**3GPP TSG RAN WG1 Meeting #103-e R1-200xxxx**

**e-Meeting, October 26 – November 13, 2020**

**Source: Moderator (Intel Corporation)**

**Title: 38.808 TR Text Proposal Discussion**

**Agenda item: 8.2.1**

**Document for: Discussion**

# Introduction

This document is to facilitate discussion of text proposal for the TR38.808. Please note evaluation assumption related agreement made in the previous meeting should have been already incorporated in the endorsed TR and is omitted in the discussion below.

# Agreements from RAN1 #101-e and #102-e

### Agreement #1:

For NR system operating in 52.6 GHz to 71 GHz,

* NR should be designed with maximum FFT size of 4096 and maximum of 275RBs per carrier;
* Candidate supported maximum carrier bandwidth(s) for a cell is between 400 MHz and 2160 MHz;
* If subcarrier spacing 240 kHz or below are supported, NR in 52.6 to 71 GHz is expected to use normal CP length only (does not have any implications on whether ECP is supported for the higher subcarrier spacings, if supported).

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture under 4.1.2 Candidate numerology and bandwidth**
	* **In order to bound implementation complexity, it is recommended to limit the maximum FFT size required to operate system in 52.6 GHz to 71 GHz frequency to less or equal to 4096 and to limit the maximum of RBs per carrier to 275 RBs.**
	* **The candidate supported maximum carrier bandwidth(s) for a cell should be between 400 MHz and 2160 MHz.**
	* **It is recommended that for subcarrier spacing 240 kHz or below, normal CP length is utilized for candidate subcarrier spacings.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | Suggest to wait for the updated agreement being discussed under 8.2.1. |

### Conclusion #2:

RAN1 continues study and specification effort for both licensed and unlicensed operation for supporting NR from 52.6 GHz to 71 GHz SI.

* RAN1 strives for maximum commonality for the system design for licensed and unlicensed operation for NR from 52.6GHz to 71GHz, and for maximum re-use of the existing NR design

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture under 4.1.1 General description of study in RAN1**
	* **It is recommended to strive for maximum commonality for the system design for licensed and unlicensed operation for NR from 52.6GHz to 71GHz, and maximize re-use of the existing NR design.**

**Moderator note: Not entire sure if the conclusion should be captured in TR or not. Please provide comments on what you think.** |
|  **Company** | **Comments** |
| Huawei, HiSilicon | We agree to capture this conclusion in the TR. |

### Agreement #3:

* Instruct rapporteur to create dedicated (sub-)section for set of identified issues for physical layer NR design.
* Endorse following text proposal as introduction to the (sub-)sections for discussing identified issues for physical layer.
	+ For supporting NR operation in both licensed and unlicensed band in the frequency range from 52.6 GHz to 71 GHz, FR2 numerologies and additional numerologies beyond that supported currently in NR are studied. Existing framework for numerology scaling is considered i.e. 2μ ×15 subcarrier spacing to select the candidates. For SSB transmissions, it is investigated whether or not µ>4 (larger than 240 kHz) is needed and corresponding impacts, if any, on the aspects including at least SSB pattern, multiplexing of other signal/channels, and transmission window, if supported. For data and control channel transmissions, it is investigated if µ>3 (larger than 120 kHz) is needed and corresponding impacts, if any, on aspects including at least processing timelines, PDCCH monitoring capability (BD/CCE), scheduling enhancements, beam-management, and reference signal design. For investigating the need for higher numerologies, some of the key aspects that are studied are the impact due to phase noise, delay spread, TAE, analog beam switching delay, and impact to coverage, spectral efficiency and peak data rates, and relative delay in intra-cell/inter-cell multi-TRP operations.

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| ***Rapporteur suggestion for capturing agreement/conclusion:***1. **Capture as is (text above) under 4.1.1 General description of study in RAN1**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | Agree |

### Agreement #4:

* Study whether or not different SSB patterns should be supported for licensed and unlicensed bands.
* For each licensed and unlicensed band, if issues are identified for reuse of existing SSB, consider at least the following aspects for SSB
	+ Beam switching gap between SSB(s) and between SSB and other signal(s)/channel(s)
	+ SSB pattern in time domain
	+ Whether or not it is needed to define a transmission window (such as DRS window), and if needed, number of SSB transmission opportunities within a transmission window
* For each licensed and unlicensed band, if issues are identified for reuse of all or some of the existing SSB and CORESET#0 multiplexing pattern, consider at least the following aspects for SSB, CORESET#0, and other signal/channel design
	+ Supported multiplexing pattern type(s) (Pattern 1, 2, and/or 3) for SSB and CORESET#0 multiplexing.
	+ Multiplexing of other signal/channels (e.g. RMSI, paging, CSI-RS) with SSB
	+ Configuration of Type0-PDCCH search space set

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapportuer has yet to provide a correspoding TP for this agreement. Rapportuer assumes agreement should be captured in some form to correctly represent progress made in RAN1 and RAN4. Please comment on whether you think the agreement should be not captured in some form to the TR or if you have suggestions on how this can be captured.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | We may want to revisit later since we are still discussing related recommendations for SSB under 8.2.1, and many of the aspects are overlapping or repeating. |

### Agreement #5:

RAN1 at least considers the following aspects for determination of supported SSB subcarrier spacing

* Detection performance of SSB (including PSS, SSS, PBCH DMRS, and PBCH) and SSB coverage requirement
* Impact on initial cell search complexity due to frequency errors (e.g. carrier frequency offset, Doppler shift, etc)
* Timing detection accuracy and its relation to uplink transmission accuracy
* Signaling design for supporting different subcarrier spacing for SSB and CORESET#0 (if supported)
* Multi-TRP delay considerations
* Consideration of SSB-based RRM/RLM and beam management if the SSB SCS is significantly different from that of the active BWP (e.g., switching gap, scheduling constraint, etc.)

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapportuer has yet to provide a correspoding TP for this agreement. Rapportuer assumes agreement should be captured in some form to correctly represent progress made in RAN1 and RAN4. Please comment on whether you think the agreement should be not captured in some form to the TR or if you have suggestions on how this can be captured.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | We think the agreement should be captured, as it lists various criteria for the determination of SSB SCS, and it is so far the only complete agreement/observation that lists all those criteria. |

### Agreement #6:

Consider the at least following aspects for PRACH design of NR operating in 52.6 GHz to 71 GHz

* PRACH coverage requirements
* applicable PRACH Sequence length(s) and subcarrier spacing(s) for PRACH, including any impact on PRACH coverage and capacity from the applicable sequence length(s).
* RACH RO configurations with new SCS (if new SCS is supported)
* LBT gap between RACH occasions (RO)

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapportuer has yet to provide a correspoding TP for this agreement. Rapportuer assumes agreement should be captured in some form to correctly represent progress made in RAN1 and RAN4. Please comment on whether you think the agreement should be not captured in some form to the TR or if you have suggestions on how this can be captured.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | We think the agreement should be captured, and may need to consider related agreements made at RAN1#103e in order to avoid repetitions/overlap. |

### Agreement #7:

Consider at least the following aspects of PT-RS design for a given SCS

* Phase noise compensation performance of existing PT-RS design
* Study of need of any modification/changes to existing PT-RS design
	+ Potential modification to the PT-RS pattern or configuration to aid performance improvement for CP-OFDM and DFT-s-OFDM waveforms (if needed)
	+ Potential methods to aid ICI compensation at the receiver (if needed)

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapportuer has yet to provide a correspoding TP for this agreement. Rapportuer assumes agreement should be captured in some form to correctly represent progress made in RAN1 and RAN4. Please comment on whether you think the agreement should be not captured in some form to the TR or if you have suggestions on how this can be captured.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | As commented under 8.2.1, we suggest that RAN1 recommends to investigate and specify the type of PTRS enhancements needed for supporting large MCS with ICI compensation, for all supported SCS. |

### Agreement #8:

Consider at least the following aspects of DM-RS design for a given SCS

* Channel estimation performance of existing DM-RS design with existing and new SCSs (if any)
* Study whether there is a need of any modification/changes to existing DM-RS design
	+ Potential modification or introduction of new DM-RS pattern, configuration or indication to aid performance improvement for CP-OFDM and DFT-S OFDM waveforms (if needed)

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapportuer has yet to provide a correspoding TP for this agreement. Rapportuer assumes agreement should be captured in some form to correctly represent progress made in RAN1 and RAN4. Please comment on whether you think the agreement should be not captured in some form to the TR or if you have suggestions on how this can be captured.**
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|  **Company** | **Comments** |
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### Agreement #9:

Consider at least the following aspects of processing timelines for new SCS (if agreed) that are not currently supported,

* appropriate configuration(s) of k0, k1, k2,
* PDSCH processing time (N1),
* PUSCH preparation time (N2),
* HARQ-ACK multiplexing timeline (N3)
* CSI processing time, Z1, Z2, and Z3, and CSI processing units
* Any potential enhancements to CPU occupation calculation
* Related UE capability(ies) for processing timelines
* minimum guard period between two SRS resources of an SRS resource set for antenna switching

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapportuer has yet to provide a correspoding TP for this agreement. Rapportuer assumes agreement should be captured in some form to correctly represent progress made in RAN1 and RAN4. Please comment on whether you think the agreement should be not captured in some form to the TR or if you have suggestions on how this can be captured.**
2. **Note: part of this may be covered by TP by the email discussion thread #1**
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|  **Company** | **Comments** |
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### Agreement #10:

Consider at least the following aspects of PDCCH monitoring for a given SCS

* For new SCS, if agreed, that are not supported in Rel-15/16 NR,
	+ investigate on the maximum number of BDs/CCEs for PDCCH monitoring per time unit
		- e.g. slot as Rel-15, or new scheduling/monitoring unit
	+ any potential limitation to PDCCH monitoring configurations (e.g. search spaces, DCI formats, overbooking/dropping, etc) to help with UE processing, if needed
		- e.g. increased minimum PDCCH monitoring unit
	+ potential enhancements for CORESET, if needed
	+ related UE capability(ies) for PDCCH processing

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapportuer has yet to provide a correspoding TP for this agreement. Rapportuer assumes agreement should be captured in some form to correctly represent progress made in RAN1 and RAN4. Please comment on whether you think the agreement should be not captured in some form to the TR or if you have suggestions on how this can be captured.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | It would be good to capture this agreement in order to keep track of the specification effort for new SCS, so that a complete WID can be provided to TSG RAN. |

### Agreement #11:

Consider at least the following aspects of scheduling for BWP with a given SCS

* Study of frequency domain scheduling enhancements/optimization for PDSCH/PUSCH, if needed
	+ e.g. potential impact to UL scheduling if frequency domain resource allocation with different granularity than FR1/2 (e.g. sub-PRB, or more than one PRB) is supported
* Study of time domain scheduling enhancements for PDSCH/PUSCH, if needed
	+ e.g. increasing the minimum time-domain scheduling unit to be larger than one symbol, supporting multi-PDSCH scheduled by one DCI, supporting one TB mapped to multiple slots (i.e., TTI bundling)
* Study potential enhancements or alternatives to the scheduling request mechanism to reduce scheduling latency due to beam sweeping, if needed

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapportuer has yet to provide a correspoding TP for this agreement. Rapportuer assumes agreement should be captured in some form to correctly represent progress made in RAN1 and RAN4. Please comment on whether you think the agreement should be not captured in some form to the TR or if you have suggestions on how this can be captured.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | It seems those study objectives may become superceded by later agreements/observations on the ”if needed” parts. We suggest deferring drafting a TP until those agreements are made under 8.2.1. |

### Agreement #12:

Consider at least the following aspects for uplink transmission

* Study of potential enhancements for PUSCH/PUCCH/PRACH transmissions to achieve higher transmit power (when transmit power spectral density limits apply), if needed
* Study whether uplink interlace needs to be supported for unlicensed operation in 60 GHz band.
	+ If supported, study uplink PRB and/or sub-PRB based interlace design for PUCCH, PUSCH, and/or SRS.

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapportuer has yet to provide a correspoding TP for this agreement. Rapportuer assumes agreement should be captured in some form to correctly represent progress made in RAN1 and RAN4. Please comment on whether you think the agreement should be not captured in some form to the TR or if you have suggestions on how this can be captured.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | It seems those study objectives may become superceded by later agreements/observations on the ”if needed” parts. We suggest deferring drafting a TP until those agreements are made under 8.2.1. |

### Agreement #13:

* Study single carrier and multi carrier operations for achieving wide bandwidth utilization, while at least considering aspects such as control signaling overhead, transceiver complexity, spectral efficiency, etc.

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapportuer has yet to provide a correspoding TP for this agreement. Rapportuer assumes agreement should be captured in some form to correctly represent progress made in RAN1 and RAN4. Please comment on whether you think the agreement should be not captured in some form to the TR or if you have suggestions on how this can be captured.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | We believe CA should continue being supported, it is business as usual, and thus the TR could simply recommend to support CA. |

### Agreement #14:

Consider at least the following aspects in system operations with beams

* Study of BFR mechanism enhancements, if supported
	+ e.g., the use of aperiodic CSI-RS for BFR, increased number of RSs for monitoring/candidates and efficient utilization of the increased number of RSs, enhanced reliability to cope with narrower beamwidth
* Study of UE capabilities on beam switch timing in beam management procedure
* Study of enhancements for beam management and corresponding RS(s) in DL and UL are needed further considering at least the following aspects, if supported:
	+ beam switching time, beam alignment delay (including initial access), LBT failure, and potential coverage loss (if large SCS is supported)
* Study of beam switching gap handling for signals/channels (e.g. CSI-RS, PDSCH, SRS, PUSCH) for higher subcarriers spacing, if supported

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapportuer has yet to provide a correspoding TP for this agreement. Rapportuer assumes agreement should be captured in some form to correctly represent progress made in RAN1 and RAN4. Please comment on whether you think the agreement should be not captured in some form to the TR or if you have suggestions on how this can be captured.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | It seems those study objectives may become superceded by later agreements/observations on the ”if supported” parts. We suggest deferring drafting a TP until those agreements are made under 8.2.1. |

### Agreement #15:

* Consider the study of at least the following aspects, including the justification for the features and their potential benefits, if applicable
	+ System overhead impact from TDD switching time for larger subcarrier spacing
	+ Coverage enhancement mechanisms for control channels and SSB, if larger SCS is supported
	+ Any potential modifications to HARQ processes including number of processes, if supported
	+ Impact from MAC buffering for larger subcarrier spacing, if any
	+ NR channelization/sub-channelization and any potential impact from RAN1 perspective
	+ Additional RF impairments that impact evaluations
	+ Impact on BWP switching procedure due to new higher SCS, if supported
	+ Support of rank 2 transmission for DFT-s-OFDM in the uplink
* Other aspects and impacts due to introduction of higher SCS are not precluded.

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapportuer has yet to provide a correspoding TP for this agreement. Rapportuer assumes agreement should be captured in some form to correctly represent progress made in RAN1 and RAN4. Please comment on whether you think the agreement should be not captured in some form to the TR or if you have suggestions on how this can be captured.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | Such types of agreements may be turned into TPs of the sort: ”RAN1 studied the following aspects...” and list only those that were indeed studies and for which observations were agreed. |

Conclusion #16:

The OCB requirement of draft version v2.1.20 of EN 302 567 implies that

* Device supports one or multiple declared nominal channel bandwidths.
* For each declared nominal channel bandwidth, RAN1 design should support at least one physical layer signal/channel transmission that occupies at least 70% of the nominal channel bandwidth.
* FFS: Mapping of nominal channel bandwidth to bandwidth definitions in NR.

Conclusion #17:

The RAN1 understanding of the CCA check procedure in draft v2.1.20 of EN 302 567 is as follows:

* When performing CCA before initiating transmission, during count down, when an observation slot fails ED, the counter freezes, and will continue count down 8us after the interference is detected to be gone

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapportuer has yet to provide a correspoding TP for this conclusion. Rapportuer assumes agreement should be captured in some form to correctly represent progress made in RAN1 and RAN4. Please comment on whether you think the conclusion should be not captured in some form to the TR or if you have suggestions on how this can be captured.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | We believe that Conclusion # 16 needs to be captured in TR minus the FFS part. If RAN1 makes an agreement regarding nominal channel bandwidth, that agreement may follow conclusion #16 in the TR. We believe that Conclusion #17 needs to be captured in TR. |

### Agreement #18:

* For gNB/UE to initiate a channel occupancy, both channel access with LBT mechanism(s) and a channel access mechanism without LBT are supported
* FFS: LBT mechanisms such as Omni-directional LBT, directional LBT and receiver assisted LBT type of schemes when channel access with LBT is used.
* FFS: If operation restrictions for channel access without LBT are needed, e.g. compliance with regulations, and/or in presence of ATPC, DFS, long term sensing, or other interference mitigation mechanisms
* FFS: The mechanism and condition(s) to switch between channel access with LBT and channel access without LBT (if local regulation allows)

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture under ”5.2 Channel access and interference mitigation techniques” (exact section TBD)**
	* **It is recommended to support both channel access with LBT mechanism(s) and a channel access mechanism without LBT for gNB and UE that initiate a channel occupancy. Further studies on:**
		+ **LBT mechanisms such as omni-directional LBT, directional LBT, and receiver assisted LBT type of schemes when channel access with LBT is used,**
		+ **whether operation restrictions for channel access without LBT are needed, e.g. compliance with regulations, and/or in presence of ATPC, DFS, long term sensing, or other interference mitigation mechanisms, and**
		+ **the mechanism and condition(s) to switch between channel access with LBT and channel access without LBT (if local regulation allows)**
	* **may be needed in the corresponding WI phase, if approved.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | In general, OK to capture the first bullet. However, subbulets of Bullet 1 may be updated by the possible future agreements in RAN1 103-e. Also, the intenion of the second bullet is unclear and we suggest to remove it at this time. |

### Agreement #19:

Use the LBT procedures in draft v2.1.20 of EN 302 567 as the baseline system evaluation with LBT

* Enhancements to ED threshold, contention window sizes etc. can be considered as part of the evaluations.

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Rapporteur’s understanding is this agreement has been captured into the TR as part of the evaluation assumptions. No need to consider further.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | Only the main line of the agreement is currently captured in Section A.3. The bullet ”Enhancement to ED threshold....” is not mentioned anywhere in TR. We believe that the bullet needs to be captured in A.3 right after the sentence ” LBT procedures in draft v2.1.20 of EN 302 567 as the baseline system evaluation with LBT” or the whole agreement (including the bullet) be mentioned in Section 5 of the TR.  |

# Agreements from RAN1 #103-e

### Agreement #20:

* Numerologies below 120 kHz or above 960 kHz are not supported for any signal or channel.

### Agreement #21:

* For operation in 52-71 GHz:
	+ 120 kHz should be supported
	+ Up to two additional SCS may be considered and at least one should be supported
	+ FFS: Applicability of additional SCS to particular signals and channels

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture under 4.1.2 Candidate numerology and bandwidth**
	* **In order to minimize specification effort while maximizing supported use cases and deployment scenarios applicable for 52.6 GHz to 71 GHz frequency, It is recommended to support 120 kHz subcarrier spacing with normal CP length, and at least one more subcarrier spacing. It is recommended to consider supporting at most up to three subcarrier spacings, including 120 kHz subcarrier spacing.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | It is not clear whether we should continue commenting on the same TP under 8.2.1 or here...? |

### Agreement #22:

* At least when operating with LBT, MCOT is 5ms, including all the gaps inside
* Note: Discussions related to further reductions in MCOT due to potential definition of CAPC will be handled separately.

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture under 5.2.X (exact section TBD)**
	* **For NR operating with LBT, maximum channel occupancy time (MCOT) duration is 5 msec, including all gaps inside the COT.**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | We believe that the ”Note” to the agreement is important and needs to also be captured. We suggest the following:**”For NR operating with LBT, maximum channel occupancy time (MCOT) duration is 5 msec, including all gaps inside the COT.** Discussions related to further reductions in MCOT due to potential definition of CAPC will be handled separately” |

### Agreement #25:

* Use the CCA check procedure in EN 302 567 (per RAN1 understanding as from RAN1 #102-e) as the baseline for channel access for 60GHz band when LBT is applied. The following can be discussed further during normative work.
	+ Whether CAPC and contention window adjustment mechanisms are introduced
	+ Whether ED threshold change is needed, e.g., due to changes in bandwidth, beamforming gain etc.
	+ Whether contention window range needs to be adjusted

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture under 5.2 (exact section TBD)**
	* **Delete** (per RAN1 understanding as from RAN1 #102-e) **and copy & paste agreement from RAN1 #102-e.**
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|  **Company** | **Comments** |
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### Agreement #26:

* Capture the following in the TR:
	+ On the LBT bandwidth (bandwidth over which a single contiguous LBT is performed) relative to channel bandwidth (as defined in RAN4), the following alternatives have been discussed. Further down-selection of one or more of these alternatives (if needed) should be further discussed when specifications are developed.
		- Alt 1: LBT bandwidth equals channel bandwidth
		- Alt 2: LBT bandwidth equals the minimum of channel bandwidth and the transmission bandwidth (number of RBs for a given transmission)
		- Alt 3: LBT bandwidth can be wider than channel bandwidth
		- Alt 4: LBT bandwidth can be narrower than the channel bandwidth, with multiple LBT subband within a channel
		- Alt 5: LBT bandwidth equals with minimum supported channel bandwidth or multiples of the minimum supported channel bandwidth

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture under 5.2 (exact section TBD)**
 |
|  **Company** | **Comments** |
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### Agreement #27:

* Capture the following in the TR:
	+ For operation where LBT is not required, it can be further discussed when specifications are developed
		- If RAN1 should introduce additional conditions/mechanisms for no-LBT to be used, or leave it for gNB implementation
		- When no-LBT mode is used, if RAN1 should introduce additional restrictions, such as DFS needs to be applied, ATPC needs to be applied, long term sensing needs to be applied, certain duty cycle limitation, certain transmit power limitation, MCOT limits, etc, or leave the restriction for gNB implementation
		- When no-LBT mode is used, if RAN1 should introduce mechanism for the system to fallback to LBT mode, or leave it for gNB implementation

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture under 5.2 (exact section TBD)**
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|  **Company** | **Comments** |
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# Capturing Evaluation Results

### Agreement #23:

Capture the following observations in the TR. Editorial modifications and changes to references can be made when capturing the observations in the TR.

* Comparison of No-LBT (NLBT) and Tx Side ED based Omnidirectional Sensing (TxED-Omni) for Indoor Scenerio A: 6 Companies have compared No-LBT with Tx Side ED based Omni sensing LBT
	+ Vivo, show tail and median benefits of using TxED-Omni LBT on DL, at high loading. In other cases, including all loads for UL and other loads for DL, TdxED-Omni LBT scheme shows losses. All results are at ED threshold -47.
	+ Intel shows gains for 5%ile DL throughput at high loads with TxED-Omni LBT. In other cases including all loads for UL and other loads for DL, TdxED-Omni LBT scheme shows losses. All results are at ED threshold -47.
	+ Ericsson, HW, Nokia, Qualcomm and Samsung show loss for TxED-Omni LBT with an EDT of -47 or -48 dB for all cases.

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture as is under ”5.2.X observations for evaluations related to channel access” (exact section TBD)**
 |
|  **Company** | **Comments** |
| Huawei, HiSilicon | Suggest the following editorial modifications:* Comparison of No-LBT (NLBT) and Tx Side ED based Omnidirectional Sensing (TxED-Omni) for Indoor Scenerio A: 6 Companies have compared No-LBT with TxED-Omni LBT
	+ Vivo, show tail and median benefits of using TxED-Omni LBT on DL, at high loading. In other cases, including all loads for UL and other loads for DL, TdxED-Omni LBT scheme shows losses. All results are at ED threshold -47 dBm.
	+ Intel shows gains for 5%ile DL throughput at high loads with TxED-Omni LBT. In other cases including all loads for UL and other loads for DL, TdxED-Omni LBT scheme shows losses. All results are at ED threshold -47 dBm.
	+ Ericsson, HW, Nokia, Qualcomm and Samsung show loss for TxED-Omni LBT with an EDT of -47 dBm or -48 dBm for all cases.
 |

### Agreement #24:

Capture the following observations in the TR (updates to references and other editorial modifications can be made for inclusion in the TR):

7 sources ([61, Ericsson], [26, Qualcomm], [56, vivo], [64, OPPO], [21, Apple], [25, NTT DOCOMO], [12, Intel]) reported evaluation results of PSS/SSS detection performance in terms of SINR in dB achieving cell ID detection probability of 90% by one-shot detection from PSS/SSS. 4 sources ([61, Ericsson], [26, Qualcomm], [56, vivo], [21, Apple]) reported PBCH performance in terms of SINR in dB achieving PBCH BLER target of 10%. 2 sources ([5, vivo], [14, 61, Ericsson]) compared link budget of SSB for difference SCS.

* For PSS and SSS detection performance, all evaluated candidate SCSs (120, 240, 480 and 960 kHz) show comparable performances with the non-optional (non-optional to be replaced by references to channel model in Tables to be added when capturing in TR) channel models and delay spread values.
	+ The performance degrades as the increase of SCS.
	+ Note: the following is reference when derive the observations.
	+ 6 out of 7 sources reported minor performance difference (< or ~ 1 dB) between adjacent SCS for all evaluated candidate SCSs (120, 240, 480 and 960 kHz). The other source ([21, Apple]) reported more than 3 dB performance gap of 960 kHz SCS compared to other 120, 240 and 480 kHz SCS. It also reported that the gap of 960 kHz increases as the delay spread increases.
* For PBCH BLER performance, all evaluated candidate SCSs (120, 240, 480 and 960 KHz) show comparable performances with the non-optional (non-optional to be replaced by references to channel model in Tables to be added when capturing in TR) channel models and delay spread.
	+ The performance degrades as the increase of SCS.
	+ All 4 sources reported minor performance difference (< or ~ 1 dB) between adjacent SCS for all evaluated candidate SCSs (120, 240, 480 and 960 KHz).
	+ The performance gap between 120 and 960 kHz is up to ~ 1.8 dB.
* In terms of SSB link budget, smaller SCS have better coverage than larger SCS
	+ The MCL and MIL difference between 120 kHz SCS and 480 kHz SCS is about 5 dB. The MCL and MIL difference between 120 kHz SCS and 960 KHz SCS is about 8 dB.

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture text above under ”4.1.X observations for link level evaluations” (exact section TBD) with appropriate update to the citation references.**
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|  **Company** | **Comments** |
| Huawei, HiSilicon | Agree observations from performance evaluations should be directly captured as in the agreement. |

### Agreement #28:

Capture the following observations in the TR (updates to references and other editorial modifications can be made for inclusion in the TR):

8 sources ([61, Ericsson], [68, Huawei], [26, Qualcomm], [56, vivo], [60, ZTE], [64, OPPO], [25, NTT DOCOMO], [12, Intel]) reported evaluation results of PRACH preamble detection performance in terms of SINR in dB achieving PRACH preamble misdetection probability of 1% with evaluation assumptions and parameters as in Table A.1-1 of TR 38.808. Two sources ([14, 61, Ericsson], [19, OPPO]) compared link budget of PRACH for different SCS.

The following are observed.

* For PRACH preamble detection performances for the same PRACH format, all evaluated candidate SCSs (120, 240, 480 and 960 kHz) show comparable performances
	+ Note: The following references were used to derive the observations.
	+ 7 out of 8 sources reported minor performance difference (< or ~ 1 dB) between adjacent SCS for all evaluated candidate SCSs (120, 240, 480 and 960 kHz). The other source ([64, OPPO]) reported minor performances difference among all SCS for TDL-A with 5 and 10ns DS. It reported infinite SINR for 960 kHz SCS and comparable SINR for 120, 240 and 480 kHz SCS in TDL-A with 20ns DS using the metrics of preamble miss detection probability of 1% and the estimated timing error is within [-Tcp/2, Tcp/2].
* For PRACH link budget of the same PRACH format and the same sequence length, maximum isotropic loss (MIL) and maximum coupling loss (MCL) degrade as the subcarrier spacing is increased, negatively impacting coverage.
	+ Two sources ([14, 61, Ericsson], [19, OPPO]) reported that with UE power limitation of 25 dBm EIRP, the MCL/MIL difference between 120 KHz SCS and 480 KHz SCS is about 4 to 5 dB; the MCL/MIL difference between 120 KHz SCS and 960 KHz SCS is about 8 dB.
	+ One source ([14, 61, Ericsson]) reported that without UE power limitation of 25 dBm EIRP (but still under regulatory limits), the MCL difference between 120 kHz SCS and 480 kHz SCS is less than 2.5 dB; the MCL difference between 120 kHz SCS and 960 kHz SCS is less than 1 dB.
	+ One source ([14, 61, Ericsson]) reported that without UE power limitation of 25 dBm EIRPs (but still under regulatory limits), compared to short PRACH sequence length, longer PRACH sequence length improve MCL/MIL significantly for 120 kHz SCS due to wider bandwidth for a given SCS.

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture text above under ”4.1.X observations for link level evaluations” (exact section TBD) with appropriate update to the citation references.**
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|  **Company** | **Comments** |
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### Agreement #29:

Capture the following observations in the TR (updates to references and other editorial modifications can be made for inclusion in the TR):

For CP-OFDM, the following are observed regarding the impact of DMRS to BLER performance.

* One source ([57, InterDigital]) reported performance improvement with increased number of DMRS symbols or increased DMRS density especially for higher modulation order for 960 kHz SCS in TDL-A (5 ns and 10 ns delay spread).
* One source ([14, Ericsson]) reported for 480 kHz SCS and below with large delay spread (TDL-A with 40 ns delay spread), the room for performance improvement with a change to the Rel-15 DMRS design is very limited.
* One source ([12, Intel]) reported a performance drop when frequency domain OCC is enabled especially for higher order modulation such as 64 QAM (MCS 22) for 960 kHz SCS in TDL-A (10ns and 20 ns delay spread) and 480 kHz SCS (20 ns delay spread). The performance gap increases when channel delay spread increases.
* One source ([26, Qualcomm]) reported performance improvement with a new DMRS pattern featured by high frequency density (i.e., every RE) and 2-FD-OCC across adjacent REs for 960 kHz SCS in TDL-A (20 ns and 40 ns delay spread)..
* One source ([10, Nokia]) reported that with Rel-15 DMRS type-1, different delay spread values (10ns and 20ns) have a negligible impact to the demodulation performance of PDSCH for a high SCS (such as 960 kHz).

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture text above under ”4.1.X observations for link level evaluations” (exact section TBD) with appropriate update to the citation references.**
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|  **Company** | **Comments** |
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### Agreement #30:

Capture the following observations in the TR (updates to references and other editorial modifications can be made for inclusion in the TR):

7 sources ([61, Ericsson], [68, Huawei], [26, Qualcomm], [56, vivo], [64, OPPO], [10, Nokia], [21, Apple]) evaluated DFT-S-OFDM PUSCH BLER performance with different SCS.

* Compared to CP-OFDM when CPE-only compensation is enabled, DFT-s-OFDM is more robust under phase noise.
* For low and medium MCSs (QPSK and 16QAM), there’s minor performance difference among evaluated SCSs up to 960 kHz.
* With normal CP, for high MCS (64QAM), the performance improves as the increase of SCS, 120 kHz SCS shows up to ~2.0dB loss compared to other larger SCS.
	+ Note: the following are references when derive the observations.
	+ One source ([61, Ericsson]) reported a performance gap of 1.4~1.8 dB between 120 and 960 kHz SCS
	+ One source ([68, Huawei]) reported a performance gap of 1.3~2.5 dB between 120 and 960 kHz SCS
	+ One source ([26, Qualcomm]) reported a performance gap of 1.2~1.7 dB between 120 and 960 kHz SCS
	+ One source ([56, vivo]) reported a performance gap of ~1.4 dB between 120 and 960 kHz SCS
	+ One source ([10, Nokia]) did not report numerical SINR results in table but provided figures showing approximately similar performance difference (~ 2 dB) between 120 and 960 kHz SCS.
	+ One source ([21, Apple]) reported a performance gap of more than 7 dB performance gap between 120 kHz SCS and other SCS (240, 480 and 960 kHz) at TDL-A 5 ns DS. It also reported 120 kHz SCS cannot meet the BLER target of 10% at TDL-A 10ns DS and 960 kHz SCS cannot meet the BLER target of 10% at TDL-A 20ns DS.
	+ Another source ([64, OPPO]) reported 120 and 240 kHz SCS cannot meet the BLER target of 10% for all evaluated DS values.
* For high MCS (64QAM) at large delay spread (TDL-A 40ns or CDL-B 50ns DS), there’s error floor for 960 KHz SCS at least for BLER target 1%.
	+ Note: the following are reference when derive the observations.
	+ One source ([26, Qualcomm]) reported an error floor for 960 kHz SCS for BLER target 1%.
	+ One source ([56, vivo]) reported an error floor for 960 kHz SCS for BLER target 10%
	+ One source ([64, OPPO]) reported no error floor of 960 kHz SCS for the BLER target of 10% and 1% for CDL-B 50ns but an error floor for 960 kHz SCS at TDL-A 20ns for BLER target 1%

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture text above under ”4.1.X observations for link level evaluations” (exact section TBD) with appropriate update to the citation references.**
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|  **Company** | **Comments** |
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### Agreement #31:

Capture the following observations in the TR (updates to references and other editorial modifications can be made for inclusion in the TR):

For CP-OFDM, with evaluation assumptions and parameters as in Table A.1-1 of TR 38.808, the following are observed when CPE-only compensation based on the existing Rel-15 NR PTRS structure is used for normal CP when delay spread is not large. The performance is measured in terms of SINR in dB achieving BLER target of 10% or 1%.

* For low MCS (QPSK) and medium MCS (16QAM), there is minor performance difference between different SCS values up to 960 kHz.
* For high MCS (64QAM), the performance improves in general as the increase of SCS
* For high MCS (64QAM), 13 sources ([61, Ericsson], [68, Huawei], [26, Qualcomm], [56, vivo], [60, ZTE], [64, OPPO], [10, Nokia], [2, 55, Lenovo], [21, Apple], [18, Samsung], [25, NTT DOCOMO], [12, Intel], [7, InterDigital]) compared performance of 120 and 240 kHz SCS in 400 MHz bandwidth
	+ for 10% BLER target, there is a performance gap between 120kHz and 240kHz SCS where 240 kHz SCS performs better.
		- Note: the following references are used when derive the observations.
		- One source ([61, Ericsson]) reported better performance of 240 kHz SCS in CDL-D. It also reported both SCS cannot meet 10% BLER target for other evaluated channel model.
		- 3 sources ([68, Huawei], [64, OPPO], [10, Nokia]) reported both SCS cannot meet 10% BLER target
		- 4 sources ([56, vivo], [60, ZTE], [21, Apple], [7, InterDigital]) reported 120 kHz SCS cannot meet 10% BLER target while 240 kHz SCS can
		- One source ([2, 55, Lenovo]) reported better performance of 240 kHz SCS at TDL-A 5 and 10ns. It also reported that both SCS cannot meet 10% BLER target for other evaluated cases.
		- One source ([12, Intel]) reported better performance of 240 kHz SCS in CDL-D. It also reported that both SCS cannot meet 10% BLER target for other evaluated cases.
		- 2 sources ([26, Qualcomm], [18, Samsung]) reported better performance of 240 kHz SCS
		- One source ([25, NTT DOCOMO]) reported comparable performance for both SCS in CDL-D. It also reported better performance of 120 kHz SCS for other evaluated channel model.
* For high MCS (64QAM), 13 sources ([61, Ericsson], [26, Qualcomm], [56, vivo], [60, ZTE], [64, OPPO], [10, Nokia], [2, 55, Lenovo], [21, Apple], [18, Samsung], [25, NTT DOCOMO], [12, Intel], [67, Charter], [7, InterDigital]) compared performance of 240 and 480 kHz SCS in 400 MHz bandwidth
	+ for 10% BLER target, there is a performance gap between 240kHz and 480kHz SCS where 480 kHz SCS performs better.
		- Note: the following references are used when derive the observations.
		- One source ([61, Ericsson]) reported better performance for 480 kHz SCS in CDL-D. It also reported 240 kHz SCS cannot meet 10% BLER target for other evaluated channel model.
		- 3 sources ([64, OPPO], [10, Nokia], [67, Charter]) reported 240 kHz SCS cannot meet 10% BLER target while 480 kHz SCS can
		- One source ([2, 55, Lenovo]) reported better performance of 480 kHz SCS at TDL-A 5 and 10ns. It also reported 240 kHz SCS cannot meet 10% BLER target for other evaluated cases.
		- One source ([12, Intel]) reported better performance of 480 kHz SCS in CDL-D. It also reported 240 kHz SCS cannot meet 10% BLER target for other evaluated cases.
		- 6 sources ([26, Qualcomm], [56, vivo], [60, ZTE], [21, Apple], [18, Samsung], [7, InterDigital]) reported better performance of 480 kHz SCS
		- One source ([25, NTT DOCOMO]) reported comparable performance for both SCS in CDL-D. It also reported better performance of 240 kHz SCS for other evaluated channel model.
* For high MCS (64QAM), 14 sources ([61, Ericsson], [68, Huawei], [26, Qualcomm], [56, vivo], [60, ZTE], [64, OPPO], [10, Nokia], [2, 55, Lenovo], [21, Apple], [18, Samsung], [25, NTT DOCOMO], [12, Intel], [67, Charter], [7, InterDigital]) compared performance of 480 and 960 kHz SCS in 400 MHz bandwidth
	+ for 10% BLER target, there is a performance gap between 480kHz and 960kHz SCS where 960 KHz SCS performs better.
		- Note: the following references are used when derive the observations.
		- 7 sources ([61, Ericsson], [60, ZTE], [64, OPPO], [10, Nokia], [2, 55, Lenovo], [67, Charter], [7, InterDigital]) reported a greater than 1 dB gain of 960 kHz SCS
		- 3 sources ([26, Qualcomm], [56, vivo], [18, Samsung]) reported a smaller than 1 dB performance gain of 960 kHz SCS
		- One source ([68, Huawei]) reported better performance of 480 kHz SCS for CDL-B 50ns and better performance of 960 kHz SCS for other evaluated cases. In all comparison, the difference is greater than 1 dB.
		- Two sources ([21, Apple], [12, Intel]) reported a better performance of 480 kHz SCS than 960 kHz SCS at 20ns DS in TDL-A where 960 kHz SCS cannot meet 10% BLER target and comparable performance for both SCS in all other evaluated cases
		- One source ([25, NTT DOCOMO]) reported comparable performance for both SCS in CDL-D. It also reported better performance of 480 kHz SCS in TDL-A 5ns and better performance of 960 kHz SCS in CDL-B 20ns.
	+ for 1% BLER target, the performance for 960kHz SCS is better than 480kHz SCS.
		- Among sources reported SINR values when both SCS can meet 1% BLER target, the absolute value of the performance gap between 480 kHz and 960 kHz SCS is larger than that for 10% BLER target.
* For high MCS (64QAM), 4 sources ([61, Ericsson], [56, vivo], [10, Nokia], [18, Samsung]) compared performance of 480 and 960 kHz SCS in 1600 or 2000 MHz bandwidth. 4 out of 4 sources reported performance gain around 4 ~ 5 dB of 960 kHz SCS for 10% BLER target. All 4 sources also reported that 480 kHz SCS cannot meet 1% BLER target.

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture text above under ”4.1.X observations for link level evaluations” (exact section TBD) with appropriate update to the citation references.**
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|  **Company** | **Comments** |
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### Agreement #32:

Capture the following observations in the TR (updates to references and other editorial modifications can be made for inclusion in the TR):

For CP-OFDM, with evaluation assumptions and parameters as in Table A.1-1 of TR 38.808 (including optional delay spread value), the following are observed when CPE-only compensation based on the existing Rel-15 NR PTRS structure is used with respect to CP type and large delay spread.

* When delay spread is not large (< 40 ns in TDL-A), there is minor performance difference between normal and extended CP for SCS values up to 960 kHz when compared on the basis of equal MCS (code rate). If comparing on the basis of equal TBS (equal throughput), the performance of ECP is degraded due to higher overhead of ECP.
* Among 11 sources ([61, Ericsson], [68, Huawei], [26, Qualcomm], [56, vivo], [60, ZTE], [64, OPPO], [2, 55, Lenovo], [1, Futurewei], [25, NTT DOCOMO], [12, Intel], [7, InterDigital]) evaluated with large delay spread (i.e. 40 ns in TDL-A and/or 50ns in CDL) based on the existing Rel-15 NR PTRS structure for normal CP, 10 sources observed that for low MCS (QPSK) and medium MCS (16QAM), there is minor performance difference between different SCS values up to 960kHz for 10% BLER target
	+ The other source ([1, Futurewei]) evaluated SCS 960 kHz with CPE compensation at MCS16 with normal CP in TDL-A channel with 40ns DS. It reported that the BLER for SCS 960 kHz, MCS16, and Normal CP is not acceptable (cannot meet 10% BLER target) for 40ns DS.
* 10 sources ([61, Ericsson], [68, Huawei], [26, Qualcomm], [56, vivo], [60, ZTE], [64, OPPO], [2, 55, Lenovo], [25, NTT DOCOMO], [12, Intel], [7, InterDigital]) evaluated large delay spread (i.e. 40 ns in TDL-A and/or 50ns in CDL) with CPE compensation based on the existing Rel-15 NR PTRS structure with normal CP. Among 10 sources, 5 sources ([14, Ericsson], [68, Huawei], [5, 56, vivo], [2, 55, Lenovo], [25, NTT DOCOMO]) also evaluated extended CP at least for 960 kHz SCS with CPE compensation based on the existing Rel-15 NR PTRS structure.
	+ 9 out 10 sources observed that for high MCS (64QAM) with normal CP, larger SCS (480 and 960 kHz) performs better than smaller SCS (120 and 240 kHz) when only CPE compensation based on the existing Rel-15 NR PTRS structure is used. The other source ([25, NTT DOCOMO]) reported better performance of smaller SCS.
	+ 5 out 5 sources observed the performance of 960 kHz SCS with extended CP is significantly improved compared to with normal CP for large delay spread case when compared on the basis of equal MCS (code rate).
	+ 4 sources ([14, Ericsson], [68, Huawei], [5, vivo], [2, 55, Lenovo]) compared throughput of normal CP and extended CP at least for 960 kHz SCS with CPE compensation based on the existing Rel-15 NR PTRS structure. They all reported worse throughput of extended CP.

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture text above under ”4.1.X observations for link level evaluations” (exact section TBD) with appropriate update to the citation references.**
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|  **Company** | **Comments** |
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### Agreement #33:

Capture the following observations in the TR (updates to references and other editorial modifications can be made for inclusion in the TR):

For CP-OFDM, the following are observed with respect to phase noise compensation and PTRS.

* Compared to no phase noise compensation, CPE compensation shows little gain at low and medium MCSs for all the evaluated SCS values; while significant gain is observed for high MCS (64QAM) for all the evaluated SCS values.
	+ Two sources ([57, InterDigital], [11, Mitsubishi])) reported that increased PTRS density in frequency domain based on Rel-15 configuration does not provide significant performance benefits.
* For a given SCS, the complexity of ICI compensation increases as the number of ICI filter tap increases
* For MCS 22 evaluation of the same SCS, performance gain of ICI compensation with additional complexity of multi-tap filtering compared to CPE-only compensation is observed when there is sufficient number of PTRS in the frequency domain for 120, 240 and 480 kHz SCS.
	+ Note: the following references are used when derive the observations.
	+ One source ([61, Ericsson]) showed performance gain of ICI compensation compared to CPE-only compensation for all evaluated SCS
	+ One source ([68, Huawei]) evaluated ICI compensation and compared with CPE-only compensation. It reported performance gain for all evaluated SCS.
	+ One source ([26, Qualcomm]) compared the performance of CPE and ICI compensation for 120 kHz SCS reported performance gain of ICI compensation.
	+ One source ([64, OPPO]) compared the performance of CPE and ICI compensation for all SCS. It reported performance gain of ICI compensation for 240 kHz and 480 kHz SCS. It reported performance gain of ICI compensation in CDL-B but a performance loss in TDL-A for 960 kHz SCS. It also reported that 120 kHz SCS still cannot meet 10% BLER target with ICI compensation.
	+ One source ([10, Nokia]) reported performance gain of ICI compensation for 120, 240 and 480 kHz SCS. It also reported performance gain of ICI compensation for 960 kHz SCS at 2GHz bandwidth and a performance loss of ICI compensation for 960 kHz SCS at 400MHz bandwidth.
	+ One source ([65, Apple]) evaluated ICI compensation for different SCS with a new PTRS pattern. It reported improvement of ICI compensation compared to CPE-only compensation.
	+ One source ([18, Samsung]) evaluated 120 kHz and 240 kHz SCS performance with ICI compensation based on some new PTRS pattern and reported performance improvement.
	+ One source ([1, Futurewei]) compared ICI performance among SCS. It reported performance gain of multi-tap ICI filter over CPE compensation for 120, 240 and 480 kHz SCS
	+ One source ([12, Intel]) evaluated performance of de-ICI method for MCS 22 with small RB allocations for 240, 480 and 960 KHz SCS. It is observed that the de-ICI method do not work when there isn’t sufficient number of PTRS tones in the frequency domain.
* For MCS 22 with normal CP when delay spread is not large, it is observed that ICI compensation of multi-tap filtering is required for 120, 240 and/or 480 kHz SCS to achieve comparable performance (< 1 dB difference) to that of 960 kHz SCS with CPE-only compensation for 10% BLER target
	+ Note: the following references are used when derive the observations.
	+ 2 sources ([61, Ericsson], [10, Nokia]) reported comparable performance of 480 kHz SCS with ICI compensation and 960 kHz SCS with CPE compensation in 1600 MHz bandwidth
	+ 2 sources ([64, OPPO], [10, Nokia]) reported comparable performance of 480 kHz SCS with ICI compensation and 960 kHz SCS with CPE compensation in 400 MHz bandwidth
	+ One source ([68, Huawei]) reported comparable performance of 240 kHz SCS with ICI compensation and 960 kHz SCS with CPE compensation in 400 MHz bandwidth
	+ One source ([26, Qualcomm]) evaluated and compared 120 KHz SCS with ICI compensation to larger SCS with CPE compensation. It reported that at MCSs 22 and 24, 120 kHz SCS with ICI compensation performs almost equal to 960 kHz SCS with CPE-only compensation in 400 MHz bandwidth.
	+ One source ([1, Futurewei]) reported comparable performance of 480 kHz SCS with ICI compensation and 960 kHz SCS with CPE compensation in TDL-A 5 and 10ns as well as in CDL-D 30ns in 400 MHz bandwidth.
* At very high MCS (e.g., MCS 26 or MCS 28), three sources ([12, Intel], [26, Qualcomm], [69, Huawei]) compared ICI and CPE compensation using the Rel-15 PTRS.
	+ Note: the following references are used when derive the observations.
	+ One source ([12, Intel]) evaluated the phase noise compensation performance with MCS 28 when delay spread is not large. It is observed that de-ICI technique with 3-taps filter for smaller subcarrier spacing (240 kHz) fails even though there are sufficient number of PTRS tones available for ICI covariance construction.
	+ One source ([26, Qualcomm]) compared the performance of CPE and ICI compensation and reported for MCS 26, 120kHz SCS with ICI compensation suffers from residual ICI and is outperformed by 960kHz SCS with CPE-only compensation when delay spread is not large.
	+ One source ([68, Huawei]) showed that for MCS 28, de-ICI technique with large number of taps (11, 9 and 7 taps for 120, 240 and 480 kHz SCS respectively) outperforms 960 kHz with CPE compensation only when delay spread is not large. For normal CP, it also reported that 960 kHz with 3-tap ICI compensation has comparable performance to other SCS with larger number of taps (11, 9 and 7 taps for 120, 240 and 480 kHz SCS respectively) for MCS 28 when delay spread is not large. It also reported that with large delay spread (50ns in CDL), ECP and ICI compensation with at least 3 taps filter are needed for 960 kHz SCS to reach 1% BLER target for MCS 26.
* For high MCS (64QAM) with normal CP when delay spread is large (TDL-A with 40 ns and/or CDL-B with 50ns), 4 sources compared performance of smaller SCS (120, 240 and/or 480 kHz) with ICI compensation to that of 960 kHz SCS with CPE compensation and reported worse performance of 960 kHz SCS with CPE compensation for 10% BLER target.
	+ Note: the following are references used when derive the observations.
	+ One source ([61, Ericsson]) reported a performance gain of 5 dB in TDL-A 40ns and 0.3 dB in CDL-B 50ns for 480 kHz SCS with ICI compensation compared to 960 kHz SCS with CPE compensation in 1600 MHz bandwidth
	+ One source ([68, Huawei]) reported a performance gain of 2.6 dB (for 240 kHz SCS) and 1.6 dB (for 120 kHz SCS) in CDL-B 50ns with ICI compensation compared to 960 kHz SCS with CPE compensation
	+ One source ([64, OPPO]) reported a performance gain of 1 dB in CDL-B 50ns for 480 kHz SCS with ICI compensation compared to 960 kHz SCS with CPE compensation. It also reported the performance of 120 kHz with ICI compensation cannot meet the 10% BLER target.
	+ One source ([1, Futurewei]) reported the performance of 960 kHz SCS with CPE compensation cannot meet the 10% BLER target. It also reported that the performance of 480 kHz SCS with ICI compensation cannot meet the 10% BLER target in TDL-A 40ns. With ICI compensation, it also reported comparable performance of 120, 240 and 480 kHz SCS in CDL-B 50ns and comparable performance of 120 and 240 kHz SCS in TDL-A 40ns.
* Multiple sources evaluated and compared ICI compensation schemes using the existing Rel-15 NR distributed PTRS structure and/or new PTRS patterns. The results from different sources are not aligned on whether new PTRS patterns perform better than existing Rel-15 PTRS structure when ICI compensation is used.
	+ Note: the following are reference used when derive the observations.
	+ One source ([11, Mitsubishi]) evaluated with 120 and 240 kHz SCS and reported that the PN compensation with block-based PTRS and cyclic sequence significantly outperforms in spectral efficiency both CPE compensation and de-ICI Wiener filtering with distributed PTRS, even when the density of the scattered pattern is increased above the Rel.15 defined density.
	+ One source ([14, Ericsson]) reported that 3-tap direct de-ICI compensation with Rel-15 PTRS outperforms ICI filter approximation approach with clustered PTRS. 3-tap direct de-ICI compensation with a clustered PTRS structure does not offer any performance advantage over the existing Rel-15 NR distributed PTRS structure.
	+ One source ([23, MediaTek]) reported that with a 3-tap BLS ICI equalizer, a clustered PTRS structure does not offer any performance advantage over the existing Rel-15 NR distributed PTRS structure.
	+ One source ([62, LG]) reported that the performance of clustered PTRS allocation is worse than that of Rel-15 PTRS based ICI compensation scheme and further showed that the performance of subcarrier nulling allocation is similar or superior (up to 2 dB gain especially in the scenarios with low PTRS overhead, K=4) to that of Rel-15 PTRS based ICI compensation scheme.
	+ Two sources ([18, Samsung], [65, Apple]) evaluated the performance with some new PTRS patterns (e.g. chunk based PTRS pattern to allow adjacent PTRS symbols in frequency) and reported that the performance with ICI compensation based on new PTRS patterns is better than the Rel-15 pattern with CPE compensation only.
	+ One source ([26, Qualcomm]) reported that for the same ICI compensation algorithm, the legacy PTRS pattern outperforms the block PTRS pattern. It showed that for ICI compensation (direct de-ICI filtering) with the legacy PTRS pattern, the performance improves with the increasing number of de-ICI filter taps (3 to 5 taps). It also observed that with a fixed transport block size, the performance improves as the PTRS overhead decreases (the performance loss due to increased effective code rate is more pronounced at higher MCSs) and with a fixed effective code rate, the performance slightly improves as the PTRS overhead increases.
* For high MCS (64QAM) with normal CP, 2 sources ([61, Ericsson], [10, Nokia]) compared performance of 480 and 960 kHz SCS in 1600 MHz bandwidth when ICI compensation is used based on Rel-15 PTRS.
	+ When delay spread is not large, both sources reported a smaller than 1 dB performance gain of 960 kHz SCS for both 10% and 1% BLER target in TDL-A. One source ([61, Ericsson]) reported that for CDL-B, there is up to 1.1 dB gain at 1% BLER target for 960 kHz SCS.
	+ When delay spread is large (TDL-A with 40 ns DS), one source ([61, Ericsson]) reported 480 kHz SCS performed 3.6 dB better than 960 kHz SCS at 10% BLER target and 960 kHz SCS cannot meet the 1% BLER target.

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture text above under ”4.1.X observations for link level evaluations” (exact section TBD) with appropriate update to the citation references.**
 |
|  **Company** | **Comments** |
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### Agreement #34:

Capture the following observations in the TR (updates to references and other editorial modifications can be made for inclusion in the TR):

For CP-OFDM, two sources ([14, 61, Ericsson], [68, Huawei]) evaluated PDSCH BLER performance with optional PN models in addition to PN model in Table A.1-1 of TR 38.808. Note that such optional PN models are not confirmed and/or recommended by RAN4 at the time of RAN1#103-e (These observations can be updated if RAN4 input is available).

* When CPE-only compensation is used with an optional PN model at the UE or at BS and UE, it is observed by both sources that there is significantly less dependence of BLER performance on SCS compared to the PN model in Table A.1-1 of TR 38.808. For all test cases, no error floor is observed for smaller SCS with TDL-A or CDL-B/CDL-D for 1% BLER target. There is around 1 to 2 dB performance difference between consecutive SCSs for 1% BLER target.
* However, multiple sources expressed concerns on the validity of such optional PN models given no confirmation and/or recommendation from RAN4. In consequence, there’s a concern on whether and how the observations based on such optional PN models can be used given no RAN4 input on these optional PN models.

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Capture text above under ”4.1.X observations for link level evaluations” (exact section TBD) with appropriate update to the citation references.**
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|  **Company** | **Comments** |
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### Agreement #35:

* Update BS Antenna Pattern in Table A.2-1 of TR 38.808 as the following.

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| BS Antenna Pattern | For outdoor scenarios:- Antenna power pattern given in Table 7.3-1 of TR38.901(with exception of antenna element gain)For indoor~~/factory~~ scenarios:- Antenna power pattern given in Table A.2.1-7 of TR38.802 for ceiling mount(with exception of antenna element gain)For factory scenarios:Companies to provide information on the antenna orientation and pattern used. |

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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Updated Annex A based on agreement.**
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|  **Company** | **Comments** |
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### Agreement #36:

* Update the indoor A description as follows:

Office box 120m x 50 m, 12 BS per operator, 2 operator, BS height at 3m (ceiling), UE height 1m, x-axis ISD = 20m and y-axis ISD = 25m, where ISD is define by the distance between two adjacent 10m x 10m virtual box, BS randomly deployed within 10m x 10m virtual box, minimum distance between BS of different operators is 2m.”



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| ***Rapporteur suggestion for capturing agreement/conclusion (actual ordering will be done considering other TP for the same section):***1. **Updated Annex A based on agreement.**
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|  **Company** | **Comments** |
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### References:

Rapporteur: Companies are encouraged to check the correct Tdoc number for referencing the evaluation results. Below are the Reference that will be captured to the TR. Reference are from Summary #3 of the discussion. Reference should have [X+4], where X is the original numbering from the summary #3 of the discussion.

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| 2 ReferencesThe following documents contain provisions which, through reference in this text, constitute provisions of the present document.- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.- For a specific reference, subsequent revisions do not apply.- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.[1] 3GPP TR 38.913: "Study on Scenarios and Requirements for Next Generation Access Technologies"[2] 3GPP TR 38.807: "Study on requirements for NR beyond 52.6 GHz".[3] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".[4] ETSI EN 302 567 v2.1.20: "Multiple-Gigabit/s radio equipment operating in the 60 GHz band; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU".[5] R1-2007549 "Further discussion on B52 numerology" FUTUREWEI.[6] R1-2007558 "Discussion on physical layer impacts for NR beyond 52.6 GHz" Lenovo, Motorola Mobility.[7] R1-2007604 "PHY design in 52.6-71 GHz using NR waveform" Huawei, HiSilicon.[8] R1-2007642 "Physical layer design for NR 52.6-71GHz" Beijing Xiaomi Software Tech.[9] R1-2007652 "Discussion on required changes to NR using existing DL/UL NR waveform" vivo.[10] R1-2007785 "Consideration on required changes to NR using existing NR waveform" Fujitsu.[11] R1-2007790 "Consideration on supporting above 52.6GHz in NR" InterDigital, Inc.[12] R1-2007847 "System Analysis of NR opration in 52.6 to 71 GHz" CATT.[13] R1-2007883 "Required changes to NR using existing DL/UL NR waveform" TCL Communication Ltd.[14] R1-2007926 "Required changes to NR using existing DL/UL NR waveform" Nokia, Nokia Shanghai Bell.[15] R1-2007929 "On phase noise compensation for NR from 52.6GHz to 71GHz" Mitsubishi Electric RCE.[16] R1-2009379 "Discussion on Required Changes to NR in 52.6 – 71 GHz" Intel Corporation.[17] R1-2007965 "On the required changes to NR for above 52.6GHz" ZTE, Sanechips.[18] R1-2007982 "On NR operations in 52.6 to 71 GHz" Ericsson.[19] R1-2008045 "Consideration on required physical layer changes to support NR above 52.6 GH" LG Electronics.[20] R1-2008076 "Discussion on required changes to NR using existing DL/UL NR waveform in 52.6GHz ~ 71GHz" CMCC.[21] R1-2008082 "Study on the numerology to support 52.6 GHz to 71GHz" NEC.[22] R1-2008872 "Design aspects for extending NR to up to 71 GHz" Samsung.[23] R1-2008250 "Discusson on required changes to NR using DL/UL NR waveform" OPPO.[24] R1-2008353 "Considerations on required changes to NR from 52.6 GHz to 71 GHz" Sony.[25] R1-2008457 "A Discussion on Physical Layer Design for NR above 52.6GHz" Apple.[26] R1-2008493 "Discussions on required changes on supporting NR from 52.6GHz to 71 GHz" CAICT.[27] R1-2008501 "On required changes to NR using existing DL/UL NR waveform for operation in 60GHz band" MediaTek Inc.[28] R1-2008516 "On NR operation between 52.6 GHz and 71 GHz" Convida Wireless.[29] R1-2009062 "Evaluation Methodology and Required Changes on NR from 52.6 to 71 GHz" NTT DOCOMO, INC.[30] R1-2008615 "NR using existing DL-UL NR waveform to support operation between 52p6 GHz and 71 GHz" Qualcomm Incorporated.[31] R1-2008726 "Discussion on physical layer aspects for NR beyond 52.6GHz" WILUS Inc.[32] R1-2008769 "Waveform considerations for NR above 52.6 GHz" Charter Communications.[33] R1-2007550 "On channel access modes in 60GHz" FUTUREWEI.[34] R1-2007559 "Discussion on channel access for NR beyond 52.6 GHz" Lenovo, Motorola Mobility.[35] R1-2008976 "Channel access mechanism for 60 GHz unlicensed operation" Huawei, HiSilicon.[36] R1-2007643 "Channel access mechanism for NR on 52.6-71 GHz" Beijing Xiaomi Software Tech.[37] R1-2007653 "Discussion on channel access mechanism" vivo.[38] R1-2007791 "On Channel access mechanisms" InterDigital, Inc.[39] R1-2007848 "Channel Access Mechanism in support of NR operation in 52.6 to 71 GHz" CATT.[40] R1-2007884 "Channel access mechanism" TCL Communication Ltd.[41] R1-2007918 "Channel access mechanisms for NR from 52.6-71GHz" AT&T.[42] R1-2007927 "Design of NR channel access mechanisms for 60 GHz unlicensed band" Nokia, Nokia Shanghai Bell.[43] R1-2009380 "Channel Access Procedure for NR in 52.6 - 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71 GHz" Ericsson.[66] R1-2008047 "Considerations on phase noise compensation to support NR above 52.6 GHz" LG Electronics.[67] R1-2008873 "Evaluation results for extending NR to up to 71 GHz" Samsung.[68] R1-2009615 "Discussion on other aspects" OPPO.[69] R1-2008459 "Evaluation results for Physical Layer Design for NR above 52.6GHz" Apple.[70] R1-2009062 "Potential Enhancements for NR on 52.6 to 71 GHz" NTT DOCOMO, INC.[71] R1-2008771 "Performance evaluations for NR above 52.6 GHz" Charter Communications.[72] R1-2009610 "Link level and System level evaluation for NR system operating in 52.6GHz to 71GHz" Huawei, HiSilicon. |