individual UE to use short control signalling exemption for msg1 for the 4 step RACH and MsgA for the 2-step RACH, then the total time resources at which at least one UE within the cell transmits msg1/ MsgA can easily far exceed the 10% occupancy time for short control signaling exemption. In our view, this is a misuse of the exemption that is introduced in regulations for “short control signaling”. Therefore, our preference is to support Alt 1. |
| Lenovo, Motorola Mobility | We support the proposal and prefer Alt 2 |
| LG Electronics | We support the Alt 1. The interpretation of regulation for 10% over any 100ms interval restitution from one UE perspective (Alt-2) is likely to cause coexistence problems with the incumbent system operating in the same band. |
| Nokia, NSB | We are ok with Alt 1, although the ETSI regulation in principle allows Alt 2 too. |
| ZTE, Sanechips | Support Alt1 and if Alt 2 is adopted, we are concerned that is may cause a to misuse of Contention Exempt Short Control Signaling rule. |
| DOCOMO | We support Alt 2 since BRAN defines per equipment. |
| InterDigital | Support Alt.2. |
| Ericsson | We support Alt 2. Alt 1 need not be precluded by configuration/implementation but it is not required and need not be specified. |
| Futurewei | We prefer Alt-1 since otherwise in a congested multi-device setting such transmissions can accumulate and hinder fair coexistence. |
| CATT | We support Alt 1. If Alt 2 is supported, the total amount of UL signals which applies to Contention Exempt Short Control Signalling rule may be too large to interfere with other systems. Hence, we think Alt 1 is more reliable than Alt 2. |
| Samsung | We support Alt 2 as indicated in the summary. The progress from last agreement is to remove FFS? We didn’t see an essential change other than that… |
| Convida Wireless | We prefer Alt 2 |
| Apple | Alt 2 |
| Spreadtrum | We prefer Alt 1. |

Discussion 2.11.1-2:

For contention exemption short control signalling based UL transmission consider the following signals and channels. Please provide your views on each of the following

* Any transmission on PUCCH
* SRS
* PUSCH not carrying user plane data
  + HARQ A/N on PUSCH
  + CSI reporting on PUSCH
  + Msg 3

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| --- | --- |
| Company | View |
| vivo | We are open to discuss the potential UL channels/signals as Short control signalling. |
| Intel | We are open to discuss, but we believe that as long as the 10% duty cycle is met, either PUCCH, SRS or any PUSCH not carrying user plane data could be qualified as short control signalling and benefit from the no-LBT exemption. |
| OPPO | We should rather discuss what the criterion is to judge if a channel is qualified to be contention exemption short control signalling. According to regulation, at least PUCCH carrying Ack/Nack is clearly allowed. For the rest of the UL channels/signals, we need a clear criterion for the decision. |
| Huawei/HiSilicon | It would be challenging for the network, if not infeasible, to ensure that the restrictions are maintained if other UL signals/channels than msg1/msgA are also allowed to be transmitted with the short control signalling exemption rule. We therefore propose that the Short control signalling exemption based transmission is not upports for UL signals/channels other than msg1/msgA. |
| LG Electronics | We are open to discuss the potential UL channels/signals that applicable short control signalling. However, it is important that the duty cycle restriction should be applied to all UL signals/channels transmitted by the short control signalling from the cell perspective. |
| Nokia, NSB | We support all the above cases. The gNB should have means to ensure that 10% limit is not exceeded, e.g. by indicating the time instances when short control signaling transmissions are allowed in a cell. |
| ZTE, Sanechips | We think which UL signals/channels may be considered as long as 10ms limitation is met. |
| DOCOMO | Open to discuss. |
| Ericsson | We can discuss and support any or all of the above cases on how to configure them, as long as the total transmissions per equipment do not cross the 10% regulatory requirement. |
| Futurewei | We are open to potential inclusion as long as a mechanism to enforce 10% limit can be ensured. |
| CATT | We are open to discuss the potation UL signalling. |
| Samsung | We believe a more important discussion on the DL short control signalling is missing, and at least discovery burst should be supported as DL short control signalling. Currently, only SSB is agreed as UL short control signalling, but SSB actually is not contiguous in time domain, so the discussion about discovery burst is more essential. The discussion on DL control signalling seems more important than UL. |
| Convida Wireless | We are open for further discussions for a subset of signals/channels or all signals/channels. |
| Apple | Support all above cases.  We think the FFS DL signal should be discussed as well. Can be part of the proposal here. It is more important that the network can ensure some RLM RS or beam management RS transmitted as short control signaling, to avoid UE blind detection and long delay in RLM/BFD/CBD requirement. |
| Spreadtrum | We are open to discuss. |

## CWS and CAPC

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| Company | Key Proposals/Observations/Positions |
| Sony | Proposal 3: Support fixed Contention Window. • gNB’s contention windows size is left to network implementation. • UE’s contention window size is configured by network. |
| Lenovo Motorola Mobility | Proposal 19: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, CWS adjustment should be applied for each beam in an independent manner depending upon the corresponding CAPC (when Cat 4 LBT is done for each beam and COT is initiated for each of the beams), where the CWS adjustment for a transmit beam (TCI state) of a data channel can be based on the ACK/NACK feedback for the corresponding data channel with the same transmit beam (TCI state) |
| Samsung | Proposal 5: No need to define CAPC for 60 GHz unlicensed band. |
| CATT | Proposal 5: No need to introduce CAPC and CWS. |
| ZTE Sanechips | Observation 9: CWs adjustment can be considered to be introduced, which is beneficial in some highly congested scenarios and to friendly and fair coexistence with Wi-Fi. |
| Ericsson | Proposal 20 Do not support CAPC and CWS adjustment for NR operation in 52.6 GHz to 71 GHz. |
| Nokia, Nokia Shanghai Bell | Observation 1: We do not see a need for contention window adjustment mechanism for mitigating channel access collisions.  Proposal 2: LBT procedure uses fixed contention window size for random back-off.  Observation 2: With sufficiently short contention window size, there is no need for CAPCs  Proposal 3: Contention window size of [4] is used in the LBT procedure |
| Qualcomm Incorporated | Proposal 33: CWS adjustment need not be introduced for 60GHz band.  Proposal 34: CAPC need not be introduced for 60GHz band. |
| LG Electronics | Proposal #4: The channel access priority classes (CAPC) can be introduced for NR above 52.6 GHz to differentiate the channel access probabilities for different channels and traffic.  Proposal #5: To reduce the probability of collision, the contention window adjustment (CWS) procedure similar to Rel-16 NR-U can be adopted, and it is also necessary to discuss the relationship of the CWS and back-off counter values between wide beam LBT and independent per-beam LBT for multi-beam COT. |
| Intel Corporation | Proposal 2: For operation unlicensed 60 GHz band, when LBT is used within the COT, the principle of the type 1 channel access procedure defined for the sub-6 GHz band should be reused, and the channel access parameters should be modified in accordance with numerologies provided by the ETSI BRAN Harmonized Standard.  Proposal 3: The procedure specified in NR-U related to the CWS adjustment should be considered for operation in unlicensed 60 GHz band. RAN1 should further discuss and identify the values Zmin and Zmax. |
| ITRI | *Proposal 6: CWS adjustment mechanism could be applied per beam-based in an independent manner for 60 GHz NR-U.* |
| WILUS Inc. | *Proposal 4: We propose to introduce CAPC, CWS and CWS adjustment mechanism for 60GHz band, with Rel.16 NR-U as baseline.* |

### First Round Discussion

Discussion 2.12.1-1

Regarding introduction of CWS Adjustment, down select from the following alternatives

* Alt 1: Support the introduction of CWS adjustment
* Alt 2: Do not introduce CWS adjustment

Summary of positions so far:

* Alt 1: Motorola, ZTE, LG, Intel ~~(Keep NR-U Procedures)~~, ITRI (per beam) , WILUS
* Alt 2: Sony, Samsung, CATT, Nokia, Qualcomm, Ericsson, Futurewei, Spreadtrum

Please provide your position if not captured above

|  |  |
| --- | --- |
| Company | View |
| vivo | We see no strong motivation to introduce CWS adjustment. |
| Charter Communications | No introduction of CWS adjustment |
| Intel | Our preference is for Alt.1 and we believe that the introduction of the CWS and CAPC would be beneficial in highly congest scenario, where prioritization of traffic and contention resolution may be required. In this matter, the mechanisms and procedure define in Rel.16 could be used as a baseline. |
| OPPO | We support Alt 2. |
| ITRI | Support Alt 1 |
| LG Electronics | We support Alt 1. To reduce the probability of collision, the contention window adjustment (CWS) procedure similar to Rel-16 NR-U can be adopted, and it is also necessary to discuss the relationship of the CWS and back-off counter values between wide beam LBT and independent per-beam LBT for multi-beam COT. |
| Nokia, NSB | Alt 2: We see no need for CWS adjustment. However, it is essential to decide on the value of CWS. This discussion should be prioritized. |
| ZTE, Sanechips | Support the introduction of CWS adjustment and its introduction is beneficial in some highly congested scenarios and to friendly and fair coexistence with Wi-Fi due to it had been introduced in 802.11ad/ay. |
| InterDigital | Support Alt.1 |
| Ericsson | We support Alt2. |
| Futurewei | Alt-2 |
| CATT | Alt 2 |
| Convida Wireless | We are open for both Alt1 and Alt2 based on the identified benefits for each. |
| Apple | Alt 2 |
| WILUS | Our preference is for Alt.1 |
| Spreadtrum | We support alt 2. |

Discussion 2.12.1-2

Regarding introduction of Channel Access Priority Classes, down select from the following alternatives

* Alt 1: Support the introduction of CAPC
* Alt 2: Do not introduce CAPC adjustment

Summary of positions so far:

* Alt 1: Motorola, ZTE, LG, Intel, ITRI, WILUS
* Alt 2: Sony, Samsung, CATT, Nokia, Qualcomm, Ericsson, Futurewei

Please provide your position if not captured above

|  |  |
| --- | --- |
| Company | View |
| vivo | We see no strong motivation to introduce CAPC. |
| Charter Communications | Alt 2 – no CAPC |
| Intel | As highlighted above, we prefer Alt. 1. |
| OPPO | We support Alt 2. |
| LG Electronics | We support Alt 1. The channel access priority classes (CAPC) can be introduced for NR above 52.6 GHz to differentiate the channel access probabilities for different channels and traffic. |
| Nokia, NSB | Alt 2: we see no need for CAPCs. |
| ZTE, Sanechips | Support the introduction of CAPC to consider the requirement of different traffic type. |
| InterDigital | Support Alt. 1 |
| Ericsson | We support Alt2. |
| Futurewei | Alt-2 |
| CATT | Alt 2 |
| Apple | Alt 2 |
| Spreadtrum | We support alt 2. |

## Long Term Sensing, Interference Mitigation, ATPC, Other aspects

|  |  |
| --- | --- |
| Company | Key Proposals/Observations/Positions |
| Lenovo Motorola Mobility | Observation 1: For NR unlicensed bands between 52.6 GHz and 71 GHz, with directional LBT based channel access mechanism, LBT failure on a beam could require a beam update procedure and that results in increased latency  Observation 3: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, depending on the configuration, a collision on CG resources can cause systematic collisions between corresponding subsequent retransmissions causing transmission failure of affected packets.  Proposal 14: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, then following potential enhancements related to periodic transmissions of RS such as P-TRS should be specified to deal with LBT failure: - Termination of periodic RS transmission on beams where consecutive LBT failures are encountered - Dynamic switching of the QCL assumption (beams) for periodic RS transmission where consecutive LBT failures are encountered, where: o Multiple QCL assumptions (multiple beams) can be configured to the RS resource and beam switch can be triggered once the continuous number of LBT failures reach a certain threshold value  Proposal 20: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, ATPC could be adopted as one of the channel access mechanism, at least for regions where LBT is mandated by regulatory requirements  Proposal 21: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, adopt CG retransmission collision avoidance techniques such as retransmission deferral or additional retransmission resources.  Proposal 24: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, enhancement to the transmitter side LBT mechanism based on failure to receive HARQ feedback scheme or timer-based scheme should be supported for LBT based channel access mechanisms to consider potential interference at the receiver.  Proposal 26: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, long term sensing should be supported for both LBT based and no-LBT based channel access mechanism to consider potential interference.  Observation 6: Currently, there is no mechanism is support long-term sensing including interference measurements from WiFi or other NR operators at the UE and corresponding reporting. |
| ZTE Sanechips | Observation 1: It is worth emphasizing that the OCB should be satisfied for each transmitter such as gNB or UE.  Proposal 1: In order to avoid ambiguity about the understanding of nominal bandwidth and resolve the problem of unclear the conclusion for the OCB requirement, it is necessary to give a clear guidance on how to deal with the issue on the nominal bandwidth, e.g., introduce the definition of nominal bandwidth.  Proposal 20: Study and evaluate the impact of LBT and the limitation of COT length on the procedure of beam failure detection. |
| Ericsson | Observation 12 The effectiveness of LBT itself as medium access mechanism for co-existence in unlicensed spectrum in 60 GHz band is questionable. Therefore, any further enhancement on LBT baseline from the HS need to be justified both on the performance gain and the required complexity. |
| Nokia, Nokia Shanghai Bell | Proposal 1: Completing the design for features essential for baseline channel access operation should be prioritized. |
| ITRI | *Proposal 4: PDCCH monitoring enhancement for M-TRP operation should be supported for 60 GHz NR-U.*  *Proposal 5: Configuring multiple SRIs for a CG transmission should be supported for 60 GHz NR-U.* |
| Convida Wireless | *Proposal 9: Enhancement of resource utilization and interference mitigation in 52.6 GHz to 71 GHz should be considered.*  *Proposal 11: Enhancement of beam operation for unlicensed bands should be investigated to mitigate interference and optimize system performance due to hidden node for NR up to 71 GHz.*  *Proposal 12: Increasing the number of SSB candidate positions to above 64 to increase transmission opportunities to cope with LBT failure should be considered.* |

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