**3GPP TSG RAN WG1 Meeting #106-bis-e** **R1-210xxxx**

**October 11th – October 19th, 2021**

**Agenda item: 8.2.6**

**Source: Moderator (Qualcomm Incorporated)**

**Title: FL summary of channel access mechanism for 52.6GHz-71GHz band, ver1**

**Document for: Discussion and Decision**

# Introduction

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

# 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

$$EDT=-80 dBm+10\*log10\left(\frac{Pmax}{Pout}\right)+10\*log10(Operating Channel BW in MHz)$$

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

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

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | ***Proposal 4: 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 transmit beamforming gain of the potential following transmission(s) by the device.******Proposal 5: 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:***

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•   ***GTX is the effective transmit antenna gain at the potential transmitter [dBi]***•   ***GTX,max is the maximum supported transmit antenna gain [dBi]***•   ***a is a scaling factor such that 0≤ a≤ 1******Proposal 6: For operation in NR-U-60, when LBT is used, the sensing beamforming gain of the LBT beam is deducted from the detected energy level before comparing it to the EDT.******Proposal 7: The value of the adjustment to ED threshold based on the sensing beam and the transmission beam is zero if the transmit antenna gain reaches***

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|  ***which is the maximum supported transmit antenna gain.*** |

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| FUTUREWEI | Proposal 2: Utilize a separate EDT for each sensing beam.Proposal 3: Support additional adjustment to Energy Detection computation/threshold to include transmit beamforming and/or sensing beam. The value of the adjustment to ED threshold based on the sensing beam and the transmission beam should be zero if pseudo-omni (near 0dBi) gain sensing beam is used.  |
| Spreadtrum Communications | Proposal 5: The formula of ED threshold should consider the LBT bandwidth and beamforming gain. |
| ZTE Sanechips | **Proposal 19: Considering potential mismatch between sensing beam and transmission beam, the ED threshold provided by the ETSI BRAN 302 567 can be modified to consider mismatching between sensing beam and transmission beam.****Proposal 20: 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.** |
| vivo | **Proposal 6: The ED threshold for CCA check should consider the impact of beamforming gain of the directional sensing beams.** |
| OPPO | Proposal 6: the EDT value should be adjusted: smaller value is applied when sensing beam is narrower. |
| OPPO | Proposal 7: the EDT value should be adjusted: smaller value is applied when the sensing beamforming gain is lower than the transmission beamforming gain. |
| CATT | **Proposal 5: Adjustment value should be considered for the baseline ED threshold.****Proposal 6: For adjustment value on baseline EDT, at least beamforming gain difference between the transmission beam and sensing beam should be considered.** |
| TCL Communications | **Observation 1: The threshold is adaptable for LBT in 60GHz unlicensed band. A signaling with the similar function of ul-toDL-COT-SharingED-Threshold-r16 is necessary.** |
| Xiaomi | Proposal 10: Support further adjustment on ED threshold based on the sensing and transmission beam. |
| Ericsson | Observation 4 ED threshold defined in EN 302 567 v2.2.0 is a function of the transmission’s EIRP Pout, which includes the transmission beamforming gain. It does not include the sensing beamforming gain. |
| Ericsson | Proposal 3 Further adjustment on ED threshold based on the transmission and sensing beamforming gains could be up to implementation while not violating EDT requirements as per regulations. |
| Nokia Nokia Shanghai Bell | **Proposal 6: Further adjustment of EDT based on the sensing and transmission beams is not specified.** |
| Samsung | **Proposal 6: ED threshold should depend on:** |
| Samsung | **• Whether other technology sharing the channel is absent or not on a long-term basis;** |
| Samsung | **• LBT bandwidth (which is operation channel bandwidth in regulation);** |
| Samsung | **• Beam parameters including beamforming gain and/or beam direction for transmission and/or receiving.**  |
| Intel Corporation | **Proposal 2: When operating in unlicensed 60 GHz band, the ED threshold calculation shall account for the sensing beam used to perform the LBT procedure through an additional component which is added to the already agreed ED threshold formula.**  |
| Intel Corporation | **Proposal 3: 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 11: Adapt EDT to account for beamforming gain of the sensing beam. |
| LG Electronics | Proposal #14: The ED threshold can be further adjusted by reflecting the beam correspondence capability/requirement of UE. For pseudo-omni beam, the adjustment to ED threshold is not necessary regardless of the beam correspondence capability. |
| Qualcomm Incorporated | Proposal 2: Support additional adjustment to Energy Detection computation/threshold whenever the sensing beam has a lower beamforming gain than the transmission beam. |

Working assumption:

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

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | ***Proposal 1: For operation in NR-U-60, confirm the working assumption on Pout definition in RAN1 #104bis-e in its original form or with Pout defined as the maximum of mean EIRP of each transmission burst during the COT from the node determining the EDT.******Proposal 2: For defining Pout as the maximum of mean EIRP of each transmission burst during the COT from the node determining the EDT, define the ‘transmission burst’ stated in the HS EN 302 567 as a set of transmissions from the node determining EDT without any gaps, or with gaps no greater than X μs.***-        ***FFS: Value of X*** |
| FUTUREWEI | Proposal 1: For Pout in EDT determination, define Pout to be at least the maximum of mean EIRP of each transmission burst during the COT at the node initiating the COT. Maximum is determined over all candidate bursts and over all directions, whereas mean is computed over burst duration. • Burst is a set of (near-)contiguous transmissions from a gNB/UE (as defined in 37.213 section 4.0)Observation 1. Using common Pout (common EDT) for multiple sensing beams can limit spatial reuse. |
| vivo | **Proposal 3: The transmission burst is a set of transmissions from gNB/UE from one or more transmission beams which are “covered” by a sensing beam without any gaps greater than [16us].****Proposal 4: For Pout in EDT determination, define Pout as the maximum of mean EIRP of transmission burst for the node determining EDT during a COT.** |
| OPPO | Proposal 5: confirm the following working assumption Working assumption:Observation 1: the working assumption for Pout might limit the usage of the UE COT sharing. Working assumption:For Pout in EDT determination, define Pout as the maximum EIRP of the node determining EDT during a COT. |
| Ericsson | Observation 1 According to the regulations it is sufficient to use only the initiating device’s Pout to determine EDT.Observation 2 The argument to use both EIRPs from the initiating and responding devices to determine Pout for a node initiating a COT is insufficient as the responding device may also use a different bandwidth than the initiating device.Proposal 1 Confirm that Pout corresponds to the maximum of the mean output power EIRPs of the transmissions or transmission bursts in a COT that may contain varying transmission beams and EIRPs.Proposal 2 Confirm that Pout is estimated only based on the node initiating the COT even for COT sharing cases. |
| Nokia Nokia Shanghai Bell | Proposal 5: For Pout in EDT determination, define Pout as at least the maximum of mean EIRPs of the transmission bursts of the node initiating the COT during the COT. Observation 4: Proposal 5 allows also for implementation according to RAN1#104bis working assumption. |
| LG Electronics | Proposal #13: Confirm the working assumption on Pout definition in RAN1 #104bis-e without the change and it needs to consider when the determining the EDT: If multiple UL transmissions are scheduled within a COT, the transmissions with an EIRP larger than the max EIRP used for the initial EDT calculation may be suddenly scheduled in the middle of the COT. |
| Qualcomm Incorporated | Proposal 1: Confirm the working assumption on Pout definition in RAN1 #104bis-e with the following updates: • For Pout in EDT determination, define Pout to be at least the maximum of mean EIRP of each transmission burst during the COT at the node initiating the COT.  |
| Charter Communications | Proposal 1: Confirm the working assumption for the EDT definition: Pout is defined as the maximum EIRP of the node determining EDT during a COT. |
| Apple  | Proposal 1: Confirm the modified working assumption: For Pout in EDT determination during a COT, Pout is the maximum of the mean EIRP of each transmission burst.  |

### First round discussions

On if additional adjustment to EDT is introduced:

Discussion 2.1.1-1

Summary of positions so far:

* Support additional adjustment to ED Threshold
	+ Apple, Huawei, FUTUREWEI, Spreadtrum, ZTE, vivo, OPPO, CATT, TCL, Xiaomi, Intel, InterDigital, Qualcomm, Lenovo
	+ Samsung (other criteria), LG
* Do not Support additional adjustment
	+ Ericsson, Nokia,

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| Company | View |
| Intel | As properly captured by the FL, we support an additional adjustment to the ED threshold calculation with the aim to capture the sensing beam used. |
| Lenovo, Motorola Mobility | We also support additional adjustment to ED threshold  |
| Xiaomi |  We are open to discuss. Additional adjusting is benefical for channel access. |
| ZTE, Sanechips | We support additional to ED threshold to to consider mismatching between sensing beam and transmission beam. |

On WA confirmation:

Discussion 2.1.2-1

Summary of positions so far:

* Confirm Working Assumption after Modification as follows :

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

* + FUTUREWEI, Qualcomm, Nokia, Lenovo,
* Confirm Working Assumption as it is
	+ Huawei, Vivo, OPPO (with concern) , Ericsson, LGE, Charter, Apple, Intel, Xiaomi, ZTE

Please provide your view if not captured above

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| Company | View |
| Intel | We prefer to support the working assumption as is, and we have added above our preference. |
| Lenovo, Motorola Mobility | We are fine to confirm the WA after modification |
| Xiaomi | Confirm Working Assumption as it is |
| ZTE, Sanechips | We support the working assumption as it is and add our position in above FL proposal. |

## LBT Bandwidth FFS Items

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| Agreement:* For LBT for single carrier transmission, gNB/UE performs LBT over the channel bandwidth (or BWP bandwidth) (Alt SC.1. in earlier agreements)
* For LBT for multi-carrier transmission in intra-band CA, gNB/UE performs multiple LBT, one for each channel bandwidth separately (Alt CA.1. in earlier agreements)
	+ FFS: Additional support of performing single LBT over all CCs (Alt CA.2. in earlier agreements)

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

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | *Proposal 10: For a multi-carrier transmission in intra-band CA in NR-U-60, in addition to the agreed Alt CA.1, support performing a single LBT over all CCs, i.e., Alt CA.2.*  |
| ZTE Sanechips | Observation 1: It is worth emphasizing that the OCB should be satisfied for each transmitter such as gNB or UE.Proposal 1: In order to avoid ambiguity about the understanding of nominal bandwidth and resolve the problem of unclear the conclusion for the OCB requirement, it is necessary to give a clear guidance on how to deal with the issue on the nominal bandwidth, e.g., introduce the definition of nominal bandwidth.Proposal 2: The nominal bandwidth can be defined as follows:• Nominal bandwidths for the purpose of OCB requirements at the UE are the channel BWs for transmission supported by the UE from the set of channel BWs (carrier BWs) to be defined in 38.101.• Nominal bandwidths for the purpose of OCB requirements at the gNB are the channel BWs for transmission supported by the gNB from the set of channel BWs (carrier BWs) to be defined in 38.104.Proposal 3: from the perspective of the probability of channel access and the waste of resources, it is not recommended that single LBT over all CCs (Alt CA.2. in earlier agreements) is supported for Rel-17 above 52.6GHz. |
| vivo | Proposal 5: The LBT bandwidth should be used as the operating channel bandwidth for EDT evaluation. |
| OPPO | Proposal 1: Alt SC.1 should be further clarified about the channel bandwidth and BWP bandwidth for LBT from gNB and UE perspective respectively.Proposal 2: Do not support Alt CA.2 additionally. |
| CATT | Proposal 4: If performing single LBT over all CCs is supported, the EDT should be computed based on the smallest channel bandwidth among the all CCs. |
| CAICT | Proposal 1: For LBT for multi-carrier transmission in intra-band CA, single LBT over all CCs (Alt CA.2) should be supported. |
| Nokia Nokia Shanghai Bell | Proposal 7: Alt CA.2 is also supported for multiple carrier transmission.Proposal 8: For multiple carrier transmission, how to perform LBT is left to gNB/UE implementation. |
| Samsung | Proposal 2: For LBT bandwidth, RAN1 shall further clarify: |
| Samsung | • For LBT for single carrier transmission, gNB/UE performs LBT over the channel bandwidth (or BWP bandwidth) (Alt SC.1. in earlier agreements). |
| MediaTek Inc. | Proposal 1: RAN 1 should discuss the relation between sensing result and permissible transmission of each LBT bandwidth for DL and UL transmissions before finalizing the LBT bandwidth for 60 GHz.  |
| MediaTek Inc. | Proposal 2: If UL in 60 GHz can only begin the transmission when all LBT bandwidth has “idle” sensing results as in sub-6 NR-U, CA. 2 can be supported. |
| NTT DOCOMO INC. | Proposal 1:Deprioritize the discussion on whether to support performing single LBT over all CCs in case of multi-carrier transmission in intra-CA |
| InterDigital Inc. | Proposal 12: The Operating Channel BW used in the EDT formula is equivalent to the LBT BW. |
| LG Electronics | Proposal #1: The bandwidth of multiple CCs up to 2 GHz (or 2.16 GHz) can be supported considering the coexistence with incumbent system in addition to the carrier bandwidth (or BWP bandwidth) which is already agreed upon. |
| Convida Wireless | Proposal 14: To down-select the options of LBT BW with single carrier and multi-carrier operation for supporting NR form 52.6 GHz to 71 GHz, co-existence of single carrier and multi-carrier operation within a same channel BW should be studied.  |
| Qualcomm Incorporated | Proposal 3: For LBT for multi-carrier transmission in intra-band CA, the support for single LBT over all CC is not required. |
| Charter Communications | Proposal 2: For multi-carrier LBT, do not additionally support Alt CA.2, i.e., performing single LBT over all CCs. |
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### First round discussions

Discussion 2.2.1-1

On if further introduce single LBT over multiple CCs under CA, the summary of positions so far:

* Additional support of performing single LBT over all CCs (Alt CA.2. in earlier agreements)
	+ Huawei, CATT ( use right EDT), Nokia, LGE
* Do not support single LBT over all CCs
	+ ZTE, OPPO, Qualcomm, Charter, Intel, Lenovo, Xiaomi,
* Other: Deprioritize (Docomo)

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| Company | View |
| Intel | We do not see any strong technical reason to support a single LBT over all CCs. In this matter, we have added our preference above. |
| Lenovo, Motorola Mobility | We don’t prefer to support single LBT over all CCs |
| Xiaomi | Do not support single LBT over all CCs.From our understanding, single LBT over all CCs will increase failure possibility thus not preferred. |
| ZTE, Sanechips | There is no see the necessity of supporting single LBT over all CCs.Besides, we have another question on how to define and understand nominal bandwidth. The definition of nominal bandwidth has been discussed in the previous meetings, but there is no a basic and clear consensus. So we would like to ask other companies' views on how to deal with this remaining issue. |

## Sensing Structures FFS Items

Agreement:

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

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

Agreement:

For energy measurement in 8us deferral period, Alt 2 is supported while Alt 1 and Alt 3 can be considered as gNB/UE implementation (Alt. 1/2/3 are defined as per previous agreement)

Working assumption:

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

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | *Proposal 8: Confirm the following WA reached in RAN1 #104bis-e:* |
| Huawei HiSilicon | *“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.”* |
| Huawei HiSilicon | *Proposal 9: For operation in NR-U-60, when LBT is used, the measurement duration X us within the 5us observation is implementation specific.* |
| Spreadtrum Communications | Proposal 6: The duration of the measurement should be 3us for 5us observation slot. |
| ZTE Sanechips | Observation 9: For deferral period and 5us observation slot, the minimum duration of energy measurement can be configured as 3us. |
| OPPO | Proposal 3: the location of the 5us observation slot within the 8us deferral period can be left for implementation. |
| OPPO | Proposal 4: a minimum measurement duration of 2us can be considered.  |
| OPPO | 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. |
| Ericsson | Observation 19 8us deferral period in IEEE 802.11ad and IEEE 802.11ay consists of the 5us observation slot at the end of the 8us periodProposal 24 For energy measurement in 8 µs deferral period, 5us observation slot is located at the end of the 8us deferral period similar to IEEE 802.11ad/ay.Proposal 25 The minimum measurement duration X within a 5 µs observation slot can be left for implementation with the maximum value as 3µsProposal 26 Confirm the working assumption that the location of the energy measurement in 5us can be left for implementation. |
| Qualcomm Incorporated | Proposal 4: Minimum requirement for sensing for both 5us and 8us slots should be 1us irrespective of bandwidth.  |
| Intel | Proposal 1: Within a 5us or 8us observation window, a device must perform a measurement of the medium for at least 2us. |

### First round discussions

Discussion 2.3.1-1

On sensing structure for 5us observation slot, summary of positions so far:

* The minimum measurement duration X within a 5 µs observation slot
	+ Implementation
	+ Other :1 us (Qualcomm), 2us (OPPO, Intel), 3us (ZTE, Spreadtrum, Lenovo)
* Location of the X us measurement within a 5 us observation slot:
	+ Implementation: Ericsson, Oppo, Huawei, Lenovo

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| Company | View |
| Intel | We strongly prefer to set a reasonable lower bound for the measurement window in order to ensure a device would perform a proper sensing of the media. In this matter, we would prefer to align it with that of IEEE 11ac/ay (i.e., 2 us). |
| Lenovo, Motorola Mobility | We are fine to specify the minimum duration X within a 5us observation slot and prefer 3usWe are fine to keep the location X as implementation |
| ZTE, Sanechip | We prefer to set the minimum measurement duration X as 3us. |

## COT Sharing

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| Agreement:On COT sharing from an initiating device transmission to responding device transmission, support both of the following two alternatives* Alt 1: No maximum gap defined between the initiating device transmission and responding device transmission. A responding device transmission can occur without LBT with any gap within the maximum COT duration
* Alt 3: Define a maximum gap Y, such that a responding device transmission can occur without LBT only if the transmission starts within Y from the end of the initiating device transmission. If the responding device transmission starts after Y from the end of the initiating device transmission, a Cat 2 LBT is needed before the responding device transmission.
	+ The Cat 2 LBT uses the same sensing structure as the 8 us initial deferral period as in eCCA
	+ Further downselect between the following options:
		- Option 1: Y=8 us (motivated by need to operate in all regions)
		- Option 2: Y=a multiple number of OFDM symbols
		- Option 3: gNB determines Y (for example, according to local regulation)
	+ Cat. 2 LBT is a UE capability
* The usage of the two alternatives is a gNB choice and depends at least on local regulations.
* Note: Alt. 3 is motivated by the regulations in Japan but use of Cat. 3 LBT is also an option for operation in Japan and Cat. 2 LBT is not restricted for use only in Japan.

Note: Maximum gap allowed without Cat 2 LBT between two initiating device transmissions is to be separately discussedNote: Other use cases of Cat 2 LBT will be separately discussed |

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | ***Proposal 18: For COT sharing without LBT in NR-U-60, support Option 2 for defining the maximum gap Y within which a transmission from a responding device occurs without LBT (Y=a multiple number of OFDM symbols).*** |
| FUTUREWEI | Proposal 5: Define a maximum gap Y, such that a later transmission from an initiating node can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission from the initiating node or a responding node. If the later transmission starts after Y from the end of the earlier transmission, a one-shot LBT is needed to share the COT: |
| FUTUREWEI | • FFS: Specific value of Y. |
| OPPO | Proposal 10: for maximum gap Y, Option 1, i.e., Y=8us should be supported. |
| NEC | **Proposal 3: On COT sharing from an initiating device transmission to responding device transmission, the value of a maximum gap Y (if supported) should be defined as a multiple number of OFDM symbols depending on supported SCS.****Proposal 4: On COT sharing between two initiating device transmissions, 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, a Cat 2 LBT is needed to share the COT.****Proposal 5: Cat 2 LBT for 60GHz unlicensed band operation should be introduced for resuming transmission by the initiating device within the COT after a gap Y.** |
| TCL Communications | Proposal 3: The overhead reduction should be studied when configuring the ED Thresholds for uplink-to-downlink COT sharing. |
| CAICT | **Proposal 2: the selection of the maximum gap Y could be either 8us or a multiple number of OFDM symbols with SCS 120kHz.** |
| Nokia Nokia Shanghai Bell | Observation 14: In case of Alt. 3 for COT sharing, there is need for a wide range of time gap Y values to facilitate efficient scheduling while fulfilling local regulations having a wide range in requirements.Proposal 18: Support Option 3 for maximum gap Y in Alt. 3. There is no need to signal the value Y to the UEs. |
| Samsung | **Proposal 3: For the gap duration Y in COT sharing, support Y as the duration of Cat 2 LBT, e.g. 8 us.** |
| Intel Corporation | **Proposal 5: Y is defined as:****§ 1 OFDM symbol for 120 KHz SCS,****§ 4 OFDM symbols for 480 KHz SCS,****§ 8 OFDM symbols for 960 KHz SCS.****Proposal 6: If an initiating device is capable to perform Cat-2 LBT, and if the initiating device performs an additional burst within the initiated COT which may be separated with any prior burst of at least a minimum gap Y, then under Alt-3 a Cat 2 LBT is needed before the initiating device transmission.** |
| NTT DOCOMO INC. | **Proposal 2: For the down-selection on Y value on Cat-2 LBT, support Option 1** |
| Lenovo Motorola Mobility | ***Proposal 17: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, COT sharing between the initiating device and responding device should be supported with at least Cat 2 LBT:******- If the responding device is capable of beam correspondence and it is expected to use only any of the Rx beam(s) as Tx beam(s) for its transmission that have been used to receive at least One of the transmissions from the initiating device within the same COT******- If the responding device determines at least one suitable beam on which it is allowed to transmit within the same COT, where the suitable beam can be determined as follows:******Proposal 18: For NR unlicensed bands between 52.6 GHz and 71 GHz with directional LBT based channel access mechanism, multiple COT sharing indicators and their corresponding association to different beams can be signaled in a group common DCI and the association of COT sharing indicator to transmission is semi-statically signaled*** |
| LG Electronics | Proposal #3: Regarding the options for the maximum gap Y, Option 3 (gNB determines Y (for example, according to local regulation)) can be supported and the CP extension indication may need to be discussed depending on the value of Y. |
| Convida Wireless | Proposal 5: For COT sharing consider Alt 3. Define a maximum gap Y, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, an one-shot LBT is needed to share the COT. |
| Qualcomm Incorporated | Proposal 5: For Alt-3 for COT sharing, gNB determines the value of Y and is transparent to UE. |

### First round discussions

Discussion 2.4.1-1

On the gap Y for Cat 2 LBT when COT Sharing is applied, the summary of positions so far:

* Option 1: Y=8 us (motivated by need to operate in all regions)
	+ FUTUREWEI, CAICT, Samsung, NTT, ZTE
* Option 2: Y=a multiple number of OFDM symbols
	+ Huawei, NEC, CAICT, ZTE
	+ Intel (SCS based 1,4 8 symbols for 120,480,960KHz)
* Option 3: gNB determines Y (for example, according to local regulation) and is transparent to UE
	+ Nokia, LG, Qualcomm, Apple (cell specific RRC with 0 symbols as an option), Lenovo,

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| Company | View |
| Intel  | We support option 2, which we believe would exemplify the implementation, and allow the CCA to be always aligned with the ODFM symbol boundary.  |
| Lenovo, Motorola Mobility | We support Option 3 |
| Xiaomi | Support Option 2. Option 3 will increase the configuration overhead unnecessary. Moderator: The intention is the Y chosen by gNB is transparent to UE. Clarified in red above |
| ZTE, Sanechips | We support Option1. |

## Cat 2 LBT

Agreement:

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

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

Agreement:

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

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

Other use cases not precluded.

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

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | *Proposal 19: The following use cases of CAT2 LBT related to COT initiation should be prioritized in the discussion due to the low complexity and overhead of CAT2 LBT compared to eCCA:*-         *Starting transmission on a secondary channel in Type B multi-channel access, if supported*-        *Energy measurement and reporting of Rx-assistance information by the receiver in Rx-assisted LBT, if supported*  |
| FUTUREWEI | Proposal 6: When independent per-beam LBT sensing at the start of COT is performed for beams used in the COT, an additional requirement on Cat 2 LBT before switching to new beam during the COT should be specified if the time duration from the initial LBT sensing for that beam exceeds a threshold. |
| Spreadtrum Communications | Proposal 7: Cat 2 LBT should be supported for 60GHz unlicensed band operation. |
|  | Proposal 8: Cat 2 LBT may be used in case of directional LBT. |
| ZTE Sanechips | Proposal 11: Cat 2 LBT can be considered in the following use cases:l 1) Resuming transmission/beam switching situation; l 2) Type B multi-channel access procedure; l 3) Rx-assisted LBT when COT is initiated by transmitter.Proposal 12: For the maximum gap Y, similar rule as specified in LTE-LAA can be reused, such as Option1 that “Y=8 us (motivated by need to operate in all regions)” that is at least equal to the duration of Cat2 LBT. |
| NEC | Proposal 6: Cat 2 LBT for 60GHz unlicensed band operation should be introduced for channel sensing of receiver assistance measurements.Proposal 7: Cat 2 LBT for 60GHz unlicensed band operation should be introduced for Type B multi-channel access. |
| CATT | Proposal 2: Cat 2 LBT should be introduced for 60GHz NR-U.Proposal 10: Performing Cat 2 LBT before beam switching within the COT could be supported, and it can be decided by gNB.Proposal 3: Cat2 LBT could be used for more use cases. |
| Ericsson | Observation 16 It is worthy to note that, use of CAT3 LBT is also an option for operation in Japan and CAT2 LBT is a UE capability featureObservation 17 Cat2 LBT is not specified in HS EN 302 567Observation 18 Simulation studies show that there is no gain using Ca2 LBT compared to no LBT for the proposed used cases.Proposal 22 Do not support Cat2 LBT for any of the use cases in 52.6 GHz to 71 GHz. It is not precluded to do CAT2 LBT in addition to CAT3 LBT requirements. |
| Nokia Nokia Shanghai Bell | Observation 3: For initiating device resuming transmission after a long transmission gap, Cat-2 LBT performance cannot be compared against Cat-3 LBT as long as Cat-3 LBT design remains open.Proposal 4: Do not support Cat-2 LBT in beam switching or in multi-channel LBT.Observation 8: Cat-2 LBT at every gNB beam switch would cause significant increase in overhead and is not even possible between the SSBs in the agreed SSB time locations. Observation 10: Simulation results do not show any gain from introduction of additional Cat-2 LBT at gNB beam switch during COT.  |
| Intel Corporation | Proposal 4: When a UE is capable to perform Cat-2 LBT, whether to operate with or without Cat-2 LBT would be dynamically indicated by the gNB via scheduling DCIs.Proposal 7: In addition to support CAT-2 LBT for COT-sharing procedure, the gNB may configure the UE to use CAT-2 LBT for RX-assisted LBTProposal 9: Do not support, Cat-2 LBT for multi-beam switching and multi-beam TDM COT. |
| NTT DOCOMO INC. | Proposal 3: Use of Cat-2 LBT should be considered for the transmission of a certain signal/channel, for which LBT is not needed in a region (e.g., BRAN with short control signalling), while LBT is always needed in another region (e.g., Japan).  |
| Sony | Proposal 4: Introduce Cat 2 LBT for 60 GHz unlicensed band operation |
| InterDigital Inc. | Proposal 14: A UE determines whether to use Cat 2 LBT based on the gap duration Y between the upcoming transmission and a preceding transmission on the same beam. |
| Qualcomm Incorporated | Proposal 6: Introduce Cat 2 LBT for the use case of Multi-Beam LBT. |
| WILUS Inc. | ü Proposal 2: We support Alt-2 to introduce Cat 2 LBT for 60GHz unlicensed band operation. |

### First round discussions

Discussion 2.5.1-1

Support potential CAT2 LBT use cases:

* 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)
	+ ZTE, Intel, Lenovo, Motorola Mobility
* 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)
	+ FUTUREWEI, Spreadtrum, , CATT, Lenovo, Motorola Mobility, ZTE
	+ No: Intel, Nokia
* Rx-Assistance:  Cat 2 LBT may be used for sensing at the receiver as a responding device for Rx-Assistance measurements and associated signalling
	+ Huawei, ZTE, Intel, Lenovo, Motorola Mobility
* Multi-channel Type B access if supported
	+ Huawei, ZTE. NEC
	+ No: Intel Nokia
* In general
	+ CAICT
* No
	+ Ericsson, Nokia (no for beam switch, multichannel,)

Please provide your view if not captured above

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| Company | View |
| Intel | We support Cat-2 for two specific use cases:* Resume transmission after Y gap. This is motivated by Japanese regulatory requirements, which is mandated by ARIB, and whose text is very generic and does not define any concept of initiating or responding device, but rather distinguishes a device from a transmitter to a receiver.

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| * **Interference mitigation function**
* Sending and receiving identification signals
* (Enforcement Article 6-2)
* (Facilities Article 9-4)
* Shall automatically transmit or receive identification codes.
* Carrier Sense
* (Facilities Article 49-20)
* If the transmission power of the transmitter exceeds 10 mW, provide a carrier sense that will operate at beginning of the transmission.
 |

In this matter, our understanding is that carrier sensing would be needed at the beginning of every transmission, unless the transmissions are back-to-back. Notice that we have updated the list of supporting companies for this use case.* Receiver assisted LBT: Cat2 LBT is preferred to support scheme 2 for the RX assistance given that by using Cat4 at the receiver the LBT overhead may limit and overcome the benefits from using a receiver assisted mechanism.
 |
| Lenovo, Motorola Mobility | Added our preference for each of the above use cases |
| Xiaomi | We think it is more nature to discuss how Cat 2 LBT is used in diverse scenarios when the related scenario is detailed discussed and Cat 2 LBT is needed. The current proposal/agreement give a misleading impression that the related scenarios/schemes are already supported. For example, we haven’t decided how to do receiver assisted LBT, so it’s quite early to say “Cat 2 LBT may be used for sensing at the receiver as a responding device for Rx-Assistance measurements and associated signalling”. |
| ZTE, Sanechip | In addition to the position captured in the above FL proposal, we also support Cat 2 LBT for multi-beam LBT case. |

## Rx Assistance

Agreement:

For receiver to provide assistance in channel access, channel sensing and reporting need to be performed. The following schemes can be further considered. Target down-selection by RAN1 #106bis-e

* Scheme 1: L1-RSSI based receiver assistance
	+ Resource used for RSSI measurement
		- Alt 1: RSSI measurement is based on the time/frequency resources configured for ZP-CSI-RS
			* FFS: any enhancement needed for ZP-CSI-RS for this purpose (e.g., ZP-CSI-RS over all REs in BWP over one or more symbols).
		- Alt 2: Energy measurement on operating BW over indicated or specified number of symbols or time interval
	+ L1-RSSI is reported in an AP-CSI report
	+ L1-RSSI trigger in UL grant
		- FFS if L1-RSSI trigger can also be carried in DL grant
	+ Timeline for L1-RSSI reporting is at least equal to AP-CSI reporting and RAN1 strives to tighten the timeline
		- Note: If L1-RSSI reporting timeline cannot be tighter than AP-CSI reporting timeline, this scheme is not needed
	+ FFS: How to indicate the measurement beam for L1-RSSI
	+ FFS: What is included in the L1-RSSI report, such as the value of RSSI measurement, comparison outcome with Energy Detection threshold, etc
* Scheme 2: CCA or eCCA based receiver assistance with existing phy channel/signals
	+ Scheme 2-1: gNB schedules/triggers UL PUCCH/SRS transmission with the DL assignment DCI and indicates CCA or eCCA in the DCI. UE performs CCA or eCCA for the scheduled/triggered UL transmission and if LBT passes, transmits the Receiver-assistance information (implicitly or explicitly) in the PUCCH (or SRS in the case of 1-bit Rx-assistance) to indicate the LBT outcome. gNB detects the scheduled UL transmission to tell if UE passes the CCA or eCCA. After detecting the Receiver-assistance information, the downlink data transmission happens.
		- FFS if the downlink data transmission can be granted with the same DL DCI that schedules/triggers the first UL PUCCH/SRS transmission, in which case, the CCA or eCCA is performed for at least the first UL PUCCH/SRS transmission
	+ Scheme 2-2: gNB schedules/triggers UL transmission PUSCH with the UL assignment DCI and indicates CCA or eCCA in the DCI. UE performs CCA or eCCA for the scheduled/triggered UL transmission and if LBT passes, transmits the Receiver-assistance information (implicitly or explicitly) in the PUSCH to indicate the LBT outcome. gNB detects the scheduled UL transmission to tell if UE passes the CCA or eCCA. After detecting the Receiver-assistance information, the downlink data transmission happens.
* Scheme 3: CCA or eCCA based receiver assistance with new RTS/CTS type transmission
	+ New RTS/CTS-like signaling introduced.
	+ gNB sends RTS-like signaling to UE. UE performs CCA or eCCA and if LBT passes, transmits CTS-like signaling to explicitly indicate the LBT outcome. gNB detects the CTS-like signaling to identify if the UE passed CCA or eCCA. After detecting the CTS-like signal, the data transmission happens
* Scheme 4: Legacy L3-RSSI with potential enhancements
	+ FFS potential enhancements, e.g., supporting gNB indicating the beam used for UE RSSI measurement, supporting gNB indicating new reference SCS and measurement bandwidths
* Note: The schemes listed above are not mutually exclusive and should be discussed separately.

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | *Observation 4: 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 5: 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.**Proposal 20: For a receiver UE to provide assistance information in channel access in the DL scenario, support Scheme 2-1 with the downlink data transmission being scheduled by the same DL DCI that schedules/triggers the first UL PUCCH/SRS transmission.**Proposal 21: For a receiver-assistance in channel access in the UL scenario, discuss supporting a scheme corresponding to Scheme 2-1 for the case in which the scheduling offset K2 is too long for the LBT performed by gNB before the UL grant to represent the interference at gNB during the reception of the scheduled PUSCH(s).**Proposal 22: For a receiver UE to provide assistance information in channel access in the DL scenario, support introducing a new field in DCI format 1\_1 scrambled with C-RNTI, CS-RNTI or MCS-C-RNTI, to schedule/trigger PUCCH/A-SRS resource before the start of the scheduled PDSCH(s)*-           *PUCCH: A 3-bit field ‘ChannelAccess-PUCCH resource indicator’ is introduced and the existing mechanism for indicating PUCCH resource can be reused* o    *UCI Payload size is configurable between 1 bit (CTS only) or 7 bits (energy measurement report such as L1-RSSI)*-           *A-SRS: 2-bit ‘Channel access indicator’ indicates the SRS trigger mode for reusing existing ‘SRS Request’ field to trigger a single aperiodic SRS resource set for receiver-assisted channel access, or trigger aperiodic SRS resource set(s) for legacy MIMO/positioning purposes, or both.*o    *The UE can be configured with one or more aperiodic SRS resource set(s) in SRS-Config (Currently supported). For the configured aperiodic SRS resource sets, an optional RRC parameter (e.g., ‘SRS-ChannelAccess’) is configured to indicate that the SRS resource set is for receiver assistance report for channel access only.* *Proposal 23: For a receiver UE to provide assistance information in channel access in the DL scenario, support configuring/indicating a time offset of a small value range to the UE for transmitting the scheduled/triggered PUCCH/A-SRS resource with respect to the beginning of the scheduled PDSCH(s)*-           *PUCCH: Add a new field of a configurable bitwidth (0, 1 or 2 bits) in the DCI format 1\_1 to indicate the slot level offset from the indicated PUCCH resource to the start of the scheduled PDSCH(s), e.g., ‘ChannelAccess-PUCCH-to-PDSCH timing indicator’.* -           *A-SRS: Higher layer parameters startPosition and slotOffset and can be reused such that slotOffset for an aperiodic SRS resource (set) triggered for providing receiver assistance in channel access is reinterpreted as the number of slots from the actual transmission of the triggered aperiodic SRS resource (set) to the start of the scheduled PDSCH(s).**Proposal 24: For a receiver UE to provide assistance information in channel access in the DL scenario, support configuring a higher layer parameter providing the LBT type for the UE to access the channel and transmit the scheduled/triggered PUCCH/A-SRS* -           *This can be provided using common or dedicated signaling.* *Proposal 25: For a receiver UE to provide assistance information in channel access in the DL scenario, the following procedures are applied:* *1)      A UE that has received a DCI format 1\_1 scheduling/triggering PUCCH/A-SRS resource before the start of the scheduled PDSCH(s) transmits the triggered A-SRS or the scheduled PUCCH, including the detected energy level if configured, only if it has accessed the channel according to the UE-side LBT performed prior to the indicated time resource for transmitting the scheduled/triggered PUCCH/A-SRS.**2)      A gNB that has transmitted a DCI format 1\_1 to a UE scheduling/triggering PUCCH/A-SRS resource before the start of the scheduled PDSCH(s) may transmit the scheduled PDSCH(s) and any subsequent DL control/data only if it has received the scheduled/triggered PUCCH/A-SRS from that UE, the transmission of the scheduled PDSCH(s) is dropped otherwise.* |
| FUTUREWEI | Proposal 8: Further discuss scheme 1 and scheme 2 for receiver assistance |
| Spreadtrum Communications | 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. |
| ZTE Sanechips | Proposal 13: For receiver assisted channel access and interference management,l Scheme 2 can be considered for CCA/eCCA based receiver assistance and propose to use the same DL DCI signalling to trigger/schedule UL transmission and DL data transmission considering complexity. l Scheme 4 can be considered either as a supplementary method to CCA/eCCA based receiver assistance or when Scheme 2 is not supported. |
| Fujitsu | Proposal 1: For receiver to provide assistance in channel access, further consider only Scheme 1 and Scheme 2.Proposal 2: For Scheme 1 for receiver to provide assistance in channel access, to reduce latency and signaling overhead, support triggering AP-CSI report directly by the DCI with DL grant.Proposal 3: For Scheme 2 for receiver to provide assistance in channel access, support Scheme 2-1 for lower latency and signaling overhead |
| OPPO | Proposal 16: For RX assisted LBT, Scheme 2 should be supported.  |
| CATT | Proposal 11: For receiver assistance based on L1-RSSI measurement, Alt 2 (energy measurement on operating BW over specified number of symbols) is preferred.*Proposal 12: For receiver assistance based on L1-RSSI measurement, L1-RSSI can be triggered by DL grant.**Proposal 13: For receiver assistance based on L1-RSSI measurement, the L1-RSSI report can be 1 bit which is the outcome of the value of RSSI measurement and Energy Detection threshold.**Proposal 14: For receiver assistance based on L1-RSSI measurement, it is recommended to add the QCL source information for the L1-RSSI measurement.* |
| Xiaomi | Proposal 6: No support of Scheme 2/3 as receiver assisted channel access for their complexing process increasing transmission delay. |
| Xiaomi | Proposal 7: Support Scheme 4 as receiver assisted channel access, since Scheme 4 has little specification impact and has a concise process. |
| Ericsson | Observation 13 Receiver assisted LBT does not show consistent performance improvement as compared to no LBT operation.Observation 14 Receiver assisted LBT involves RTS/CTS-like handshaking in every data transfer procedure, which significantly increases data transfer latency, reduces spectrum efficiency and system capacity.Observation 15 The standardization and implementation technical complexity and cost for receiver assisted LBT should not be under-estimated.Proposal 14 Do not support receiver assisted LBT.Proposal 15 Support receiver interference measurement that is based on the existing RSSI and CSI reporting mechanisms with minimal enhancement when it is necessary.Proposal 16 The current RSSI and CO measurement in Rel-16 should be enhanced to support NR unlicensed operation in FR2-2 in Rel-17. The enhancement at least includes extension of reference SCS and indication of channel bandwidth for RSSI measurement. The signalling details of the RRC configuration for RSSI and CO measurement should be decided by RAN2.

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| Proposal 17 For RSSI and CO measurement in FR2-2, UE can assume the configured RSSI measurement resources are QCL-ed with Type-D to one of the latest received PDSCH and the latest monitored CORESET. |

Proposal 18 The following enhancements on the current CSI reporting can be considered to better support receiver assistance information reporting, if time allows:Proposal 19 Explicit feedback approach requires similar spec changes as Scheme 1 …Scheme 2-2 can be considered if the UL transmission step (i.e., CCA at the receiver) can be de-coupled from the data transmission procedure and if the implicit feedback approach is adopted.

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| Proposal 20 Do not support Scheme 2-1 in receiver-assistance schemes. |

Proposal 21 Do not support Scheme 3 in receiver-assistance schemes. |
| Nokia Nokia Shanghai Bell | Proposal 24: Employ existing RSSI measurements as the receiver assistance. |
| Observation 15: The network can operate scheme 2 in a fully standards transparent manner. There is no need to define further mechanisms to support scheme 2.  |
| Proposal 25: Deprioritize discussions on new mechanisms for receiver assistance until more essential parts of the channel access solution have been agreed. |
| Observation 16: Any Rx assistance scheme should be configurable per UE, so that it could be used only with UEs frequently detecting high interference. |
| Samsung | Proposal 11: For RX-assistant LBT, support:• Scheme 2 with DCI for triggering and UCI for reporting the assistant information;• Scheme 4 with supporting new SCS and measurement bandwidth for 60 GHz unlicensed band.Proposal 12: Support RSSI measurement outside the active BWP and in non-serving cell. |
| MediaTek Inc. | Proposal 5: For receiver-assisted LBT, scheme 2 can be supported. If down selection between schemes 2-1 and 2-2 is needed, support scheme 2-2. |
| Intel Corporation | Proposal 18: For receiver-assisted LBT procedure both scheme 1 and 2 could be supported, where both scheme 1 and 2 could be used up to UE’s capability.  |
| NTT DOCOMO INC. | Proposal 5: For Rx assistance, support Scheme 4 (Legacy RSSI measurement and reporting with possible enhancements) and/or Scheme 1 (AP-CSI report with possible enhancements):l Scheme 4 with enhancements to consider new SCSs, measurement bandwidth, and possibly beam-related aspects should be a starting point at least for the support of long-term Rx-assistancel Scheme 1 should also be considered if the need of short-term Rx-assistance is observed |
| Sony | *Proposal 9: Receiver assisted LBT should be supported in 60 GHz unlicensed operation.* *Proposal 10: L1-RSSI based receiver assistance and L3-RSSI with potential enhancements should be introduced in Rel-17* |
| Lenovo Motorola Mobility | *Proposal 23: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, receiver assistance should be supported for both LBT and no-LBT based channel access mechanisms to avoid potential interference at the receiver.**Proposal 25: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, following schemes should be supported:• Scheme 1: L1-RSSI based receiver assistanceo Resource used for RSSI measurement§ Alt 2: Energy measurement on operating BW over indicated or specified number of symbols or time intervalo L1-RSSI is reported in an AP-CSI reporto L1-RSSI trigger in UL grant§ FFS if L1-RSSI trigger can also be carried in DL granto Timeline for L1-RSSI reporting is at least equal to AP-CSI reporting and RAN1 strives to tighten the timeline§ Note: If L1-RSSI reporting timeline cannot be tighter than AP-CSI reporting timeline, this scheme is not neededo FFS: How to indicate the measurement beam for L1-RSSIo FFS: What is included in the L1-RSSI report, such as the value of RSSI measurement, comparison outcome with Energy Detection threshold, etc• Scheme 3: CCA or eCCA based receiver assistance with new RTS/CTS type transmissiono New RTS/CTS-like signaling introduced. o gNB sends RTS-like signaling to UE. UE performs CCA or eCCA and if LBT passes, transmits CTS-like signaling to explicitly indicate the LBT outcome. gNB detects the CTS-like signaling to identify if the UE passed CCA or eCCA. After detecting the CTS-like signal, the data transmission happens**Proposal 26: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, for scheme 3, following should be supported:**• Short transmission using control channels (such as with 1-bit) or reference signals for before the actual transmission could be supported* |
| Lenovo Motorola Mobility | 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 following enhancements to legacy RSSI measurements should be supported: |
| InterDigital Inc. | Proposal 2: Receiver assistance should be considered for both omni-directional and directional LBT.Proposal 4: Support Scheme 1 L1-RSSI reporting, where the UE is configured with periodic resources on which to measure L1-RSSI and can be aperiodically triggered to report L1-RSSI.Proposal 5: L1-RSSI includes one or more values associated to one or more BWs or beams.Proposal 6: L1-RSSI includes a comparison to an energy detection threshold.Proposal 7: L3-RSSI is enhanced to support reporting for multiple beams and measurement BWs. |
| LG Electronics | Proposal #4: Rx assistance Scheme 1 is not needed because L1-RSSI reporting timeline cannot be tighter than AP-CSI reporting timeline, according to the agreement made in RAN1#106 that for 480 kHz and/or 960 kHz SCS, only value(s) for CSI computation delay requirement 2 are to be defined.Proposal #5: For the receiver to provide assistance, the feedback mechanisms already supported by the current specification such as implicit method in Scheme 2 (appearance of the scheduled PUCCH/SRS/PUSCH) can be considered but it is not preferred to introduce the additional or new mechanism (such as added explicit payload bit in PUSCH/PUCCH or introduction of new RTS/CTS-like signalling in Scheme 3). |
| Convida Wireless | Proposal 10: Receiver assisted LBT and channel access should be supported in 52.6 GHz to 71 GHz.Proposal 12: For receiver to provide assistance, the following can be further discussed: legacy RSSI measurement and reporting with possible enhancements, AP-CSI report with possible enhancements and LBT at receiver using eCCA or Cat2 LBT.  |
| Qualcomm Incorporated | Proposal 7: Among Rx-Assistance schemes, prioritize and adopt L1-RSSI enhancements to AP-CSI framework. Proposal 8: L1-RSSI enhancements to AP-CSI framework should be considered independently of Rel 17 IIOT/URLLC AP-CSI enhancements. Proposal 9: Consider the use of RSSI compared to a configurable threshold as part of the L1-RSSI report. Proposal 10: Consider use of UL grant DCI for trigger of Beam Specific L1-RSSI measurement and reporting for enhanced AP-CSI in PUSCH.Proposal 11: L1-RSSI trigger should also be carried in DL grant. Consider use of PUCCH for sending Beam Specific L1-RSSI measurement and reporting for enhanced AP-CSI. Proposal 12: Use Rel. 16 AP-CSI timelines as baseline for enhanced AP-CSI reporting with L1-RSSI and study further possible tightening of the timelines. Use worst case UE capability for BeamReportTiming for 120KHz SCS, namely 56 OFDM symbols, as a guideline for setting the minimum requirement for L1-RSSI reporting timeline. Proposal 13: Beam Specific L1-RSSI measurement and reporting should be supported. Proposal 14: Consider the design of timeline, triggering and beam indication mechanisms of L1-RSSI to be analogous to CSI-RS based L1-RSRP reporting in AP-CSI. Proposal 4: For receiver to provide assistance in channel access, specify support for both Scheme 1 (L1-RSSI) and Scheme 4 (L3-RSSI). |

### First round discussion

Summary of positions so far:

* Scheme 1: Spreadtrum , ~~ZTE,~~ Fujitsu Intel (capability), Docomo (second pref) ,CATT, Lenovo, InterDigital, Qualcomm, Apple
* Scheme 2: Huawei, Futurewei, Vivo, Fujitsu (2-1), OPPO, , Samsung, MediaTek(2-2), Intel (capability), Sony, LG (oppose 1), Apple, ZTE, Sanechips
* Scheme 3: Lenovo?
* Scheme 4: Spreadtrum, Xiaomi, (oppose 2/3), Ericsson (no to 2-1,3), Nokia, Samsung, Docomo, Sony, Lenovo, Convida, Apple, ZTE, Sanechips

For L1-RSSI, the following details are collected from supporting companies.

Discussion: 2.6.1-1:

L1-RSSI based receiver assistance is introduced with the following design components

* Resource used for RSSI measurement
	+ Alt 1: RSSI measurement is based on the time/frequency resources configured for ZP-CSI-RS
		- FFS: any enhancement needed for ZP-CSI-RS for this purpose (e.g., ZP-CSI-RS over all REs in BWP over one or more symbols).
		- Qualcomm
	+ Alt 2: Energy measurement on operating BW over indicated or specified number of symbols or time interval
		- Intel, Lenovo
* L1-RSSI is reported in an AP-CSI report
* L1-RSSI trigger in UL grant
	+ FFS if L1-RSSI trigger can also be carried in DL grant
* Timeline for L1-RSSI reporting is at least equal to AP-CSI reporting of L1-RSRP
* Reuse the same mechanism for L1-RSRP beam determination for L1-RSSI
* On the content of L1-RSSI report, down-select one or more of the following alternatives
	+ Alt 1. L1-RSSI provides the (quantized) value of RSSI measurement
	+ Alt 2. L1-RSSI provides the comparison outcome with a preconfigured Energy Detection threshold
		- Intel, Lenovo
* Support: Intel, Lenovo, Qualcomm
* Not support: ZTE

Please provide your view

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| Company | View |
| Intel  | We prefer Alt2 for both the discussion related to time-domain resource used for RSSI measurements as well as the discussion related to the actual content of the L1-RSSI report.  |
| Lenovo, Motorola Mobility | In principle we are fine with the listed design components for L1-RSSI based receiver assistance.For resource used for RSSI measurement, we prefer Alt 2.On the content of L1-RSSI report, we prefer Alt 2. |
| ZTE, Sanechips | Considering that L1-RSSI measurement has not been supported in the existing specs and it is very similar to CCA/eCCA based receiver assistance and some additional standardization works are needed, we don’t particularly prefer this method.Besides, our view is not correctly captured in the above listed summary. So we updated our position for candidate several schemes. |

For scheme 2 with CCA or eCCA based receiver assistance with existing phy channel/signals with following schemes

* Scheme 2-1: gNB schedules/triggers UL PUCCH/SRS transmission with the DL assignment DCI and indicates CCA or eCCA in the DCI. UE performs CCA or eCCA for the scheduled/triggered UL transmission and if LBT passes, transmits the Receiver-assistance information (implicitly or explicitly) in the PUCCH (or SRS in the case of 1-bit Rx-assistance) to indicate the LBT outcome. gNB detects the scheduled UL transmission to tell if UE passes the CCA or eCCA. After detecting the Receiver-assistance information, the downlink data transmission happens.
	+ FFS if the downlink data transmission can be granted with the same DL DCI that schedules/triggers the first UL PUCCH/SRS transmission, in which case, the CCA or eCCA is performed for at least the first UL PUCCH/SRS transmission
* Scheme 2-2: gNB schedules/triggers UL transmission PUSCH with the UL assignment DCI and indicates CCA or eCCA in the DCI. UE performs CCA or eCCA for the scheduled/triggered UL transmission and if LBT passes, transmits the Receiver-assistance information (implicitly or explicitly) in the PUSCH to indicate the LBT outcome. gNB detects the scheduled UL transmission to tell if UE passes the CCA or eCCA. After detecting the Receiver-assistance information, the downlink data transmission happens.

Discussion: 2.6.1-2:

Do you agree with the following observation:

* For scheme 2-1, if DL data transmission is not granted with the same DL DCI that schedules/triggers the first UL PUCCH/SRS transmission, and if we don’t enforce the behavior that the gNB should not transmit if PUCCH/SRS is not detected, the scheme has no spec impact and can be left for implementation
* For scheme 2-2, if we don’t enforce the behavior that the gNB should not transmit if the PUSCH is not detected, the scheme has no spec impact and can be left for implementation

Support the observation: Intel, ZTE, Qualcomm

Please provide your view

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| Company | View |
| Intel | We agree with the FL’s observation. |
| ZTE, Sanechips | We agree with the FL’s observation, but there is a question on how to handle or whether to limit the position of DCI to scheduling DL data transmission and if DCI to scheduling DL data transmission occurs before or after first UL PUCCH/SRS transmission, whether to need a LBT for DL DCI transmission. Moderator: For this observation, I am assuming DL grant is transmitted after the UL PUCCH/SRS is detected. If another LBT is needed for the DL grant/DL data transmission is a separate discussion. |

Discussion: 2.6.1-3:

Do you support to explicitly introduce in the spec that

* In Scheme 2-1, the gNB should not transmit DL data if PUCCH/SRS is not detected
* In Scheme 2-2, the gNB should not transmit DL data if PUSCH is not detected

Support to explicitly introduce the restriction: Intel, ZTE

Not support:

Please provide your view

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| Company | View |
| Intel | We support to explicit indicate the conditional transmission upon detection of either PUCCH/SRS or PUSCH for scheme 2-1 and scheme 2-2, respectively.  |
| ZTE, Sanechips | We agree with the FL’s suggestion. |

Discussion: 2.6.1-4:

Do you support the following:

* For Scheme 2-1, the same DCI schedules the DL data also triggers the PUCCH/SRS transmission

Support: ZTE

Not support: Intel,

Please provide your view

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| Company | View |
| Intel  | The DL data could be scheduled through a separate DCI. |
| ZTE, Sanechips | We tend to support the same DCI schedules the DL data also triggers the PUCCH/SRS transmission. |

For scheme 3, seems that we don’t have consensus to support it.

Proposed conclusion 2.6.1-5

There is no consensus to support CCA or eCCA based receiver assistance with new RTS/CTS type transmission

Support the conclusion: Intel, Xiaomi, ZTE

Please provide your view below.

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| Company | View |
| Intel | We are Ok with the proposed conclusion. |
| Xiaomi | We are Ok with the proposed conclusion |
| ZTE, Sanechips | We are Ok with the proposed conclusion |

On scheme 4 (L3-RSSI based RX assistance)

Discussion: 2.6.1-6:

Please provide your views on Legacy L3-RSSI with potential enhancements

* Do you support introducing gNB indication of the beam used for UE RSSI measurement and how?
	+ Support: Xiaomi, ZTE
	+ Alt 1: gNB indicates beam when configures the L3-RSSI measurement
		- Xiaomi
	+ Other alternatives?
* Do you support introducing gNB indication of new reference SCS and measurement bandwidths and how

Not support: Intel

Please provide your view

|  |  |
| --- | --- |
| Company | View |
| Intel | We actually do not see any benefit in supporting this scheme, since the reporting of the channel occupancy status may be infrequent enough that the effective channel occupancy status at a given time would not be well captured. In this matter, the use of the channel occupancy status report may be counter-productive and actually may end up degrading the overall system performance. |
| Xiaomi | Yes, we support to introduce gNB indication of the beam used for UE RSSI measurement. this could be done by high layer configuration. |
| ZTE, Sanechips | We support introducing gNB indication of the beam used for UE RSSI measurement and specific related indication method can be further discussed and determined. |

## Multi-Beam COT

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| Agreement:For a COT with MU-MIMO (SDM) transmission, further consider the follow alternatives (down-select or support both)* Alt 1: Single LBT sensing at the start of the COT with wide beam ‘cover’ all beams to be used in the COT with appropriate ED threshold
* Alt 2: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT

Agreement:Within a COT with TDM of beams with beam switching, down-select one or more of the following LBT operations * Alt 1: Single LBT sensing with wide beam ‘cover’ all beams to be used in the COT with appropriate ED threshold
	+ FFS: Details on the definition of “cover”
* Alt 2: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT
* Alt 3: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT with additional requirement on Cat 2 LBT before beam switch

Agreement:* SSB transmission with LBT is supported, at least when the conditions for contention exempt short control signalling based SSB transmission is not met
	+ Note the channel access for SSB with LBT may not be different from a normal COT with multiple beams
	+ FFS: If any difference from a multi-beam COT LBT needs to be introduced

Agreement:For a COT with MU-MIMO (SDM) transmission, when independent per-beam LBT sensing at the start of COT is performed for beams used in the COT (Alt 2 in earlier agreement) is considered, the following alternatives are further considered* Alt A: The per-beam LBT for different beams is performed in TDM fashion
	+ Alt A-1: The node completes one eCCA on one beam, and directly move on to the eCCA on the other beam, with no transmission in the middle
	+ Alt A-2: The node completes one eCCA on one beam, start transmission with the beam to occupy the COT, then move on to the eCCA on the other beam
	+ Alt A-3: The node performs eCCA of the different beams simultaneous, round robin between different beams
* Alt B: The per-beam LBT for different beams is performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams

Agreement:Within a COT with TDM of beams with beam switching, when independent per-beam LBT sensing at the start of COT is performed for beams used in the COT (Alt 2 or Alt 3 in earlier agreement) is considered, the following alternatives are further considered* Alt A: The per-beam LBT for different beams is performed one after another in time domain
	+ Alt A-1: The node completes one eCCA on one beam, and directly move on to the eCCA on the other beam, with no transmission in the middle
	+ Alt A-2: The node completes one eCCA on one beam, start transmission with the beam to occupy the COT, then move on to the eCCA on the other beam
	+ Alt A-3: The node performs eCCA of the different beams simultaneous, round robin between different beams
* Alt B: The per-beam LBT for different beams is performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams
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| --- | --- |
| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | *Proposal 12: To define the sensing beam for LBT where at least the sensing beam(s) “covers” the transmission beam(s), support both Alt 1 and Alt 2 each for an appropriate use case as follows:*-        *Alt 2: One-to-one correspondence between LBT beam(s) and transmit beam(s), e.g., independent per-beam LBTs*-        *Alt 1: One-to-many correspondence between LBT beam and transmit beams and using quasi-omni-directional LBT beam* *Proposal 13: For initiating a COT with SDM or TDM of different beams using a single LBT beam that “covers” all the subsequent DL transmission beams, gNB selects a spatial sensing filter that minimizes the resulting [3]dB sensing beamwidth which at least contains all beam peak directions of the subsequent DL transmission beams within the COT (Alt-1E).**Proposal 14: For initiating a COT with SDM or TDM of different beams, support multiple independent per-beam LBTs, i.e. Alt 2.**Proposal 15: When gNB performs multiple independent per-beam LBTs, the spatial domain sensing filter for an LBT beam is the same as the spatial domain filter used for the corresponding transmission beam.**Proposal 16: For initiating a COT with SDM or TDM of different beams, support one LBT beam covering all transmission beams (Alt 1) as a fallback mechanism when the one-to-one correspondence between the LBT beams and transmission beams cannot be established.**Proposal 17: For initiating a COT with SDM or TDM of different beams, when independent per-beam LBT sensing at the start of COT is performed for beams used in the COT, support performing the per-beam LBTs simultaneously in parallel (Agree to FL Proposals 2.7.1-2 and 2.7.1-4 from RAN1#105-e).*-        *FFS: How to coordinate these parallel LBTs to align the start times of the SDMed transmissions, and how to determine the COT start time in the TDM case.*-        *If the node is incapable of sensing simultaneously in different beams, a single LBT beam covering the multiplexed transmission beams should be used.* |
| Spreadtrum Communications | Proposal 9: For a COT with MU-MIMO (SDM) transmission, 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 should be supported.Proposal 10: For a COT with MU-MIMO (SDM) transmission, independent per-beam LBT sensing at the start of COT is performed for beams used in the COT should be supported, and the per-beam LBT for different beams is performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams.Proposal 11: Within a COT with TDM of beams with beam switching, 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 should be supported.Proposal 12: Within a COT with TDM of beams with beam switching, when independent per-beam LBT sensing at the start of COT is performed for beams used in the COT: If the transmitter has the capability to simultaneously sense in different beams, the per-beam LBT for different beams is performed simultaneously in parallel- If the transmitter does not have the capability to simultaneously sense in different beams, Alt A-1 should be supported. |
| ZTE Sanechips | Proposal 8: Considering transmission opportunity and utilization of resource, Alt2 that “multiple per-beam LBT that cover multiple transmission beams used in COT” should be considered for the transmission with multiple beams in spatial domain multiplexing if directional LBT is supported.Proposal 9: Considering LBT overhead and transmission delay, Alt B that“The per-beam LBT for different beams is performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams” should be considered for the transmission with multiple beams in spatial domain multiplexing if Alt 2 is supported.Proposal 10: Considering transmission opportunity and unnecessary interference to other device that is going to transmit transmission, Alt-3 that “Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT with additional requirement on Cat 2 LBT before beam switch” can be considered for the transmission with multiple beams in time domain multiplexing, if directional LBT is supported.l Considering LBT overhead and transmission delay, Alt B that“The per-beam LBT for different beams is performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams” should be considered if Alt-2 or Alt-3 is supported |
| vivo | Proposal 7: A node can initiate two (or more) (partially) overlapping COTs in two (or more) different beams.Proposal 8: For a COT with MU-MIMO (SDM) transmission, both Alt 1 and Alt 2 are supported.Proposal 9: For a COT with TDM transmission, both Alt 1 and Alt 3 are supported.Proposal 10: For a COT with MU-MIMO (SDM) transmission, both Alt A-1 and Alt B are supported. Proposal 11: Alt A-1 and Alt-B are supported for the transmission within a COT with TDM of beams with beam switching. |
| OPPO | Proposal 11: for COT containing multiple beams, including MU-MIMO (SDM) and TDM of beams, Alt A-2 is not supported. Alt A-1 and Alt A-3 can be left for implementation.  |
| OPPO | *Proposal 12: introduce Cat 2 LBT into the independent per-beam LBT sensing procedure.* |
| NEC | Proposal 8: For a COT with SDM transmission, when independent per-beam LBT sensing at the start of COT is performed and the node does not has the capability to simultaneously sense in different beams, at least the following LBT operations should be supported:Ÿ The node performs eCCA of the different beams simultaneous, round robin between different beams.Proposal 9: Within a COT with TDM of beams with beam switching, when independent per-beam LBT sensing at the start of COT is performed for beams used in the COT and the node does not has the capability to simultaneously sense in different beams , the following LBT operations should be supported:• The node completes one eCCA on one beam, start transmission with the beam to occupy the COT, then move on to the eCCA on the other beam.• The node performs eCCA of the different beams simultaneous, round robin between different beams. |
| CATT | Proposal 7：Consider supporting both of single LBT sensing with wide beam and independent per-beam LBT sensing for all beams to be used within the COT at the start of the COT.Proposal 8: If supporting Alt A-1 or Alt A-2, the ‘blocking issue’ (failure of previous beam LBT causes subsequent beams unable to perform LBT) should be addressed.Proposal 9: Alt A-3 of which node performs eCCA round robin between different beams should be supported to increase the multi-beam LBT efficiency. |
| CAICT | Proposal 4: Both single LBT sensing with wide beam and independent per-beam LBT sensing should be supported for COT with MU-MIMO transmission. Alt. B for per-beam LBT should be supported. |
|  | Proposal 5: For LBT within a COT with TDM of beams with beam switching, Alt 1 and 3 should be supported. |
| Xiaomi | Proposal 2: COT should be per sensing beam based. If a sensing beam can “cover” several transmission beams, the transmission beams will share the same COT.Proposal 8: Multi-beam transmission for semi-static configured channels, such as CG-PUSCH should be studied to fully take advantage of spatial diversity. |
| Ericsson | Proposal 12 If any enhancements to better enable multiple beam transmissions within a COT when LBT mode is used can be agreed now, it is to support Alt 1 in principle for TDM and SDM case where a single LBT at the beginning of the COT is performed with the definition of “cover” meaning omni-directional or quasi-omni-directional.Proposal 13 RAN1 needs to decide on whether and how to specify directional LBT for single sensing beam case before further discussing multiple sensing beams. |
| Nokia Nokia Shanghai Bell | Proposal 14: COT initiating LBT with multiple independent per-beam LBT sensing should be deprioritised while completing the design for baseline channel access procedures.Proposal 15: For a COT with MU-MIMO (SDM) or within a COT with TDM of beams with beam switching, support both Alt 1 and Alt 2.Proposal 16: For a COT with MU-MIMO (SDM) transmission, support Alt B.Observation 11: It is important to maintain flexibility of gNB implementation for multi-beam COTObservation 12: Alt A-1 should be modified as: The node completes one eCCA on one beam, and directly moves on to the eCCA on the other beam, with no transmission in the middle. After completing eCCA on all beams, a further round robin CCA check is carried out in all beams (except the last beam).Observation 13: Alt A-3 should be modified as: The node performs eCCA of the different beams simultaneous, round robin between different beams. • single contention window is shared by beams or each beam has a separate contention window.• the last CCAs shall indicate vacant channel on all beams that are part of the COTProposal 17: For a COT with TDM transmission, support the modified Alt A-1 and Alt A-3:• Alt A-1: The node completes one eCCA on one beam, and directly moves on to the eCCA on the other beam, with no transmission in the middle. After completing eCCA on all beams, a further round robin CCA check is carried out in all beams (except the last beam).• Alt A-3: The node performs eCCA of the different beams simultaneous, round robin between different beams. o single contention window is shared by beams or each beam has a separate contention window.o the last CCAs shall indicate vacant channel on all beams that are part of the COT |
| Samsung | Proposal 9: Support directional channel sensing in multi-beam operation:• For multi-beam SDM scenario, both Alt 1 and Alt 2 can be supported.• For multi-beam TDM scenario, Alt 1 can be supported as baseline, and selection between Alt 2 and Alt 3 depends on whether sensing is required for switching beams within a COT.Proposal 10: For per-beam LBT for different beams,• Support both Alt A and Alt B, and up to implementation to choose between Alt A and Alt B.• Within Alt A, support Alt A-1 as the baseline. |
| Intel Corporation | Proposal 10: For a COT with MU-MIMO, both Alt-1 and Alt-2 are supported. As for Alt-2 both Alt-A-2 and Alt-B could be considered.Proposal 11: For a COT with beam switching, both single LBT sensing with wide beam and independent per-beam LBT sensing at the start of the COT are supported. Proposal: 12: An initiating device is able to initiate multiple overlapping COT over different beams. Proposal 13: When directional sensing is performed, the COT should be considered to be acquired only in the transmission beams for which the LBT is performed and the LBT measurements have indicated that the channel is idle.Proposal 14: When directional sensing is performed, and multiple concurrent COTs are acquired, these should be independently treated unless LBT measurements have overlapping beams. In this case, RAN1 should define some rules on how to handle these cases. |
| Sony | Proposal 6: 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 7: 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 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) should be supported. |
| Sony | *Observation 4: If per-beam LBT sensing is introduced, per beam COT indication may be needed.* |
| 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 (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 COTProposal 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, for a COT with MU-MIMO (SDM) transmission, the per-beam LBT for different beams is performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams**Proposal 11: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz with LBT based channel access mechanism, for a COT with TDM transmission, the per-beam LBT for different beams can be supported with both alternatives below:**• Alt A: The per-beam LBT for different beams is performed one after another in time domain**o 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**o 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**o 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**Proposal 12: 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 13: 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* |
| InterDigital Inc. | Proposal 13: A node that has initiated a first COT and wishing to transmit on a new transmission beam not applicable to the first COT, performs LBT on a sensing beam covering at least the new transmission beam and if possible, initiates a new COT and terminates the first COT. |
| InterDigital Inc. | Proposal 15: For a COT with MU-MIMO (SDM) transmission, support at least independent per-beam LBT sensing (Alt 2) and support simultaneous round robin eCCA between different beams (Alt A-3). |
| InterDigital Inc. | Proposal 16: For a COT with TDM of beams with beam switching, support at least independent per-beam LBT sensing at the start of COT with additional requirement on CAT 2 LBT before beam switch (Alt 3) and support Alt A-2 or A-3. |
| InterDigital Inc. | Proposal 17: Support of Alt B for SDM or TDM of beams can be considered for some UEs. |
| LG Electronics | Proposal #6: For a COT with MU-MIMO (SDM) and TDM of beams transmission, adopt Alt A-1 (the node completes one eCCA on one beam, and directly move on to the eCCA on the other beam, with no transmission in the middle) when independent per-beam LBT sensing at the start of COT. |
| Convida Wireless | Proposal 6: 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 7: 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: For a COT with MU-MIMO (SDM) transmission, consider both per-beam LBT for different beams performed in TDM fashion and per-beam LBT for different beams performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams.Proposal 9: Within a COT with TDM of beams with beam switching, consider both per-beam LBT for different beams performed in TDM fashion and per-beam LBT for different beams performed simultaneously in parallel, assuming the node has the capability to simultaneously sense in different beams. |
| Qualcomm Incorporated | Proposal 15: For SDM transmission, support both (Alt1) single LBT sensing with wide beam covers all beams used in the COT and (Alt 2) independent per beam sensing. Proposal 16: For a COT with MU-MIMO (SDM) transmission if independent per beam LBT is supported, and if the node has the capability to perform simultaneous sensing in different beams, simultaneous per-beam LBT for different beams is supported.Proposal 17: Within a COT with TDM of beams with beam switching, if independent per beam LBT is supported, and if the node has the capability to perform simultaneous sensing in different beams, simultaneous per-beam LBT for different beams is supported.Proposal 18: Within a COT with TDM of beams with beam switching, when independent per-beam LBT sensing at the start of COT is performed for beams used in the COT (Alt 2 or Alt 3 in earlier agreement is considered), select, Alt A-2, namely, the node completes one eCCA on one beam, start transmission with the beam to occupy the COT, then move on to the eCCA on the other beam.Proposal 19: Within a COT with TDM of beams with beam switching, downselect to the following LBT operations Alt A: Support both Alt-1 and Alt-2, where Alt-1 and Alt -2 are part of earlier agreement as follows: • Alt 1: Single LBT sensing with wide beam ‘cover’ all beams to be used in the COT with appropriate ED threshold o FFS: Details on the definition of "cover”• Alt 2: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT |
| ITRI | Proposal 2: For a COT with MU-MIMO (SDM) transmission, the per-beam LBT for different beams is performed simultaneously in parallel.Proposal 3: For a COT with TDM transmission, the per-beam LBT for different beams is performed one after another in time domain. |
| Panasonic | Proposal 1: Agree on Proposal 2.7.1-1 in Feature Lead Summary [1] i.e. For a COT with MU-MIMO (SDM) transmission, support both Alt 1 and Alt 2 below:• Alt 1: Single LBT sensing at the start of the COT with wide beam ‘cover’ all beams to be used in the COT with appropriate ED threshold• Alt 2: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COTProposal 2: Agree on Proposal 2.7.1-2 in Feature Lead Summary [1] i.e.For a COT with MU-MIMO (SDM) transmission if Alt 2 is supported (independent per beam LBT), and if the node has the capability to perform simultaneous sensing in different beams, simultaneous per-beam LBT for different beams is supported.Proposal 3: Agree on Proposal 2.7.1-3 in Feature Lead Summary [1], and further select Alt 3 by recognizing that it is a valid use case for Cat-2 LBT i.e.Within a COT with TDM of beams with beam switching, at least support Alt 1• Alt 3 is additionally supportedProposal 4: Agree on Proposal 2.7.1-4 in Feature Lead Summary [1] i.e. Within a COT with TDM of beams with beam switching, if Alt 2 or Alt 3 is supported (independent per beam LBT), and if the node has the capability to perform simultaneous sensing in different beams, simultaneous per-beam LBT for different beams is supported.Proposal 5: Support A-1 and A-3 in the discussion point 2.7.1-5 in Feature Lead Summary [2] of RAN1#105e. It means to support following.For a gNB/UE to initiate a COT with SDM or TDM multiple beams with separate LBT per beam and the gNB/UE does not have the capability to simultaneously sense in different beams, the following alternatives are supported:•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-3: The node performs eCCA of the different beams simultaneous, round robin between different beams |
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### First round discussion (on hold)

For this topic, it will be more efficient to discuss after we agree on how to validate sensing beam for a given transmission beam. The moderator proposes to put the discussion on hold

### Second round discussion (not started yet)

Proposal 2.7.1-1 (on hold)

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

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

Summary of Positions:

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

Proposal 2.7.1-2 (on hold)

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

Summary of Positions as of RAN1-105e:

* Stable with wide support except Ericsson

Proposal 2.7.1-3 (on hold)

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

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

Proposal 2.7.1-4 (on hold)

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

## 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

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| Company | *View* |
| Huawei HiSilicon | *Proposal 11: For multi-channel access in NR-U-60, support both Type A and Type B procedures.* |
| vivo | Proposal 1: 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. |
| vivo | Proposal 2: Both Type A and Type B multi-channel channel access can be supported. |
| CAICT | Proposal 6: Support both Type A and Type B multi-channel channel access. |
| Ericsson | Observation 5 ETSI regulation for 60 GHz bands do not support Type B multi-channel access. |
| Ericsson | Proposal 4 Support Alt1 in the agreement that allows only Type A multi-channel access from 37.213. |
| Ericsson | Proposal 5 Do not support Type B multi-channel access for NR operation in 52.6 GHz to 71 GHz. |
| Nokia Nokia Shanghai Bell | Proposal 9: Only Type A multi-channel access procedure (i.e. Alt.1 defined in RAN1#104-e meeting) shall be supported in NR-U on 60GHz band. |
| MediaTek Inc. | Proposal 4: Support only type A multi-channel channel access scheme. |
| Intel Corporation | Proposal 8: Do not support, type B channel access mode for multi-carrier operation. |
| Qualcomm Incorporated | Proposal 20: Adopt Alt-1 for multi-channel access, i.e., support Type A multi-channel access only.  |
| WILUS Inc. | ü Proposal 3: At least Type A multi-channel access which performs independent clear channel assessment (CCA) for each channel should be supported. For support of the Type B multi-channel access, it should be further discussed after the decision on support of Cat-2 LBT including the definition of Cat-2 LBT. |

### First Round Discussion

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

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

Summary of Positions based on contribution proposals:

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

Proposal 2.8.1-1:

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

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| Company | View |
| Intel | We support Alt.1, since applying CAT-2 LBT to initiate a COT for a specific CC or CCS may be against the adaptivity mechanism defined by the ETSI BRAN for this band.  |
| Xiaomi | Currently we are a little confused, compared to previous agreements “For LBT for multi-carrier transmission in intra-band CA, gNB/UE performs multiple LBT, one for each channel bandwidth separately (Alt CA.1. in earlier agreements)” , what is the application scenario for this multi-channel channel access? and what does “channel” mean in “multi-channel”? does the channel means something as “LBT bandwidth”? but we don’t have such definition as LBT bandwidth in 60GHz, if I remember correctly. Please correct me if I am wrong. Thanks.Moderator: Previous agreement is how LBT covers the CCs in frequency domain, and we agreed to do one LBT per CC. Now this discussion is more on time domain, i.e., what kind of LBT is performed, CCA or eCCA. |
| ZTE, Sanechips | We think this issue can be discussed after the use case of Cat 2 LBT is determined. |

## Directional LBT

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| Agreement:3GPP specification consider defining at least the relative relationship between all applicable sensing beam(s) and the transmission beam(s) to define sensing beam for LBT, where at least sensing beam(s) “covers” the transmission beam(s), considering following alternatives. Target down-selection by RAN1 #106bis-e* Alt 1: Specify necessary requirement/test procedure to guarantee sensing beam “covers” the transmission beam
	+ Some methods to define “cover” have been discussed in RAN1 (may further down select the list) and are considered as acceptable from RAN1 perspective
		- Alt-1A: the angle included in the [3] dB beamwidth of the transmission beam is included in the [X, FFS] dB beamwidth of the sensing beam.
		- Alt-1B: the sensing beam gain measured along the direction of peak transmission direction is at least X [FFS] dB of the transmission beam gain
		- Alt-1C: The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP. The sensing beam gain measured along the chosen directions is at least X [FFS] dB of the transmission beam gain in those directions.
		- Alt-1D: The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP and the sensing beam gain measured along the chosen directions is at least X [FFS] dB of the peak sensing beam gain
		- Alt-1E: Sensing beam has the minimum [3] dB beamwidth which at least contains all beam peak directions of transmission beams.
	+ Sending LS to RAN4 and inform them the above and request them to make the final choice
		- RAN4 choice may not be limited by the list above, but if different method is selected, RAN1 would like to have an opportunity to check as well
* Alt 2. Extending the beam correspondence framework and QCL/TCI/SpatialRelationInfo framework to define “cover” and to indicate sensing beam(s) associated with a transmission beam(s)
	+ On gNB side sensing beam selection for a DL transmission beam,
		- Option 1: The selection of eligible sensing beam for a transmission beam is left for gNB implementation
			* No testing or enforcement introduced in 3GPP spec for this option
		- Option 2: Beam correspondence at gNB side is assumed. Supporting one or more of the following behaviors
			* A1. For a gNB transmission beam corresponding to TCI state A for a certain UE, the gNB can use the same beam for sensing
			* A2. If TCI B is used as QCL source (Type D) for TCI A for a certain UE, then gNB transmission beam corresponding to TCI B can be used as the sensing beam for transmission with TCI A.
			* A3. If TCI C is NOT used as QCL source (Type D) for TCI A for any UE, then gNB cannot use the transmission beam corresponds to TCI C as the sensing beam for transmission with TCI A.
			* FFS: How and if to support sensing with a beam without corresponding RS sent? For example, how to use quasi-Omni beam for sensing if there is no SSB transmitted with quasi-omni beam
	+ On UE side sensing beam selection for a UL transmission beam
		- Beam correspondence is assumed at UE
			* FFS: What if beam correspondence is not supported at UE.
		- Supporting one or more of the following behaviors
			* If the UE is indicated to transmit with a beam corresponding to a certain SRI, the UE can use the same beam for sensing
			* Assuming Rel.17 unified TCI framework, if the UE is indicated to transmit with a beam corresponding to a certain unified TCI, the UE can use the reception beam corresponding to the TCI for sensing
			* FFS: How and if to support a wider sensing beam (such as pseudo-omni beam, which is supported in WiFi) to be used for a narrower transmission beam under QCL/TCI framework
				+ Option 0: Not supported
				+ Option 1: UE implementation.

No testing or enforcement introduced in 3GPP spec for this option * + - * + Option 2: gNB indication.

FFS details.* + FFS: How and if to support multiple sensing beams to be used for a transmission beam under QCL/TCI framework
* Note: Supporting both alternatives or a combination of the two alternatives is not precluded
 |

Summary of positions so far:

* Alt 1: Huawei, FUTUREWEI, ZTE( No Beam Correspondence), Vivo, Xiaomi, Ericsson , Nokia, Intel, (gNB), Interdigital, Qualcomm (mixed)
* Alt 2: Spreadturm, ZTE ( Beam Correspondence), OPPO, NEC, TCL, Samsung, Intel (UE), DOCOMO, Lenovo, LGE, Convida, Qualcomm (mixed) ,Charter
* ITRI : Do not allow mismatched sensing

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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | ***Observation 1: specifying the spatial relationship between a wide LBT beam and multiple subsequent transmission beams is feasible if spatial properties similar to those defined in TS 38.104 for a transmission beam are defined for the LBT beam, including beam peak direction, beam center direction and beamwidth.*** |
| FUTUREWEI | Proposal 4: Consider cover relation based on Alt-1.  |
| Spreadtrum Communications | Proposal 1: The directional LBT should be supported in 60GHz unlicensed band.Proposal 2: The relationship between all the LBT beams and the transmission beam should be defined and at least LBT beam “covers” the transmission beam.Proposal 3: The beam correspondence framework or QCL/TCI framework can be extended to define “cover”. |
| ZTE Sanechips | Proposal 7: If directional LBT is supported, it is necessary to further define the relationship between sensing/receiving beam(s) and transmission beam(s) and at least one of the following methods can be considered :l If Alt1 is supported, it is recommended that RAN1 can further discuss all potential candidate alternatives and try to down-select in order to reduce RAN4’s workload.l If Alt2 is supported,  - For gNB side, Option 1 that “The selection of eligible sensing beam for a transmission beam is left for gNB implementation” can be considered in order to provide more flexibility to gNB. - For UE side, ü if beam correspondence is supported, SpatialRelationInfo or Rel-17 unified TCI framework can be used for defining the relationship between transmission beam and sensing/receiving beam. Wherein, which method will be used depends on UE capability.ü If beam correspondence is not supported, Alt 1 can be considered for determining the relationship between transmission beam and sensing/receiving beam. |
| vivo | **Proposal 3: The transmission burst is a set of transmissions from gNB/UE from one or more transmission beams which are “covered” by a sensing beam without any gaps greater than [16us].**Proposal 12: The “cover” for sensing beam is defined as: the angle included in the [3] dB beam width of the transmission beam(s) is included in the [X] dB beam width of the sensing beam.Proposal 13: Adopt the modified scheme 2. |
| OPPO | Proposal 7: consider using QCL/TCI framework to define ‘cover’.  |
| NEC | **Proposal 1: The energy detection threshold adaptation for beam based channel access procedure should take into account the beamforming gain and mapping between transmission beam(s) and sensing beam(s).****Proposal 2: Conditioned on directional LBT introduced with details in spec, extending the beam correspondence framework and QCL/TCI framework should be supported to define “cover” and to indicate sensing beam(s) associated with a transmission beam(s).**  |
| TCL Communications | **Proposal 1: To have a unified frame framework with existing QCL/TCI and reduce the standardization work, we support Alt.2 to decide the relative relationship between all applicable sensing beam(s) and the transmission beam(s).**Proposal 2: The relative relationship of the sensing beam(s) and the transmission beam(s) on the gNB side is provided to UE to configure ED threshold(s) for uplink-to-downlink COT sharing. |
| Xiaomi | **Proposal 3: Both Omni-directional LBT and directional LBT should be supported.****Proposal 4: Support Alt 1 is to define the relationship between sensing beam(s) and the transmission beam(s).** |
| Ericsson | Observation 3 Reference point regarding which RSSI value (before or after antenna beamforming gain) is compared with the EDT to determine channel idle/busy needs to be clarifiedObservation 8 Common understanding in ETSI and IEEE 802.11ad and IEEE 802.11ay specs are omni-directional LBT or quasi-omnidirectional LBTObservation 9 Simulation studies in general indicate no significant gain from using directional LBT.Observation 10 Directional LBT is currently not precluded in the existing regulations. EN 302 567¨s tests intrinsically ensure sensing beam is in the direction of the transmission beam for devices equipped with directional antenna systems.Observation 11 Notion of “beams” for sensing/LBT is non-existent in 37.213.Observation 12 All alternatives agreed to be considered for a COT with TDM and SDM of beams, depends solely on how directional LBT for a single beam would be specified.Proposal 9 Support omni-directional LBT or quasi-omni-directional LBT as the baseline LBT procedure for 60 GHz band.Proposal 10 Do not support Alt.2 on extending the beam correspondence framework and/or QCL/TCI framework to define “cover”.Proposal 11 For the relationship between sensing and transmission beams, support Alt1 and send an LS to RAN4 to specify the necessary test/requirements |
| Nokia Nokia Shanghai Bell | Observation 7: Generic requirements for relative relationship between LBT sensing beam(s) and transmission beam(s) should be done in RAN4, not in RAN1.Proposal 13: Alt 1 from RAN1#106-e is agreed for defining the relative relationship between applicable LBT sensing beam(s) and the transmission beam(s). |
| Samsung | **Proposal 8:****• Support extending the beam correspondence framework and/or QCL/TCI framework to define “cover” (Alt 2), option.2;****• Support option 2 gNB indication in the sense of broad sensing beam can be implicitly indicated by reusing the set of DL RS signals which are used as QCL-D sources for the covered UL narrow transmission beams.** |
| Intel Corporation | **Proposal 19: Take Alt 2, “extending the beam correspondence framework and QCL, TCI, SpatialRelationInfo framework to define “cover” and to indicate sensing beam(s) associated with a transmission beam(s)” as baseline for further discussion and standards development.****Proposal 20: Support option 1, “The selection of eligible sensing beam for a transmission beam is left for gNB implementation”, for gNB side of alternative 2.**

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| **Proposal 21: Beam correspondence mandatory capability signaling is set to 1 for all supported unlicensed bands in FR2-2.**  |

**Proposal 22: Support option 1, up to UE implementation on how to support wide sensing beaming using QCL/TCI framework, for UE side of alternative 2.** **Proposal 23: RAN1 should extend the QCI or Spatial Relation Info framework to define and indicate the sensing beam associated with a transmission beam.**  |
| NTT DOCOMO INC. | **Proposal 4: Support Alt 2 for the definition of relationship between sensing beam and transmission beam** |
| Sony |

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| Proposal 5: Directional LBT should be supported in 60 GHz unlicensed operation. |

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| Lenovo Motorola Mobility | ***Proposal 1: For NR unlicensed bands between 52.6 GHz and 71 GHz, with directional LBT based channel access mechanism, Alt 2 should be supported as:• Alt 2. Extending the beam correspondence framework and QCL/TCI/SpatialRelationInfo framework to define “cover” and to indicate sensing beam(s) associated with a transmission beam(s)o On gNB side sensing beam selection for a DL transmission beam, § Option 1: The selection of eligible sensing beam for a transmission beam is left for gNB implementation• No testing or enforcement introduced in 3GPP spec for this option § Option 2: Beam correspondence at gNB side is assumed. Supporting one or more of the following behaviors• A1. For a gNB transmission beam corresponding to TCI state A for a certain UE, the gNB can use the same beam for sensing • A2. If TCI B is used as QCL source (Type D) for TCI A for a certain UE, then gNB transmission beam corresponding to TCI B can be used as the sensing beam for transmission with TCI A. • A3. If TCI C is NOT used as QCL source (Type D) for TCI A for any UE, then gNB cannot use the transmission beam corresponds to TCI C as the sensing beam for transmission with TCI A. • FFS: How and if to support sensing with a beam without corresponding RS sent? For example, how to use quasi-Omni beam for sensing if there is no SSB transmitted with quasi-omni beamo On UE side sensing beam selection for a UL transmission beam§ Beam correspondence is assumed at UE• FFS: What if beam correspondence is not supported at UE.§ Supporting one or more of the following behaviors• If the UE is indicated to transmit with a beam corresponding to a certain SRI, the UE can use the same beam for sensing• Assuming Rel.17 unified TCI framework, if the UE is indicated to transmit with a beam corresponding to a certain unified TCI, the UE can use the reception beam corresponding to the TCI for sensing• FFS: How and if to support a wider sensing beam (such as pseudo-omni beam, which is supported in WiFi) to be used for a narrower transmission beam under QCL/TCI frameworko Option 0: Not supportedo Option 1: UE implementation. § No testing or enforcement introduced in 3GPP spec for this option o Option 2: gNB indication. § FFS details.o FFS: How and if to support a multiple sensing beams to be used for a transmission beam under QCL/TCI framework*** |
| Lenovo Motorola Mobility | ***Proposal 2: For NR unlicensed bands between 52.6 GHz and 71 GHz, with directional LBT based channel access mechanism, Alt 2 should be supported for both UE side and gNB side.******Proposal 3: For NR unlicensed bands between 52.6 GHz and 71 GHz, with directional LBT based channel access mechanism, with Alt 2, all the listed behaviors for UE side sensing beam selection should be supported.******Proposal 4: For NR unlicensed bands between 52.6 GHz and 71 GHz, with directional LBT based channel access mechanism, with Alt 2, UE reporting can be enhanced such that UE can report sensing beams corresponding to the UL transmission beams (or activated TCI states or SRI for UL transmission)*** ***gNB can then indicate sensing beams to UE corresponding to the indicate UL transmission beam******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 specified 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, the relationship between the sensing and transmission beams can be configured based on the TCI framework to be:******- One-to-One mapping between sensing beam and transmission beam******- One sensing beam to many transmission beams mapping******- many sensing beams to One transmission mapping******Proposal 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*** ***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*** |
| InterDigital Inc. | Proposal 1: Support sensing beam determination using Alt.1 (at least for multiple associated transmission beams) and Alt.2 (for single associated transmission beam). |
| InterDigital Inc. | Proposal 3: Directional receiver assistance is supported. |
| LG Electronics | Proposal #8: 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 #9: It would be beneficial for coexistence that channel occupancy acquired by directional LBT is shared only for DL and UL signals/channels having spatial QCL relationship.Proposal #10: For the directional LBT, support Alt 2 that extends the beam correspondence framework and QCL/TCI/SpatialRelationInfo framework to define “cover” and to indicate sensing beam(s) associated with a transmission beam(s).Proposal #11: On gNB side sensing beam selection for a DL transmission beam, support Option 1 (the selection of eligible sensing beam for a transmission beam is left for gNB implementation).Proposal #12: For the FFS point regarding how and if to support a wider sensing beam (such as pseudo-omni beam, which is supported in WiFi) to be used for a narrower transmission beam under QCL/TCI framework, Option 2 should be supported. Proposal #18: To reduce the probability of collision, the contention window adjustment (CWS) procedure similar to Rel-16 NR-U can be adopted, and it is also necessary to discuss the relationship of the CWS and back-off counter values between wide beam LBT and independent per-beam LBT for multi-beam COT. |
| Convida Wireless | Proposal 3: If beam correspondence is assumed, sensing beam may be determined from transmission beam corresponding to a certain TCI state for frequency range of 52.6GHz to 71GHz. |
| Convida Wireless | Proposal 4: If beam correspondence is not assumed, sensing beam may be determined from a certain dB beamwidth for frequency range of 52.6GHz to 71GHz. |
| Qualcomm Incorporated | Proposal 21: If Alt 1 is chosen, Support Alt -1-D namely the sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP and the sensing beam gain measured along the chosen directions is at least X [FFS] dB of the peak sensing beam gain.Proposal 22: Alt-1-D Alternative formulation: The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP and the sensing beam gain measured along the chosen directions is at least X [FFS] dB of the transmission beam gain in those directions.Proposal 23: If Alt -2 is chosen, adopt gNB behaviors A1 and A2 for sensing at gNB.Proposal 24: If Alt -2 is chosen, and UE has beam correspondence and if the UE is indicated to transmit with a beam corresponding to a certain SRI, the UE can use the same beam for sensing.Proposal 25: If Alt -2 is chosen, and UE has beam correspondence, assuming Rel.17 unified TCI framework, if the UE is indicated to transmit with a beam corresponding to a certain unified TCI, the UE can use the reception beam corresponding to the TCI for sensing.Proposal 26: Adopt Alt 2 behaviors in the known-beam situations i.e. cases where sensing beam and transmission beams can be connected by TCI/QCL/beam correspondence relationship for the UE, and the behaviors A1, A2 hold for gNB in Alt -2 . In other situations specify requirement/test procedure to guarantee sensing beam “covers” the transmission beam, via RAN4.  |
| ITRI | Proposal 1: In order to avoid resource wastage and hidden node problem, the LBT beam should be the same as the transmission beam. |
| Charter Communications | Proposal 3: Support Alt. 2 for sensing beam framework. |
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### First Round Discussion

Please provide your views below on the compromise option.

Discussion 2-9.1-1:

If beam correspondence at gNB side is assumed. Support the following two behaviors on gNB side

* A1. For a gNB transmission beam corresponding to TCI state A for a certain UE, the gNB can use the same beam for sensing
* A2. If TCI B is used as QCL source (Type D) for TCI A for a certain UE, then gNB transmission beam corresponding to TCI B can be used as the sensing beam for transmission with TCI A.

Support: Lenovo

Not support (leave for gNB implementation): Intel, Xiaomi, ZTE

Please provide your view

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| Company | View |
| Intel | For gNB, our view is that the relationship between the sensing and transmit beam could be left up to implementation and there is no need to define any behaviour. |
| Lenovo, Motorola Mobility | We support A2 |
| Xiaomi | Agree with Intel that DL behaviour is left to gNB implementation.  |
| ZTE, Sanechips | For gNB side, we tend to leave the selection of eligible sensing beam for a transmission beam for the implementation from the flexibility point of view. |

Discussion 2.9.1-2:

When UE has beam correspondence, support the following behaviors

* If the UE is indicated to transmit with a beam corresponding to a certain SRI, the UE can use the same beam for sensing
* Assuming Rel.17 unified TCI framework, if the UE is indicated to transmit with a beam corresponding to a certain unified TCI, the UE can use the reception beam corresponding to the TCI for sensing
* Note: This discussion is focused on single transmission beam. After we have better understanding for this case, we can further discuss how to extend to multiple beam case
* Note: This discussion is focused on the case of using the same beam for transmission and sensing. Using wider sensing beam for transmission is discussed in 2.9.1-3

Support: Intel, Lenovo, Xiaomi

Not support:

Please provide your view

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| Company | View |
| Intel | We support the above behaviour. |
| Lenovo, Motorola Mobility | We are generally fine with the listed behaviours.However, we think that additional behaviour to indicate multiple sensing beams corresponding to a single transmission beam should also be considered for increased possibility of LBT success.Also, we suggest discussing the behaviour/details when UE has not beam correspondence. In our contribution [R1-2109902], we provide details on them |
| Xiaomi | Support in principle. but I think an important case is missed in the Proposal, that is how to defied a sensing beam that is wider than the transmission beam. and we are open to discuss this issue.Moderator: The sensing beam wider than transmission beam is to be covered by Discussion 2.9.1-3 |
| ZTE, Sanechips | It is necessary to clarify which cases the above listed method are applied in, e.g., one-to-one, one-to-many and many-to-one “covers” relationship between sensing beam and transmission.Moderator: Intend to discuss single beam first |

Discussion 2-9.1-3:

For situations not covered by Discussion 2.9.1-1 and 2.9.1-2, Specify necessary requirement/test procedure to guarantee sensing beam “covers” the transmission beam

* Some methods to define “cover” have been discussed in RAN1 (may further down select the list) and are considered as acceptable from RAN1 perspective
	+ Alt-1A: the angle included in the [3] dB beamwidth of the transmission beam is included in the [X, FFS] dB beamwidth of the sensing beam.
	+ Alt-1B: the sensing beam gain measured along the direction of peak transmission direction is at least X [FFS] dB of the transmission beam gain
	+ Alt-1C: The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP. The sensing beam gain measured along the chosen directions is at least X [FFS] dB of the transmission beam gain in those directions.
	+ Alt-1D: The sensing beam gain is measured in one or more directions where the transmission beam EIRP is within A [FFS] dB of the peak EIRP and the sensing beam gain measured along the chosen directions is at least X [FFS] dB of the peak sensing beam gain
	+ Alt-1E: Sensing beam has the minimum [3] dB beamwidth which at least contains all beam peak directions of transmission beams.
* Sending LS to RAN4 and inform them the above and request them to make the final choice
	+ RAN4 choice may not be limited by the list above, but if different method is selected, RAN1 would like to have an opportunity to check as well
* Note: Please provide your view for this discussion on gNB side and UE side separately

Support: Lenovo, Xiaomi, ZTE

Not support: Intel

Please provide your view

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| Company | View |
| Intel | We do not see any purpose for discussion 2-9.1-3, since we believe that one-to-many mapping between the sensing and transmit beam is only applicable to gNB, and in this case it is preferable to leave the whole procedure up to gNB’s implementation. Moderator: How about UE side? |
| Lenovo, Motorola Mobility | We are fine to send LS to RAN4 |
| Xiaomi | Support the proposal. |
| ZTE, Sanechips | We support this proposal, it is helpful to handle the case that Beam correspondence is not supported. |

## No LBT

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| Agreement:For regions where LBT is not mandated, gNB should indicate to the UE this gNB-UE connection is operating in LBT mode or no-LBT mode* Support both cell specific (common for all Ues in a cell as part of system information or dedicated RRC signalling or both) and UE specific (can be different for different Ues in a cell as part of UE-specific RRC configuration) gNB indication
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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | ***Observation 2: When network allows enabling/disabling the LBT mode, coexistence issues would arise as the performance of the nodes operating with LBT mode would be adversely impacted by the nodes operating with No-LBT on the channel without a time limit .******Observation 3: When No-LBT is used in regions where LBT is not mandated by regulations, the hidden node issue would still persist.******Proposal 26: For operation in the 60 GHz band, in regions where LBT is not mandated, indication of the decision on applying LBT mode or no-LBT mode per beam is not supported.******Proposal 27: For operation in the 60 GHz band, in regions where LBT is not mandated, indication of the decision on applying LBT mode or no-LBT mode using L1 signaling is not supported.******Proposal 28: 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.*** ***Proposal 29: For operation in the 60 GHz band, in regions where LBT is not mandated, COT should be limited when No–LBT is used.*** |
| FUTUREWEI | Proposal 9: For regions where LBT is not mandated, indication of UE specific per-beam LBT/no-LBT indication from the gNB is not supported. Proposal 10: In deployments without LBT consider specification of channel vacation policies accounting for disparity among co-existing devices. |
| ZTE Sanechips | Proposal 4: No LBT can be considered to be used in the following cases:• 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 8: No LBT should be workable only if some interference elimination mechanisms are applied on top of it. If no LBT is supported, the spec impact of introducing such enhancement should be further studied and evaluated.Proposal 5: 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 6: Conditions for No LBT fallback to LBT should be further studied, e.g., based on the interference level or correctly decoding rate.Proposal 16: Support Per beam indication for LBT mode.Proposal 17: Support gNB and its UE(s) having different LBT mode.Proposal 18: Support L1 signalling for the indication of LBT mode.**Proposal 22: If per beam is agreed for LBT mode, it is suggested to capture the feature of per beam for LBT mode in Rel-17 RRC parameters list.** |
| vivo | Proposal 14: Per-beam based channel access mode indication is not necessary.Proposal 15: 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. |
| OPPO | Proposal 8: support gNB and UE having different modes. Proposal 9: support LBT mode per beam indication.  |
| NEC | **Observation 1: Based on long term measurement, the channel assessment in statistic could be considered to determine or switch the operation mode.** **Proposal 10: For regions where LBT is not mandated, the mechanism and conditions for LBT mode and no-LBT mode switching should be specified to simplify the system implement.** |
| CATT | **Proposal 1: During the initial access procedure before RRC\_CONNETED state, the LBT mode indication can be transmitted by MIB or reserved bits in DCI format 1\_0 scrambled by SI-RNTI.** |
| Xiaomi | Proposal 1: How to prevent long time continuous channel occupying for Tx using No-LBT should be further studied.Proposal 5: Conditions about whether to enable/disable receiver assisted LBT can be studied.  |
| Ericsson | Proposal 27 Cell-specific system information indication of LBT ON/OFF is included in SIB1i. Define same DCI\_1\_0 sizes for both LBT on/off (licensed and unlicensed operation) |
| Nokia Nokia Shanghai Bell | Observation 9: Use of LBT provides mostly loss in median throughput compared to no-LBT mode and reduces throughput for cell edge UEs**Proposal 26: Leave any additional conditions/mechanisms/restriction/fallback modes on the no-LBT channel access mode for gNB implementation.** |
| Samsung | **Proposal 1: For regions where LBT is not mandated,****• the cell-specific indication is a group of mode pairs, wherein each mode pair defines the modes of gNB and UE for a particular beam;****• the UE-specific indication is a mode pair;****• gNB determines its operation mode up to implementation.** |
| Sony | **Observation 1: In EU, no-LBT mode cannot be operated at least under the ‘C1’ mode for indoor and outdoor deployment.****Observation 2: No-LBT mode works in the uncongested environment.****Observation 3: Congestion could be measured by average RSSI and channel occupancy which have already been introduced in NR-U.****Proposal 1: No-LBT mode is configured by the network based on measurement results of RSSI and channel occupancy.** |
| InterDigital Inc. | Proposal 8: The UE receives indication of the channel access mode (omni-directional, directional, receiver assistance, no LBT) from the gNB.Proposal 9: The indication of channel access mode is received per cell and per beam.Proposal 10: L1 signaling can be used for UE specific indication, at least for initial access. |
| LG Electronics | Proposal #15: For regions where LBT is not mandated, the mechanism for switching between the no-LBT mode and LBT mode should be supported and specified at least for UL, and the channel access mode switching between no-LBT mode and LBT mode can be determined e.g., based on the consecutive decoding success or failure or interference measurement. |
| Convida Wireless |

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| Proposal 1: Both omni-directional and directional LBT should be supported for frequency range of 52.6GHz to 71GHz. |

Proposal 2: Adaptation and indication for LBT mode, no-LBT mode and LBT sub-mode for system performance optimization should be considered. |
|  |
| Qualcomm Incorporated |  Proposal 27: Do not support per beam indication of the decision on applying LBT mode or no-LBT mode. |

### First Round Discussion

Discussion 2.10.1-1

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

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

Summary of current positions:

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

Please provide your view if not already captured above

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| Company | View |
| Intel  | As correctly captured by the FL, we do not see any technical reason to support per beam indication. |
| Lenovo, Motorola Mobility | We are also ok to support per beam indication for gNB as well |
| Xiaomi | Do not support per beam indication |
| ZTE, Sanechips | We support per beam indication to UE. |

Discussion 2.10.1-2

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

Summary of current positions:

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

Please provide your view if not already captured above

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| Company | View |
| Intel | As captured above, we do not support L1-signalling for the matter of indicating no-LBT mode. |
| Xiaomi | L1 Signaling for No-LBT mode should not be supported |
| ZTE, Sanechips | Our position has been correctly captured in summary. But we are a little confused that No-LBT mode is used in current description, it seems to imply that L1-Signalling can only indicate No-LBT mode, while cannot indicate LBT mode for the regions where LBT is not mandated. In order to avoid ambiguity, we propose the following the updated proposal for reference.* L1 Signaling for No-LBT mode or LBT mode should be supported
* L1 Signaling for No-LBT mode or LBT mode should not be supported
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## Short Control Signaling and Contention Exempt Transmission

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| Agreement:* Contention Exempt Short Control Signaling rules can be applicable to the transmission of SS/PBCH.
	+ FFS: What are the other DL signals and channels that can be multiplexed with SS/PBCH transmission under Contention Exempt Short Control Signaling rule
	+ FFS: Whether this can be applied to all supported SCS or specific SCS.
	+ FFS: Extension to discovery burst if it is defined including signals other than SS/PBCH
	+ Note: Restriction for short control signalling transmissions apply (10% over any 100ms interval)
* FFS: Other DL signals/channels can be transmitted with Contention Exempt Short Control Signaling rule, such as PDCCH, broadcast PDSCH, PDSCH without user plain data, CSI-RS, PRS, etc

Agreement:For contention exemption short control signalling based DL transmission of SS/PBCH, further consider if the following signals/channels can be multiplexed with SS/PBCH block transmission.* RMSI PDCCH and RMSI PDSCH
* Other broadcast PDSCH
* PDSCH without user-plane data
* PDCCH
* CSI-RS
* PRS
* Other signals/channels contained in Discovery Burst (i.e., exemption applies to Discovery Burst)

Note: Total exempted signals/channels should meet the restriction of 10% over any 100ms interval.FFS: If contention exemption short control signalling based DL transmission is allowed when not multiplexed with SS/PBCH block transmission. |

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| Agreement:* Contention Exempt Short Control Signaling rules apply to the transmission of msg1 for the 4 step RACH and MsgA for the 2-step RACH for all supported SCS.
	+ Note restriction for short control signalling transmissions apply (10% over any 100ms intervals)
	+ Alt 1: The 10% over any 100ms interval restriction is applicable to all available msg1/msgA resources configured (not limited to the resources actually used) in a cell
	+ Alt 2: The 10% over any 100ms interval restriction is applicable to the msg1/msgA transmission from one UE perspective
* FFS: Other UL signals/channels can be transmitted with Contention Exempt Short Control Signaling rule, such as msg3, SRS, PUCCH, PUSCH without user plain data, etc
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| Company | Key Proposals/Observations/Positions |
| Huawei HiSilicon | ***Proposal 30: In regions where LBT is mandated, only channels/signals included in the DB as defined for Rel-16 NR-U should be supported for contention exemption short control signaling based DL transmission.******Proposal 31: In regions where LBT is mandated, contention-exempt short control signaling rules apply to the transmission of msg1 for 4 step RACH and msgA for 2-step RACH such that the 10% over any 100ms interval restriction is applicable to all available msg1/msgA resources configured in a cell (Alt 1).******Proposal 32: In regions where LBT is mandated, contention-exempt short control signaling based transmission is not supported for UL signals/channels other than msg1/msgA.*** |
| FUTUREWEI | Proposal 7: The 10% over any 100ms interval restriction is applicable to all available msg1/msgA resources configured (not limited to the resources actually used) in a cell. FFS Candidates for short control exempt signaling subject to enforceability of 10% limit. |
| ZTE Sanechips | Observation 2: Other channel/signal is allowed to be multiplexed with a channel/signal that has been regarded as Short Control Signalling only if their total transmission time does not exceed 10ms limitation within 100ms observation period.Observation 3: If channel(s)/signal(s) is not regarded as Short Control Signalling and not multiplexed with any Short Control Signalling, it is a natural way that such channel(s)/signal(s) cannot apply Contention Exempt Short Control Signaling rule.Observation 4: l For 120 kHz SCS SS/PBCH, transmitted 64 SS/PBCH with 20ms SS/PBCH period exceeds 10ms limitation within a 100ms observation period required for short control signalling.l For larger SCS (e.g., 240/480/960kHz) SS/PBCH, transmitted 64 SS/PBCH with 20ms SS/PBCH period does not exceed 10ms limitation within a 100ms observation period required for short control signalling.Observation 5: As long as total time corresponding to all available UL resources that be used to transmit Short Control Signalling (e.g., Msg1/Msg A/potential Msg 3 ) meets 10ms limitation within a 100ms observation period, Contention Exempt Short Control Signaling rule can be applied.Observation 6: Once the transmission of DL/UL channels/signals considered as Short Control Signalling exceeds 10ms limitation, it is a nature way to switch from No LBT mode to LBT mode.Observation 7: For the case of the transmission of DL/UL channels/signals considered as Short Control Signalling is in a COT initiated by gNB or UE and LBT is performed before Short Control Signalling transmission, it is suggested that such transmission should not be counted into 10ms limitation within the 100ms observation period. |
| vivo | Proposal 16: The contention exempt short control signaling can be extended to discovery burst with duration at most 1ms.Proposal 17: The contention exempt short control signaling based SS/PBCH can be multiplexed with RMSI PDCCH, RMSI PDSCH and CSI-RS.Proposal 18: The 10% over any 100ms interval restriction is applicable to the msg1/msgA transmission from one UE perspective. |
| OPPO | ***Proposal 13: PUCCH carrying HARQ-ACK information belong to short control signaling.******Proposal 14: msg3, SRS, and PUSCH without user plain data should not belong to short control signaling.******Proposal 15: restriction for short control signalling transmissions is applicable to all available msg1/msgA resources configured in a cell.*** |
| CATT | ***Proposal 15: The 10% over any 100ms interval restriction should be applicable to all Contention Exempt Short Control Signals from cell perspective.*** |
| ***Proposal 16: In order to meet 10ms limit over 100ms, it should be supported to apply the Contention Exempt Short Signaling rules to sub-set of PRACH slots for msg1/msg3.*** |
| ***Proposal 17: For UL signal, the Contention Exempt Short Control Signaling rules can be applied to the PUCCH and PUSCH without user-plane data.***  |
| ***Proposal 18: The Contention Exempt Short Control Signaling can be applied to any signaling without user-plane data multiplexed with SS/PBCH block transmission.*** |
| ***Observation 1: When the periodicity of SS/PBCH block is 20 msec and the number of SSB beams is 64, the total duration of SSB transmission is more than 10ms over 100ms.*** |
| ***Proposal 19: In order to meet 10ms limit over 100ms, the Contention Exempt Short Signaling rules may be applied to sub-set of SSB beams for 120 kHz SCS when the up to 64 SSBs transmission is supported.*** |
| Xiaomi | Proposal 9: Support Alt 1, that is 10% over any 100ms interval restriction is applied to all available msg1/msgA resources configured. |
| Ericsson | Observation 6 In HS EN 302 567, SCS transmissions have a duty cycle requirement but no limitations on the number of SCS transmissions within the observation period.Proposal 6 Support extending the Short control signalling transmissions exemption to Discovery Burst.Proposal 7 Support Alt2 in which the short control signalling transmissions requirement of 10ms over 100ms duration is applicable to control and management transmissions from a single UE perspectiveProposal 8 Consistent with EN 302 567, a node can access the channel without LBT for control signal/channel transmissions, the total duration of which shall not exceed 10 ms within an observation period of 100ms. The following signals/channels shall be classified as short control signaling transmissions:1 msg3 for the 4 step RACH and MsgB for the 2-step RACH |
| Nokia Nokia Shanghai Bell | **Observation 5: 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 10: NR-U design for 60 GHz bands supports transmission of the following DL and UL control and management signals as short control signalling without LBT: • Downlink: SS/PBCH blocks (already agreed), PDCCH, CSI-RS and other reference signals, e.g., for beam management, SIBs, Paging• Uplink: HARQ-ACK feedback on either PUCCH or PUSCH, Scheduling Request, CSI feedback, Sounding RS, e.g., for beam management, RACH related transmissionsProposal 11: For the UL transmissions, the 10% short control signalling allowance is shared by all the UEs in the cell.Observation 6: Short contention window of [4] observation slots facilitates flexible LBT timing for SSB transmissions.Proposal 12: Use of short control signal contention exemption and use of LBT for SSBs is predetermined or semi-statically determined, distributing the channel access uncertainty over the SSBs. |
| Samsung | **Proposal 7: For “short control signalling”:****• support at least discovery burst as part of the short control signalling;****• support limitation on the duty cycle to use “short control signalling”, wherein the duty cycle are defined from the perspective of a node.** |
| MediaTek Inc. | **Proposal 3: For sensing structure within a 8 us deferral period, support Alt 2.** |
| Intel Corporation | **Proposal 24: It is left up to gNB to decide and apply SSE to any signals/channels which are additionally multiplexed with SS/PBCH, as long as when it does the 10% duty cycle over a 100ms observation period is met.****Proposal 25: SSB transmission with no LBT is supported at least for 960 kHz and type0-PDCCH.****Proposal 26: It is up to the gNB to decide and apply SSE to the discovery burst, as long as when it does the 10% duty cycle over a 100ms observation period is met.****Proposal 27: The 10% over any observation period of 100ms is applicable to the msg1/msgA transmission from one UE perspective.** **Observation 4: For 120 kHz, 480kHz, and 960 kHz PRACH transmission, UE does not exceed total transmission duration of 10 msec for PRACH within a 100 msec observation period.****Proposal 28: Contention Exempt Short Control Signaling rules apply to the transmission of msg3 for the 4-step RACH for all supported SCS.****Proposal 29: It is up to the UE to decide and apply SSE to SRS, PUSCH without user plain data, and PUCCH, as long as when it does the 10% duty cycle over a 100ms observation period is met.****Proposal 30: The gNB indicates through a cell-specific RRC parameter which specific channels/signals could be qualifies as short control signaling.** |
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| NTT DOCOMO INC. | **Proposal 6: Contention Exempt Short Control Signaling rules can be applicable irrespective of SCS** **Proposal 7: Support Alt 2 on the interpretation of Contention Exempt Short Control Signaling rules, i.e., the 10% over any 100ms interval restriction is applicable to the msg1/msgA transmission from one UE perspective** |
| Sony | **Proposal 2: Contention exempt short control signalling should be adopted for transmission of RMSI PDCCH, RMSI PDSCH, and/or CSI-RS contained in Discovery Burst.** |
| LG Electronics | Observation #1: The interpretation of regulation for 10% over any 100ms interval restitution from one UE perspective (Alt-2) is likely to cause coexistence problems with the incumbent system operating in the same band.Proposal #16: Whether a short control signing rule is applicable or not to the configured msg1/msgA resources can be explicitly indicated by the gNB or can be implicitly determined by the UE. |
| Qualcomm Incorporated | Proposal 28: Support Alt 2. Contention Exempt Short Control Signaling rules apply to the transmission of msg1 for the 4 step RACH and msgA for the 2-step RACH for all supported SCS. The 10% over any 100ms interval restriction is applicable from the perspective of the UE in accordance with per device requirement set by regulation.Proposal 29: SRS should be included towards contention exempt transmissions.Proposal 30: PUCCH should be included towards contention exempt transmissions.Proposal 31: PUSCH without user plane data, such as CSI or Ack/Knack, and msg3 should be included towards contention exempt transmissions.Proposal 32: Under the restrictions of duty cycle for short control signaling, allow SS/PBCH, PDCCH, CSI-RS and PRS for contention exempt transmission.  |

### First Round Discussion

Summary of Current Positions:

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

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

Proposal 2.11.1-1:

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

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

Please provide your view if not captured

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| Company | View |
| Intel  | We prefer alt-2, since this is more in line with the ETSI BRAN requirements, and given the infrequency of msg1/msgA, we do not see any coexistence issue. |
| Xiaomi | Alt 1 is preferred to give gNB more control of the wireless environment.so that interference is better controlled. |
| ZTE, Sanechips | Our position has been correctly captured in above proposal. |

Discussion 2.11.1-2:

For contention exemption short control signalling based UL transmission consider the following signals and channels.

* Any transmission on PUCCH
	+ Support: OPPO (HARQ A/N only), CATT , Nokia, Qualcomm, Intel, Lenovo, Motorola Mobility
* SRS
	+ Support: Qualcomm, Intel
	+ Oppose: OPPO
* PUSCH not carrying user plane data
	+ HARQ A/N on PUSCH
	+ Support: CATT, Nokia, Qualcomm, Intel, Lenovo, Motorola Mobility
		- Oppose: OPPO
	+ CSI reporting on PUSCH
		- Support: CATT, Nokia , Qualcomm, Intel, Lenovo, Motorola Mobility
		- Oppose: OPPO
	+ Msg 3
		- Support: CATT, Ericsson, Nokia, Qualcomm, Intel. Lenovo, Motorola Mobility
		- Oppose: Oppo
* No other Contention Exempt UL transmission should be permitted: Huawei

Please provide your views if not captured:

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| Company | View |
| Intel | As long as 10% duty cycle is met, any control information (PUCCH, SRS, msg3, PUSCH with no user plane data) could be qualified as short control signalling. Notice that we have updated he list of supporting companies and include our preference. |
| Lenovo, Motorola Mobility | Added our position above |
| Xiaomi | In principle, we agree that as long as 10% duty cycle is met, any control information (PUCCH, SRS, msg3, PUSCH with no user plane data) could be qualified as short control signalling.But we are still inclined to give gNB more control, so that a UL transmission can only be qualified as short control signalling when gNB configure or indicate it to be.  |
| ZTE, Sanechips | We think it is necessary to carefully evaluate which channels/signals are suitable to be seen as Contention Exempt UL transmission to avoid abuse of this rule. |

Discussion 2.11.1-3:

For contention exemption short control signalling based UL transmission, further introduce RRC configuration to allow gNB to control which channels can be transmitted with contention exemption.

Support: Intel, Xiaomi, ZTE, Qualcomm

Not support: Lenovo,

Please provide your views:

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| Company | View |
| Intel | We support the proposal, and we believe this would be helpful to provide to the gNB further control on which signal/channel the UE should qualify as short control signalling.  |
| Lenovo, Motorola Mobility | We don’t see the need for gNB to enable/disable short control signalling for channels/signals specifically |
| Xiaomi | Support the proposal. |
| ZTE, Sanechips | We agree with this proposal |

## CWS and CAPC

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| Company | Key Proposals/Observations/Positions |
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| ZTE Sanechips | Proposal 14: 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. |
|  | Proposal 15: Current CCA check procedure in EN 302 567 can be regarded as “Cat 4” rather than “Cat 3”. |
| CATT | **Proposal 3: There is no need to introduce CAPC and CWS.**  |
| Ericsson | Proposal 23 Do not support CAPC and CWS adjustment for NR operation in 52.6 GHz to 71 GHz. |
| Nokia Nokia Shanghai Bell | Proposal 1: Completing the design for features essential for baseline channel access operation should be prioritized. Observation 1: We do not see a need for contention window adjustment mechanism for mitigating channel access collisions. Proposal 2: LBT procedure uses fixed contention window size for random back-off. Observation 2: With sufficiently short contention window size, there is no need for CAPCs Proposal 3: Contention window size of [4] is used in the LBT procedureProposal 19: For dynamically scheduled UL transmissions, adopt Rel-16 DCI indication with appropriate modifications on the indicated channel access types. There is no need for an indication of CAPC or CP extension. |
| Samsung | **Proposal 4: Support Cat 3 LBT, i.e., without the need to adjustment the CW size.****Proposal 5: No need to define CAPC.** |
| Intel Corporation | **Proposal 16: 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 17: 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.** |
| Sony | **Proposal 3: Support fixed Contention Window.****• gNB’s contention windows size is left to network implementation.****• UE’s contention window size is configured by network.** |
| Lenovo Motorola Mobility | ***Proposal 19: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, CWS adjustment should be applied for each beam in an independent manner depending upon the corresponding CAPC (when Cat 4 LBT is done for each beam and COT is initiated for each of the beams), where the CWS adjustment for a transmit beam (TCI state) of a data channel can be based on the ACK/NACK feedback for the corresponding data channel with the same transmit beam (TCI state)*** |
| LG Electronics | Proposal #7: 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 valueProposal #17: The channel access priority classes (CAPC) can be introduced for NR above 52.6 GHz to differentiate the channel access probabilities for different channels and traffic. |
| Qualcomm Incorporated | Proposal 33: CWS adjustment need not be introduced for 60GHz band.Proposal 34: CAPC need not be introduced for 60GHz band. |
| ITRI | Proposal 6: CWS adjustment mechanism could be applied per beam-based in an independent manner for 60 GHz NR-U. |
| WILUS Inc. | ü Proposal 1: We propose to introduce CAPC, CWS and CWS adjustment mechanism for 60GHz band, with Rel.16 NR-U as baseline. |
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### First Round Discussion

Discussion 2.12.1-1

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

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

Summary of positions so far:

* Alt 1: Lenovo, Motorola, ZTE, LG, Intel ~~(~~ITRI (per beam) , WILUS
* Alt 2: Sony, Samsung, CATT, Nokia, Qualcomm, Ericsson, Futurewei, Spreadtrum, Xiaomi

Please provide your position if not captured above

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| Company | View |
| Intel | While this concept is not explicitly captured in the ETSI BRAN, it is neither precluded as well. Therefore, given that this procedure is well established in the specification, and allow to address different channel and traffic conditions that may impact the channel access procedure, RAN1 should consider to adopt it in the above 52.6 GHz band with the necessary modifications.  |
| Xiaomi | Do not introduce CWS adjustment |
| ZTE, Sanechips | We support the introduction of CWS adjustment, which is beneficial in some highly congested scenarios and to friendly and fair coexistence with Wi-Fi. |

Discussion 2.12.1-2

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

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

Summary of positions so far:

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

Please provide your position if not captured above

|  |  |
| --- | --- |
| Company | View |
| Intel | See comment above. |
| Xiaomi | Do not introduce CAPC adjustment |
| ZTE, Sanechips | We support the introduction of CAPC  |

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

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| Company | Key Proposals/Observations/Positions |
| ZTE Sanechips | Proposal 21: Study and evaluate the impact of LBT and the limitation of COT length on the procedure of beam failure detection. |
| Ericsson | Observation 7 The effectiveness of LBT itself as medium access mechanism for co-existence in unlicensed spectrum in 60 GHz band is questionable. Therefore, any further enhancement on LBT baseline from the HS need to be justified both on the performance gain and the required complexity. |
| Nokia Nokia Shanghai Bell | Proposal 20: For configured UL transmissions like scheduling request and CG-PUSCH, consider and agree on the necessary signalling indicating appropriate channel access type for the UE.Proposal 21: CG PUSCH configuration shall include indication of whether the CG PUSCH configuration is used inside or outside of a gNB initiated COT, or both.Proposal 22: Study the benefits of sharing the ED measurements results at gNB to the UEs.Proposal 23: Support for Cat-3 LBT is UE capability.Observation 17: Channel access mechanism without LBT should fulfil the requirements of EN 303 722 as well as the expected requirements of EN 303 753. |
| Intel Corporation | Proposal 15: RAN1 should further study how to efficiently allow beam-pairing due to LBT success.  |
| Lenovo Motorola Mobility | *Proposal 14: If a UE is going to transmit a set of consecutive PUSCH transmissions including both dynamically scheduled PUSCH transmissions and CG-PUSCH transmissions, the UE can select the latest indicated UL Tx beam to transmit the consecutive UL transmissions**Proposal 15: 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 16: For NR unlicensed bands between 52.6 GHz and 71 GHz with directional LBT based channel access mechanism, within a COT, PDCCH monitoring is not supported in the CORESETs corresponding to other COTs (PDCCH monitoring restricted to monitoring corresponding to only one COT at a time)**Proposal 20: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, ATPC could be adopted as one of the channel access mechanism, at least for regions where LBT is mandated by regulatory requirements**Proposal 21: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, adopt CG retransmission collision avoidance techniques such as retransmission deferral or additional retransmission resources.**Proposal 22: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, UE assistance information to indicate whether and which UL Tx beams can be used with no-LBT mode as initiating and/or responding device should be supported**Proposal 24: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, enhancement to the transmitter side LBT mechanism based on failure to receive HARQ feedback scheme or timer-based scheme should be supported for LBT based channel access mechanisms to consider potential interference at the receiver.**Proposal 27: For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, long term sensing should be supported for both LBT based and no-LBT based channel access mechanism to consider potential interference.*Observation 6: Currently, there is no mechanism is support long-term sensing including interference measurements from WiFi or other NR operators at the UE and corresponding reporting. - for long term sensing to measure interference statistics from WiFi systems or other NR operators, a new category of ZP CSI-RS should be supported where the UE is not expected to receive any channel/signal (including NZP CSI-RS for interference measurement) and only measure potential interference from WiFi nodes or other NR operators and report back corresponding measurements. Proposal 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 #2: If ChannelAccess-CPext field is kept as 2 bits in DCI format 0\_0 and 1\_0 for FR2-2 unlicensed band same as in NR-U, it is necessary to define UE behaviour for LBT type indication before identifying the Cat-2 LBT capability of the UE, such as initial access. |
| Convida Wireless | Proposal 11: Enhancement of resource utilization and interference mitigation in 52.6 GHz to 71 GHz should be considered.Proposal 13: 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. |
| ITRI | Proposal 4: PDCCH monitoring enhancement for M-TRP operation should be supported for 60 GHz NR-U. Proposal 5: Configuring multiple SRIs for a CG transmission should be supported for 60 GHz NR-U. |
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