**3GPP TSG RAN WG1 Meeting #104bis-e R1-** **2103791**

**April 12th – April 20th, 2021**

**Agenda item: 8.2.6**

**Source: Moderator (Qualcomm Incorporated)**

**Title: Email discussion summary for 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.

# 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** |
| Apple | ***Proposal 3: Reuse the definition in EN 302 567, Pout is the mean EIRP during a transmission burst.*** |
| AT&T |  |
| CAICT |  |
| CATT | **Proposal 3: Adjustment value should be considered for the baseline ED threshold.**  **Proposal 4: For adjustment value on baseline EDT, at least beamforming gain difference between the transmission beam and sensing beam should be considered.** |
| Charter Comm. | Proposal 1a) In the EDT definition, Pout is defined as the instantaneous output EIRP.  Proposal 1b) The EDT operating channel BW is determined based on the LBT bandwidth.  Proposal 1c) Support relaxation of ED threshold for NR-U and NR-U coexistence scenarios (e.g, at regulation level). |
| Convida Wireless |  |
| Ericsson | Proposal 1 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 2ED threshold is defined as in the agreement from RAN1#104e. 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.  Proposal 3Pmax should be fixed at 40 dBm in the EDT equation for products in this band as stipulated by the regulations. |
| Fujitsu |  |
| FUTUREWEI | Proposal 1: The EDT value used for a COT initiation should correspond to a Pout that is the maximum RF output power (EIRP) used for the transmissions during that COT. |
| Huawei HiSilicon | Proposal 1: 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 2: For operation in NR-U-60, clarify the definition of Pout in the agreed baseline EDT formula as the mean or maximum output power (EIRP) of the potential transmission burst following the CCA check by the device.  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:***   * + ***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*** |
| Intel Corporation | Proposal 4: Within the formulation to calculate the ED threshold, Pout is defined as the maximum output EIRP for the specific channel that a device intends to acquire.  Proposal 5: When operating in unlicensed 60 GHz band, the ED threshold calculation shall account for the sensing beam used to perform the LBT procedure.  Proposal 6: 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. |
| InterDigital Inc. | Proposal 10: Adapt EDT to account for beamforming gain of the sensing beam.  Proposal 11: The Operating Channel BW used in the EDT formula is equivalent to the LBT BW. |
| ITRI |  |
| Lenovo Motorola Mobility |  |
| LG Electronics | Proposal #13: The ED threshold provided by the ETSI 302 567 can be enhanced considering the following points:l  The size of LBT bandwidthl  Transmit power of beam(s) in the COTl  The beam correspondence capability/requirement of UE. |
| MediaTek Inc. |  |
| NEC | Proposal 1: The energy detection threshold adaptation for beam based channel access procedure should take into account the antenna gain and mapping between transmission beam(s) and sensing beam(s). |
| Nokia Nokia Shanghai Bell | Proposal 6: Further adjustment of EDT based on the sensing and transmission beams is not specified.  Proposal 7: Pout in EDT determination is the mean EIRP of following transmission burst.  Proposal 8: The operating channel bandwidth in EDT determination equals to the LBT bandwidth |
| NTT DOCOMO INC. | Proposal 1:   For detailed aspects for EDT determination,   On whether to consider the transmission beam, it depends on whether Pout can consider the directivity gain or not.   On whether to consider the sensing beam, it depends on the variety of beams to be supported/used for the sensing beam.   On the definition of “Operating Channel BW”, it implies “the bandwidth used for the associated LBT”.   Leaving it as it is, or clarifying it as “the bandwidth used for the associated LBT” should be considered   Scenario-dependent EDT determination is not necessary in Rel-17 NR 52.6 - 71 GHz   EDT when the COT has time varying transmission beams should be discussed after defining LBT mechanism for initiating the COT with TDMed multiple transmissions. |
| OPPO | **Proposal 4: the EDT value should be adjusted: smaller value is applied when sensing beam is narrower.**  **Proposal 5: the definition of the operating channel BW is equal to the LBT bandwidth.** |
| Panasonic |  |
| Qualcomm |  |
| Samsung | **Proposal 5: 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.** |
| Sony |  |
| Spreadtrum Comm. | ***Proposal 5: The formula of ED threshold should consider the LBT bandwidth and beamforming gain.*** |
| vivo | **Proposal 1: The ED threshold for CCA check should take into account the impact of beamforming gain of the directional LBT beams.**  **Proposal 2: The maximum instantaneous output EIRP of the beams involved in a COT is used to calculate the EDT.**  **Proposal 3: The LBT bandwidth should be used as the operating channel bandwidth for EDT evaluation.** |
| WILUS Inc. |  |
| Xiaomi |  |
| ZTE Sanechips | Proposal 13: Considering mismatch between LBT sensing beam and transmission beam, the ED threshold provided by the ETSI BRAN 302 567 can be modified to consider mismatching between LBT sensing beam and transmission beam.  Proposal 14: 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.  Proposal 15: Study and evaluate the impact of LBT and the limitation of COT length on the procedure of beam failure detection. |

### First round discussion

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.

Discussion point 2.1.1-1 (closed):

For definition of Pout in EDT, down-select one of following alternatives.

* Alt 1: Pout is the maximum EIRP during a COT.
  + Support: Apple, Ericsson, FUTUREWEI, Huawei, LGE, Nokia, vivo, Charter, Intel, Futurewei, WILUS, NEC, Lenovo, Spreadtrum, Panasonic, CATT, Samsung, Qualcomm, MTK
* Alt 2: Pout is the maximum EIRP the node can transmit
  + Support: ~~Intel(?)~~
* Alt 3: Pout is the mean EIRP during a COT
  + Support: ZTE,
* Alt1-b: Pout is the maximum allowed EIRP during a COT.
  + Support: OPPO

Given the majority view, FL would like to propose the following:

Proposal 2.1.1-2 (closed):

For Pout in EDT determination, define Pout as the maximum EIRP during a COT

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| Company | View |
| Ericsson | Alt 1 is preferred.  eCCA  MCOT  **Time**  **Tx EIRP**  Transmission burst #1  Transmission burst #2  Transmission burst #3  Poutb1  Poutb2  gap  gap  A COT may consist of multiple transmission bursts with varying EIRPs and/or transmission beams. Pout is the maximum EIRP in a COT as this value corresponds to the most conservative EDT. In the figure below, if a single LBT is performed before the COT, *Poutb2 i*s used to determine EDT for the eCCA at the start of the channel access. |
| vivo | Alt-1 is preferred. Considering that there may be multiple of transmission bursts during a COT, the Pout should be the maximum EIRP during the COT. |
| Intel | Alt-1 is preferred. Notice that our view has not been correctly captured, and it has been corrected in the summary above. |
| Futurewei | We support Alt -1 |
| ZTE, Sanechips | In principle, we think the definition of Pout should follow that of subclause 4.2.2.1 of the EN 302 567, copied below:  *4.2.2.1 Definition*  *The RF output power is the mean equivalent isotropically radiated power (EIRP) for the equipment during a transmission burst.*  The above definition is close to Alt-3, the difference is that the definition of Pout is limited for a transmission burst or a channel occupancy time(COT).  For Alt-1, we understand it is a more conservative way and may be beneficial for the case of multiple transmission bursts with varying EIRPs and/or transmission beams and LBT only performed at the start of COT, not for within COT. Based on this, we have some confusion about:   * For different transmission burst with different EIRP within COT, for this point, whether can specify different transmission burst with same EIRP within COT. * The definition of Pout may also be related to whether Cat2 LBT (Section 2.5) and/or Maximum gap (Section 2.4) is supported in COT sharing case. If Cat2 LBT is supported, it seems to more appropriate to use the Pout of the current transmission burst specified in subclause 4.2.2.1 of the EN 302 567 within COT to determine CCA threshold. |
| LG | For definition of Pout in EDT, Alt-1 should be adopted because the transmission of beams that have directions different from the CCA range (due to large transmit power than ED threshold) shall not be allowed to be multiplexed (SDM/TDM) in the COT. In addition, the operating channel bandwidth in the EDT formula is closely related to the definition of LBT bandwidth.  Moreover, 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 relationship can be determined based on the beam correspondence capability/requirement of UE. For example, the lower (i.e., more sensitive) ED threshold can be applied to the UE satisfying the relaxed requirement for the beam correspondence capability/requirement |
| WILUS | Alt-1 is preferred which uses maximum EIRP during the COT as the most conservative ED threshold. |
| NEC | We support Alt 1, and also share the similar view with LG that the adjustment of EDT could take into account the relationship between sensing beam and transmission beam. |
| Nokia, NSB | We support Alt 1. Later on, we may need to clarify the exact definition of maximum EIRP. |
| Lenovo, Motorola Mobility | Support Alt. 1 |
| Spreadtrum | We share the same view as Ericsson, Alt-1 is preferred. |
| Panasonic | Alt-1 is preferred. Note that Alt-3 using the average EIRP across multiple transmission bursts within a COT might introduce some uncertainty of calculating the EDT in view of the fact that if Cat-2 LBT (if agreed to support) may fail before the gap and the following burst cannot be transmitted. |
| CATT | Alt-1 is preferred. The Pout in the EDT should be the maximum EIRP during a COT. |
| OPPO | We added one more alternative Alt 1-b: the Pout is a maximum allowed EIRP within a COT.  In our preference, the EDT definition should keep a similar principle as NRU. In NRU, although the regulation says that the EDT is proportional to the maximum transmit power (quoted below), the RAN1 agreement is to set this maximum transmit power as Pcmax\_H,c, i.e. an allowed power instead of an actual power, which implies that the actual power may be smaller than the allowed maximum power.  *Section 4.2.7 of ETSI EN 301 893*  *The ED Threshold Level (TL), at the input of the receiver, shall be proportional to the maximum transmit power (PH) according to the formula which assumes a 0 dBi receive antenna and PH to be specified in dBm e.i.r.p.* |
| Apple | OK with Alt 1. |
| Samsung | We are ok with Alt 1 for simplicity. |
| Huawei, HiSilicon | In principle were are Ok with either Alt 1 or Alt 3. However, considering the difficulty of predicting/calculating the mean output power for the whole COT duration apriori,  we prefer Alt1.  We also believe that other related discussion points such as adjusting EDT based on beamforming gain or the relation between sensing and Tx beams should be discussed in this meeting. |
| Qualcomm | Alt 1.  To Oppo: Can you elaborate the difference between proposed Alt1-b and Alt2? |
| Mediatek | Support Alt 1. |

## 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** |
| Apple | Proposal 5: LBT bandwidth is channel bandwidth for single carrier.  Proposal 6: For multi-carrier, gNB/UE perform multiple LBT, one for each channel bandwidth separately. |
| AT&T |  |
| CAICT | ***Proposal 1: For LBT for single carrier transmission, Alt SC.2 should be supported and the way to reduce the complexity of UE monitoring needs to be considered.***  ***Proposal 2: For LBT for multi-carrier transmission, Alt SC.3 should be supported.*** |
| CATT | **Proposal 5：For single carrier transmission, LBT bandwidth shall equal to the transmission bandwidth, which is from the lowest RB to the highest RB used for the transmission.**  **Proposal 6: Alt CA.3 (gNB/UE performs multiple LBT, one for each CC over the transmission bandwidth) should be supported for multi-carrier transmission in intra-band CA.** |
| Charter Comm. | Proposal 2: For single-channel LBT, Alt SC.3 may be a reasonable compromise wherein a certain minimum unit of LBT bandwidth is pre-defined, for e.g., 400 MHz. |
| Convida Wireless | Proposal 10: The LBT indication and channel occupation time should be studied when the channel BW for NR-U from 52.6 GHz to 71 GHz is smaller than WiFi 802.11 ad/ay channel BW. |
|  | Proposal 4 Support Alt SC1/Alt CA1 or Alt SC2/Alt CA3 for LBT in single carrier and multi-carrier operation |
| Fujitsu |  |
| FUTUREWEI |  |
| Huawei HiSilicon | ***Proposal 8: For a single-carrier transmission in NR-U-60, support performing a single LBT over the channel/BWP bandwidth, i.e. Alt SC.1 in the agreement made in the previous meeting RAN1#104-e.***  ***Proposal 9: 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, in the agreement made in the previous meeting RAN1#104-e.*** |
| Intel Corporation | Proposal 7: In single carrier transmission, a gNB/UE performs LBT over the channel bandwidth.  Proposal 8: For carrier aggregation, a gNB/UE performs multiple LBTs and one over each channel bandwidth. |
| InterDigital Inc. | Proposal 12: For single-carrier transmission, support Alt SC.3.  Proposal 13: For multi-carrier transmission, support Alt CA.1.  Proposal 14: Support a set of LBT BWs and LBT is performed in each CC on one or more adjacent LBT BWs that covers at least the transmission BW. |
| ITRI |  |
| Lenovo Motorola Mobility | Proposal 2: 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 3: 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 bandwidth  -          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 |
| LG Electronics | Proposal #4: Define a unit of LBT bandwidth and gNB/UE performs LBT in all the LBT units (to be transmitted in) in the channel bandwidth. |
| MediaTek Inc. |  |
| NEC |  |
| Nokia Nokia Shanghai Bell | ***Proposal 11:*** *For single carrier transmission, both Alt SC.1 and Alt SC.3 can be considered for LBT on 60GHz unlicensed band due to different characteristic and usage scenario of the alternatives. However, before making final decisions, the details of channelization (numerology) should be agreed first.*  ***Proposal 12:*** *For multi-carrier transmission in intra-band CA, both Alt CA.1 and Alt CA.5 can be considered for LBT on 60GHz unlicensed band.* |
| NTT DOCOMO INC. | **Proposal 2:**   * *For LBT for single carrier transmission, support either of the following:*   + *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, support either of the following:*   + *Alt CA.1: gNB/UE performs multiple LBT, one for each channel bandwidth separately*   + *Alt CA.3: gNB/UE performs multiple LBT, one for each CC over the transmission bandwidth (from the lowest RB to the highest RB used for the transmission in the CC)*   + *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*   + *The decision on multi-carrier transmission in intra-band CA should depend on the one on single carrier transmission.* |
| OPPO | **Proposal 1: Take NRU R16 framework as a baseline for LBT bandwidth definition, i.e.**   * **For LBT performed by UE, the LBT bandwidth is equal to the active UL BWP, unless the network configures smaller bandwidth granularity as LBT bandwidth.** * **For LBT performed by gNB, the LBT bandwidth is equal to usable channel bandwidth, unless the network configures smaller bandwidth granularity as LBT bandwidth.** |
| Panasonic |  |
| Qualcomm | Proposal 1: 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. FFS how to indicate the aggregated LBT bandwidth from the COT initiating node to the COT sharing node.  Proposal 2: For multi-carrier transmission in intra-band CA, support Alt-CA.1, Alt-CA-2, and Alt CA.5 as implementation choices, as long as the aggregated LBT bandwidth covers the transmission bandwidth.  Proposal 3: Consider specifying the maximum number of LBT-Bandwidth units a UE can sense as a UE capability. |
| Samsung | **Proposal 2: Support Alt SC.1, CA.1, and CA.2 as the first preference, and SC.3 and CA.5 as the second preference.** |
| Sony |  |
| Spreadtrum Comm. | ***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*** |
| vivo | Proposal 4: For single carrier transmission, 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 5: Down-select the LBT schemes for multi-carrier transmission in intra-band CA after the LBT scheme for single carrier is determined. |
| WILUS Inc. |  Proposal 1: We support  o Alt SC.3 for LBT on single carrier transmission.  o At least Alt CA.1 or Alt CA.5 for LBT on multi-carrier transmission in intra-band CA. |
| 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***. |
| ZTE Sanechips | Proposal 1: 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”should be considered to be supported, considering channel access probability and spectrum utilization and friendly and fair coexistence between the same systems or different systems.  Proposal 2: 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 3: 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 introduce a clear the definition of nominal bandwidth.  Proposal 4: 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. |

### First round discussion

From the papers submitted, we collected the support for different alternatives as follows:

For LBT for single carrier transmission:

* Alt SC.1. gNB/UE performs LBT over the channel bandwidth (or BWP bandwidth)
  + Support: vivo, Spreadtrum, Samsung, Qualcomm, OPPO, Nokia, Intel, Huawei, Ericssson, Apple
* Alt SC.2. gNB/UE performs LBT over the transmission bandwidth (from the lowest RB to the highest RB used for the transmission)
  + Support: Ericssson, CATT, CAICT
* 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
  + Support: ZTE, Xiaomi, WILUS. Qualcomm, OPPO, Nokia, LGE, Lenovo, InterDigital, Charter

For LBT for multi-carrier transmission in intra-band CA,

* Alt CA.1. gNB/UE performs multiple LBT, one for each channel bandwidth separately
  + Support: WILUS, Spreadtrum, Samsung, Qualcomm, Nokia, InterDigital, Intel, Huawei, Ericssson, Apple
* Alt CA.2. gNB/UE performs single LBT over all CCs
  + Support: Samsung, Qualcomm, Huawei
* 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)
  + Support: Ericsson, CATT , CAICT
* 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)
  + Support:
* 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
  + Support: ZTE, WILUS, Qualcomm, Nokia, Lenovo, InterDigital

Discussion point 2.2.1-1 (on hold)

Discuss the following approaches:

* Approach 1: Down-select the above alternatives
  + Vivo (SC.3 for gNB, SC.1 for UE), Intel, FW (SC.1 preferred), DCM, ZTE, LGE, Convida, WILUS, Lenovo (SC.3, CA.5), Spreadtrum, CATT, Oppo, Apple, Sony
* Approach 2: Support multiple or all of the alternatives, but leave how to perform LBT to implementation, as long as the (combined) LBT bandwidth covers the transmission bandwidth
  + Support: Ericsson, Nokia (after some down-selection), Samsung, Qualcomm, MTK

From the discussion, seems that majority view is to continue down-selection. Given the support received so far, shall we down-select to the following:

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| Company | View |
| Ericsson | Approach 2 is preferred. |
| vivo | The LBT bandwidth for gNB and UE can be discussed separately.  For single carrier case:   * For gNB, Alt SC.3 can be adopted for the sake of flexibility when there are narrow band RATs in the vicinity. * For UE, Alt SC.1 is preferred since UE is not allowed to transmit in non-contiguous resources, therefore, it make no sense to perform multi-channel LBT for UL transmission. Since EDT is a function of the operation channel bandwidth, Alt SC.2 is not preferred. The EDT will change every time according to the transmission bandwidth.   For intra-band CA, the LBT bandwidth should be determined after the decision on the LBT bandwidth for single carrier. |
| Intel | We prefer approach 1. Approach 2 may eventually lead even in deployments with only NR operators that networks and devices may performing LBT differently resulting in co-existence issues, and the adjustment in ED threshold based on operating channel would be meaningless, since these could be calculated differently based on the LBT implementation and alternative supported. |
| Futurewei | We prefer Alt SC 1, it is simpler. We are open to discuss Alt SC 2 and Alt SC 3, which require additional design decisions and may be added later. |
| DOCOMO | We prefer Approach 1. The unified condition to determine whether to initiate transmission(s) should be applied to the transmission(s) with the same bandwidth in our view. If we take Approach 2, the conditions would be varied depending on the LBT bandwidth determined by implementation. Even if Approach 2 is taken, the range of LBT bandwidth has to be narrowed-down somehow. |
| ZTE, Sanechips | We prefer Approach 1 and share similar view with vivo. That is, we should down-select LBT bandwidth for signal-carrier case first and then further determine that of multi-carrier. |
| LG | Although the definition of LBT bandwidth is ambiguous in the regulation, it may be necessary to define a unit LBT bandwidth. The channel access probability may be reduced if the gNB/UE should always perform channel access procedure on large bandwidth more than necessary. On the contrary, if the gNB/UE adjusts the LBT bandwidth per transmission (i.e., according to the transmission bandwidth), it may cause coexistence issues with other incumbent system (e.g., WiGig) and also create high overhead for regulatory testing.  Therefore, it is necessary to define a unit of LBT bandwidth and for gNB/UE to perform LBT in all the LBT units (to be transmitted in) in the channel bandwidth. Unlike NR-U, the LBT bandwidth of 60GHz may have a structure in which multiple BWPs/CCs are confined within only a single LBT bandwidth. In other words, one BWP/CC smaller than a LBT bandwidth does not overlap with multiple LBT bandwidths. When the unit LBT bandwidth is defined, it is no need to distinguish between single-carrier LBT and multi-carrier transmission LBT. Moreover, the operating channel bandwidth of the baseline ED threshold formula can also be calculated by replacing with the unit LBT bandwidth. |
| Convida Wireless | We prefer Approach 1. |
| WILUS | We prefer Approach 1 |
| Nokia, NSB | We are ok with approach 2, assuming that we will do at least some down-selection of alternatives, to avoid excessive specification effort. The choice of LBT mechanism used can be up to implementation (at least of the gNB). |
| Lenovo, Motorola Mobility | We refer Approach 1 and support Alt SC 3 and CA 5. |
| Spreadtrum | We prefer approach 1. Regarding approach 2, in case of COT sharing, there are some issues if gNB and UE have different LBT mechanisms. For example, if the gNB accesses the channel through the LBT mechanism of alt SC.2, and shares the COT with the UE. But if the UE only support alt SC.1, the UE may not be able to access the channel due to different energy detection results. |
| CATT | We prefer approach 1. We observer the value of EDT increases with increasing LBT bandwidth. Since the transmission bandwidth is always no larger than channel bandwidth, the EDT for Alt SC.1 will be always no larger than the EDT for Alt SC.2. The following figure shows that although the gNB/UE performs LBT according to Alt SC.1 and Alt SC.2 respectively, the actual detected energy is the same value. Note that the values of the EDT for two cases are not same. Alt SC.2 can provide more accurate LBT result on the transmission bandwidth. The UE already knows the frequency transmission resource before the LBT. Therefore, Alt SC.2 should be supported at least for UL transmission.  When Alt SC.3 is supported, considerable standard effects will be introduced, such as how to deal with the case where only partial LBT units within channel bandwidth are successful and so on.    If we leave how to perform LBT to implementation as long as LBT bandwidth covers the transmission bandwidth, Approach 2 may cause relaxation of LBT measurement. |
| OPPO | We support Approach 1. And we don’t understand approach 2. If it is up to implementation, basically, it does not make sense to say support all alternatives, because we don’t even know what alternatives are. Are they the ones only appeared above? Or are there possibly other alternatives? |
| Apple | We prefer approach 1. We do not see benefit of approach 2. It can create coex issue even within NR system as Intel commented. We prefer Alt SC1. |
| Samsung | We prefer Approach 2. |
| InterDigital | For single carrier, we prefer Alt SC.3.  For multi-carrier, we prefer Alt CA.1 or Alt CA.5 or a combination thereof. That is, an LBT BW unit should not cover multiple CCs.  Given that this can have an impact on EDT, we believe that at least Approach 1 is require. However, in the end we are fine with supporting multiple (though not all) alternatives (e.g. Approach 2). |
| Huawei, HiSilicon | Support Approach 1 as long as it is clarified “down-select” does not mean “select only one alternative”.  The Discussion point is formulated a bit unclearly. What if we agree only 2 or 3 alternatives out of 5 for multi-carrier transmission are supported? We both “down-select” (Approach 1) and support “multiple alternatives” (Approach 2). For the sake of progress, and as we do believe that some down-selection should be made, we can agree with Approach 1 as long as it is clarified “down-select” does not mean “select only one alternative”. In particular, for the multi-channel case we support both Alt CA.1 and Alt. CA.2.  To make a case for down-selection, it can be seen that some alternatives are essentially equivalent to some other alternatives yet with more implications on the complexity and/or energy consumption.  For instance, Alt SC.2 compared to Alt SC.1, would lead to relatively increased complexity since the energy measurements and sampling in the frequency domain would be tied to the dynamic frequency domain allocation of the potential transmissions(s) in contrast to the semi-statically configured bandwidth of the channel/BWP. Alt SC.2 does not seem to have much support from companies compared to Alt 1.  Also, Alt CA.3 and Alt CA.4 are more complex equivalents of Alt CA.1 and Alt CA.2, respectively, while they do not seem to have much support either (none for CA.4 so far ).  Therefore, it makes more sense to down select the simpler alternatives, especially that the proposal is applicable to UEs as well.  Furthermore, defining a fixed unit of LBT bandwidth is quite restrictive as it may not be suitable for different channel bandwidths and a small unit of LBT bandwidth would significantly increase the computational complexity and energy consumption of the LBT procedure. |
| Sony | We prefer Approach 1 and support Alt SC.1 and Alt CA.1. |
| Mediatek | Provided LBT covers the channel bandwidth intended to be used beyond this it can be left to implementation on how to achieve this. Support Approach 2. |

### Second round discussion

From the first round discussion, seems that most companies prefer to continue down-selection. The next proposal tries to capture the alternatives with more supports and continue down-selection from these remaining alternatives.

Proposal 2.2.2-1:

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.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

Please provide your view:

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| Company | View |
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## 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

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| **Company** | **Key Proposals/Observations/Positions** |
| Apple | Proposal 9: Within 5us slot, 802.11ad sensing structure can be used as the starting point. Sensing time and accuracy requirement need further study.  Proposal 10: Only one sensing is required in 8us initial sensing period. Reuse the same 5us slot structure. |
| AT&T |  |
| CAICT | ***Proposal 3: One measurement for energy measurement in 8us deferral period is proposed.***  ***Proposal 4: the minimum duration of one measurement in 5us observation slot equals the length of one symbol length for 480kHz and the measurement is in the middle of 5us observation slot.*** |
| CATT | **Proposal 11: Considering LBT for multi-beam operation, deferral period should be extended to 10us for multi-bean operation.** |
| Charter Comm. |  |
| Convida Wireless |  |
| Ericsson | Proposal 17 For energy measurement in 8 µs deferral period, Alt2 is preferred.  Proposal 18 For energy measurement in 5 µs, the duration can be implementation dependent.  Proposal 19 For the location of the energy measurement in 5us, it can be implementation dependent. |
| Fujitsu |  |
| FUTUREWEI |  |
| Huawei HiSilicon | ***Proposal 6: For operation in NR-U-60, when LBT is used, the 5us observation slot contains a measurement duration X us starting after Y us from the slot start such that Y+X<4us, where X<3us and 0us<Y<1us.***  ***Proposal 7: For operation in NR-U-60, when LBT is used, support one energy measurement in the 8us deferral period, i.e., Alt 2 in the agreement made in RAN1#104-e.***   * ***Td consists of a Tf duration immediately followed by a 5us slot duration, and Tf=3us does not include any measurement duration.*** |
| Intel Corporation | **Proposal 1: Alt-1 is supported and the 8us observation period is divided into two slots of 3 and 5us, respectively.** |
| InterDigital Inc. |  |
| ITRI |  |
| Lenovo Motorola Mobility |  |
| LG Electronics |  |
| MediaTek Inc. |  |
| NEC |  |
| Nokia Nokia Shanghai Bell | ***Proposal 9:*** *We prefer Alt. 1, two energy measurements, for the deferral period.*  ***Proposal 10:*** *The location of the energy measurement within the 5 us observation slot is left for implementation.* |
| NTT DOCOMO INC. |  |
| OPPO | **Proposal 2: two energy measurements are required during a 8us deferral period.**  **Proposal 3: a minimum measurement duration of 2us at the start of a 5us sensing slot can be considered.** |
| Panasonic |  |
| Qualcomm | Proposal 15: Consider the use of two energy measurements for deferral period and \*one\* for contention slot.  Proposal 16: Consider deployment bandwidth dependence on the minimum sensing duration requirement. |
| Samsung |  |
| Sony |  |
| Spreadtrum Comm. | ***Proposal 6: Two energy measurements are required for 8us deferral period.***  ***Proposal 7: The duration of the measurement should be 3us for 5us observation slot.*** |
| vivo |  |
| WILUS Inc. | Proposal: We propose to support Alt-2 that one measurement is required for energy measurement in 8us deferral period. |
| Xiaomi |  |
| ZTE Sanechips | Observation 8: For 8us deferral period, two energy measurements are performed in 3us observation slot and 5us observation slot, respectively.  Observation 9: Single energy measurement is performed in 5us observation slot.  "Observation 10:   The location of energy measurement can be anywhere in each observation slot.   The length of energy measurement can be further discussed." |

### First round discussion

Discussion point 2.3.1-1 (closed):

For energy measurement in 8us deferral period:

* Alt 1. Two energy measurements are required
  + Support: ZTE, Spreadtrum, Qualcomm, OPPO, Nokia, Intel, Vivo, Lenovo,
* Alt 2. One measurement is required
  + Support: Huawei, Ericsson, CAICT, Apple, FW, LG, WILUS, Nokia (also fine), Spreadtrum (also fine), Samsung, MTK
* Alt 3. Extend the 8us to 10us and perform two measurements, one in each 5us segment
  + Support: CATT, Qualcomm

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| Company | View |
| Ericsson | Alt 2 is the baseline and preferred approach. Alt 1 can be done by implementation. |
| vivo | Alt-1 can be supported. |
| Intel | Alt-1 is preferred, since it would mitigate any misdetection deriving from a single measurement performed at the tail of the 8us deferral time. In fact if a single measurement is performed, the assumption is that in the first X us of the deferral period the channel would be idle, when in reality depending on when the measurement would be perform, X may be actually ~ 5us, which would be enough for an entire SIFS to be transmitted while undetected. |
| Futurewei | We agree with Ericsson , Alt 2 should be the baseline. |
| ZTE, Sanechips | We prefer Alt 1 and such design has been specified in LAA and NR-U. from this point of view, we do not see a strong reason to introduce a new way of energy measurement. |
| LG | We think that Alt-2 can be the baseline. |
| WILUS | We prefer Alt-2 which has one energy measurement for 8us deferral period by considering 5us observation slot similar to define performing one energy measurement for 16us Cat-2 LBT in Rel-16 NR. |
| Nokia, NSB | We have a preference for Alt 1,but are also ok with Alt 2. |
| Lenovo, Motorola Mobility | Support Alt 1 |
| Spreadtrum | We prefer Alt-1. But we are ok with Alt 2. |
| CATT | Alt 3 is preferred, and it should be supported in the case where gNB/UE is expected to perform LBT for different beam simultaneously. Once the one observation slot is detected as busy state, the gNB/UE requires performing energy detection in an additional deferral period. As shown in the following figure, there is an additional deferral period on the beam2. When the deferral period is extended to 10us, the edge of the subsequent observation slots on beam2 can still align with other beams, which can bring benefits to perform LBT on different beams simultaneously. |
| OPPO | Alt-1 |
| Apple | The motivation for 2 sensing within 8us seems to be better accuracy. Does this imply NR will define two sensing requirements for 8us and 5us separately?   * If only one sensing requirement, then Alt 2 is baseline. Equipment can perform 2 sensing, or one longer sensing, or the same sensing structure as 5us slot by implementation within 8us, as long as it meets the requirement. * If two sensing requirements are defined, we can further discuss the sensing structure for 8us and 5us separately, and whether it is up to implementation as updated in 802.11ad-2020.   We see Alt 2 is the simple way to go, based on regulation requirement and 802.11ad specification. |
| Samsung | Since there is no requirement in the regulation, Alt 2 is a simpler way and preferred by us. |
| Huawei, HiSilicon | We support Alt 2  Since a device may transmit immediately after Td=8us, it should be intuitive that Td should end with a 5us observation slot. Therefore, if another measurement is required it would have to be conducted in the remaining 3us interval which would be quite difficult to achieve in practice.  More importantly, given the operation is in a shared spectrum, it is important that the measurement duration is not much longer than that used by other coexisting technologies over the same interval to ensure a fair spectrum sharing. It is noted then that the 3us aSIFSTime in 802.11ad/ay does not include aCCATime. |
| Qualcomm | We understand Alt 2 is simpler. However, the problem with Alt 2 is, if the counter is zero, the node will acquire the channel with single measurement (within 8us) and if the single measurement passes, it will acquire the channel. Seems that there is no protection against the measurement falls in a very short gap.  We actually see CATT proposal as an interesting compromise. In this case, we only need to define 5us sensing. |
| Mediatek | For energy measurement in 8us or 5us deferral period there should be a single measurement with duration of 8us or 6us respectively less an implementation margin for radio Rx to Tx turn-around time. This implementation margin should be exactly that, left to implementation and not specification. There is no need to specify anything beyond this. Breaking this into multiple measurements is adding complexity where none is needed or warranted or indeed inline with the spirit of the regulation. |

### Second round discussion

From the first round discussion, but Alt 1 and Alt 2 has strong support. It is recommended to continue down-selection between Alt 1 and Alt 2. It might be possible to treat Alt 3 as implementation.

Discussion point 2.3.2-1:

For energy measurement in 8us deferral period, continue down-selection between the following alternatives

* Alt 1. Two energy measurements are required
* Alt 2. One measurement is required

Please provide your view:

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| Company | View |
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For the 5us observation slot, we still have the duration and location for the single measurement as FFS. For the duration, it might be too early to decide. For the location of the measurement, I wonder if we can leverage what we have in NR-U 9us observation slot and leave it as implementation.

Proposal 2.3.2-2:

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.

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| Company | View |
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## COT Sharing

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 2. Define a maximum gap X, such that a later transmission can share the COT without LBT only if the later transmission starts within X from the end of the earlier transmission
  + FFS: Value for X
* 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

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| **Company** | **Key Proposals/Observations/Positions** |
| Apple | Proposal 11: 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. |
| AT&T |  |
| CAICT | ***Proposal 5: Alt.3 should be supported for COT sharing.*** |
| CATT |  |
| Charter Comm. | Proposal 3: For COT sharing, support Alt 1. No maximum gap defined. A later transmission can share the COT without LBT with any gap within the maximum COT duration. |
| Convida Wireless |  |
| Ericsson | Proposal 15 Support Alt 1 for gaps in COT sharing. |
| Fujitsu |  |
| FUTUREWEI | Proposal 7: Support 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, a one-shot LBT is needed to share the COT  • Where Y (for all SCS) may be the time duration of 3 symbols (@120 kHz SCS  • Where One-shot LBT duration (for all SCS): the time duration of 1 symbol @ 120kHz SCS |
| Huawei HiSilicon | ***Proposal 15: For COT sharing without LBT in NR-U-60, no maximum gap is defined and a later transmission from a responding device can share the COT without LBT irrespective to the gap duration within the MCOT.***   * ***Any gap duration should be counted in the COT duration***   ***Proposal 16: Support introducing CAT2 LBT for 60GHz unlicensed band operation (Alt 2 in the agreement made in RAN1#104-e).***   * ***Support only use cases related to COT initiation, i.e., starting transmission on a secondary channel in Type B multi-channel access, and energy measurement and reporting of Rx-assistance information by the receiver in Rx-assisted LBT.*** |
| Intel Corporation |  |
| InterDigital Inc. | ***Proposal 15****: When COT sharing, a UE determines what LBT to use based on the gap duration between the upcoming transmission and a previous transmission on the same beam.* |
| ITRI |  |
| Lenovo Motorola Mobility | Proposal 15: 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 16: 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 17: 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. |
| LG Electronics |  |
| MediaTek Inc. |  |
| NEC | Proposal 2: 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. |
| Nokia Nokia Shanghai Bell | ***Proposal 22:*** *On maximum gap within a COT to allow COT sharing without LBT, we support either Alt. 1 or Alt. 2*  ***Proposal 23:*** *In case of Alt.2 for COT sharing without LBT, the maximum time gap X is at least longer that PDSCH processing time and PUSCH preparation time.* |
| NTT DOCOMO INC. |  |
| OPPO | **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, an one-shot LBT is needed to share the COT. The value of Y is 8us or 13us.** |
| Panasonic |  |
| Qualcomm | Proposal 9: Support Alt 1 (no maximum gap defined), but if Cat 2 LBT define, optionally allow the initiating device to trigger the responding device to use Cat 2 LBT to sense the channel before starting COT sharing transmissions. |
| Samsung |  |
| Sony |  |
| Spreadtrum Comm. | ***Proposal 8: Regarding COT sharing, no maximum gap is needed.*** |
| vivo | **Proposal 6: 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.** |
| WILUS Inc. |   *Proposal 2: We support Alt-1 since it seems no need to define a maximum gap for COT sharing within the maximum COT duration from the ETSI regulation perspectives.* |
| Xiaomi | Proposal 7: Support Alt.3 on maximum gap within a COT to allow COT sharing without LBT. |
| ZTE Sanechips |  |

### First round discussion

Discussion point 2.4.1-1 (closed)

On maximum gap within a COT to allow COT sharing without LBT

* Alt 1. No maximum gap defined. A later transmission can share the COT without LBT with any gap within the maximum COT duration
  + Support: Apple, Charter, Ericsson, Huawei, Nokia, Qualcomm, Spreadtrum, Vivo, WILUS, Intel, Convida, CATT, Qualcomm
* Alt 2. Define a maximum gap X, such that a later transmission can share the COT without LBT only if the later transmission starts within X from the end of the earlier transmission
  + Support: Nokia, MTK
* 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
  + Support: CAICT, FUTUREWEI, InterDigital, Lenovo, NEC, OPPO, Xiaomi, Intel, DCM, ZTE, LGE, Convida, Nokia (also fine), CATT, Qualcomm, Samsung, Sony

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| Company | View |
| Ericsson | Alt 1 is preferred. |
| vivo | Alt-1 is supported. According to the ETSI BRAN regulation, no maximum gap is specified. Therefore, we prefer not to impose additional constrains. |
| Intel | We support both Alt.1 and Alt. 3. Alt-3 would be used only in case single shot is enabled by the network. |
| Futurewei | We prefer Alt 3. Without a maximum gap allowable defined in a COT, there is no proper COT sharing or ownership. |
| DOCOMO | Alt.3 can be considered as possible option for the operation in case where collision probability is relatively high. For other cases, a later transmission can share the COT without LBT with any gap within the maximum COT duration. |
| ZTE, Sanechips | We prefer Alt.3. if there is no define a maximum gap within COT, this will lead to the risk of channel during channel occupancy especially for scenario of denser layouts. |
| LG | We added our related proposal to above table, and we support Alt-3. Similar to NR-U, if the gap between the transmissions is larger than the maximum gap, the COT acquired by the initiating device cannot be maintained and the collisions may occur by the transmissions from other devices that sensed the channel to be idle. |
| Convida Wireless | We prefer Alt 1 and Alt 3. |
| WILUS | We support Alt-1 since it seems no need to define a maximum gap for COT sharing within the maximum COT duration from the ETSI regulation perspectives. |
| NEC | We prefer Alt 3. Regarding the gap in a COT which is far great than the sensing deferral period for initiating the channel access, defining the maximum gap is necessary for fair channel occupancy without leading to unintentional interference from other nodes. With an additional LBT, later transmission still can share the COT. |
| Nokia, NSB | We see Alt 2 as a sensible middle-ground option, but for the sake of progress we can narrow down to Alt1 and Alt3 for further discussion. Between Alt and Alt 2, our preference is to go with Alt 1. |
| Lenovo, Motorola Mobility | We support Al 3. If no maximum gap is defined, and channel can be accessed without LBT within the maximum COT duration, there is a possibility that channel can become occupied. |
| Spreadtrum | We prefer Alt 1. So far the ETSI HS EN 302 567 does not mandate any maximum gap for COT sharing. Additional restriction beyond the regulation in ETSI HS EN 302 567 should not be introduced to 60GHz band. |
| CATT | We support both Alt 1 and Alt 3. Whether applying Alt 1 or Alt 3 could be configurable. |
| OPPO | Support Alt-3, and we are against Alt-1, this will cause conflicting issue. If the max gap is not introduced, the responding UE can transmit without LBT even after a long duration. Then there would be likely that the channel is occupied by other device as shown in figure below, resulting in confliction. |
| Apple | Alt 1 is preferred.  EN 302 567 does not specify the gap to keep the regulation technology agnostic. |
| Samsung | Alt 3 is preferred for a co-existence consideration when recovering a transmission. |
| InterDigital | Alt-2 or Alt-3. The only difference between the two is that Alt-3 says that if LBT is required, it would be a one-shot LBT. The LBT type can be determined after deciding whether a gap can lead to an LBT within a COT.  We believe that it is especially important to consider LBT in a COT if a COT is used for TDM on multiple beams. In such a case, an LBT on a beam done at the beginning of a COT may not be relevant by the time transmission on that beam occurs later in the COT. Therefore, the gap should be measured between two transmissions on the same beam (or between the time of last LBT on the beam and transmission on the beam). |
| Huawei, HiSilicon | Support Alt 1 with the further clarification that any gap duration should be counted in the COT duration.  We do not see the need to restrict the scheduling within the COT by applying restrictions on the gap between transmissions, and to even further increase the LBT overhead and the complexity of the channel access procedures by introducing additional LBT instances within the COT. |
| Sony | We prefer Alt 3. If there is long gap between transmission, other device may start to transmit signal during the gap. One-shot LBT is beneficial to detect the transmission from the other device. |
| Mediatek | There is nothing in EN 302 567 to suggest that a gap in transmission can occur without first a completely new channel access procedure unless the gap is sufficiently short to appear like a single transmission. Alt 2 is the closest fit to what is currently written in EN 302 567. |

### Second round discussion

From the first round discussion, seems that Alt 1 and Alt 3 have more support. It is suggested to continue down-selection between Alt 1 and Alt 3.

Proposal: 2.4.1-1:

On maximum gap within a COT to allow COT sharing without LBT, further down-select between Alt1 and Alt3:

* 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

Please provide your view:

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| Company | View |
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## 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** |
| Apple | Proposal 12: No CAT-2 LBT needs to be defined for COT sharing. |
| AT&T | 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) |
| CAICT | ***Proposal 6: Cat2 LBT should be supported.*** |
| CATT |  |
| Charter Comm. | Proposal 4: Do not introduce Cat 2 LBT for 60GHz unlicensed band operation. |
| Convida Wireless |  |
| Ericsson | Proposal 14 Do not support CAT2 LBT in 60 GHz unlicensed band. |
| Fujitsu |  |
| FUTUREWEI | Proposal 6: Support Alt 2: Introduce Cat 2 LBT for 60GHz unlicensed band operation. |
| Huawei HiSilicon |  |
| Intel Corporation | Proposal 11: Cat-2 LBT is introduced for 60 GHz unlicensed band operation. |
| InterDigital Inc. |  |
| ITRI |  |
| Lenovo Motorola Mobility |  |
| LG Electronics | Proposal #9: Type 2 (e.g., 2A/2B/2C) channel access procedure can be introduced for the use cases such as COT sharing, multi-beam LBT, and Rx-Assistance and the maximum gap Y between the transmissions within the COT can be defined for above 52.6 GHz. |
| MediaTek Inc. | **Proposal 8: Whether to introduce cat 2 LBT or not can be determined by discussing its applicability in the potential use cases first.** |
| NEC | Proposal 3: Cat 2 LBT for 60 GHz unlicensed band operation should be introduced. |
| Nokia Nokia Shanghai Bell | ***Proposal 3****: Decide on Cat-2 LBT support separately for gNB and UE.*  ***Proposal 4****: Do not support Cat-2 LBT at the UE side.*  ***Proposal 5****: Do not support Cat-2 LBT at the gNB side unless required for SSB transmission.*  ***Proposal 15:*** *One-shot LBT within COT is not required before gNB beam switch between SSBs* |
| NTT DOCOMO INC. | Proposal 3: 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.   Other use cases can be studied further |
| OPPO | **Proposal 9: introduce Cat-2 LBT with a sensing duration of 13us, which further consists of an 8us duration followed by a 5us sensing slot.** |
| Panasonic |  |
| Qualcomm | Proposal 7: If any Cat 2 LBT procedure before beam switch is considered, let it be optional/configured and not mandatory.  Proposal 8: Consider defining Cat 2 LBT as a sensing/measurement. Consider the use of such Cat 2 LBT sensing as an optional/configured and triggered component of LBT procedures in all the 4 use-cases above and for Multi-channel medium access. |
| Samsung | **Proposal 3: 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.** |
| Sony | **Proposal 4: Support fixed Contention Window. ·           gNB’s contention windows size is left to network implementation. ·           UE’s contention window size is configured by network.**  Proposal 5: Introduce Cat 2 LBT for 60 GHz unlicensed band operation |
| Spreadtrum Comm. | ***Proposal 9: Cat 2 LBT should be supported for 60GHz unlicensed band operation.***  ***Proposal 10: Cat 2 LBT may be used in case of Multi-Beam LBT or Receiver-Assistance.*** |
| vivo | **Proposal 7: 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.**  **Proposal 8: If Cat 2 LBT is introduced, both Type A and Type B multi-channel channel access can be supported.** |
| WILUS Inc. | ü  Proposal 4: We support Alt-2 to introduce Cat 2 LBT for 60GHz unlicensed band operation. |
| Xiaomi | Proposal 2: COT sharing/ resuming and receiver assisted LBT should be discussed and determined first, then we can decide whether or not to introduce Cat 2 LBT. |
| ZTE Sanechips |  |

### First round discussion

Discussion point 2.5.1-1:

On the support of Cat 2 LBT”

* Alt 1: Do not introduce Cat 2 LBT for 60GHz unlicensed band operation
  + Support: Apple, Charter, Ericsson, Nokia, MTK
* Alt 2: Introduce Cat 2 LBT for 60GHz unlicensed band operation
  + Support: FUTUREWEI, Intel, LGE, NEC, DOCOMO, OPPO, Qualcomm, Samsung, Sony, Spreadtrum, Vivo, WILUS, AT&T, ZTE, Convida, Lenovo, Panasonic, CATT, IDC, HW

Other: By Use case: MediaTek, Xiaomi

Seems more discussions are needed

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| Company | View |
| Ericsson | Alt 1 is the preferred option.  Our simulation studies do not show any gain due to introduction of additional CAT2 LBT for COT sharing. In another contribution submitted to this meeting, simulation results do not show any gain due to introduction of additional Cat-2 LBT during beam switching at gNB during a COT. It is noteworthy that CAT2 LBT is not specified in the ETSI HS EN 302 567. It is beneficial to keep UE-side simple and not implement CAT2 LBT when it is not needed. |
| vivo | We prefer Alt-2. Cat 2 LBT can be introduced in 60GHz unlicensed operation for the following scenarios: before response with assistant information at the receiver, beam switching within a COT with TDM beams, Type-B multi-channel channel access |
| Intel | Alt-2 is preferred. In our understanding single shot LBT still provides high value to the system under certain circumstances. While we acknowledge that in average, Cat-2 LBT may not provide any gains considering the directive nature of the transmissions, it is important to highlight that the design should also keep in mind the QoS of the cell edge users, which may be the one more highly impacted. |
| Futurewei | Alt-2 is preferred. |
| AT&T | We prefer Alt. 2 esp. before switching to a new transmission beam in a COT with TDM beams or resume a previously used transmission beam after a gap |
| DOCOMO | Support Alt 2 as captured above. There is actually a regulation in which only “carrier sense” is required before initiating transmission(s) e.g. in Japan. It would be beneficial to support LBT with simpler sensing structure (e.g. cat-2 LBT) in such region. |
| ZTE, Sanechips | We prefer Alt 2 that will be at least beneficial to support some cases: COT sharing, TypeB multi-channel channel access, receiver assistance. |
| LG | Type 2 (e.g., 2A/2B/2C) channel access procedure can be introduced for the use cases such as COT sharing, multi-beam LBT, and Rx-Assistance. The definition of Type 2 (e.g., 2A/2B/2C) channel access procedure in Rel-16 NR-U can be reused with possible modifications to the parameters such as the gap duration for each type of LBT. |
| Convida Wireless | We prefer Alt 2. |
| WILUS | We prefer Alt-2. It might be quite useful to apply Cat-2 LBT for the device at least for the use cases such as resuming transmission after a certain gap, multi-beam LBT in multiple beam operation, COT sharing between an initiating node and a responding node for the fair coexistence with other technologies or other RAT using unlicensed band. |
| NEC | We support Alt2, and be open to discuss the definition and use cases in detail for Cat 2 LBT. |
| Nokia, NSB | Unlike e.g. 5 GHz regulations, ETSI EN 302 567 does not recognize Cat 2 LBT, and we have not identified a need for that either. Furthermore, one should clarify the use case(s) for which Cat 2 LBT is needed before introducing it in general. |
| Lenovo, Motorola Mobility | Support Alt 2 and it is applicable to use cases of COT sharing, in case of receiver assistance, beam switching within COT with TDM |
| Spreadtrum | We prefer Alt 2. We believe that Cat-2 LBT can be used as a tool to mitigate interference from other sites, at least for the case of multi-beam LBT. |
| Panasonic | Alt-2 is preferred. Cat-2 LBT is useful at least for beam switching of TDM beams in a COT. |
| CATT | Alt 2 is preferred. |
| OPPO | Support Alt-2 |
| Apple | Alt-1 is preferred.  One shot CAT2 LBT is not defined either in EN 302 567. We have not seen benefit to define CAT-2 LBT so far. |
| Samsung | We support Alt 2 as indicated in the summary. Alt 2 LBT is still needed for use cases especially for directional sensing. Also, supporting Alt 2 LBT for 60 GHz can reduce the spec impact. |
| InterDigital | Alt-2 is preferred |
| Huawei, HiSilicon | Support Alt-2.  Please note that we have added our missing Proposal 16 from our tdoc R1-2102332 in the table above  Our view is that introducing such short one-shot LBT is beneficial for procedures related to COT initiation rather than for transmitting within the COT. For instance, the benefits of Type B multi-channel access procedures cannot be realized without introducing CAT2 LBT to initiate a CO on a ‘secondary’ channel. Furthermore, on initiating a CO using Rx-assisted LBT, CAT2 LBT can be used for energy measurement at the receiver and providing the Rx-assistance information from only the devices that pass the LBT.  Therefore, we support Alt 2 in principle but the use of CAT2 LBT should be limited to only agreed use cases |
| Sony | We prefer Alt-2. Cat 2LBT is beneficial for several use cases such as COT sharing, multi-beam LBT and resuming transmission after gap on COT. |
| Mediatek | CAT-2 LBT is not justifiable under what is currently written in EN 302 567 therefore we support Alt 1. |

## 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** |
| Apple | Proposal 14: Consider AP-CSI enhancement for inter-cell interference coordination. |
| 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 |
| CAICT |  |
| CATT | **Proposal 12：The receiver assistance information can be designed base on the A-CSI feedback framework.** |
| Charter Comm. |  |
| Convida Wireless |  |
| Ericsson | |  | | --- | | Proposal 12 Support Alt 1 and 2. New receiver assistance mechanisms such as Alt 3 requires further studies and clarifications with all overheads and processing delays considered. | | Proposal 13 If any enhancements to better support receiver assisted channel access are to be specified at all, it should be based on CSI reporting enhancement as currently being discussed in the URLLC WI, with potential enhancements to the CSI report type and the CSI processing timeline. | |
| Fujitsu | **Proposal 3: To support that gNB determines whether to transmit a PDSCH based on UE’s assistance information, LBT at receiver (Alt 3) is preferred.** |
| FUTUREWEI | Proposal 8: For receiver assisted LBT, support NR CSI-IM based reporting for the clear channel assessment at the receiver.  Proposal 9: For receiver assisted LBT, the receiver shall report the resource map 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. |
| Huawei HiSilicon | ***Observation 3：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.***  ***Proposal 17：For operation in the 60 GHz band, receiver-side LBT should be supported (Alt 3 in the agreement made in the RAN1#104-e).***  ***Observation 5: When No-LBT is used in regions where LBT is not mandated by regulations, the hidden node issue would still persist.***  ***Observation 6: 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 7: 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.*** |
| 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.** |
| 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 4****: Receiver based LBT should be considered for both omni-directional and directional LBT.* | | ***Proposal 5****: Receiver based directional LBT is supported.* | | ***Proposal 6****: A single receiver based directional LBT 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 7****: Enhance legacy RSSI measurements and AP-CSI reporting to enable beam-based receiver assisted channel sensing and reporting.* | | ***Proposal 8****: The UE receives configuration and indication of the channel access mechanism to use (omni-directional, directional, receiver based, no LBT) from the gNB..* | | ***Proposal 9****: The UE can select a channel access mechanism as a function of measurements (e.g. RSRP) or prior LBT performance.* | |
| ITRI |  |
| Lenovo Motorola Mobility | Observation 3: 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 4: 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.  Observation 5: 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 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 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 |
| LG Electronics | Proposal #7: For receiver to provide assistance, adopt Alt 1 (i.e., legacy RSSI measurement and reporting with possible enhancements). |
| MediaTek Inc. | **Proposal 7:Among candidate mechanisms to obtain assistant information from receiver in receiver-assisted LBT, at least RSSI should not be considered.** |
| NEC |  |
| Nokia Nokia Shanghai Bell | ***Proposal 25****. Employ RSSI measurements and CSI reporting as a part of the receiver assistance.*  ***Proposal 26****. Wait for the URLLC discussion to conclude on aperiodic CSI on PUCCH feature.*  ***Proposal 27:*** *Any Rx assistance scheme should be configurable per UE, so that it could be used only with UEs frequently detecting high interference.*  ***Proposal 28:*** *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.*  ***Proposal 29:*** *Rx assistance should not be limited to the beginning of COT only.* |
| NTT DOCOMO INC. | Proposal 4: For Rx assistance, support Alt 1 (Legacy RSSI measurement and reporting with possible enhancements) and/or Alt 2 (AP-CSI report with possible enhancements):   Alt 1 with enhancements to consider beam-related aspects should be a starting point at least for the support of long-term Rx-assistance   Alt 2 should also be considered if the need of short-term Rx-assistance is observed |
| OPPO | **Proposal 12: RTS-like signal can be carried in a PDCCH and CTS-like signal can be carried in a PUCCH.** |
| Panasonic |  |
| Qualcomm | Proposal 10: Any LBT based Rx-Assistance procedure should be made optional/configurable on a per UE link basis.  Proposal 11: Support enhanced RSSI reporting for Rx-Assistance, enhancements include at least L1-RSSI reporting.  Proposal 12: Study further LBT sensing at the receiver with a conditional response from the receiver for Rx-Assistance. Consider the use of CAT 2 LBT for LBT-sensing for Rx-Assistance |
| Samsung | **Proposal 8: Support dynamic RX-assistant channel access mechanism with handshake between transmitter and receiver, e.g. wherein the channel access request is based on DCI and channel access response is based on UCI in a downlink scenario.** |
| Sony | Proposal 9: Receiver assisted LBT should be supported in 60 GHz unlicensed operation. |
| Spreadtrum Comm. | ***Proposal 4: 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.***  ***Proposal 10: Cat 2 LBT may be used in case of Multi-Beam LBT or Receiver-Assistance*** |
| vivo | **Proposal 9: LBT at receiver is supported and Cat 2 LBT can be applied.**  **Proposal 10: The assistant information can include the channel state information at the receiver, such as the LBT results, AP-CSI report.**  **Proposal 11: The transmitter request triggering UE to send assistant information should be studied.**  **Proposal 12: Each transmitter request monitoring occasion corresponds to a receiver feedback transmission opportunity.** |
| WILUS Inc. |  |
| Xiaomi | |  | | --- | | ***Proposal 8: Conditions about whether to enable/disable receiver assisted LBT can be studied.*** | | ***Proposal 9: How to design a receiver assisted LBT with a simpler flow and little spec impact should be considered.*** | | ***Proposal 10:*** ***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.*** | |
| ZTE Sanechips | Proposal 12: For receiver assisted channel access and interference management,   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.   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.   If Cat2 LBT is used for receiver, then Cat4 LBT should be used for transmitter to initiate a COT.t |

### First round discussion

Discussion point 2.6.1-1

On receiver assisted channel access:

* Alt 1. Legacy RSSI measurement and reporting with possible enhancements
  + Support: LGE, MediaTek, Nokia, DOCOMO, Spreadtrum, AT&T, Ericsson, FW, ZTE. Convida, Lenovo, Apple, Sony
* Alt 2. AP-CSI report with possible enhancements
  + Support: Apple, CATT, Ericsson, FUTUREWEI, Inter-digital, Nokia, DOCOMO, AT&T, Spreadtrum, ZTE, Convida (open to discuss), Sony, MTK
* Alt 3. LBT at receiver
  + Support: Fujitsu, Huawei, Vivo ZTE, AT&T, Intel, Convida, Lenovo, Samsung, Sony, MTK
  + Alt 3.1 eCCA
    - Support:
  + Alt 3.2 Cat2 LBT
    - Support: Vivo ZTE

Seems more discussions are needed:

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| --- | --- |
| Company | View |
| Ericsson | We support Alt 1 and Alt 2. Alt 3 needs more information on the details of reporting and measurement. Please see our contribution for further comments.   1. It is unclear what Alt3 represents. From our understanding, Alt2 and Alt3 are similar aperiodic reporting mechanisms with Alt3 having additional overhead in terms of LBT. 2. Support Alt 1 and 2. New receiver assistance mechanisms such as Alt 3 requires further studies and clarifications with all overheads and processing delays considered. |
| vivo | Alt-3 is preferred to solve the hidden node problem by providing prompt assistance information from the receiver. Alt-1 and Alt 2 are existing techniques, which will not additionally improve the performance of the receiver in hidden node scenario. |
| Intel | We support Alt-3. |
| Futurewei | We support Alt 1 and Alt 2. |
| AT&T | We can live with any alternative but are okay with Alt.1 or Alt.2 only for Rel. 17, i.e., to focus on measurement enhancements |
| DOCOMO | Support Alt 1 and Alt 2. |
| ZTE, Sanechips | We prefer Alt 3, but also open to Alt 1 and Alt 2. |
| LG | The additional or new mechanism for the receiver assisted LBT is not necessary because the assistance information or feedback mechanism is already supported by the current specification. In this regard, the legacy RSSI measurement and reporting with possible enhancements are enough for the receiver to provide assistance. |
| Convida Wireless | We prefer Alt 1 or Alt 3, but also open to discuss Alt 2. |
| Nokia, NSB | Alt 1 and Alt 2 are readily available solutions, and will of course be supported. We are in principle open to consider related enhancements, as long as they are building on top of the existing framework.  The definition and the feasibility of Alt 3 as well as the added benefits over Alt 1/2 are unclear. If the UE is expected to report the LBT result to the gNB, will it be any faster than e.g. CSI reporting? |
| Lenovo, Motorola Mobility | We support both Alt 1 and Alt.3 |
| Spreadtrum | We prefer Alt 1 and Alt 2. |
| Fujitsu | We support Alt 3 and share the similar view with vivo. The 3 alternatives are for different use case and should not be exclusive with each other. Alt 3 is beneficial to handle the issue of instant interference incurred by hidden node, which would not be achieved by Alt 1 and Alt 2. |
| CATT | We support Alt 2. |
| Apple | We support Alt-1 and Alt-2 |
| Samsung | We support Alt 3. Actually Alt 3 is not conflicting with Alt 1 or Alt 2, if the enhancement is to include LBT at the receiver side. It would also be good to clarify what are the enhancements considered in Alt 1 and Alt 2, and what’s their relationship and distinguish from Alt 3, then we can do further down-selection with better understanding. |
| Huawei, HiSilicon | We support Alt. 3  In Alt 3, interference measurement is via simple ED during the receiver LBT itself, reporting is conditional on passing that Rx-side LBT, and CO initiation is based on the success of the handshake:    In regard to Ericsson’s comment, we think that the AP-CSI reporting mechanism in Alt.2 would incur more latency and resource overhead and would introduce a more complex handshake for each CO compared to receiver-side LBT. This is due to the following facts   * 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 delay the UE needs to perform a more complex measurement procedure, e.g. including FFT, as compared to simple energy detection as part of LBT, due to the sparse nature of the CSI-RS measurement resource in the frequency domain. * Current processing delays for CSI reports in NR are rather long, which means that such a handshake would also result in increased overhead in time per CO compared to receiver-side LBT. * 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 it is not a legacy mechanism supported in Rel15/16.  Also about the use of legacy RSSI as Rx-assistance in Alt.1, we have the following concerns:   * Legacy RSSI is periodic measurement and thus not representative of the experienced interference immediately prior to data reception. * Legacy RSSI requires resources dedicated for measurements and the resources used by each of the M UEs to report the measurements in UL channels. This also incurs complexity at each UE to conduct and report the measurements periodically regardless of the gNB’s intent to schedule it, as well as the complexity at gNB to continuously process these reports. * Legacy RSSI is less efficient in terms of resource overhead and complexity at both UE and gNB, especially at high load, compared to only 1 or 2 UEs reporting Rx-assistance info upon passing LBT * Configuring shorter periodicities for measurements and reporting further emphasizes the overhead and complexity savings of Receiver-side LBT. |
| Sony | We prefer Alt 3, but also open to Alt 1 and Alt 2. |
| Mediatek | We are open to Alt 2 and Alt 3 and not supportive of Alt 1. Please see proposal in our contribution.  **Proposal 7:Among candidate mechanisms to obtain assistant information from receiver in receiver-assisted LBT, at least RSSI should not be considered.** |

Discussion point 2.6.1-2

On Alt 1 (legacy RSSI measurement and reporting with possible enhancement), we may need some more details on what kind of enhancements we are talking about. Please provide your view below. A list of potential areas for enhancements is captured below. The list will increase as more comments come in.

* RSSI reporting based on comparison with EDT
* Beam specific RSSI measurement and reporting
* ZP-CSI-RS based RSSI measurement
* L1-RSSI reporting possibly in the form of a special CSI report

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| Company | View |
| Futurewei | Based on the decisions regarding the number of measurements in 8 us interval for channel sensing and on the short LBT definition duration, RSSI measuring and reporting may require some changes. For instance, separate measurements in each 8us may be compared with an EDT for the duration of short LBT. |
| DOCOMO | In our understanding, RSSI measurement and reporting supported in Rel-16 would not capture beam-related aspects, e.g. in which direction RSSI/CO is measured and reported. As directional sensing is discussed and may be supported, RSSI/CO measurement and reporting may also need to consider using directional beam(s) for LBT. |
| Lenovo, Motorola Mobility | For measuring 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 |
| Apple | Consider enable omni and directional RSSI and channel occupancy report |
| Qualcomm | Can further consider L1 RSSI reporting to decrease the RSSI delay, possibly in the form for a CSI report |

Discussion point 2.6.1-3

On Alt 2 (AP-CSI report with possible enhancements), we may need some more details on what kind of enhancements we are talking about. Please provide your view below. A list of potential areas for enhancements is captured below. The list will increase as more comments come in.

* AP-CSI report on measurement during LBT duration and values on energy detected

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| --- | --- |
| Company | View |
| Futurewei | Practically only the interference measurement is necessary for the duration of a short LBT duration. |
| DOCOMO | Agree with Futurewei. |
| CATT | The information carried by CSI report can be further extended. For example, the results of LBT or the energy detection level of LBT could be feedback via AP-CSI report. |
| Apple | AP-CSI enhancement for inter-cell interference coordination, based on R17 MIMO enhancement where TCI is associated with PCI. |
| InterDigital | A UE can aperiodically report interference or channel occupancy. Enhancements to enable aperiodic CSI reporting on PUCCH may also be required. |

## Multi-Beam COT and SSB

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

|  |  |
| --- | --- |
| **Company** | **Key Proposals/Observations/Positions** |
| Apple |  |
| AT&T | 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 |
| 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.***  ***Proposal 8: Three alternatives for LBT within a COT with TDM of beams with beam switching should be supported.*** |
| CATT | **Proposal 8：Consider supporting both of single LBT sensing with wide beam and per-beam LBT sensing at the start of COT.**  **Proposal 9:**  **When the beams transmitted within the COT are spatially dispersive, additional LBT before beam switching can be provisioned.**  **Proposal 10: Multi-beam energy detection in one observation slot should be supported to improve the efficiency of the multi-beam LBT.**  **Proposal 11: Considering LBT for multi-beam operation, deferral period should be extended to 10us for multi-bean operation.** |
| Charter Comm. |  |
| Convida Wireless | Proposal 3: 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 4: 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 8: 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. |
| Ericsson | Proposal 10 For time domain multiplexing of DL/UL transmissions in multiple beams when LBT mode is used, support Alt 1 where the definition of “cover” at least supports omni-directional or quasi-omni-directional LBT at the beginning of the COT, and no LBT for the following beams in the COT. |
| Fujitsu |  |
| FUTUREWEI |  |
| Huawei HiSilicon | ***Proposal 13: For initiating a COT with SDM or TDM of different beams, support multiple per-beam LBTs, i.e. Alt 2 in the agreements of RAN1#104-e.***  ***Proposal 14: For initiating a COT with SDM or TDM of different beams, support one LBT beam covering all transmission beams (Alt 1 in the agreements of RAN1#104-e) as a fallback mechanism when the one-to-one correspondence between the LBT beams and transmission beams cannot be established.***   * ***FFS how to specify the spatial relationship of a wide LBT beam covering all the transmission beams.***   ***Observation 1: (Quasi-)omni-directional simplifies the implementation but could lead to an ‘over protection’ problem and thus reduction of spatial reuse.***  ***Observation 2: Directional LBT potentially improves the channel access probability and enhances the spatial reuse. However, when performed at the transmitter side, the hidden node problem could be more severe due to limited sensing direction.*** |
| Intel Corporation | Proposal 16: 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. |
| InterDigital Inc. | ***Proposal 16****: Independent per-beam LBT sensing at the start of a COT is performed for all beams used in the COT for a COT with MU-MIMO (SDM) transmission or TDM of beams with beam switching.* |
| ITRI | Proposal 2: Independent per-beam LBT sensing should be supported for 60 GHz NR-U. |
| Lenovo Motorola Mobility | Proposal 8: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, for a COT with MU-MIMO +C183:C193(SDM) transmission, all of the following should be supported:  -          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  -          Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT  Proposal 9: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, within a COT with TDM of beams with beam switching, all of the following should be supported:  -          Single LBT sensing with wide beam covering all beams to be used in the COT with appropriate ED threshold, where covering implies that the coverage region of wide beam contains the coverage region of all the beams  -          Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT  -          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  Proposal 10: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, when multiple DL/UL transmissions are scheduled on multiple beams in TDM in same COT, then LBT can be performed at the beginning of the transmissions and also in the middle of same COT, if needed, which is depending upon following gaps:  -          Maximum allowed gap between the first symbol of the following scheduled transmission on a given beam and the last symbol of the transmitted (same) beam  -          Or if there is no previous transmission on the same beam within a COT, then the maximum allowed gap between the between the first symbol of the following scheduled transmission on a given beam and the time instance when Cat 4 LBT was successful on a beam covering the transmit beam  Proposal 11: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, when multiple DL/UL transmissions are scheduled on multiple beams in TDM and if directional LBT is performed on multiple beams with Cat 4 LBT, then multiple COTs should be initiated corresponding to each of the sensing beam  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 |
| LG Electronics | "Proposal #8: If the directional CCA procedure is introduced the followings points can be considered:l  How to perform the CCA procedure for multiple-beam sweeping transmissionl  How to define CWS management (e.g., per-direction or across-direction management)l  How to manage the back-off counter value" |
| MediaTek Inc. | **Proposal 6:Both LBT for independent beams or LBT using single sensing beam should be supported for SDM/TDM transmissions.** |
| NEC | Proposal 4: For a COT with SDM transmission, both single LBT sensing with wide beam and independent per-beam LBT should be supported.  "Proposal 5: Within a COT with TDM of beams with beam switching, the following LBT operations should be supported:  • Single LBT sensing with wide beam ‘cover’ all beams to be used in the COT with appropriate ED threshold.  • Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT with additional requirement on LBT for a gap greater than maximum gap (if any)." |
| Nokia Nokia Shanghai Bell | ***Proposal 15:*** *One-shot LBT within COT is not required before gNB beam switch between SSBs*  ***Proposal 16:*** *High CAPC with short contention window of [3] CCAs is supported for SSB transmission.*  ***Proposal 17:*** *Use of short control signal contention exemption and use of LBT is periodically cycled over the SSBs, evenly distributing the channel access uncertainty over the SSBs.*  ***Proposal 19:*** *For a COT with MU-MIMO (SDM) transmission, support both Alt 1 and Alt 2*  ***Proposal 20:*** *Within a COT with TDM of beams with beam switching, support both Alt 1and Alt 2 for LBT operations.*  ***Proposal 21:*** *CCA check procedure allows the use of both single and multiple LBT beams for the sensing of the intended transmission directions.* |
| NTT DOCOMO INC. | Proposal 5:   For LBT initiating a COT with SDMed multiple transmissions, support a single LBT at the start of COT, covering all the SDMed beams.   For LBT initiating a COT with TDMed multiple transmissions, support independent per-beam LBT at the start of COT. |
| OPPO | **Proposal 10: At least support single LBT sensing at the start of the COT with wide beam covering all transmission beams in the COT.** |
| Panasonic | Proposal 1: Support both Alt 1 (single wide beam LBT sensing) and Alt 2 (independent per-beam LBT sensing) at the start of COT with SDM of beams.  Proposal 2: For a COT with TDM of beams, support both Alt-1 and Alt-2 in the previous agreement at the start of COT. Whether or not additional Cat 2 LBT is required before beam switching within the COT depends on the gap of no transmission of the next beam direction. |
| Qualcomm | Proposal 5: For SDM transmission, support both single LBT sensing with wide beam covers all beams used in the COT and independent per beam sensing.  Proposal 6: For a COT with TDM of beams, support both Alt 1 (single LBT sensing with wide beam covers all beams) and ALT 2 (independent LBT sensing to be performed at the start of the COT).  Proposal 18: SSB burst transmission could be regarded as a Multi-Beam TDM COT, with support for both pre-burst single LBT with wide sensing and per beam independent LBT performed at the start of the COT. |
| Samsung | **Proposal 7:**   * **Support channel access mechanism with directional channel sensing.** * **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.**   + **The details of per-beam LBT sensing and its associated per-beam transmission for both SDM and TDM scenarios should be further investigated.** |
| Sony | Proposal 7: For a COT with MU-MIMO (SDM) transmission, 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) and Alt 2 (Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT) should be supported.  Proposal 8: Within a COT with TDM of beams with beam switching, both Alt 1 (single LBT sensing with wide beam ‘cover’ all beams to be used in the COT with appropriate ED threshold) and Alt 2 (independent per-beam LBT sensing at the start of COT is performed for beams used in the COT) should be supported.  Observation 4: If per-beam LBT sensing is introduced, per beam COT indication may need to be needed. |
| Spreadtrum Comm. | ***Proposal 10: Cat 2 LBT may be used in case of Multi-Beam LBT or Receiver-Assistance*** |
| vivo | **Proposal 13: For a COT with MU-MIMO (SDM) transmission, independent per-beam LBT sensing is used at the start of the COT.**  **Proposal 14: 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.** |
| WILUS Inc. |  |
| Xiaomi | Proposal 11: Multi-beam transmission should be studied to fully take advantage of spatial diversity.  Proposal 12: Support independent per-beam LBT sensing at the start of COT for a COT with TDM of beams with beam switching. |
| ZTE Sanechips | Proposal 10: Considering transmission opportunity and utilization of resource, multiple per-beam LBT that cover multiple transmission beams used in COT can be considered to be performed at the start of COT, if directional LBT is supported.  Proposal 11: 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. |

### First round discussion

For a COT with MU-MIMO (SDM) transmission

* 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,
  + Support: NTT DOCOMO, OPPO, Ericsson (omni or quasi-omni), HW (if not Alt 2)
* Alt 2: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT
  + Support: Huawei, InterDigital, ITRI, Vivo, Xiaomi, AT&T
* Alt 3: Support both Alt 1 and Alt 2
  + Support: CAICT, CATT, Convida, Lenovo, MediaTek, NEC, Nokia, Qualcomm, Samsung, Sony, AT&T, Intel, FW, LG, Spreadtrum, Panasonic, Apple

Discussion point 2.7.1-1 (closed):

For “independent per-beam LBT” in Alt 2, can we further clarify from proposing companies the independent per-beam LBT is performed in TDM fashion or simultaneously?

* Alt A: The per-beam LBT for different beams is performed one after another in time domain. In this case, do we assume a transmission between the two LBT?
  + Support: Intel
* Alt B: The per-beam LBT for different beams is performed simultaneously
  + Support: vivo, ZTE, NEC, Nokia, Lenovo, Spreadtrum, Panasonic, CATT (also support Alt B-2), HW, Sony, ITRI
* Alt C: Both
  + Support: Convida, Apple, Samsung, IDC

|  |  |
| --- | --- |
| Company | View |
| Ericsson | For Multi-beam COT, Ericsson’s views are not captured adequately.  Alt 1 is the preferred option. We prefer single LBT sensing at the beginning of the COT as Omni-directional or quasi-omni directional and no LBT later within the COT for multi-beam COTs. It is difficult to agree to anything further without defining “cover”.   Regarding independent per-beam LBT, it is relevant only to Alt 2 above. Therefore, we propose to change the discussion point to :  *Discussion point 2.7.1-1:*  *For “independent per-beam LBT” in Alt 2, can we further clarify from proposing companies the independent per-beam LBT is performed in TDM fashion or simultaneously?*   * *Alt A: The per-beam LBT for different beams is performed one after another in time domain* * *Alt B: The per-beam LBT for different beams is performed simultaneously*   *Alt C: Both* |
| vivo | Alt B is preferred for “independent per-beam LBT” for MU-MIMO (SDM) transmission. |
| Intel | In our view both Alt-1 and Alt-2 could be supported, and their usage may be left up to the network. As for “independent per-beam LBT” in our view, a device may perform the LBT for a different beam once it intends to transmit over that beam right before the transmission is initiated in that direction. So our preference is Alt-A, but the LBTs do not need to be necessarily performed in a consecutive manner, but only before a transmission is initiated over a specific beam. |
| Futurewei | We note that our views were not captured for this topic.  We think that first the group needs to reach a common understanding for what “beam cover” means. We offer the following proposal:  “For the CCA check procedure, the COT initiating device may use one or multiple spatial domains receive filters. For each transmission during the COT, there should be associated the COT initiating device should use one or multiple spatial domains receive filters from those used by the device for used in the CCA check procedure”  With this clarification we think that both Alt-1 and Alt-2 may be supported and their usage left to the implementation. |
| AT&T | Our view is similar to Intel |
| ZTE, Sanechips | We prefer Alt B. For Alt A, we are not sure LBT result on beam(s) that has completed LBT earlier will be valid when COT starts. |
| LG | We support Alt 3 for a COT with MU-MIMO (SDM) transmission. For independent per-beam LBT, we support Alt A. For Alt B, we think that when and what conditions is need to support Alt B should be clarified first. For example, only the transmitter equipped with multi-TRP may perform the per-beam LBT for different beams simultaneously. |
| Convida Wireless | We prefer Alt C to consider both. |
| NEC | We prefer Alt B. Although much more system overhead needed for Alt B, the timing uncertainty and validity for multiple end-to-end LBT procedures in Alt A may be a hard issue needs to be deliberated designed. |
| Nokia, NSB | Alt B: In the MU-MIMO case, LBT for the involved beams can be performed simultaneously. |
| Lenovo, Motorola Mobility | For MU-MIMO case, we support both Alt 1 (single sensing beam to cover all transmission beams) and Alt 2 (independent sensing beams for transmission beams)  Both the alternatives have their benefits depending what transmission beams are used. For example, when the transmit beams are distributed in terms of coverage, then it might make more sense to have separate sensing. However, when neighboring beams are used, then sensing can be done simultaneously with done sensing beam. It can be up to network on how it indicates the sensing beams corresponding to transmit beams  Then regarding the independent sensing beams (Alt 2), we think the Alt B should be supported where simultaneous LBT can be done on each of the sensing beams |
| Spreadtrum | We support Alt 3. Regarding “independent per-beam LBT”, we prefer Alt B. |
| Panasonic | Our views in the tdoc were not captured. We support both Alt-1 and Alt-2. For independent per-beam LBT in Alt-2, it can be performed simultaneously for MU-MIMO (SDM) transmission. Therefore, we support Alt-B. |
| CATT | Regarding Alt B, we have two understandings:   * Alt B-1: The energy detection for different beams within an observation slot is performed simultaneously. * Alt B-2: The energy detection for different beams within an observation slot is performed in TDM. At observation slot level, the per-beam LBT for different beams is performed simultaneously.     In our view, both Alt B-1 and Alt B-2 should be supported to improve the efficiency of the multi-beam LBT. And we are also ok with Alt1.  *Moderator: When I put Alt B together, I have your Alt B-1 in mind.* |
| Apple | Support Alt 3.  Within Alt 2, Alt-C can be used and it can be up to implementation. |
| Samsung | Both Alt A and Alt B can be supported, and up to implementation which one to choose (e.g. up to gNB/UE’s capability). |
| InterDigital | At least Alt-2 should be supported, but both can be supported.  As for how to perform independent per-beam LBT, we are fine with Alt-C. |
| Huawei, HiSilicon | Huawei’s views were no accurately reflected COT with MU-MIMO (SDM) transmission. We support Alt.1 as a fall-back option of Alt. 2 if the one-to-one correspondence between LBT and Tx beams is not configured.  Further, we believe that the correspondence between single LBT beam and single Tx beam should first be discussed before moving to the possible correspondence between multiple LBT beam and multiple Tx beams.  As for the discussion point 2.7.1-1, first, all per-beam LBTs should be performed simultaneously at the beginning of the COT (Alt B). If the per-beam LBTs are performed sequentially, the first LBT in the sequence of LBTs is far off from the beginning of the COT; rendering its sensing result irrelevant. Of course, even if per-beam LBTs start simultaneously, some may end (assess that the corresponding channel/beam is clear) earlier than others. How to coordinate these parallel LBTs to avoid a large discrepancy among the LBT end time can be further investigated. Moreover, the exact time that COT is acquired in relation to the per-beam LBT end times should be clarified. |
| Sony | We support Alt B and share the same view with ZTE. |
| ITRI | Alt B is preferred for “independent per-beam LBT” for MU-MIMO (SDM) transmission. |

Within a COT with TDM of beams with beam switching

* Alt 1: Single LBT sensing with wide beam ‘cover’ all beams to be used in the COT with appropriate ED threshold
  + Support: Ericsson (omni or quasi-omni), OPPO, Lenovo, HW (as fallback)
* Alt 2: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT
  + Support: DOCOMO, Xiaomi, AT&T, Lenovo, HW
* 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
  + Support: CAICT, Vivo, AT&T, Lenovo, CATT
* Alt 4: Support both Alt1 and Alt 2
  + Support: Convida, MediaTech, Nokia, Qualcomm, Samsung, Sony, Intel, FW, LGE, Lenovo, Spreadtrum, Panasonic, Apple
* Alt 5: Support Alt1 and Alt 3
  + Support: CATT, Lenovo, NEC, Samsung (if beam switching requires LBT), InterDigital

Discussion point 2.7.1-2 (closed):

For “independent per-beam LBT sensing” in Alt 2 and Alt 3, can we further clarify from proposing companies the independent per-beam LBT is performed in TDM fashion or simultaneously?

* Alt A: The per-beam LBT for different beams is performed one after another in time domain
  + Support: vivo, Intel, AT&T, DCM, ZTE, LG, Convida, NEC, Spreadtrum, Sony
* Alt B: The per-beam LBT for different beams is performed simultaneously
  + Support: ZTE (also fine), CATT, HW
* Alt C: Both
  + Support: Lenovo, Panasonic, Apple, Samsung, InterDigital, ITRI

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| --- | --- |
| Company | View |
| Ericsson | For Multi-beam COT, Ericsson’s views are not captured adequately.  Alt 1 is the preferred option. We prefer single LBT sensing at the beginning of the COT as Omni-directional or quasi-omni directional and no LBT later within the COT for multi-beam COTs. It is difficult to agree to anything further without defining “cover”.  Regarding independent per-beam LBT, it is relevant only to Alt 2 and Alt 3 above. |
| vivo | Alt-A is preferred for “independent per-beam LBT sensing” with TDM beams within a COT. |
| Intel | Our preference is for Alt-4, and in our view, a device may perform the LBT for a different beam once it intends to transmit over that beam right before the transmission is initiated in that direction. So our preference is Alt-A, but the LBTs do not need to be necessarily performed in a consecutive manner, but only before a transmission is initiated over a specific beam. |
| Futurewei | We prefer Alt-4 (both Alt 1 and Alt 2), the selection left to the network. However, when Alt-2 is used further limitations need to be consider. If the time between sensing and transmission is too large it may violate the LBT requirements imposed by the regulations. In that case additional , maybe one shot LBT could be necessary right before a transmission. |
| AT&T | Our preference is Alt. A |
| DOCOMO | In case of COT with TDMed beams, the transmitter would not be able to perform LBT with different beams simultaneously (and hence it uses TDMed beams for transmission). Therefore, we assume Alt.A for the case of COT with TDMed beams. |
| ZTE, Sanechips | Our 1st preference is Alt A. but for Alt B, it can also support considering it can provide more chance of channel access before each beam switch within COT. |
| LG | We support Alt 4 for a COT with TDM of beams with beam switching. However, if the maximum gap Y within a COT is defined, the Alt 3 should be also supported. If the gap is larger than Y between the transmissions or the beam switching, the transmitter may perform the Cat-2 LBT.  For independent per-beam LBT, we support Alt A. For Alt B, we think that when and what conditions is need to support Alt B should be clarified first. For example, only the transmitter equipped with multi-TRP may perform the per-beam LBT for different beams simultaneously. |
| Convida Wireless | We prefer Alt. A. |
| NEC | We support Alt A. |
| Nokia, NSB | Alt C. Both options need to be supported to cover cases with and without analog beam-forming, and to provide implementation flexibility. |
| Lenovo, Motorola Mobility | We are in favour of support Alt 1, Alt 2 and Alt 3. It could be up to network to configured which mechanism is applied.  Alt 1 is useful when the transmission beams are neighbouring beams, where a single wide sensing beam can be applied.  Alt 2 is useful for the case when transmission beams are distributed, and a single wide beam is not preferable. Furthermore, Alt 2 can be used after Alt 1, if the LBT failed with wide sensing beam in Alt 1  Alt 3 is useful for one short LBT depending up on the gap between transmissions  For the independent per-beam sensing, both Alt A and Alt B can be supported |
| Spreadtrum | Our preference is Alt 4. Regarding “independent per-beam LBT”, we prefer Alt A. |
| Panasonic | Our views in tdoc were not captured. We support both Alt-1 and Alt-2 at the start of COT. Whether additional Cat-2 LBT is used depends on the gap of no transmission over a given beam direction, and it is independent from whether Alt-1 (wide beam) or Alt-2 (multiple narrow beams) are used at the start of COT.  Regarding the “independent per beam LBT sensing” in Alt 2 and Alt 3, we agree with Nokia to support Alt C to cover different implementation cases. |
| CATT | CATT’s view has not been correctly captured. We the additional CAT2 LBT before switching can be provision when the beams transmitted within the COT are spatially dispersive. Therefore, we prefer the additional CAT2 LBT before switching is configurable.  Regarding Alt B, we have two understandings:   * Alt B-1: The energy detection for different beams within an observation slot is performed simultaneously. * Alt B-2: The energy detection for different beams within an observation slot is performed in TDM. At observation slot level, the per-beam LBT for different beams is performed simultaneously.     In our view, both Alt B-1 and Alt B-2 should be supported to improve the efficiency of the multi-beam LBT. And we are also ok with Alt1. |
| Apple | Support Alt 4. With Alt-2, we favour Alt-C “both” |
| Samsung | Both Alt A and Alt B can be supported, and up to implementation which one to choose (e.g. up to gNB/UE’s capability). |
| InterDigital | We support Alt. 5. Although Alt-3 should be discussed in 2.4.  For independent per-beam LBT, similar to 2.7.1-1, we support Alt C. |
| Huawei, HiSilicon | Huawei’s views were no accurately reflected. We support Alt. 2. We also support Alt.1 as a fall-back option if the one-to-one correspondence between LBT and Tx beams is not configured.  Further, we believe that the correspondence between single LBT beam and single Tx beam should first be discussed before moving to the possible correspondence between multiple LBT beam and multiple Tx beams.  As for the discussion point 2.7.1-2, first, all per-beam LBTs should be performed simultaneously at the beginning of the COT (Alt B). If the per-beam LBTs are performed sequentially, the first LBT in the sequence of LBTs is far off from the beginning of the COT; rendering its sensing result irrelevant. Of course, even if per-beam LBTs start simultaneously, some may end (assess that the corresponding channel/beam is clear) earlier than others. How to coordinate these parallel LBTs to avoid a large discrepancy among the LBT end time can be further investigated. Moreover, the exact time that COT is acquired in relation to the per-beam LBT end times should be clarified. |
| Sony | We support Alt A. |
| ITRI | Support both, up to gNB/UE’s capability |

### Second round discussion

For discussion point 2.7.1-1, additional clarification seems to be necessary. The discussion is revised as follows in red. Note I remove the “both” option.

Discussion point 2.7.2-1:

For “independent per-beam LBT” in Alt 2, can we further clarify from proposing companies the independent per-beam LBT is performed in TDM fashion or simultaneously?

* 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
  + Support: vivo, ZTE, NEC, Nokia, Lenovo, Spreadtrum, Panasonic, CATT, HW, Sony, ITRI

Please provide additional comments.

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| --- | --- |
| Company | View |
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Discussion point 2.7.1-2 needs some clarification as well. Please see the updated discussion point below

Discussion point 2.7.2-2:

For “independent per-beam LBT sensing” in Alt 2 and Alt 3, can we further clarify from proposing companies the independent per-beam LBT is performed in TDM fashion or simultaneously?

* 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
  + Support: Previous support list removed pending clarification
* 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
  + Support: ZTE (also fine), CATT, HW

Please provide additional comments.

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| Company | View |
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## 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** |
| Apple |  |
| AT&T |  |
| CAICT | ***Proposal 9: Support both Type A and Type B multi-channel channel access.*** |
| CATT | **Proposal 7: Multi-channel access procedure in Rel-16 NR-U could be reused for up to 71GHz operation.** |
| Charter Comm. |  |
| Convida Wireless |  |
| Ericsson | |  | | --- | | 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. | |
| Fujitsu |  |
| FUTUREWEI |  |
| Huawei HiSilicon | ***Proposal 10: For multi-channel access in NR-U-60, support both Type A and Type B procedures, i.e., Alt2 in the agreement made in the previous meeting RAN1#104-e.*** |
| Intel Corporation |  |
| InterDigital Inc. |  |
| ITRI |  |
| Lenovo Motorola Mobility |  |
| LG Electronics |  |
| MediaTek Inc. |  |
| NEC |  |
| Nokia Nokia Shanghai Bell | ***Proposal 13:*** *NR-U at 60 GHz supports Type A multiple-channel channel access as the baseline operation on 60GHz unlicensed band. The need for Type B multi-channel LBT requires further discussion* |
| NTT DOCOMO INC. |  |
| OPPO |  |
| Panasonic |  |
| Qualcomm | Proposal 17: Support Alt 2 for Multi-Channel LBT. For Type B multi-channel access, introduce Cat 2 LBT for non-primary channels. |
| Samsung |  |
| Sony |  |
| Spreadtrum Comm. |  |
| vivo | **Proposal 15: If Cat 2 LBT is introduced, both Type A and Type B multi-channel channel access can be supported.** |
| WILUS Inc. | ü  Proposal 5: At least Type A multi-channel access which performs independent eCCA for each channel should be supported. For support of the Type B multi-channel access, it should be further discussed after the decision by depending on support of Cat-2 LBT including definition of Cat-2 LBT. |
| Xiaomi |  |
| ZTE Sanechips |  |

### First round discussion

For multi-channel channel access:

* Alt1: Support Type A multi-channel channel access only
  + Support: Ericsson, Nokia (Further discussion), Intel, DCM, Apple, InterDigital
* Alt2: Support both Type A and Type B multi-channel channel access.
  + Support: CAICT, CATT, Huawei-HiSilicon, Qualcomm (non primary channel) , WILUS (Further discussion), vivo, FW, ZTE, LG, Convida, Lenovo, Spreadtrum, Oppo, Samsung, ITRI, MTK

Discussion point 2.8.1-1

More discussion needed. Would like other companies to provide their view.

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| Company | View |
| Ericsson | Support Alt 1. We should not consider Type B multi-channel access from 37.213 in this WI for three reasons. Firstly, there is no fixed channelization or nominal channel BW in 60 GHz. Secondly, any channel bandwidth, including multiple carriers with different carrier BWs for each carrier, is allowed for the “primary channel” in Type B channel access according to the regulation. Thirdly, it is not straight-forward how to select the primary channel for type B channel access as the HS EN 302 567 does not specify multi-channel access nor CAT2 LBT. Consequently, a device may randomly choose a carrier with narrower bandwidth as its primary channel and perform CAT2 LBT on the wider bandwidth secondary channels. Therefore, we note that there is too much specification effort in 3GPP RAN1 to allow Type B channel access for this band. |
| vivo | Both Type A and Type B multi-channel channel access should be supported as in NR-U. |
| Intel | Support Alt.1 and agree with Ericsson’s arguments. |
| Futurewei | We support Alt 2. It offers more flexibility. |
| DOCOMO | Support Alt 1. Agree with Ericsson’s arguments. |
| ZTE, Sanechips | Support Alt 2 and considering there two types multi-channel channel access has been supported in LAA and Rel-16 NR-U, so it is a nature way to reuse it in above 52.6GHz. |
| LG | We support Alt 2. Whether to support Type B multi-channel channel access may be discussed after the discussion on the introduction of Cat-2 LBT |
| Convida Wireless | We prefer Alt 2 to consider both Type A and Type B multi-channel channel access. |
| WILUS | We support Alt 2. At least Type A multi-channel access should be supported but it is FFS for support of Type B multi-channel access. |
| Nokia, NSB | Alt 2. ETSI regulation does not acknowledge Type B channel access. Moreover, Type B channel access relies on an assumption on predetermined, fixed channelization and channel bonding, which is poorly suited for operation at 60 GHz, where different channel bandwidths are supported. |
| Lenovo, Motorola Mobility | Support Alt 2. |
| Spreadtrum | We prefer Alt 2. Regarding whether to support Type B channel access, it can be discussed after determining the LBT bandwidth and Cat-2 LBT. |
| CATT | Support Alt 2. |
| OPPO | We support Alt-2. |
| Apple | Alt-1 |
| Samsung | We support Alt 2. We didn’t see a need to exclude Type B since it’s already in the spec. |
| InterDigital | We agree with Ericsson’s argument and support Alt. 1 |
| Huawei, HiSilicon | We support Alt2 to have the option of using Type B (eCCA on a primary channel + CAT2 on secondary channels). We think that performing one eCCA on a primary channel is important to avoid unnecessary multiple parallel eCCAs on each individual channel especially in low traffic environments. Note that 802.11 ad/ay uses a similar mechanism as in Type B for multi-channel access where, in fact, secondary channel BWs are integer multiple of the primary channel BW. In NRU-60, how to define the BW of primary channel should be further discussed. In our view, there is no need to define a fixed BW for the primary channel as in Rel-16 NR-U. |
| ITRI | Support Alt 2 |
| Mediatek | Support Alt 2. |

## Directional LBT

|  |  |
| --- | --- |
| **Company** | **Key Proposals/Observations/Positions** |
| Apple | |  | | --- | | ***Proposal 1: Sensing beam and transmission beam difference should be adjusted in the Pout calculation.*** | | ***Proposal 2: Perform directional or omni-directional LBT at the beginning of COT with the sensing beam(s) that covers all TDM beams and with no LBT before each beam switching in the middle of COT*** | |  | | ***Proposal 4: 3GPP specify relative relationship between all applicable sensing beams and the transmission beam. The acquired COT should be associated with the corresponding Pout including beam direction and EIRP.*** | |
| AT&T | Proposal 1: Directional LBT is defined as a complete beam sweep with Cat. 4 LBT followed by Cat. 2 LBT before actually transmitting on any spatial direction deemed idle during the complete beam sweep  • Complete, in this context, means all beams the transmitter intends to use during the COT  Proposal 2: The relationship between sensing and transmitting beams should be specified.  • ED threshold adaptation mechanisms can be considered |
| CAICT |  |
| CATT |  |
| Charter Comm. |  |
| Convida Wireless | Proposal 1: Both omni-directional LBT and directional LBT should be supported for frequency range of 52.6GHz to 71GHz. |
| Ericsson | |  | | --- | | Proposal 8 Support omni-directional LBT or quasi-omni-directional LBT as the baseline LBT procedure for 60 GHz band. | | Proposal 9 When LBT mode is used, relationship between sensing and transmission beam(s) is left to implementation while not violating the regional regulations. |   Proposal 10 For time domain multiplexing of DL/UL transmissions in multiple beams when LBT mode is used, support Alt 1 where the definition of “cover” at least supports omni-directional or quasi-omni-directional LBT at the beginning of the COT, and no LBT for the following beams in the COT. |
| Fujitsu |  |
| FUTUREWEI | Proposal 2: UE shall support spatial domain relations for receive and transmit beams for beyond 52.6GHz to 71 GHz band.  Observation 1: The energy detection threshold shall be adjusted to account for the difference between the transmit antenna characteristics used for transmission and the sensing antenna characteristics when the sensing antenna is different than the transmit antenna.  Proposal 4: The EDT value should be adjusted with the difference between the maximum Pout for the transmission and an equivalent transmit power EIRP, Pout\_eq, obtained when sensing antenna is used as transmit antenna. |
| Huawei HiSilicon | ***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 when comparing it to the EDT.***  ***Proposal 11: For operation in the 60 GHz band, specify the spatial relation between the LBT beam and the transmission beam(s).***  ***Proposal 12: 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 for the transmission during the COT.***  ***Observation 1: (Quasi-)omni-directional simplifies the implementation but could lead to an ‘over protection’ problem and thus reduction of spatial reuse.***  ***Observation 2: Directional LBT potentially improves the channel access probability and enhances the spatial reuse. However, when performed at the transmitter side, the hidden node problem could be more severe due to limited sensing direction.*** |
| 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 13: Both omni-directional and directional LBT are supported. When directional LBT is used, a receiver-aided LBT should complement its CCA procedure.** | | **Proposal 14: RAN1 to define some relationship between the received beams used for LBT measurements, and the transmit beam to be used after LBT success. Further details of how the relationship is defined is FFS in RAN1.** | | **Proposal 17: RAN1 should further study how to efficiently allow beam-pairing due to LBT success.** | | **Proposal 18: A device should perform directional sensing at the beginning of the COT with sensing beam(s) that covers all transmit beams or the first transmission beam, and additional directional LBT with sensing beam that covers the transmission beam(s) .** | |
| 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. |
| ITRI | Proposal 1: In order to avoid resource wastage and hidden node problem, the LBT beam should be the same as the transmission beam. |
| Lenovo Motorola Mobility | Observation 1: For NR unlicensed bands between 52.6 GHz and 71 GHz, for LBT based channel access mechanism, if only omni-directional LBT is supported, then the exposed node problem could result in reduce spatial reuse.  Observation 2: For NR unlicensed bands between 52.6 GHz and 71 GHz, with directional LBT based channel access mechanism, LBT failure on a beam could require a beam update procedure and that results in increased latency.  Proposal 4: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, direction LBT operation should be supported  Proposal 5: 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 supported for beam-based UL transmission  Proposal 6: 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 supported, where the sensing beams may or may not be same as the transmit beam  Proposal 7: 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 |
| LG Electronics | Proposal #6: 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 #10: It should be discussed how to indicate the direction of LBT (e.g., omni-directional LBT or directional LBT) and the type of LBT (e.g., Type 1 or Type 2A/2B/2C channel access procedure in NR-U) when scheduling a UL transmission inside or outside of a channel occupancy.  Proposal #11: 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 #12: 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. |
| MediaTek Inc. | **Proposal 5:The calculation of ED threshold should be discussed after the relation between sensing beam and transmission beam is determined.** |
| NEC | Proposal 1: The energy detection threshold adaptation for beam based channel access procedure should take into account the antenna gain and mapping between transmission beam(s) and sensing beam(s). |
| Nokia Nokia Shanghai Bell | ***Observation 3:*** *The feasibility and possible limitations of the true omnidirectional ED sensing for prospective gNBs operating in 60 GHz unlicensed band are not clear.*  ***Proposal 18:*** *Leave the choice of the beam width for the LBT operation to the 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 4:*** *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.* |
| NTT DOCOMO INC. |  |
| OPPO |  |
| Panasonic |  |
| Qualcomm | Observation 2: For the same interference caused, the measured values under directional and omni-directional sensing are starkly different due to increased beamforming gain under directional sensing  Observation 3: Directional sensing matching transmission beam provides a tighter match between sensing and interference footprint.  Observation 4: Especially for UEs, omni-directional sensing may pick up ‘spurious’ energy from transmissions that do not fall in the interference footprint. Directional sensing naturally avoids those transmissions.  Proposal 4: Consider use of ED adjustment when sensing and transmission beams are different before comparison with ED Threshold. |
| Samsung | **Proposal 7:**   * **Support channel access mechanism with directional channel sensing.** * **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.**   + **The details of per-beam LBT sensing and its associated per-beam transmission for both SDM and TDM scenarios should be further investigated.** |
| Sony | Proposal 6: Directional LBT should be supported in 60 GHz unlicensed operation. |
| Spreadtrum Comm. | ***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.*** |
| vivo |  |
| WILUS Inc. |  |
| Xiaomi | ***Observation 1: Omni-directional LBT is more suitable for broadcasted channels and groupcasted channels, and directional LBT is more suitable for unicast channels and receiver assisted LBT.*** |
| ZTE Sanechips | Proposal 9: If directional LBT is supported, it is necessary to further define the relationship between LBT sensing beam and transmission beam:   Under the assumption of channel reciprocity between transmission beam and LBT sensing beam, LBT sensing beam and transmission beam are actually equivalent.   Without the assumption of channel reciprocity between transmission beam and LBT sensing beam, when LBT 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., introduce an additional factor to reflect the difference of transmission beam and reception beam, or directly consider transmission beam as LBT sensing beam.t |

### First round discussion

Discussion point 2.9.1-1:

Continue discussion from previous meeting

* 3GPP specification defines the relative relationship between all applicable sensing beams and the transmission beam, at least sensing beam “covers” the transmission beam~~,~~ 
  + Alt 1. To define “cover”, the angle included in the [3]dB beamwidth of the transmission beam is included in the [3]dB beamwidth of the sensing beam
  + Alt 2. Extending the beam correspondence framework to define “cover”
  + Alt 3. Leave RAN4 to define cover
  + ~~FFS: How to define the relationship~~
  + ~~FFS: What is the exact definition of sensing beam “covers” the transmission beam.~~
  + ~~FFS: Whether or not there is RAN1 specification impact, and if no RAN1 impact, whether or not it can be left to RAN4 to introduce a testing requirement~~

In the last meeting, Ericsson has concerns on if this relationship needs to be specified in 3GPP specs.

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| Company | View |
| Ericsson | We do not agree to this proposal.  We are not objecting to using Directional LBT in 60 GHz band. We think that it is intuitive that the sensing beam covers the transmission beam. Furthermore, directional LBT can already be used without the need for specifying the above relationship. However, we cannot agree to something without knowing what it entails. The proponents should propose exactly how the relationship should be defined for all the plausible cases of directional LBT, only then can we discuss further on the options, if any. |
| Moderator | To address Ericsson’s concern, an example to define “covers” is include. Please provide your view or alternatives how this can be addressed. Eventually this can replace the FFS in the proposal. |
| Intel | We are OK with the FL’s proposal. |
| Futurewei | We support more discussions on the subject. We provide a definition for “covers” above. The example given here is not clear and needs further discussions. Beam correspondence as defined in TS 38.306 and used in RAN4 may be a starting point. |
| NTT DOCOMO | We agree 3GPP specification should define the relative relationship between all applicable sensing beams and the transmission beam. We prefer a simple definition, e.g., the same beam is assumed between sensing beam and transmission beam. Considering that the transmission beam is up to RAN1, beam selection for sensing should also be up to RAN1. |
| ZTE, Sanechips | We support the FL’s proposal. |
| LG | We are fine with the FL’s proposal. We think that the relationship between the sensing beam and transmission should be defined. Then, the meaning of “covers” and the definition of the relationship can be further discussed.  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. Moreover, 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 relationship can be determined based on the beam correspondence capability/requirement of UE. |
| Convida Wireless | We are fine with the FL’s proposal |
| NEC | We support the FL’s proposal. |
| Nokia, NSB | We share Ericsson’s concern in a sense that specifying the relationship of TX and LBT beams will be a complicated task. From our point of view, it should be sufficient just to define in RAN4 a simple test fulfilling the ETSI requirement, verifying that the transmitter reacts to an interference coming from the direction of the intended received. |
| Lenovo, Motorola Mobility | We support the proposal. The relationship between sensing beams and transmission beams can be configured by network based on the TCI state association (could be possibly handled by RAN1). We show in example below (also described in detail in our contribution R1-2103001)  An example of mapping table is illustrated in Table 1 and corresponding mapping is shown in Figure 4.  **Table 1: Example mapping table between 1 transmit beam and multiple sensing beams**   |  |  | | --- | --- | | **TCI state of Transmit Beam**  **(indicated/configured to UE for UL)** | **TCI state(s) sensing beams** | | TCI State 1 (TxB) | TCI State 1 (SB), TCI State 6 (SB1), TCI State 2 (SB2), TCI State 3 (SB3) | | ….. | ….. |     **Figure 4: Example of one wider transmit beam mapped to multiple LBT (narrower) beams** |
| Spreadtrum | We are fine with moderator’s proposal. We agree with Futurewei’s view that beam correspondence could be the starting point for the definition of “cover”. |
| OPPO | We support FL proposal and it is important to clarify the relationship between the transmission beam and the sensing beam.  From our understanding, the beam correspondence concept can be reused, e.g. the UE is able to select a receiver beam based on the UL transmitter beam. Furthermore, the example given by FL can further elaborate the details for the ‘correspondence’. For instance, the angle for the 3dB beamwidth should include the angle of the UL transmission beam. |
| Apple | We are OK with the proposal.  Directional COT is initiated after directional sensing. The COT directivity should be signalled for COT sharing purpose. Therefore, LBT TCI state can be defined and mapped to transmission TCI state and SSB/CSI-RS association. |
| Samsung | We support the proposal. |
| InterDigital | We agree with the FL proposal. |
| Huawei, HiSilicon | We agree with the Discussion point 2.9.1-1 in principle. We suggest the following roadmap for defining the LBT beam/ Tx beam correspondence:   1. Define the correspondence between one LBT beam and one transmission beam: This correspondence can be easily stablished using similar approach that the correspondence between SRS and a DL RS is stablished using *spatialRelationInfo*.    1. Note that above correspondence can be easily extended to multiple LBT beams each corresponding to one of multiple TDM (SDM) beams as in Alt. 2 in multi-beam COT discussion in Section 2.7.1.   Define the correspondence between one LBT beam and multiple Tx beams. The example provided by Moderator can be a starting point. |
| ITRI | We support the proposal. |
| Mediatek | We are ok with the proposal. |

### Second round discussion

Start a new round of discussion to list options first

Proposal 2.9.2-1:

* 3GPP specification defines the relative relationship between all applicable sensing beams and the transmission beam, at least sensing beam “covers” the transmission beam~~,~~ 
  + Alt 1. To define “cover”, the angle included in the [3]dB beamwidth of the transmission beam is included in the [3]dB beamwidth of the sensing beam
  + Alt 2. Extending the beam correspondence framework to define “cover”
  + Alt 3. Leave RAN4 to define cover

Please provide additional comments.

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| --- | --- |
| Company | View |
|  |  |

## No LBT

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| **Company** | **Key Proposals/Observations/Positions** |
| Apple | Proposal 13: Consider using omni and directional RSSI and channel occupancy for long term sensing. |
| AT&T |  |
| CAICT |  |
| CATT | **Proposal 1: Both Cell-specific and UE-specific indication should be supported to indicate LBT/No-LBT mode for UE.**  **Proposal 2: DCI format 1\_0 scrambled by SI-RNTI could be used as Cell-specific LBT/No-LBT mode indication.** |
| Charter Comm. |  |
| Convida Wireless | Proposal 2: Adaptation between LBT modes and LBT sub-modes for optimizing system performance should be considered. |
| Ericsson | Proposal 20 Support Alt.1 and Atl.2 in the Proposal 2.2.7-1 in [8].  “*Proposal 2.2.7-1:*  *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. Further discussion whether one or both of the following alternatives can be used for indication:*   * *Alt.1. Cell specific (common for all UEs in a cell) as part of system information or dedicated RRC signaling or both* * *Alt 2. UE specific (can be different for different Ues in a cell) as part of UE-specific RRC configuration* * *FFS: 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 per cell (can be different for different cells for a UE in carrier aggregation)* * *FFS: Whether a gNB and its UE(s) can have different mode”* |
| Fujitsu |  |
| FUTUREWEI | Proposal 1: For regions where LBT is not mandatory, no-LBT mode can be applied and switching between LBT mode and no-LBT mode can be supported. No other condition is needed.  Proposal 2: For indication of LBT mode and no-LBT mode, cell specific (common for all Ues in a cell) indication as part of system information and dedicated RRC signaling should be supported.  • For additional flexibility, UE specific (can be different for different Ues in a cell) indication as part of dedicated RRC signaling can be supported. |
| Huawei HiSilicon | ***Proposal 18：For operation in the 60 GHz band, in regions where LBT is not mandated, a gNB/UE can initiate a channel occupancy access using a channel access mechanism without LBT if it is used in conjunction with an interference mitigation scheme.***   * ***Interference mitigation schemes such as ATPC or DFS would be implemented as specified by the region-specific regulations and do not need to be specified by 3GPP.***   ***Proposal 19: For operation in the 60 GHz band, in regions where LBT is not mandated, support switching between channel access with LBT and channel access without LBT in a equire cell by gNB configuration.***  ***Proposal 20: 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 4: When network allows enabling/disabling the LBT mode through cell-specific gNB configuration, coexistence issues would arise as the performance in the cells operating with LBT mode would be adversely impacted by the No-LBT mode operation in the neighboring cells.***  ***Proposal 21: For operation in the 60 GHz band, in regions where LBT is not mandated, MCOT limits should be applied for a channel occupancy initiated without LBT.*** |
| Intel Corporation | |  | | --- | | **Proposal 9: gNB indicates whether LBT or no-LBT procedure should be used via both system information and UE-specific RRC configuration.** | | **Proposal 10: A switching mechanism between LBT and no-LBT is defined, but it is up to gNB’s control.** |   Proposal 12: 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. |
| InterDigital Inc. |  |
| ITRI |  |
| Lenovo Motorola Mobility | Observation 6: 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 19: 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, switching between LBT and no-LBT based channel access mechanism should be supported for regions where LBT is not mandated.  Proposal 22: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, different implicit and/or explicit methods for switching between LBT and no-LBT mode should be considered.  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 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 7: 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.  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. |
| LG Electronics | Proposal #1: The channel access mechanism can be switched from LBT mode to no-LBT mode based on timer operation when receiving the information of the local regulation from the gNB (by cell specific or UE specific signaling) and satisfying certain conditions such as a low interference environment. |
| MediaTek Inc. | **Proposal 1:Both cell-specific and UE-specific method should be supported for gNB to indicate UE operating in LBT or no LBT mode.**  **Proposal 2:In addition to indicating UE to operate in LBT or no LBT mode, switching between different LBT schemes (e.g., from omni-directional to directional LBT or from directional LBT to receiver-assisted LBT) should be considered.** |
| NEC |  |
| Nokia Nokia Shanghai Bell | ***Observation 5:*** *Use of LBT does not provide significant increase of median throughput compared to no-LBT mode*  ***Observation 6:*** *Use of LBT introduces reduction of throughput for cell edge Ues*  ***Observation 7:*** *Simulation results do not show any gain due to introduction of additional Cat-2 LBT at gNB beam switch during COT.*  ***Proposal 24:*** *Ues without LBT functionality are supported.*  ***Observation 8****: Channel access mechanism without LBT should fulfil the expected equirement of EN 303 722 but also possibly EN 303 753.*  ***Observation 9****: NR for 60 GHz band shall be able to fulfil the EN 303 722 requirements for spectrum sharing based on automatic transmit power control and/or automatic link adaptation. Needed specification changes, if any, are to be considered along with EN 303 722 progress.*  ***Proposal 30:*** *Channel access mechanism (i.e. whether or not LBT is in use) is part of the cell configuration.*  ***Proposal 31:*** *Signalling supporting flexible selection of channel access mechanism (LBT or no-LBT) per gNB beam is considered further.*  ***Proposal 32****: Leave any additional conditions/mechanisms/restriction/fallback modes on the no-LBT channel access mode for gNB implementation.* |
| NTT DOCOMO INC. |  |
| OPPO | **Proposal 7: network can signal to the UE whether the LBT is requested or not, the signaling can be cell-specific.** |
| Panasonic |  |
| Qualcomm | Proposal 19: Support provision for sensing and measurement gaps for discovery of aggressors and victims in a No-LBT deployment  Proposal 20: For No-LBT deployments, consider specification of optional good neighbor procedures, such as away time, to break persistent beam collisions for better coexistence. |
| Samsung | **Proposal 1: Support LBT mode and no-LBT mode per node in a cell.**   * **Ues in a cell can operate in same or different mode;** * **UE can operate in same or different mode from its serving gNB;** * **gNB determines its operation mode up to implementation;** * **gNB indicates both gNB’s and UE’s operation mode to its serving UE in both cell-specific (e.g. system information and RRC parameter) and UE-specific/UE-group-specific (e.g. RRC parameter) manners.**   **Proposal 9: Support RSSI measurement outside the active BWP and in non-serving cell.** |
| 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 2: No-LBT mode is configured by the network based on measurement results of RSSI and channel occupancy. |
| Spreadtrum Comm. |  |
| Vivo | **Proposal 16: Both cell-specific and UE-specific indication of the channel access mode should be supported. Per-beam based channel access mode indication is not necessary.**  **Proposal 17: 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.** |
| WILUS Inc. |  |
| Xiaomi | |  | | --- | | ***Proposal 3: Whether No-LBT*** ***channel access mechanism is allowed can be broadcasted by gNB or be informed by message from core network.*** | | ***Proposal 4: At least the energy/interference detection threshold for determining whether No-LBT is applicable should be defined in specification.*** | | ***Proposal 5: Switching between LBT and No-LBT channel access should be studied. The following three alternatives can be considered,*** | | ***Alt 1, gNB self-determines the applied channel access mechanism for both itself and UEs.*** | | ***Alt 2, Both gNB and UE self-determines the applied channel access mechanism for itself.*** | | ***Alt 3,*** ***gNB self-determines the applied channel access mechanism for itself, and gNB determines for UEs based on request.*** | | ***Proposal 6: How to prevent long time continuous channel occupying for Tx using No-LBT should be further studied.*** | |
| ZTE Sanechips | "Proposal 6: No LBT can be considered to be used in the following cases:  • COT sharing case.  o Support 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, a one-shot LBT is needed to share the COT.  • 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."  Observation 5: 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 7: 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 8: Conditions for No LBT fallback to LBT should be further studied, e.g., based on the interference level or correctly decoding rate. |

### First round discussion

The following discussion points are continuation from the previous meeting. Seems more discussions are needed.

Discussion point 2.10.1-1 (closed):

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. Further discussion whether one or both of the following alternatives can be used for indication:

* Alt.1. Cell specific (common for all UEs in a cell) as part of system information or dedicated RRC signaling or both
  + Support: FW, DCM, Spreadtrum, HW
* Alt 2. UE specific (can be different for different UEs in a cell) as part of UE-specific RRC configuration
* Support both: Ericsson, vivo, Intel, ZTE, LG, Convida, WILUS, NEC, Nokia (Alt1 baseline), Lenovo, Fujitsu, CATT, Apple, Samsung, InterDigital, Sony, ITRI, MTK
* FFS: 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 per cell (can be different for different cells for a UE in carrier aggregation)
* FFS: Whether a gNB and its UE(s) can have different mode

|  |  |
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| Company | View |
| Ericsson | We support both Alt 1 and Alt2. |
| vivo | Both Alt1 and Alt 2 are supported. Alt 1 is used before RRC connection and Alt 2 is used after RRC connection. Per-beam based channel access mode indication is not necessary. |
| Intel | We are also supportive of both options. |
| Futurewei | We support Alt 1, we do not see necessary to have it per UE, it would create a lot of unfairness. No simulations or use cases were provided to show the need. |
| DOCOMO | Support Alt 1. |
| ZTE, Sanechips | We generally support Alt 1 and Alt2, but we think the indication of LBT mode or No LBT mode by L1 signalling should not be precluded. Thus, suggest considering L1 signalling in above alternatives. |
| LG | We support both Alt 1 and Alt 2. |
| Convida Wireless | We support both Alt 1 and Alt2. |
| WILUS | We support both Alt 1 and Alt 2. |
| NEC | We support both Alt 1 and Alt 2. |
| Nokia, NSB | Alt 1 shall be the baseline. Additionally, Alt 2 may be considered on top, if benefits are observed. |
| Lenovo, Motorola Mobility | We are fine to support both options |
| Spreadtrum | We prefer Alt 1. The channel access mechanism is a fundamental function for the unlicensed operation. It not only guarantees the fair coexistence between RATs, but also guarantees the fair coexistence between UEs in the same cell. Regarding Alt 2, this is unfair for UEs operating in LBT mode. |
| Fujitsu | We support Alt 1 and Alt 2. |
| CATT | We support both Alt 1 and Alt 2. |
| Apple | Both Alt 1 and Alt 2 can be used. |
| Samsung | We support both Alt 1 and Alt 2. |
| InterDigital | We support both options. |
| Huawei, HiSilicon | We support Alt. 1. We do not support Alt. 2 as either all UEs in a cell should operate with LBT mode or should operate without LBT mode. Alt. 2 results in a mixed mode operation in a cell; putting the UEs that operate with LBT in disadvantage.  Regarding the first FFS point, we would like to have a further clarification on how a cell-specific indication on whether or not LBT mode is used can be per beam. If such a combination is not plausible, we think the first FFS point should be a sub-bullet of Alt 2. |
| Sony | We support both Alt 1 and Alt 2. |
| ITRI | We support Alt 1 and Alt 2. |
| Mediatek | We support both Alt 1 and Alt 2. |

Discussion point 2.10.1-2:

For regions where LBT is not mandated, shall we introduce additional conditions for no-LBT to be used, or leave it for gNB implementation. The condition can be based on DFS, long term sensing, etc

* Alt 1: Up to gNB implementation:
  + Support: Apple, vivo, FW, QC, Ericsson, Samsung, Intel, Fujitsu, CATT, Nokia, DCM (based on RSSI and CO), Sony (based on RSSI and CO), Spreadtrum, OPPO, NEC, IDC, NEC, Charter, FW, WILUS, Fujitsu, MTK
  + Also define mechanism to assist gNB identify issues: QC, Samsung
* Alt 2: Introduce conditions for no-LBT to be used:
  + Support: LGE (low interference detection), Xiaomi (energy/interference detection), Lenovo (long term sensing, HARQ feedback), ZTE (use case, length of transmission, etc), HW(?)

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| Company | View |
| Ericsson | We support Alt 1. |
| Intel | We support Alt.1 |
| Futurewei | We support Alt 1 |
| DOCOMO | Support Alt 1 |
| ZTE, Sanechips | Support Alt 2.  In our understanding, some use cases can use No LBT, for example:   * COT sharing case.   + Gap between two consecutive transmission burst is smaller than defined a maximum gap Y * 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.   Besides, if No LBT is supported, also need to limit transmission length similar to Rel-16 NR-U. |
| LG | We support Alt 2. We think that the LBT mode should be the baseline of channel access mechanism considering the fair coexistence with the incumbent system (e.g., WiGig or other gNBs). The no-LBT can be used when conditions such as low interference environment are met. Hence, the additional conditions are required for the no-LBT mode. |
| WILUS | We support Alt 1. |
| Nokia, NBT | Alt 1. We have not observed a benefit from further conditions, and there is no need to define further mandatory conditions for use of LBT. The network is anyhow allowed to apply LBT when seen as necessary based on implementation. |
| Lenovo, Motorola Mobility | In our view, multiple conditions can be defined as shown under Alt 2, but then it could be up to gNB implementation which of the conditions to apply. |
| Spreadtrum | We prefer Alt 1. |
| Fujitsu | Support Alt 1. |
| CATT | We support Alt 1. |
| Apple | Support Alt 1, , based on RSSI and CO |
| Samsung | We support Alt 1. Enhancement to measurement can be considered, but the decision itself is fully to up gNB’s implementation. |
| InterDigital | We support Alt. 1 |
| Huawei, HiSilicon | Mechanisms that are already supported by regulations (e.g ATPC) or inherently used in NR (e.g. DFS) are up to gNB implementation (Alt. 1). If we introduce additional mechanisms they should be specified (Alt. 2). |
| Mediatek | We support Alt 1. |

Discussion point 2.10.1-3 (closed):

For regions where LBT is not mandated when no-LBT is used, what are the good neighbor procedures, if any that can be useful?

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

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| Company | View |
| Ericsson | No need to discuss anything more than ETSI BRAN HS. The discussion point 2.10.1-2 and 2.10.1-3 are redundant. We suggest deleting this discussion point. |
| Intel | We agree with Ericsson. |
| Futurewei | The good neighbour procedure should be defined inter-RAT. Therefore, we agree with Ericsson, that here is not the right place to define them. There are available mechanisms already in NR to schedule the activity and limit it if necessary. |
| DOCOMO | Agree with Ericsson. |
| ZTE, Sanechips | At least one of the above mentioned methods can be considered. In our views, no LBT should be workable only if some interference elimination mechanisms are applied on top of it, e.g. Automatic Transmit Power Control (ATPC), Dynamic frequency selection (DFS), duty cycle. If no LBT is supported, the spec impact of introducing such enhancement should be further studied and evaluated. |
| LG | As mentioned before, the additional conditions and fallback mechanism should be designed for the no-LBT mode mechanism considering the fair coexistence with the incumbent system (e.g., WiGig or other gNBs). For example, the channel access mechanism can be switched from LBT mode to no-LBT mode based on timer operation when receiving the information of the local regulation from the gNB (by cell specific or UE specific signaling) and satisfying certain conditions such as a low interference environment. |
| WILUS | We agree with Ericsson. |
| Nokia, NSB | There is no need to specify any of the above mechanisms. The use of such schemes is up to implementation as long as related regulations (e.g. EN 303 722 or EN 303 753) are met. |
| Lenovo, Motorola Mobility | Should be discussed along with 2.10.1-2 |
| Spreadtrum | We agree with Ericsson. |
| Fujitsu | Agree with Ericsson. |
| CATT | Agree with Ericsson. |
| Samsung | We agree with Ericsson’s comment. |
| InterDigital | As discussed in 2.10.102, this is up to gNB implementation. |
|  |  |
| Huawei, HiSilicon | We support designing mechanisms similar to maximum occupancy time for operation without LBT so that the (continuous) channel occupancy of each node is restricted in time. We find such a mechanism establishes a fair co-existence with a network that operates using LBT mode.  No need to design ATPC-like or DFS-like or long term sensing type mechanisms. |
| Sony | We agree with Ericsson. |
| Mediatek | Agree with Ericsson. |

Discussion point 2.10.1-4:

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

* Yes (define mechanism): Apple (long term sensing and feedback, and RRC signalling), vivo, LGE (timer and HARQ feedback), Xiaomi, Lenovo, ZTE (interference level, decoding rate), DCM (RSSI/CO), HW, Spreadtrum (RSSI/CO), Convida, Lenovo, InterDigital, HW
* No (gNB implementation): FW, QC (define procedures to switch), Ericsson, Samsung, Intel (define mechanism, but not usage), Fujitsu, CATT, Nokia, OPPO, IDC, Charter, WILUS, Spreadtrum, Apple, MTK

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| Company | View |
| Ericsson | No, left to gNB implementation |
| Futurewei | No, left for implementation. |
| DOCOMO | Yes, mechanism should be defined. But the existing NR frameworks should be reused as much as possible. |
| ZTE, Sanechips | Yes.  This issue is related to 2.10.1-3, in order to better ensure the performance for using No LBT, it is necessary to consider at least one of methods mentioned in 2.10.1-3 or interference measurement and report mechanism and so on. Considering these points, we think it is necessary to support certain mechanism to allow the fallback from no LBT to LBT,especially when the condition on No LBT is not satisfied. |
| LG | As mentioned before, the additional conditions and fallback mechanism should be designed for the no-LBT mode considering the fair coexistence with the incumbent system (e.g., WiGig or other gNBs). For example, the channel access mechanism can be switched from LBT mode to no-LBT mode based on timer operation when receiving the information of the local regulation from the gNB (by cell specific or UE specific signaling) and satisfying certain conditions such as a low interference environment. |
| Convida Wireless | Yes. |
| WILUS | No, left to gNB implementation |
| Nokia, NSB | No. The regulations do not mandate such mechanisms and in fact e.g. EN 303 722 is specified with the intent that LBT is not required. The gNB is of course allowed to apply LBT if seen as beneficial, in an implementation specific manner. |
| Lenovo, Motorola Mobility | Yes, mechanism should be defined. Different mechanisms can be supported such as long term sensing, HARQ feedback and timer based solutions. gNB can decide which one to apply |
| Spreadtrum | No, left to gNB implementation |
| Fujitsu | No, left to gNB implementation. |
| CATT | No, left to gNB implementation |
| Apple | Decision is left to gNB implementation. But the feedback mechanism is needed to provide such info for gNB decision |
| Samsung | The decision for switching is up to gNB’s implementation, and the gNB should indicate its decision as in another proposal. |
| InterDigial | Yes. The switching mechanism can be based on measurements. |
| Huawei, HiSilicon | Yes, mechanism should be defined for the sake of a unified behaviour among multiple gNBs within the network as well as among co-existing NR networks.  For instance, serving cell can be configured for Rx-side LBT to mitigate the interference from hidden nodes and improve performance. We note that mitigating/avoiding the potential interference at the receiver caused by hidden nodes should be targeted to overcome this drawback of the full spatial reuse in the No-LBT mechanism. |
| Mediatek | No, left to gNB implementation. |

### Second round discussion

From discussion point 2.10.1-1, all companies support cell specific configuration. The majority view is also support UE specific configuration, though there is no consensus. Propose to agree on gNB indication first.

Discussion point 2.10.2-1:

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. Down-select between

* Alt 1. Support cell specific (common for all UEs in a cell as part of system information or dedicated RRC signaling or both) gNB indication
* Alt 2. Support both cell specific (common for all UEs in a cell as part of system information or dedicated RRC signaling or both) and UE specific (can be different for different UEs in a cell as part of UE-specific RRC configuration) gNB indication
* FFS: 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 per cell (can be different for different cells for a UE in carrier aggregation)
* FFS: Whether a gNB and its UE(s) can have different mode

Please provide your view

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| Company | View |
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## Short Control Signaling and Contention Exempt Transmission

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| **Company** | **Key Proposals/Observations/Positions** |
| Apple | Proposal 7: For DL, at least SSB should be considered as short control signaling. For UL, at least PRACH should be considered as short control signaling. Other signal such as CSI-RS and SRS can be further discussed.  Proposal 8: Transmission of SSB/PRACH within an acquired COT after LBT success is not counted into 10% limitation within 100ms observation period. |
| AT&T |  |
| CAICT |  |
| CATT |  |
| Charter Comm. |  |
| Convida Wireless |  |
| Ericsson | |  | | --- | | Proposal 7Consistent 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 100 ms. The following signals/channels shall be classified as short control signaling transmissions: | | 1Discovery burst (as defined in Rel-16) | | 2msg1 and msg3 for the 4 step RACH and MsgA for the 2-step RACH |   3FFS: Other control transmissions not multiplexed with user data (subject to gNB configuration) |
| Fujitsu |  |
| FUTUREWEI |  |
| Huawei HiSilicon | ***Proposal 22: For operation in the 60 GHz band, in regions where LBT is mandated, support transmission of short control signalling without LBT, and with a duty cycle 10 % within an observation period of 100 ms.***   * ***Short control signaling is defined as a*** ***short transmission burst that contains control information without any user plane data.*** |
| Intel Corporation | Proposal 19: SSB transmission with no LBT is supported at least for 960 kHz and type0-PDCCH.  Observation 2: 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 20: Consider applying short control signal exemption to PRACH transmission by the UE. |
| InterDigital Inc. |  |
| ITRI |  |
| Lenovo Motorola Mobility |  |
| LG Electronics | Proposal #3: The contention exempt short control signalling can be supported in NR above 52.6 GHz at least for the transmission(s) initiated by gNB with only SS/PBCH or with SS/PBCH multiplexing with non-unicast information (e.g., SIB1, CSI-RS), where the transmission(s) duration is not exceed 10ms within an observation period of 100ms. |
| MediaTek Inc. |  |
| NEC |  |
| Nokia Nokia Shanghai Bell | ***Observation 2:*** *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 14:*** *NR-U design for 60 GHz bands supports transmission of DL and UL control and management signals as short control signalling without LBT. Details are FFS.*  ***Proposal 17:*** *Use of short control signal contention exemption and use of LBT is periodically cycled over the SSBs, evenly distributing the channel access uncertainty over the SSBs.* |
| NTT DOCOMO INC. | Proposal 6: SSB in DL and PRACH in UL should be considered as Short Control Signalling, as long as the limits required in the regulation are ensured |
| OPPO | **Proposal 11: PUCCH carrying HARQ-ACK information and SSB burst belong to short control signaling; while the duty cycle limitation should be met.** |
| Panasonic |  |
| Qualcomm | Proposal 13: Under the restrictions of duty cycle for short control signaling, allow SS/PBCH, PDCCH, CSI-RS and PRS for contention exempt transmission  Proposal 14: Under the restrictions of duty cycle for short control signaling, allow PRACH, msg1, msg3, msgA, SRS, PUCCH and PUSCH without user plane data for contention exempt transmission |
| Samsung | **Proposal 6: For “short control signal”:**   * **any periodic transmission with high priority can be part of “short control signal”, including discovery burst, non-unicast information, PRACH, PDCCH, PUCCH, and RS.** * **support limitation on the transmission duration and duty cycle to use “short control signal”, wherein the transmission duration and duty cycle are defined from the channel occupancy point of view.** |
| Sony | **Proposal 3: Contention exempt short control signalling should be adopted at least for SSB and PRACH transmission** |
| Spreadtrum Comm. |  |
| vivo |  |
| WILUS Inc. |  |
| Xiaomi |  |
| ZTE Sanechips | Observation 1: On 10ms limitation of Short Control Signalling, it is recommended that “Understanding1: a cumulative sum of all transmitted symbols for SCS transmission is used to evaluate whether to meet 10ms limitation” should be considered.  "Observation 2:   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.   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 3: Based on the Understanding1: a cumulative sum of all transmitted symbols for SCS transmission is used to evaluate whether to meet 10ms limitation, Msg1 or Msg3 or MsgA can be considered to apply Contention Exempt Short Control Signaling rules.  Observation 4: 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, it is suggested that such transmission should not be counted into 10ms limitation within the 100ms observation period.  Proposal 5: SS/PBCH other than 120kHz SCS and Msg1 or Msg3 or MsgA can be considered using Contention Exempt Short Control Signaling rules. |

### First round discussion

Discussion point 2.11.1-1: (closed)

* 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.
  + Note restriction for short control signalling transmissions apply (10% over 100ms)
* 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

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| Company | View |
| Ericsson | We agree to Discussion point 2.11.1-1 |
| vivo | Clarification on the “10% over 100ms restriction” should be made. From this statement, it is not clear how the 100ms is counted, is it a sliding window or a fixed window? |
| Intel | As long as signal/channels (except regular unicast data PDSCH) are multiplexed with SSB in the same slot, we think it could be reasonable to be able to multiplex and transmit them with SSB without LBT.  As for applicability of short control signal exemption, we are supportive of leveraging this for 480kHz and 960kHz SSB (and potentially signal/channel (other than unicast data channel) that are multiplexed in the same slot as the transmitted SSB.  For 120kHz SSB, the total transmission period could exceed the regulatory limits for short control signal exemption, and providing complex behavior rules on sometimes using no LBT and sometimes using LBT for 120kHz SSB is not preferred. If all companies think support of short control signal exemption for 120kHz SSB is preferred, we suggest to apply short control signal exemption for 120kHz SSB only if gNB is limiting the SSB transmission to only 16 beams or less, it might be possible to apply the short control signal exemption.  To limit the extent of how short control signal exemption is leveraged, we suggest not to apply short control signal exemption to all other DL transmission cases (other than Msg2).  We suggest modifying the main bullet as follows:  Contention Exempt Short Control Signaling rules can be applicable to the transmission of SS/PBCH with 480kHz and 960kHz SCS, and SS/PBCH with 120 kHz SCS when total number of SS/PBCH transmitted per SS/PBCH transmission period by the gNB is equal or less than 16. |
| Futurewei | We support the proposal. |
| DOCOMO | We support to apply Short Control Signalling rule to SSB transmissions. We also agree that other DL signals/channels can be transmitted with this rule, as long as the restriction of 10 % over 100 ms is satisfied. |
| ZTE, Sanechips | We think 10% limitation within 100 observation window should be clarified first before discussion which type of signals/channels can be regarded as Short Control Signalling.  In our understanding, such 10% limitation should be for transmission resource of a channel/signal for a transmitter. |
| LG | We support the proposal. The contention exempt short control signalling can be supported in NR above 52.6 GHz at least for the transmission(s) initiated by gNB with only SS/PBCH or with SS/PBCH multiplexing with non-unicast information (e.g., SIB1, CSI-RS), where the transmission(s) duration is not exceed 10ms within an observation period of 100ms. |
| Convida Wireless | We are fine with the proposal. |
| WILUS | We support this proposal. |
| Nokia, NSB | We support the proposal. Additionally, we see that short control signaling can apply to any DL control and reference signals, as long as the 10% limit is not exceed. Note that even if e.g. some of the SSBs cannot be transmitted within the 10 % limit, it is still beneficial to use short control signaling for SSBs that fit in. Therefore, we see no need for SCS specific restrictions either. |
| Lenovo, Motorola Mobility | As long as restriction of 10% in 100ms is applied, other signals/channels can be multiplexed as well.  We support the proposal |
| Spreadtrum | We support this proposal. |
| CATT | We are ok with the proposal. The total duration of SSB for 480 kHz and 960 would always meet the restriction of short control signalling transmissions. Only total duration of SSB for 120 kHz might be beyond 10ms within 100ms observation. So we suggest clarifying the SCS of SSB as follows:   * FFS: whether this can be applied to 120 kHz |
| Apple | We support the proposal.  Regarding Intel’s comment on 120KHz SCS, with 10% limitation and 20ms SSB periodicity, total of 56 SSB can be transmitted instead of 16, counting SSB transmission only not including the OFDM symbols between SSB.  We would also like to point out the 10% limitation is per TRP, as the interference scenario is independent from TRP to another TRP. If one cell has 2 TRP, each transmits 32 SSB, then there is no issue of short control signal either. |
| Samsung | We support the proposal. |
| InterDigital | We agree with the discussion point 2.11.1-1 |
| Huawei, HiSilicon | We can consider support for Short Control Signalling for SSB only if the total burst meets 10% over 100ms restriction and the short control signalling exemption can be revoked by the gNB. |
| Sony | We support the proposal. |

Discussion point 2.11.1-2: (closed):

* Contention Exempt Short Control Signaling rules apply to the transmission of msg1 or msg3 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 100ms)
  + FFS: If the 10% over 100ms restriction is applicable to all available msg1/msg3/msgA resources configured in a cell, or msg1/msg3/msgA transmission from one UE perspective
* FFS: Other UL signals/channels can be transmitted with Contention Exempt Short Control Signaling rule, such as SRS, PUCCH, PUSCH without user plain data, etc

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| Company | View |
| Ericsson | We agree to Discussion point 2.11.1-2. |
| vivo | Clarification on the “10% over 100ms restriction” should be made. From this statement, it is not clear how the 100ms is counted, is it a sliding window or a fixed window? |
| Intel | We are supportive of applying short control signal exemption for PRACH, as we don’t believe devices will be transmitting PRACH very frequently, and should have minimal interference footprint. The same logic could be applied to Msg A and Msg 3.  To limit the extent of how short control signal exemption is leveraged, we suggest not to apply short control signal exemption to all other UL transmission cases. One potential exception that we would be ok discussing further is PUCCH transmission containing HARQ-ACK only.  In summary, we are ok with the proposal. |
| Futurewei | We support the proposal. |
| DOCOMO | We support to apply Short Control Signalling rule to msg1/3 for the 4 step RACH and msgA for the 2 step RACH for all supported SCS. We also agree that other UL signals/channels can be transmitted with this rule, as long as the restriction of 10 % over 100 ms is satisfied. |
| ZTE, Sanechips | We think 10% limitation within 100 observation window should be clarified first before discussion which type of signals/channels can be regarded as Short Control Signalling.  In our understanding, such 10% limitation should be for transmission resource of a channel/signal for a transmitter. |
| LG | For other UL signals and channels, the clarifications on whether the constraints/conditions such as duty cycle are per cell or per UE (for UL only) should be preceded. |
| Convida Wireless | We are fine with the proposal. |
| WILUS | We support this proposal. |
| Nokia, NSB | We support the proposal. Similarly as for DL, we see that short control signaling can also be used for other UL control transmissions, including HARQ-ACK, SR, CSI, etc. We may discuss further if the 10% short control signaling limit is UE or cell specific |
| Lenovo, Motorola Mobility | Support the proposal |
| Spreadtrum | We support this proposal. |
| CATT | We support this proposal. |
| Apple | We support the proposal |
| Samsung | We support the proposal. |
| InterDigital | We agree with the discussion point 2.11.1-2 |
| Huawei, HiSilicon | We do not support short control signalling exemption for msg1 or msg3 for the 4 step RACH and MsgA for the 2-step RACH.  In our view, it is not possible to maintain the 10% over 100ms restriction for at least contention-based RACH in initial access, during RRC connection reestablishment after RLF, or CBRA-based BFR. Moreover, when the total transmitted RACH reaches the quota of 10% on every 100 ms, it is not clear for us how gNB can effectively communicate to UEs sending contention-based RACH that the short control signalling exemption for RACH is being revoked. Note that CBRA may be used by initial access UEs and after Radio Link failure. Finally, it is very much possible that UE sends RACH but gNB does not receive it altogether. In such a case, how network can account for the transmitted CBRAs that it has never received when assessing whether or not 10% transmission restriction is met? |
| Sony | We support the proposal. |

Discussion point 2.11.1-3:

Alt 1. Usage restriction on short control signalling is enforced by gNB implementation

* Apple, FW, Qualcomm, Ericsson, Samsung, Intel, NEC, Xiaomi, Nokia (at least DL), ZTE, Spreadtrum, OPPO, Charter, DCM, Sony (at least DL)

Alt 2. Introduce additional mechanism to explicitly restrict the short control signalling usage. FFS how.

* Vivo, ZTE, HW

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| Company | View |
| Ericsson | For Discussion point 2.11.1-3, Alt 1 is preferred. |
| vivo | First of all, as commented to 2.11.1-1 and 2.11.1-2, clarification on the “10% over 100ms restriction” should be made. From this statement, it is not clear how the 100ms is counted, is it a sliding window or a fixed window?  We think additional mechanism is needed to restrict the usage of short control signalling. |
| Futurewei | We support Alt 1, it can be implement by gNB requesting the device to do or not to do LBT before transmission. |
| DOCOMO | Support Alt 1 in Discussion point 2.11.1-3, but the captured transmissions in Discussion point 2.11.1-1/2 (i.e. SSB in DL, msg1/3/A in UL) should be prioritized. |
| ZTE, Sanechips | Considering a case that the transmission of DL/UL channels/signals considered as Short Control Signalling is in a COT initiated by gNB or UE, in our understanding, transmission of SCS for this situation should not be counted into 10ms limitation within the 100ms observation period. |
| LG | We would like to ask the companies supporting Alt 2 about what has the thinking of the additional mechanism to restrict the short control signalling. |
| WILUS | We support Alt 1. |
| Nokia, NSB | Alt 1 is sufficient for at least DL. For the UL, the gNB should be able to signal to the UE which signals / channels can be transmitted without LBT and when. |
| Lenovo, Motorola Mobility | Support Alt 1 |
| Spreadtrum | We prefer Alt 1. |
| CATT | In our view, it is premature to discussion this point before determining which the UL signals/ DL signals can be applied short control signal exempting. If the total duration of UL signals/ DL signals would excess the limitation of short control signalling, then an additional mechanism to explicitly restrict the short control signalling usage should be introduced. |
| OPPO | We support Alt-1 for SSB transmission. When the 10% duty cycle is not respected, the gNB shall fallback to perform LBT. However, for UL, we still need more investigations. |
| Apple | Alt -1 |
| Samsung | We support Alt 1 at least for DL. |
| Huawei, HiSilicon | We prefer Alt. 2 to avoid different behaviours of gNBs within a network. |
| Sony | We share the same view with Nokia. For DL, no restriction is necessary since gNB can fully control. However, for UL, signalling to apply the condition of short control signalling may be required. |

### Second round discussion

Discussion point 2.11.2-1:

For contention exemption short control signaling based DL transmission of SS/PBCH, what are the other signals/channels we can multiplex with

* RMSI PDCCH and RMSI PDSCH
* Other broadcast PDSCH
* PDSCH without user-plane data
* PDCCH
* CSI-RS
* PRS

Please provide your view

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| Company | View |
|  |  |

For discussion 2.11.1-2, there are some concern on how to interpret the 10% over 100ms. The proposal is revised as follows:

Proposal 2.11.2-2:

* Contention Exempt Short Control Signaling rules apply to the transmission of msg1 or msg3 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 in a cell
  + Alt 2: The 10% over any 100ms interval restriction is applicable to the msg1/msg3/msgA transmission from one UE perspective
* FFS: Other UL signals/channels can be transmitted with Contention Exempt Short Control Signaling rule, such as SRS, PUCCH, PUSCH without user plain data, etc

Please provide your view

|  |  |
| --- | --- |
| Company | View |
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## CWS and CAPC

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| --- | --- |
| **Company** | **Key Proposals/Observations/Positions** |
| Apple |  |
| AT&T |  |
| CAICT |  |
| CATT |  |
| Charter Comm. |  |
| Convida Wireless |  |
| Ericsson | Proposal 16CAPC, CWS adjustment can be implementation dependent. |
| Fujitsu |  |
| FUTUREWEI |  |
| Huawei HiSilicon |  |
| 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.** | |
| InterDigital Inc. |  |
| ITRI |  |
| Lenovo Motorola Mobility | Proposal 18: 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) |
| LG Electronics | Proposal #5: Introduce channel access priority class and the contention window adjustment mechanisms when LBT is used in NR above 52.6 GHz, similar to Rel-16 NR-U. |
| MediaTek Inc. | **Proposal 9: For channel access mechanism, at least channel access priority class should be considered to prioritize different traffic.**  **Proposal 10: Current CAPC table can be a starting point for 52.6 – 71 GHz.** |
| NEC |  |
| Nokia Nokia Shanghai Bell | ***Observation 1:*** *We do not see a need for contention window adjustment mechanism for mitigating channel access collisions.*  ***Proposal 1:*** *LBT procedure uses fixed contention window size for random back-off. The size of the fixed contention window is FFS.*  ***Proposal 2:*** *At most two CAPCs are supported.* |
| NTT DOCOMO INC. |  |
| OPPO |  |
| Panasonic |  |
| Qualcomm |  |
| Samsung | **Proposal 4: No need to define CAPC for 60 GHz unlicensed band.** |
| Sony | **Proposal 4: Support fixed Contention Window. ·           gNB’s contention windows size is left to network implementation. ·           UE’s contention window size is configured by network.** |
| Spreadtrum Comm. |  |
| vivo |  |
| WILUS Inc. |   *Proposal 3: We propose to introduce CAPC, CWS and CWS adjustment mechanism for 60GHz band, with Rel.16 NR-U as baseline.t* |
| Xiaomi |  |
| ZTE Sanechips | Observation 6: 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.  Observation 7: Current CCA check procedure in EN 302 567 can be regarded as “Cat 4” rather than “Cat3”. |
|  |  |

### First round discussion

The following discussion points are continuation from the previous meeting. More discussion needed

Discussion point 2.12.1-1:

* Alt 1. Not introduce CAPC 60GHz band
  + Support: Ericsson, Samsung, Qualcomm, vivo, FW, Spreadtrum, Oppo, Apple, Sony
* Alt 2. Introduce CAPC for 60GHz band, with Rel.16 NR-U as baseline.
  + Support: Intel, Lenovo, LG, WILUS, ZTE, Nokia (Max 2) , MediaTek, Convida, InterDigital, HW, MTK

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| Company | View |
| Ericsson | Alt 1 is the preferred option. There is a justification for having channel access priority class (CAPC), contention window size (CWS) adjustment in 5 GHz because the propagation characteristics and coverage of this frequency range might result in interference issues. So, it was important to make sure that high priority data is prioritized in this case (via CAPC) and collisions are resolved via CWS adjustment.  The situation is very different in 60 GHz. Most companies have shown that the LBT is inducing unnecessary deferral that reduces throughput performance. Differentiating between traffic types would mean inducing even larger unnecessary latencies.  In general, LBT in 60 GHz may or may not bring gains for the 5th perc. users, but what all companies agree on is that it has a negative impact on the aggregated system performance. Therefore, there is no justification to increase the LBT overhead by further introducing CAPC and CW adjustment.  Furthermore, it is not specified in the ETSI HS EN 302 567 either. This work should be focused on what is needed to enhance the performance and not to re-specify the 5 GHz LBT aspects in 60 GHz without a strong motivation. |
| vivo | Support Alt-1. We prefer to follow the current regulation. No additional changes (e.g., CWS, CAPC, etc.) on the channel access procedure are needed. |
| Intel | Prefer Alt.2, since this allows to better address different channel and traffic conditions that may impact the channel access procedure. Also, we would like to remark that even if the ETSI BRAN does not define something, It does not mean that this is precluded. The ETSI BRAN only provides minimum requirements but does not provide guidance of the design. |
| Futurewei | We prefer Alt 1. The regulation in 60 GHz does not ask for CAPC and CWS adjustment. |
| ZTE, Sanechips | Support Alt-2. we think at least CAPC should be considered to prioritize different traffic. |
| LG | We support Alt 2. Because the purpose of CAPC and CWS adjustment are to prioritize high priority traffic and resolve the collision between the transmissions, the introduction of CAPC and CWS adjustment mechanism can be beneficial in highly congested scenario. Moreover, considering the fair coexistence with the incumbent system (e.g., WiGig) operating in the above 52.6GHz, it is necessary to consider the introduction of CAPC and CWS adjustment procedure. The procedures specified for the CAPC and CWS adjustment mechanism in Rel-16 NR-U can be reused as baseline for operation in the 60 GHz band. |
| Convida Wireless | We prefer Alt 2. |
| WILUS | We prefer Alt-2. It seems beneficial to address better different channel and traffic conditions that may impact the channel access procedure such as prioritization of high priority traffic and resolution of the collision in some highly congested scenarios. |
| Nokia, NSB | We may consider at most two CAPCs: one for SSBs and other control signals that do not fit into the 10% short control signaling allowance, and another one for data. This also depends on the maximum size of the CWS. |
| Lenovo, Motorola Mobility | Support Alt 2 |
| Spreadtrum | We prefer Alt 1. Additional restriction beyond the regulation in ETSI HS EN 302 567 should not be introduced to 60GHz band. |
| CATT | The range of contention window size should be clarified first. When the range of contention window size is relatively small, it is not required to introduce CAPC. |
| OPPO | Support Alt 1. |
| Apple | Prefer Alt 1. The regulation does not define CAPC and CWS adjustment. |
| Samsung | No CAPC is required in the regulation, so avoid supporting it can simplify the specification work. CAPC can be supported by implementation without specification impact. |
| Interdigital | We prefer Alt. 2. |
| Huawei, HiSilicon | We support Alt.2 |
| Sony | We support Alt 1. The regulation does not require using CAPC. |
| Mediatek | We prefer Alt 2. |

Discussion point 2.12.1-2:

* Alt 1. Not introduce CWS, and CWS adjustment for 60GHz band
  + Support: Ericsson, Samsung, Qualcomm, vivo, FW, Nokia, Spreadtrum, Oppo, Apple, Sony, MTK
* Alt 2. Introduce CWS and CWS adjustment mechanism for 60GHz band, with Rel.16 NR-U as baseline.
  + Support: Intel, Lenovo, LG, WILUS, ZTE, Convida, HW, ITRI

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| Company | View |
| Ericsson | Alt 1 is the preferred option. There is a justification for having channel access priority class (CAPC), contention window size (CWS) adjustment in 5 GHz because the propagation characteristics and coverage of this frequency range might result in interference issues. So, it was important to make sure that high priority data is prioritized in this case (via CAPC) and collisions are resolved via CWS adjustment.  The situation is very different in 60 GHz. Most companies have shown that the LBT is inducing unnecessary deferral that reduces throughput performance. Differentiating between traffic types would mean inducing even larger unnecessary latencies.  In general, LBT in 60 GHz may or may not bring gains for the 5th perc. users, but what all companies agree on is that it has a negative impact on the aggregated system performance. Therefore, there is no justification to increase the LBT overhead by further introducing CAPC and CW adjustment.  Furthermore, it is not specified in the ETSI HS EN 302 567 either. This work should be focused on what is needed to enhance the performance and not to re-specify the 5 GHz LBT aspects in 60 GHz without a strong motivation. |
| vivo | Support Alt-1. We prefer to follow the current regulation. No additional changes (e.g., CWS, CAPC, etc.) on the channel access procedure are needed. |
| Intel | Alt.2 – if a CWS and CWS adjustment is introduced, we would prefer to use the Rel.16 NR-U procedure as a baseline. |
| Futurewei | We prefer Alt 1, which follows the regulations. |
| ZTE, Sanechips | Considering such design has been specified Rel-16 NR-U and 802.11ad/ay, thus support Alt 2 to better backward compatible with the existing specs and fair and friendly coexistence with Wi-Fi. |
| LG | We support Alt 2. Because the purpose of CAPC and CWS adjustment are to prioritize high priority traffic and resolve the collision between the transmissions, the introduction of CAPC and CWS adjustment mechanism can be beneficial in highly congested scenario. Moreover, considering the fair coexistence with the incumbent system (e.g., WiGig) operating in the above 52.6GHz, it is necessary to consider the introduction of CAPC and CWS adjustment procedure. The procedures specified for the CAPC and CWS adjustment mechanism in Rel-16 NR-U can be reused as baseline for operation in the 60 GHz band. |
| Convida Wireless | We prefer Alt 2. |
| WILUS | We prefer Alt-2. It seems beneficial to address better different channel and traffic conditions that may impact the channel access procedure such as prioritization of high priority traffic and resolution of the collision in some highly congested scenarios. |
| Nokia, NSB | Alt 1. we see no need for CWS adjustment |
| Lenovo, Motorola Mobility | Support Alt 2 |
| Spreadtrum | We prefer Alt 1. Additional restriction beyond the regulation in ETSI HS EN 302 567 should not be introduced to 60GHz band. |
| CATT | The range of contention window size should be clarified first. When the range of contention window size is relatively small, it is not required to introduce CAPC. |
| OPPO | Support Alt 1. |
| Apple | Prefer Alt 1. The regulation does not define CAPC and CWS adjustment. |
| Samsung | No CWS adaptation is required in the regulation, so avoid supporting it can simplify the specification work. CWS adaptation can be supported by implementation without specification impact.  Whether the concept of CWS is kept or not can be up to editor (depending on how the specification is written). |
| Huawei, HiSilicon | We support alt. 2 |
| Sony | At least CWS should be necessary since ETSI EN 302 567 requires CWS.  For CWS adjustment, control of CWS could be left to network implementation. No need to introduce the same CWS adjustment mechanism as Rel-16 NR-U. |
| ITRI | Considering fair coexistence, traffic priority and collision, we support alt.2 |
| Mediatek | Support Alt 1. |

## Other

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| **Company** | **Key Proposals/Observations/Positions** |
| Apple |  |
| AT&T |  |
| CAICT |  |
| CATT |  |
| Charter Comm. |  |
| Convida Wireless | Proposal 9: Increasing the number of SSB candidate positions to above 64 to increase transmission opportunities to cope with LBT failure should be considered. |
| Ericsson |  |
| Fujitsu |  |
| FUTUREWEI |  |
| Huawei HiSilicon |  |
| Intel Corporation |  |
| InterDigital Inc. |  |
| ITRI | Proposal 3: PDCCH monitoring enhancement for M-TRP operation should be supported for 60 GHz NR-U.  Proposal 4: Configuring multiple SRIs for a CG transmission should be supported for 60 GHz NR-U. |
| Lenovo Motorola Mobility | Proposal 13: 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 14: 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) |
| LG Electronics | "Proposal #2: Adopt the definition of a discovery burst described in TS 37.213 for NR above 52.6GHz-       A discovery burst refers to a DL transmission burst including a set of signal(s) and/or channel(s) confined within a window and associated with a duty cycle. The discovery burst can be any of the following-  Transmission(s) initiated by a gNB that includes at least an SS/PBCH block consisting of a primary synchronization signal (PSS), secondary synchronization signal (SSS), physical broadcast channel (PBCH) with associated demodulation reference signal (DM-RS) and may also include CORESET for PDCCH scheduling PDSCH with SIB1, and PDSCH carrying SIB1 and/or non-zero power CSI reference signals (CSI-RS)." |
| MediaTek Inc. | **Proposal 11: Choose which ETSI EN HS to follow.** |
| NEC |  |
| Nokia Nokia Shanghai Bell |  |
| NTT DOCOMO INC. |  |
| OPPO |  |
| Panasonic |  |
| Qualcomm |  |
| Samsung |  |
| Sony | **Channelization**: Proposal 1: NR devices support 2.16 GHz bandwidth in 60GHz spectrum as one of the nominal channel bandwidths. |
| Spreadtrum Comm. |  |
| vivo |  |
| WILUS Inc. |  |
| Xiaomi |  |
| ZTE Sanechips |  |

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