**3GPP TSG RAN meeting #92e RP-20xxxx**

**Electronic Meeting, June 14 – 18, 2020**

## Status Report to TSG

**Agenda item:** 9.7.2

|  |  |
| --- | --- |
| **WI / SI Name** | **Study on supporting NR from 52.6 GHz to 71 GHz** |
| included in this status report | Study Item: No | Core part: Yes | Performance part:Yes | Testing part:No |
| **Acronym** | NR\_ext\_to\_71GHz |
| **Unique ID** | 860041 |
| **TSG Tdoc of latest approved WI/SI description (if any)** | RP-210862 |
| **Target Completion Date****(indicate if changed)** | Study Item: N/A | Core part: 03/2022 | Performance part: 06/2022 | Testing part: mm/yyyy |
| **Overall Completion level** | Study Item: N/A | Core part: 25% | Performance Part: 0% | Testing part: xx% |

Note: Overall completion level percentage numbers should use one of the colors below:

* xx%: Normal progress, no RAN plenary action needed
* xx%: Progress behind schedule, may need RAN plenary intervention. If so, SR should clearly define requested action
* xx%: Progress critically behind, RAN plenary shall intervene. SR should define requested action

**Source:**

|  |  |
| --- | --- |
| **Leading WG** | RAN1 |
| **Rapporteur** | **Name** | Jing Sun (RAN1); Jiwoo Kim (RAN4) |
| **Company** | Qualcomm; Intel Corporation |
| **Email** | jingsun@qti.qualcomm.com; Jiwoo.kim@intel.com |

## 1 Work plan related evaluation

|  |  |
| --- | --- |
| **Do you want to modify the time budget for this WI/SI compared to what was endorsed at the last RAN meeting?** | No |

*If you answered No: Then please remove the Excel file from the zip file of this status report.*

*If you answered Yes: Then please fill out the attached Excel template to request a modification of the time budgets for your WI /SI. The Excel table has to be filled out for all affected RAN WGs and up to the target date of the WI/SI. The basis are the endorsed time budgets of the last RAN meeting. Please highlight all changes of the values.
 One time unit (TU) corresponds to ~ 2 hours in the meeting.
 If this status report covers a WI with Core and Performance part, then please have one line for each in the attached Excel table.
 Note: If no Excel table is attached, then this means no time budget change.*

**Additional explanations/motivations for the time budget changes in the attached Excel table:**

## 2. Detailed progress in RAN WGs since last TSG meeting (for all involved WGs)

 NOTE: Agreements and Open issues impacted cross-TSG aspects shall be explicitly highlighted

### 2.1 RAN1

#### 2.1.1 Agreements

**Agreements for RAN1 #104bis-e**

[104b-e-NR-52-71GHz-01] Email discussion/approval on initial access aspects with checkpoints for agreements on Apr-15, Apr-20 – Daewon (Intel)

Agreement:

For the case where SSB location and SCS are explicitly provided to the UE (non-initial access) and SSB does not configure Type-0 PDCCH, support 480 kHz and 960 kHz numerologies for the SSB

* Note: Strive to minimize specification impact due to the new SCS for SSB

Agreement:

* For operation with shared spectrum channel access of NR 52.6 – 71 GHz, support discovery burst (DB) and define the DB same as in Rel-16 37.213 Section 4.0
* FFS: Support discovery burst transmission window (DBTW) at least for SSB with 120 kHz SCS with the following requirements
	+ PBCH payload size is no greater than that for FR2
	+ Duration of DBTW is no greater than 5 ms
	+ Number of PBCH DMRS sequences is the same as for FR2
	+ FFS: applicability of DBTW design for 120kHz to SSB with 480kHz and 960kHz SCS
	+ Support mechanism to indicate or inform that DBTW is enabled/disabled for both IDLE and CONNECTED mode UEs
		- FFS: how to support UEs performing initial access that do not have any prior information on DBTW.
		- FFS: details of the mechanism for enabling/disabling DBTW considering LBT exempt operation and overlapping licensed/unlicensed bands
		- FFS: details of how to inform UEs of the configuration of DBTW

Agreement:

For SSB with 120kHz SCS for NR 52.6 GHz to 71 GHz,

* 120 kHz SCS: the first symbols of the candidate SS/PBCH blocks have indexes {4, 8,16, 20} + 28×n, where index 0 corresponds to the first symbol of the first slot in a half-frame.
* For carrier frequencies within 52.6 GHz to 71GHz, support at least 𝑛 = 0, 1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13, 15, 16, 17, 18.
	+ Other values of *n* (if any) are FFS, and support of additional n values are subject to support of DBTW for 120kHz SSB

Agreement:

* PRACH configuration for 480/960 kHz SCS (if agreed)
	+ The minimum PRACH configuration period is 10 ms (as in FR2)
	+ For RO configuration for PRACH with 480/960kHz SCS,
		- FFS: details of how to configure the 480/960 kHz PRACH ROs using [60 or 120 kHz] reference slot considering at least:
			* location of 480/960 kHz PRACH slot per reference slot
			* location of duration containing 480/960khz PRACH slot pattern within 10ms
			* potential impact to RA-RNTI calculation

[104b-e-NR-52-71GHz-02] Email discussion/approval on PDCCH monitoring enhancements with checkpoints for agreements on Apr-15, Apr-20 – Alex (Lenovo)

Agreement:

Previous agreement is modifed as follows:

Choose one of the following alternatives for defining the multi-slot PDCCH monitoring capability

* Alt 1: Use a fixed pattern of slot groups as the baseline to define the new capability.
	+ Each slot group consists of X slots
	+ Slot groups are consecutive and non-overlapping
	+ The capability indicates the BD/CCE budget within Y consecutive [symbols or slots] in each slot group separately
	+ FFS: Supported values/constraints of X and Y, e.g. Y<=X, Y=X
	+ FFS: Restrictions on location of the Y [symbols or slots] within a slot group, e.g. the Y [symbols or slots] always start at the first slot within a slot group
	+ FFS: Further definition of capabilities
* Alt 2: Use an (X, Y) span as the baseline to define the new capability
	+ X is the minimum time separation between the start of two consecutive spans
	+ The capability indicates the BD/CCE budget within a span of at most Y consecutive [symbols or slots]
	+ Y <= X
	+ FFS: Exact values of X and Y and units in which they are defined (e.g., symbols, slots), including cases where a span is longer than one slot or crosses a slot boundary.
	+ FFS: What is a span pattern, how it is defined and whether it is supported. If it is supported, whether number of slots within which the span pattern is repeated is needed, and if needed, the value of the number of slots.
	+ FFS: Further definition of capabilities
* Alt 3: Use a sliding window of X slots as the baseline to define the new capability.
	+ The capability indicates the BD/CCE budget within the sliding window
	+ The sliding unit of the sliding window is [1] slot.
	+ FFS: Further definition of capabilities
* Specific numbers for X, Y may depend on UE capability and gNB configuration
	+ Examples:
		- X = [4] slots for 480 kHz SCS and X = [8] slots for 960 kHz SCS

Conclusion:

For 120 kHz SCS, no multi-slot UE capability for PDCCH monitoring is needed.

Agreement:

For 120 kHz SCS in 52.6-71 GHz, the BD/CCE budget is the same as that for 120 kHz in FR2.

[104b-e-NR-52-71GHz-03] Email discussion/approval on PUCCH format 0/1/4 enhancements with checkpoints for agreements on Apr-15, Apr-20 – Steve (Ericsson)

Agreement:

* The maximum values for the configured number of RBs, NRB, for enhanced PF0/1/4 are at least:
	+ 12 RBs for 120 kHz SCS
	+ 3 RBs for 480 kHz SCS
	+ 2 RBs for 960 kHz SCS
* FFS: Whether or not the above values need to be revised to support larger values (and any associated signaling impact), e.g., to support lower UE Tx beamforming gain and/or larger UE EIRP and conducted power limits for different UE power classes, different from those in the agreed evaluation assumptions

Agreement:

Down select to one of the following two alternatives for the configuration of the number of RBs, $N\_{RB}$, for enhanced PUCCH formats 0/1/4:

* Alt-1:
	+ For enhanced PF0/1
		- Support configuration of all integer values in the range [1 .. max($N\_{RB}$)] for each SCS
	+ For enhanced PF4
		- Support configuration of all integer values in the range [1 .. max($N\_{RB}$)] for each SCS that fulfill the requirement $N\_{RB}=2^{α\_{2}}∙3^{α\_{3}}∙5^{α\_{5}}$ where $α\_{2},α\_{3},α\_{5}$ is a set of non-negative integers.
* Alt-2:
	+ Same as Alt-1, but with coarser granularity, i.e., not all integer values of $N\_{RB}$ can be configured
	+ FFS: Which values of $N\_{RB}$ are supported values in the range [1 .. max($N\_{RB}$)]

Agreement:

For UCI of enhanced PF4, support pre-DFT blockwise spreading using OCCs of length 2 and 4 only, as in Rel-15/16.

Agreement:

For DMRS of enhanced PF4, a Type-1 low PAPR sequence of length equal to the total number of mapped REs of of the PUCCH resource is used. Cyclic shifts are defined in the same was as Rel-15/16 for PF4 (Alt-1 in agreement from RAN1#104-e).

Agreement:

For UCI of enhanced PF4, support pre-DFT blockwise spreading performed across all allocated RBs (Alt-1 in agreement from RAN1#104-e).

Agreement:

For addressing the FFS from the prior agreement in RAN1#104bis-e on the maximum values for the configured number RBs, send an LS to RAN4 asking for feasible maximum values for UE\_EIRP and UE\_P for operation in 52.6-71 GHz.

R1-2104061 LS to RAN4 on maximum UE conducted power and maximum UE EIRP for operation in the 52.6 – 71 GHz band

Agreement:

User-multiplexing can be considered but as lower priority compared to maximum isotropic loss for PUCCH as a design criterion.

[104b-e-NR-52-71GHz-04] Email discussion/approval on beam management for new SCSs with checkpoints for agreements on Apr-15, Apr-20 – Youngwoo (InterDigital)

Agreement:

Introduce new parameter values for additional beam switching time delay d, when triggering PDCCH with 120kHz or 480kHz has a smaller subcarrier spacing than AP-CSI-RS or PDSCH

Agreement:

For timeDurationForQCL, beamSwitchTiming and beamReportTiming,

* Following candidate values of FR2 are reused for 120 kHz:
	+ timeDurationForQCL: 14 and 28 symbols
	+ beamSwitchTiming: 14, 28, 48, 224 and 336 symbols
	+ beamReportTiming: 14, 28 and 56 symbols
* For 480 kHz
	+ Support at least the candidate values for 120 kHz scaled by 4x
	+ FFS: Support for additional candidate value(s)
* For 960 kHz
	+ Support at least the candidate values for 120 kHz scaled by 8x
	+ FFS: Support for additional candidate values(s)
* FFS: UE capability signaling details
* Note: The scaled values 224 and 336 symbols for beamSwitchTiming are used as in Rel-16 (defined in Rel-15 with updates in Rel-16).

Agreement:

For multiple PDSCHs/PUSCHs scheduled by a single DCI, at least for single TRP, support indication of only a single TCI state/SRI in DCI

* FFS: number of TCI states/SRIs in a single DCI scheduling multiple PDSCHs/PUSCHs for multi-TRP

[104b-e-NR-52-71GHz-05] Email discussion/approval on defining maximum bandwidth for new SCSs, timeline related aspects adapted to each of the new numerologies 480kHz and 960kHz and reference signals with checkpoints for agreements on Apr-16, Apr-20 – Huaming (Vivo)

Agreement:

A model-based approach is not used to derive the timelines for single PDSCH/PUSCH and multi-PDSCH/PUSCH scheduling for NR operation in 52.6 GHz to 71 GHz.

Agreement:

Continue study at least the following aspects for potential PTRS enhancement for DFT-s-OFDM for NR operation in 52.6 to 71 GHz

* The need of potential PTRS enhancement
* PTRS pattern with more PTRS groups within one DFT-s-OFDM symbol when a large number of PRBs is scheduled
	+ (Ng = 8, Ns = 4, L = 1), (Ng = 16, Ns = 2, L = 1), (Ng = 16, Ns = 4, L = 1),
	+ Note: Ng number of PT-RS groups, Ns number of samples per PT-RS group, and PTRS every L number of DFT-s-OFDM symbols
	+ Other patterns are not precluded
* Other aspects of PTRS enhancements are not precluded from further study

Agreement:

* It is recommended to strictly follow and evaluate at least based on assumptions which are not optional in previous agreed LLS assumptions for study of potential RS enhancements for NR operation in 52.6 to 71 GHz.
	+ Note: evaluation based on optional model/scenario/parameter values are not precluded from being considered for discussion and decisions
* Companies are encouraged to report results (along with previously reported aspects and cubic metric for power boosting aspects) at least for SINR in dB achieving PDSCH/PUSCH BLER of 10% in a numerical and tabular way (e.g. adapted from LLS result report template in SI).
	+ Note: other ways of presentation of results (e.g. BLER curve) is not precluded

Agreement:

* In Rel-17, for NR operation in 52.6 – 71 GHz, conclude that increased PTRS frequency density is not supported for CP-OFDM at least for Rel-15 PTRS pattern when the allocated number of RB > 32
* Companies are encouraged to study whether to increase PTRS frequency density for small RB allocations for CP-OFDM for NR operation in 52.6 to 71 GHz with respect to phase noise compensation performance
	+ CPE and ICI PN compensation
		- Note: Results for CPE compensation-only are to be reported for reference
	+ (K = 0.5, L = 1), (K = 1, L = 1), (K = 2, L = 1),
		- Note: PTRS per K number of PRBs, and PTRS every L number of OFDM symbols
	+ Number of RBs: 8, 16, 32
	+ Other values of K and number of RBs are not precluded
* Study on other aspects of potential PTRS enhancement (e.g., decreased PTRS frequency density) is not precluded

[104b-e-NR-52-71GHz-06] Email discussion/approval on scheduling particularly w.r.t. multi-PDSCH/PUSCH with a single DCI, HARQ, with checkpoints for agreements on Apr-16, Apr-20 – Seonwook (LGE)

Agreement:

* The maximum number of PDSCHs that can be scheduled with a single DCI in Rel-17 is 8 for SCS of 480 and 960 kHz.
	+ FFS: Further restrictions for 480 kHz to 4
	+ FFS: A UE capability to select between 4 and 8 for 480 kHz SCS
	+ Note: Multi-PDSCH scheduling for the case of 120 kHz SCS is still FFS as per prior agreement. This case can be addressed after this FFS has been decided.
* The maximum number of PUSCHs that can be scheduled with a single DCI in Rel-17 is 8.
	+ FFS: Further restrictions for 120 kHz and 480 kHz SCS
	+ FFS: A UE capability to select between different values for 120 kHz and 480 kHz SCS

Agreement:

For a DCI that can schedule multiple PDSCHs,

* MCS for the 1st TB: This appears only once in the DCI and applies commonly to the first TB of each PDSCH
* NDI for the 1st TB: This is signaled per PDSCH and applies to the first TB of each PDSCH
* RV for the 1st TB: This is signaled per PDSCH, with 2 bits if only a single PDSCH is scheduled or 1 bit for each PDSCH otherwise and applies to the first TB of each PDSCH
* HARQ process number: This applies to the first scheduled PDSCH and is incremented by 1 for subsequent PDSCHs (with modulo operation, if needed)
* FFS:
	+ MCS/NDI/RV for the 2nd TB for each PDSCH, including whether scheduling of the 2nd TB for each PDSCH can be supported or not
	+ Details of resource allocation related fields such as VRB-to-PRB mapping, PRB bundling size indicator, rate matching indicator, and ZP CSI-RS trigger
	+ Whether/how to signal CBGFI/CBGTI if CBGFI/CBGTI is supported for multi-PDSCH scheduling
	+ Details of fields that are common with multi-PUSCH scheduling, e.g., TDRA, FDRA, priority indicator, including potential enhancements

Agreement:

* For a DCI that can schedule multiple PUSCHs,
	+ TDRA: Alt 2 (TDRA table is extended such that each row indicates up to 8 multiple PUSCHs (that can be non-continuous in time-domain). Each PUSCH has a separate SLIV and mapping type. The number of scheduled PUSCHs is implicitly indicated by the number of indicated valid SLIVs in the row of the TDRA table signalled in DCI.), as per agreement made in RAN1#104-e
		- FFS: signaling details
	+ Note: Alt 2 does not preclude continuous resource allocation in time-domain.
* For a DCI that can schedule multiple PDSCHs,
	+ TDRA: TDRA table is extended such that each row indicates up to 8 multiple PDSCHs (that can be non-continuous in time-domain). Each PDSCH has a separate SLIV and mapping type. The number of scheduled PDSCHs is implicitly indicated by the number of indicated valid SLIVs in the row of the TDRA table signalled in DCI.
		- FFS: signaling details
	+ Note: This does not preclude continuous resource allocation in time-domain.
	+ Note: Multi-PDSCH scheduling for the case of 120 kHz SCS is still FFS as per prior agreement. This case can be addressed after this FFS has been decided.

Agreement:

For enhancements of generating type-1 HARQ-ACK codebook corresponding to DCI that can schedule multiple PDSCHs, the following options can be considered,

* Option 1: The set of candidate PDSCH reception occasions is determined according to each SLIV of each row in the TDRA table and based on extension of K1 set
* Option 1a: The set of candidate PDSCH reception occasions is determined according to each SLIV of each row in the TDRA table
* Option 2: The set of candidate PDSCH reception occasions is determined according to the last SLIV of each row in the TDRA table
* FFS: Codebook generation details, including how to handle the collision with TDD DL/UL configuration and whether/how to extend K1 set based on K1 and slot offset between last PDSCH and other PDSCHs in a row in the TDRA table

Conclusion:

The following is observed for alternative 1 from prior agreement.

* For Alt 1 (C-DAI/T-DAI is counted per DCI) of generating type-2 HARQ-ACK codebook corresponding to DCI that can schedule multiple PDSCHs,
	+ C-DAI/T-DAI in DL DCI: Same DAI overhead with Rel-16 single-PDSCH DCI
	+ T-DAI in UL DCI:
		- In case of single codebook handling feedback for both single and multi-PDSCH scheduling, same DAI overhead with Rel-16 UL DCI
		- In case of separate sub-codebooks, need additional DAI field (with same bit-width of DAI with Rel-16 UL DCI), in UL DCI for all serving cells including a serving cell not configured with multi-PDSCH DCI
			* Note that DAI field increment for this case is similar for the case in Rel-15 where CBG is configured
	+ HARQ-ACK codebook generation:
		- A separate sub-codebook can be generated when multi-PDSCH DCI is configured for a serving cell, similar to the way as 2nd sub-codebook is defined to handle CBG-based scheduling
			* FFS: whether single codebook or separate sub-codebooks is(are) generated when multi-PDSCH DCI is configured for a serving cell
			* FFS: how many sub-codebooks are generated when multi-PDSCH DCI is configured for a serving cell and CBG is configured for the serving cell and/or the other serving cell(s)
		- HARQ-ACK payload size is increased compared to single PDSCH scheduling only, since the number of HARQ-ACK bits corresponding to each DAI of the (sub-)codebook for multi-PDSCH DCI in case of separate sub-codebooks (or for all DL DCIs in case of single codebook) depends on the maximum configured number of PDSCHs for multi-PDSCH DCI across serving cells belonging to the same PUCCH cell group.
		- The number of HARQ-ACK bits for multi-PDSCH DCI in case of separate sub-codebooks, or for all DL DCIs in case of single codebook, does not depend on the number of actually scheduled PDSCHs, rather, it is fixed as the maximum configured number of PDSCHs.
		- FFS: time domain bundling of HARQ-ACK feedback, as per agreement in RAN1#104-e
	+ Note that multi-PDSCH DCI refers to a DL DCI where at least one entry of the TDRA table allows scheduling more than one PDSCH

Conclusion:

The following is observed for alternative 2 from prior agreement.

* For Alt 2a (C-DAI/T-DAI is counted per PDSCH with a single codebook) of generating type-2 HARQ-ACK codebook corresponding to DCI that can schedule multiple PDSCHs,
	+ C-DAI/T-DAI in DL DCI: Bit-width can be increased (FFS: by how much), in DL DCI not only for multi-PDSCH DCI but also for single-PDSCH DCI for all serving cells including a serving cell not configured with multi-PDSCH DCI
	+ T-DAI in UL DCI: Bit-width can be increased (FFS: by how much), in UL DCI for all serving cells including a serving cell not configured with multi-PDSCH DCI
	+ C-DAI/T-DAI in DL DCI and T-DAI in UL DCI shall be designed such that at most 3 consecutive DCI missing can be resolved, same as in Rel-15/16 NR.
		- FFS: details on increment of DAI field size
		- FFS: whether/how to handle the case where different DCI formats (e.g., DCI format 1\_0 and DCI format 1\_1) have different field sizes for C-DAI/T-DAI
	+ HARQ-ACK codebook generation:
		- The number of HARQ-ACK bits depends on the number of scheduled PDSCHs.
		- FFS: ordering of the PDSCHs for DAI counting
		- FFS: time domain bundling of HARQ-ACK feedback, as per agreement in RAN1#104-e
	+ Note that multi-PDSCH DCI refers to a DL DCI where at least one entry of the TDRA table allows scheduling more than one PDSCH

Conclusion:

The following is observed for alternative 3 from prior agreement.

* For Alt 3 (C-DAI/T-DAI is counted per M scheduled PDSCH(s), where M is configurable) of generating type-2 HARQ-ACK codebook corresponding to DCI that can schedule multiple PDSCHs,
	+ If M equals to the maximum configured number of PDSCHs, Alt 3 is the same with Alt 1, if the same number of codebooks is assumed.
	+ Else if M equals to 1, Alt 3 is the same with Alt 2.
	+ Otherwise (i.e., 1<M<the maximum configured number of PDSCHs), Alt 3 is similar to Alt 2, except that
		- The number of HARQ-ACK bits corresponding to each DAI increases by M times.
		- NACK bits may be padded if the number of scheduled PDSCHs is not an integer multiple of M.
		- FFS: details on DAI field size
		- FFS: whether single codebook or separate sub-codebooks is(are) generated when multi-PDSCH DCI is configured for a serving cell
	+ In addition, new RRC parameter to configure M needs to be introduced.
	+ Note that multi-PDSCH DCI refers to a DL DCI where at least one entry of the TDRA table allows scheduling more than one PDSCH

[104b-e-NR-52-71GHz-07] Email discussion/approval on channel access mechanism with checkpoints for agreements on Apr-16, Apr-20 – Jing (Qualcomm)

Working assumption:

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

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

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.

Agreement:

For LBT for single carrier transmission, continue down selection between

* Alt SC.1. gNB/UE performs LBT over the channel bandwidth (or BWP bandwidth)
* Alt SC.3. Define a unit of LBT bandwidth and gNB/UE performs LBT in all the LBT units (to be transmitted in) in the channel bandwidth

For LBT for multi-carrier transmission in intra-band CA, continue down selection between

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

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

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. Down-select between

* Alt 1. Support cell specific (common for all UEs in a cell as part of system information or dedicated RRC signalling or both) gNB indication
* Alt 2. Support both cell specific (common for all UEs in a cell as part of system information or dedicated RRC signalling or both) and UE specific (can be different for different UEs in a cell as part of UE-specific RRC configuration) gNB indication
* FFS: Whether the indication of the decision on applying LBT mode or no-LBT mode is per beam (can be different for different UEs in different beams or can be different for different beam pairs between gNB and the UE) or per cell (can be different for different cells for a UE in carrier aggregation)
* FFS: Whether a gNB and its UE(s) can have different mode
* FFS: Whether L1 signalling can be used for both Alt 1 and Alt 2 for gNB indication

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.

**Agreements for RAN1 #105-e**

[105-e-NR-52-71GHz-01] Email discussion/approval on initial access aspects with checkpoints for agreements on May-24, May-27 – Daewon (Intel)

Agreement:

For 480kHz/960kHz SSB, select one of the following alternatives:

* ALT 1) First symbols of the candidate SSB have index {X, Y} + 14\*n, where index 0 corresponds to the first symbol of the first slot in a half-frame
	+ value of X and Y are identical for 480kHz and 960kHz
		- FFS: exact value of X and Y
* ALT 2) First symbols of the candidate SSB have index {4, 8, 16,20} + 28\*n, where index 0 corresponds to the first symbol of the first slot in a half-frame
* Values of n for 480kHz and 960kHz for ALT 1 and 2
	+ FFS: whether number of values for ‘n’ depend on LBT operation (i.e. LBT vs no-LBT)
	+ FFS: exact values of ‘n’ for each SCS
	+ Values of ‘n’ for one mode of operation shall be strictly a subset of values for another mode of operation, if two mode of operation exist for number of candidate SSBs
	+ FFS: whether values of ‘n’ shall not be all consecutive integer values (i.e. non-candidate SSB slots are positioned every few candidate SSB slots)

Proposal:

In addition to 120kHz, support **480** kHz SSB for initial access with support of CORESET0/Type0-PDCCH configuration in the MIB with following constraints.

* Limited sync raster entry numbers
	+ It is assumed that RAN4 supports a channelization design which results in the total number of synchronization raster entries considering both licensed and unlicensed operation in a 52.6 – 71 GHz band no larger than **665** (Note: the total number of synchronization raster entries in FR2 for band n259 + n261 is 602). If the assumption cannot be satisfied, it’s up to RAN4 to decide its applicability to bands in 52.6 – 71 GHz.
* only 480kHz CORESTE#0/Type0-PDCCH SCS supported for 480 kHz SSB SCS.
* SSB time domain candidate resource pattern (within a slot or pair of slots) for 480 and 960kHz SSB are identical
* Prioritize support SSB-CORESET0 multiplexing pattern 1. Other patterns discussed on a best effort basis.
* Note: Strive to minimize specification impact by reusing tables for CORESET#0 and type0-PDCCH CSS set configuration defined for FR2 in Rel-15, as much as possible

Formal objection sustained by: Huawei, MediaTek (would like to discuss at next meeting)

Proposal:

In addition to 120kHz, support **both** **480 and 960** kHz SSB for initial access with support of CORESET0/Type0-PDCCH configuration in the MIB with following constraints.

* Limited sync raster entry numbers
	+ It is assumed that RAN4 supports a channelization design which results in the total number of synchronization raster entries considering both licensed and unlicensed operation in a 52.6 – 71 GHz band no larger than **665** (Note: the total number of synchronization raster entries in FR2 for band n259 + n261 is 602). If the assumption cannot be satisfied, it’s up to RAN4 to decide its applicability to bands in 52.6 – 71 GHz.
* only 1 CORESTE#0/Type0-PDCCH SCS supported for each SSB SCS i.e., (480,480) and (960,960).
* SSB time domain candidate resource pattern (within a slot or pair of slots) for 480 and 960kHz SSB are identical
* Prioritize support SSB-CORESET0 multiplexing pattern 1. Other patterns discussed on a best effort basis.
* Note: Strive to minimize specification impact by reusing tables for CORESET#0 and type0-PDCCH CSS set configuration defined for FR2 in Rel-15, as much as possible

Formal objection sustained by: Huawei, MediaTek (object to 960 kHz)

Proposal:

To support ANR and PCI confusion detection for 480/960kHz SCS based SSB, support CORESET#0/Type0-PDCCH configuration in MIB of 480 and 960kHz SSB

* FFS: additional method(s) to enable support to obtain neighbor cell ~~PCI and~~ SIB1 contents related to CGI reporting
* Only 1 CORESTE#0/Type0-PDCCH SCS supported for each SSB SCS, i.e., (480,480) and (960,960).
* Prioritize support SSB-CORESET0 multiplexing pattern 1. Other patterns discussed on a best effort basis.
* Note: Strive to minimize specification impact by reusing tables for CORESET#0 and type0-PDCCH CSS set configuration defined for FR2 in Rel-15, as much as possible
* Note: From UE perspective, ANR detection for 480/960kHz SCS based SSB is not supported if the UE does not support 480/960 SCS for SSB.
* Note: for ANR, when reading the MIB, the cell containing the SSB is known to the UE, as defined in 38.133 specification.

Formal objection sustained by: Huawei

Agreement:

For the case agreed in RAN1 #104bis-e where 480/960 kHz SSB location and SCS are explicitly provided to the UE (non-initial access)

* Support configuring CORESET#0/Type0-PDCCH for the purpose of ANR/PCI confusion detection by down selecting from the following two alternatives
	+ Alt 1) Using dedicated signaling
	+ Alt 2) Using configuration in MIB
		- Note: for ANR, when reading the MIB, the cell containing the SSB is known to the UE, as defined in 38.133 specification.

Agreement:

For 480kHz and 960kHz PRACH,

* Down-select among option 1 and 2
	+ Option 1) The reference slot duration corresponds to 60 kHz SCS. A PRACH slot index, $n\_{slot}^{RA}$ , corresponds to one of the starting 480/960 kHz PRACH slots within the reference slot.
		- FFS: supported values of the starting PRACH slot index $n\_{slot}^{RA} $ within reference slot and whether or not the ROs for a given PRACH configuration can span more than one PRACH slot if gaps between consecutive ROs are supported for LBT and/or beam switching purposes
	+ Option 2) Each 120kHz RO corresponds to 4 and 8 candidate RO positions for 480kHz and 960kHz PRACH, respectively. Information about the number and locations of 480/960kHz candidate RO(s) are configured or pre-selected within each 120kHz RO. The reference 120kHz RO is determined by the current PRACH configuration method in Rel-15/16 specification.
* Following alternatives are considered on PRACH density
	+ ALT 1) At least the same density (i.e. number of PRACH slots per reference slot) as for 120kHz PRACH in FR2 is supported
		- FFS: support for higher PRACH slot density (number of PRACH slots per reference slot)
	+ ALT 2) at least the same RO density (i.e. number of RO per reference slot) as for 120kHz PRACH in FR2 is supported
		- FFS: support for higher RO density
	+ An “example” illustration of PRACH slots for 480/960kHz is shown below:



* FFS: whether and how to account for LBT in RO configuration (if needed)
* FFS: whether and how to account for beam switching gap in RO configuration (if needed)

Agreement:

FFS: Support DBTW at least for 120kHz

* FFS whether DBTW will be applicable for 480/960 kHz SSB SCS
	+ If DBTW is supported for 480/960kHz SSB:
		- For the case agreed in RAN1 #104bis-e where 480/960 kHz SSB location and SCS are explicitly provided to the UE (non-initial access), indication of DBTW configuration (e.g. enable/disable of DBTW,  $N\_{SSB}^{QCL}$, and DBTW length) are supported by dedicated signaling.
* For 120kHz SSB, support mechanism to distinguish at least the following scenarios:
	+ Case 1) (Unlicensed with LBT off) + DBTW disabled
	+ Case 2) (Unlicensed with LBT on) + DBTW enabled
	+ Case 3) (Unlicensed with LBT on) + DBTW disabled
	+ Case 4) (Licensed) + DBTW disabled
	+ FFS: Whether/how LBT on/off is indicated in MIB
		- If not indicated in MIB, then FFS whether/how the UE determines different sizes of DCI 1\_0 with CRC scrambled by SI-RNTI
	+ FFS: whether any case(s) can be combined for DBTW signaling design and how to handle implications to DCI 1\_0 size ambiguity if is not distinguished in signaling
	+ FFS: whether all above cases need an explicit indication
	+ FFS: Whether a single indication can be used for combination of more than one cases
* For 120 kHz SSB, enable/disable of DBTW is indicated by one or more of the following methods:
	+ Option 1) signaling in MIB
		- Option 1-1) disabling DBTW is jointly coded with $N\_{SSB}^{QCL}$
		- Option 1-2) indicated by other bit fields in MIB
		- FFS: among options 1-1 and 1-2
	+ Option 2) distinct GSCN used by the SSB
	+ Option 3) By comparing the value of  $N\_{SSB}^{QCL}$ in MIB and DBTW length after UE reads SIB1 or by comparing the value of  $N\_{SSB}^{QCL}$ in MIB and default DBTW length of 5 ms before UE reads SIB1.
	+ FFS: whether to support option 1, 2, 3, or any combination of the options.
	+ Note: enable/disable signaling of DBTW by MIB or GSCN does not preclude other signaling methods

Agreement:

If DBTW is supported,

* Working assumption: MIB signaling to support
	+ Alt A) indication of $N\_{SSB}^{QCL}$ at least for 120kHz SSB
		- In this case, the total number of values of $N\_{SSB}^{QCL}$ to not exceed 4
	+ Alt B) Explicit indication of SSB index and/or SSB candidate location
		- FFS on the details of signaling
	+ FFS betweenAlt A, or B, or supporting both
* Supported DBTW lengths
	+ Alt 1) 0.5, 1, 2, 3, 4, 5 msec
		- Note: same as Rel-16 FR1 NR-U
	+ Alt 2) maximum 5 msec
		- FFS other values
	+ FFS between Alt 1 and 2
* Number of candidate positions when DBTW is enabled
	+ For 120kHz SSB
		- FFS between 64 or 80
	+ If DBTW is additionally supported for 480/960kHz SSB
		- FFS between 64 or 128

[105-e-NR-52-71GHz-02] Email discussion/approval on PUCCH format 0/1/4 enhancements with checkpoints for agreements on May 24, May 27 – Steve (Ericsson)

Agreement:

* For 120 kHz SCS:
	+ Support at least Alt-1 for enhanced PF0/1 for both PUCCH resources before and after dedicated PUCCH resource configuration
	+ FFS: Whether or not Alt-2 is additionally supported for PF0/1 for either or both of the following:
		- PUCCH resources before dedicated PUCCH resource configuration
		- PUCCH resources after dedicated PUCCH resource configuration
	+ FFS: Supported RE mapping scheme(s) amongst {Alt-1, Alt-2} for enhanced PF4 including design details
* Notes:
	+ Alt-1 = all REs within each RB are mapped
	+ Alt-2 = a subset of REs within each RB are mapped (sub-PRB interlaced mapping)
	+ Which RE mapping scheme(s) to support for PF0/1/4 to be concluded in RAN1#106
* Note: No further enhancements on RB shortage issue and frequecy hopping distance issue should be considered for PUCCH resource sets prior to RRC configuration.

[105-e-NR-52-71GHz-03] Email discussion/approval on scheduling particularly w.r.t. multi-PDSCH/PUSCH with a single DCI, HARQ, with checkpoints for agreements on May 25, May 27 – Seonwook (LGE)

Agreement:

* Do not use fallback DCI (i.e., DCI formats 0\_0 and 1\_0) for multi-PDSCH/PUSCH scheduling.
* Use DCI format 0\_1 to schedule multiple PUSCHs with a single DCI.
* Use DCI format 1\_1 to schedule multiple PDSCHs with a single DCI.

Conclusion:

For a DCI that can schedule multiple PUSCHs,

* CSI-request: When the DCI schedules M PUSCHs, the PUSCH that carries the aperiodic CSI feedback is M-th scheduled PUSCH for M <= 2, or (M-1)-th scheduled PUSCH for M > 2.

Agreement:

* If a PDSCH among multiple PDSCHs that are scheduled by a single DCI is collided with uplink symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, the UE does not receive the PDSCH.
	+ FFS on how to handle HARQ-related issue for the PDSCH (e.g., HARQ process numbering)
* The UE does not expect to be scheduled with multiple PDSCHs by a single DCI, where every PDSCH is collided with uplink symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*.
* If a PUSCH among multiple PUSCHs that are scheduled by a single DCI is collided with downlink symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, the UE does not transmit the PUSCH.
	+ FFS on how to handle HARQ-related issue for the PUSCH (e.g., HARQ process numbering)
* The UE does not expect to be scheduled with multiple PUSCHs by a single DCI, where every PUSCH is collided with downlink symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*.

Agreement:

For TDRA in a DCI that can schedule multiple PDSCHs (or PUSCHs),

* A row of the TDRA table can indicate PDSCHs (or PUSCHs) that are in consecutive or non-consecutive slots.
	+ FFS: The maximum value of the gap between two consecutively scheduled PDSCHs or between two consecutively scheduled PUSCHs
	+ FFS: The maximum value of the gap between the first scheduled PDSCH and the last scheduled PDSCH or between the first scheduled PUSCH and the last scheduled PUSCH
	+ FFS: Details to introduce the gap between PDSCHs or between PUSCHs

Agreement:

For enhancements of generating type-1 HARQ-ACK codebook corresponding to DCI that can schedule multiple PDSCHs, the set of candidate PDSCH reception occasions corresponding to a UL slot with HARQ-ACK transmission is determined based on a set of DL slots and a set of SLIVs corresponding to each DL slot belonging to the set of DL slots.

* The set of DL slots includes all the unique DL slots that can be scheduled by any row index r of TDRA table in DCI indicating the UL slot as HARQ-ACK feedback timing.
* The set of SLIVs corresponding to a DL slot (belonging to the set of DL slots) at least include all the SLIVs that can be scheduled within the DL slot by any row index r of TDRA table in DCI indicating the UL slot as HARQ-ACK feedback timing.
	+ FFS: details of further pruning of the set of SLIVs
	+ FFS: impact if receiving more than one PDSCH in a slot is allowed, e.g., handling of overlapped SLIVs from different rows in the same and different DL slot
	+ FFS impact of time domain bundling, if supported

Agreement:

* At least for 120 kHz SCS, for a DCI that can schedule multiple PUSCHs and is configured with the TDRA table containing at least one row with multiple SLIVs,
	+ If CBG-based (re)transmission is configured, CBGTI field is not present when more than one PUSCHs are scheduled, but is present when a single PUSCH is scheduled, as in Rel-16.
* FFS:
	+ For 480/960 kHz SCS, whether to apply the same behavior with 120 kHz SCS or not to support CBGTI field configuration in the DCI that can schedule multiple PUSCHs
	+ For a DCI that can schedule multiple PDSCHs and is configured with the TDRA table containing at least one row with multiple SLIVs, whether/how to configure CBGTI/CBGFI fields

Agreement:

If Alt 1 (C-DAI/T-DAI is counted per DCI) is adopted for generating type-2 HARQ-ACK codebook corresponding to a DCI that can schedule multiple PDSCHs,

* At least two sub-codebooks are generated for a PUCCH cell group where
	+ The first sub-codebook is for the following cases:
		- Any DCI that is not configured with CBG-based scheduling and is configured with TDRA table containing rows each with a single SLIV
		- Any DCI that is not configured with CBG-based scheduling and is configured with TDRA table containing at least one row with multiple SLIVs and schedules only a single PDSCH
	+ The second sub-codebook is for the following case:
		- Any DCI that is configured with TDRA table containing at least one row with multiple SLIVs and schedules multiple PDSCHs
			* FFS: Methods (if needed) to align the size of HARQ-ACK feedback corresponding to different DCIs
			* FFS: Whether HARQ-ACK bits for 2 PDSCHs scheduled by this DCI can be included in the first sub-codebook in some cases
	+ FFS: SPS PDSCH release, SCell dormancy indication without scheduled PDSCH
* FFS: 2 or 3 sub-codebooks if CBG is configured for a serving cell in the PUCCH cell group
* FFS: impact of time domain bundling, if supported, e.g., the number of sub-codebooks including single codebook if all A/N bits are bundled into a single bit per DCI

Agreement:

If Alt 2 (C-DAI/T-DAI is counted per PDSCH) is adopted for generating type-2 HARQ-ACK codebook corresponding to a DCI that can schedule multiple PDSCHs,

* PDSCH(s) scheduled by a single DCI is counted firstly, serving cell(s) in the same PUCCH cell group and same PDCCH monitoring occasion is counted secondly, and PDCCH monitoring occasion(s) is counted thirdly.
* The bit width of counter DAI field in fallback DCI (i.e., DCI formats 0\_0 and 1\_0) remains the same as in Rel-15 NR.
* Note: The DAI bit width and number of sub-codebooks shall ensure that at most 3 consecutive missed DCIs can be resolved, same as in Rel-15/16 NR
	+ This shall not impose additional gNB’s scheduling restriction.
* In case where CBG retransmission is not configured for any serving cell in a same PUCCH cell group, the number of bits for each of counter DAI and total DAI in non-fallback DCI is extended (if needed) at least based on
	+ The number of SLIVs associated with the row indexes in TDRA table
		- FFS: details
* FFS: the case with configuration of CBG retransmission
* FFS: the number of sub-codebooks
* FFS: for the UE indicating by *type2-HARQ-ACK-Codebook* support for more than one PDSCH reception on a serving cell that are scheduled from a same PDCCH monitoring occasion

[105-e-NR-52-71GHz-04] Email discussion/approval on channel access mechanism with checkpoints for agreements on May 25, May 27 – Jing (Qualcomm)

Agreement:

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

* Alt 1. Two energy measurements are required, with one measurement in the first 3us and one measurement in the last 5us
* Alt 2. One measurement is required
	+ FFS where the measurement is located

Note: By implementation, it is possible to support longer than 8us deferral period (Intend to cover Alt 3 as implementation choice for either Alt 1 or Alt 2)

Agreement:

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

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

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

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

[105-e-NR-52-71GHz-05] Email discussion/approval focusing on analysis or recommendation to RAN#92e (June) on how to introduce the 52.6-71GHz frequency range with checkpoints for agreements on May 25, May 27 – Alex (Lenovo)

Final LS endorsed in R1-2106277

Conclusion:

Regarding the impact on specifications maintained by RAN1, there are only relatively small differences between potential options

Conclusion:

RAN1 can adapt to other groups' preferences on the notation for 52.6-71 GHz.

Conclusion:

Regardless of if the frequency range 52.6 to 71 GHz is an extension of FR2 or a new FR, the related UE capabilities and their applicability to the frequency range 52.6 to 71 GHz will have to be analyzed on a case by case basis

Conclusion:

From RAN1's perspective, an easy distinction between features, capabilities and other characteristics in the specifications that apply specifically to the following ranges may be useful:

* 24.25-52.6 GHz (NOTE: this is the current definition of FR2)
* 52.6-71 GHz
* 24.25-71 GHz

NOTE: The distinction can be realized with or without a designated frequency range (FRx) definition.

Include above conclusion with the note in the LS to RAN.

Conclusion:

Regardless of if the frequency range 52.6 to 71 GHz is an extension of FR2 or a new FR, the application of any of the UE feature introduced for 52.6-71 GHz to existing FR1/FR2 should be discussed case by case.

NOTE: This conclusion will not be included in the LS to RAN.

#### 2.1.2 Remaining Open issues

RAN1 objectives from WID

* Physical layer aspects including [RAN1]:
	+ In addition to 120kHz SCS, specify new SCS, 480kHz and 960kHz, and define maximum bandwidth(s), for operation in this frequency range for data and control channels and reference signals, only NCP supported.

Note: Except for timing line related aspects, a common design framework shall be adopted for 480kHz to 960kHz

* + Time line related aspects adapted to 480kHz and 960kHz, e.g., BWP and beam switching timeing, HARQ timing, UE processing, preparation and computation timelines for PDSCH, PUSCH/SRS and CSI, respectively.
	+ Support of up to 64 SSB beams for licensed and unlicensed operation in this frequency range.
	+ Supports 120kHz SCS for SSB and 120kHz SCS for initial access related signals/channels in an initial BWP.
		- Study and specify, if needed, additional SCS (240kHz, 480kHz, 960kHz) for SSB, and additional SCS(480kHz, 960kHz) for initial access related signals/channels in initial BWP.
		- Study and specify, if needed, additional SCS (480kHz, 960kHz) for SSB for cases other than initial access.
		- Note: coverage enhancement for SSB is not pursued.
	+ Specify timing associated with beam-based operation to new SCS (i.e., 480kHz and/or 960kHz), study, and specify if needed, potential enhancement for shared spectrum operation
		- Study which beam management will be used as a basis: R15/16 or R17 in RAN #91-e
	+ Support enhancement for PUCCH format 0/1/4 to increase the number of RBs under PSD limitation in shared spectrum operation.
	+ Support enhancements for multi-PDSCH/PUSCH scheduling and HARQ support with a single DCI

 Note: coverage enhancement for multi-PDSCH/PUSCH scheduling is not pursued

* + Support enhancement to PDCCH monitoring, including blind detection/CCE budget, and multi-slot span monitoring, potential limitation to UE PDCCH configuration and capability related to PDCCH monitoring.
	+ Specify support for PRACH sequence lengths (i.e. L=139, L=571 and L=1151) and study, if needed, specify support for RO configuration for non-consecutive RACH occasions (RO) in time domain for operation in shared spectrum
	+ Evaluate, and if needed, specify the PTRS enhancement for 120kHz SCS, 480kHz SCS and/or 960kHz SCS, as well as DMRS enhancement for 480kHz SCS and/or 960kHz SCS.
* Physical layer procedure(s) including [RAN1]:
	+ Channel access mechanism assuming beam based operation in order to comply with the regulatory requirements applicable to unlicensed spectrum for frequencies between 52.6GHz and 71GHz.
		- Specify both LBT and No-LBT related procedures, and for No-LBT case no additional sensing mechanism is specified.
		- Study, and if needed specify, omni-directional LBT, directional LBT and receiver assistance in channel access
		- Study, and if needed specify, energy detection threshold enhancement

### 2.2 RAN2

#### 2.2.1 Agreements

#### 2.2.2 Remaining Open issues

RAN2 objectives from WID:

* Radio interface protocol architecture and procedures [RAN2]:
	+ For operation in this frequency range: Introduce higher layer support of enhancements listed above that are agreed to be specified.

### 2.3 RAN3

#### 2.3.1 Agreements

#### 2.3.2 Remaining Open issues

### 2.4 RAN4

#### 2.4.1 Agreements

Agreements for RAN4 #98bis-e

Agreement (R4-2105410) BS RF TX requirements

Channels, bandwidth, and regulatory

* Agreed to define a band [66-71] GHz, based on which the system parameters discussion can proceed with an aim to harmonize for both licensed and unlicensed bands
	+ Agreed Focus unlicensed band work on 57 – 71 GHz
	+ Agreed Min channel BWs: 100 MHz for 120 kHz SCS, 200 MHz for 480 kHz SCS, 400 MHz for 960 kHz SCS (subject to review of any licensed block sizes)​
	+ Agreed Max channel BWs: 400 MHz 120 kHz SCS, 1600 MHz 480 kHz SCS​
	+ Max channel BWs 960 kHz SCS FFS

Agreement (R4-2106113) BS RF TX requirements

Channels, bandwidth, and regulatory

* + Agreed to define a band [66-71] GHz, based on which the system parameters discussion can proceed with an aim to harmonize for both licensed and unlicensed bands
	+ Agreed Focus unlicensed band work on 57 – 71 GHz
	+ Agreed Min channel BWs: 100 MHz for 120 kHz SCS, 200 MHz for 480 kHz SCS, 400 MHz for 960 kHz SCS (subject to review of any licensed block sizes)​
	+ Agreed Max channel BWs: 400 MHz 120 kHz SCS, 1600 MHz 480 kHz SCS​
	+ Max channel BWs 960 kHz SCS FFS

General and output power

* + The radiated transmitter characteristics requirements applying to the BS type 2-O should be considered for NR operation in 52.6 – 71 GHz range as the starting point for discussion.
	+ The BS output power for NR operation in 52.6 – 71 GHz range is declared by the manufacturer. Additional regional requirements can be added to specification to align with regulatory requirements.
	+ Total power dynamic range requirement based on 10\*log10(Nrb), similar to current FR2, can be applied to 52.6-71 GHz.

Timing and signal quality

* + Re-use frequency error requirements from current FR2.
	+ New EVM window length is defined for new SCS.
	+ Modulations up to 64 QAM are supported.

Timing and signal quality

* + For licensed operation, adjust OBUE for 52.6 – 71 GHz. Additional regional requirements can be added to specification to align with regulatory requirements.
	+ Re-use OTA occupied bandwidth from current FR2. Further discuss the measurement step sizes in conformance phase for wider channel bandwidths.

Agreement (R4-2106114) BS RF RX requirements

* + The radiated receiver characteristics requirements applying to the BS type 2-O should be considered as the for NR operation in 52.6 – 71 GHz range as starting point for discussion. Final requirement values need further considerations.
	+ Sensitivity is declared, FRCs will be discussed when minimum and maximum carrier bandwidths are known.
	+ ACS and in-band blocking interferer bandwidth are adjusted taking into account applicable channel bandwidths
	+ For receiver intermodulation the interferer levels for general receiver intermodulation for NR operation in 52.6 – 71 GHz range can be derived by applying an offset below the in-band blocking levels.
	+ The current methodology to derive ICS value for BS type 2-O can be used as baseline to calculate the wanted and interfering signal levels for NR operation in 52.6 – 71 GHz range, but the value may be adjusted for this higher frequency range.
	+ New FRCs should be defined for the larger SCSs with the wider channel bandwidth for NR operation in 52.6 – 71 GHz range than those currently defined in FR2, where the allocated RBs within the new FRCs should be scaled according to the target SCSs and channel bandwidth.

Reply LS to RAN1 on max/min CBW and channelization for NR operation in 52.6 – 71 GHz (R4-2105411)

* + For minimum channel bandwidths,
		- For 120 kHz SCS, 100 MHz
		- For 480 kHz SCS, 400 MHz
		- For 960 kHz SCS, 400 MHz
	+ For maximum channel bandwidths,
		- For 120 kHz SCS, 400 MHz
		- For 480 kHz SCS, 1600 MHz
		- For 960 kHz SCS, TBD MHz

RF work plan was approved (R4-2105412)

RRM Agreements for RAN4 #99-e

RRM Agreements on Impact of higher SCS on RRM requirements: (R4-2108354)

* + Define new RRM requirements due to higher data/SSB SCS for at least the following topics:
		- UE transmit timing, Timing advance (TA), Interruptions, Active BWP switching delay, Interruption time
	+ Study impact on RRM requirements due to higher SSB SCS for at least the Intra-frequency and Inter-frequency measurement

RRM Agreements scaling factor for RX beam sweeping (R4-2108354)

* + RAN4 to study whether the changes on scaling factor for RX beam sweeping are required for this frequency range support

RRM Agreements Operation in licensed/unlicensed band (R4-2108354)

* + RAN4 to initially focus on RRM requirements for both licensed and unlicensed bands without considering LBT and start working on LBT impact on RRM requirements in unlicensed band based on more conclusions from RAN1.

RF Agreements for RAN4 #99-e

BS TX (R4-2108638)

* + Re-use FR2 EIRP accuracy as baseline, further study next meeting
	+ Re-use fractional bandwidth concept from current FR2, with 6% breakpoint FFS
	+ Re-use OFF power requirement of -36 dBm/MHz from FR2.
	+ Consider transient period together with transmit OFF power, and also together with UE requirement
	+ Total power dynamic range requirement is based on 10\*log10(Nrb) for all SCS and ChBW.
	+ Study CA TAE and MIMO TAE further
	+ Consider BS type 2-O EVM requirements, but allow further time to check.
	+ Apply FR2 approach for spurious emissions, with necessary adaptations to emissions mask step frequencies.
	+ Occupied bandwidth measurement step size postponed to performance part
	+ For licensed operation, further consider how to adjust OBUE for 52.6 – 71 GHz taking to account the larger channel bandwidth
	+ Further consider EN 303 722 for unwanted emissions in unlicensed operation in Europe where the regulatory requirements are clear

BS RX (R4-2108639)

* + Sensitivity levels
		- Use the same principle for derivation of sensitivity level requirements as for current FR2 (i.e. declaration of sensitivity level),
	+ FRCs
		- FRCs for 52.6 GHz – 71 GHz include 100 MHz/120 kHz, 400 MHz/480 kHz, 400 MHz/960 MHz are to be defined
	+ Inband blocking
		- In-band blocking level of BS type 2-O can be used as baseline for NR operation in 52.6 – 71 GHz range, but consideration should be placed to ensure alignment between in-band selectivity and ACS.
		- Re-evaluate the interferer signal type, including its SCS, channel bandwidth
	+ OOB blocking
		- Blocker level
			* Reuse current existing FR2 OOB blocker level for 52.6-71GHz
	+ Frequency definitions
		- For out-of-band blocking RF core requirement define the interferer signal upper frequency limit to 2nd harmonic similar as for FR2
		- For receiver blocking further consider ΔfOBUE and decide if ΔfOOB needs to be aligned.
		- Postpone measurement step size discussion to performance part.

UE System Parameters and Other (R4-2107997)

* + FR definition: RAN4 agrees FR3 is not be introduced in any RAN4 specifications for the frequency range 52.6 – 71 GHz.; LS was sent to RAN (R4-2107878)
	+ Max CCBW for 960 kHz SCS: 2000 MHz for both licensed and unlicensed bands while further checking any issue with unlicensed (e.g. 802.11 ad/ay)
	+ Operation Scenario: Standalone, CA, or DC operation: RAN4 aims to finish a single band requirement first. CA/DC can be discussed in parallel.
	+ Band numbering: Reuse the reserved band numbers in FR2 for 60 GHz band
	+ Regulatory for unlicensed band: Consider EN 302 567, EN 303 753, and TR 38.805 (FCC 47 CFR 15.255) for mobile application in unlicensed band.
	+ ITS: No need to exclude ITS band for unlicensed band
	+ 60 GHz OTA testing: Agree to recommend RAN Plenary the need and urgency of studying the UE OTA test method for 52.6 – 71 GHz. LS was sent to RAN (R4-2107879)

UE TX requirements (R4-2107973)

* + UE power class framework: Power classes will be a package of four parameters – Minimum peak EIRP, EIRP spherical coverage, Maximum TRP, and Maximum EIRP (regulatory defined, captured for reference); FFS whether EIRP PSD limit needs to be included.
	+ UE TX power classes for spec: Further discuss which, if any, of the existing power classes in 38.101-2 can be reused for an unlicensed NR band or a new power class is needed. As basis for power class definition, it is beneficial to discuss what are representative antenna array sizes in this frequency range.
	+ UE types: Consider handheld, FWA, and vehicular types. Other types not precluded.
	+ Maximum UL modulation order: Study on MPR analysis for different modulation schemes and Link level performance evaluation; FFS on optionality of 64 QAM and pending on the outcome of the study

UE RX requirements (chairman report on R4-2107956)

* + The framework of FR2 UE Rx requirements can be reused, i.e., REFSENS, spherical coverage EIS, maximum input level, ACS, and in-band blocking are considered as baseline Rx requirements. The maximum DL modulation order can be further discussed.

Coexistence-related requirements – ACLR and ACS (R4-2107915)

* + WF Rationale for 60 GHz band coexistence simulation: Companies are welcome to further discuss coexistence simulation parameters before providing simulation results while keeping in mind the difference to the assumptions and parameters considered in TR 38.803. The new simulations results would need to provide technical justifications (e.g., preliminary simulation results) in next RAN4 meeting, showing the impact of the new results on the required ACIR comparing to the current ones in TR 38.803.
	+ WF on coexistence simulation parameters in Table 1. A preliminary list of parameters for indoor and dense urban deployment is proposed in Table 1. Further discussions on parameters are FFS in next RAN4 meeting. Companies are welcome to provide simulation results based on the simulation assumptions in Table 1 in next RAN4 meeting.

Time-related issues (R4-2107972)

* + For NR operation in the 52.6 – 71 GHz range, the Rx-Tx and Tx-Rx transition time shall reuse the FR2 value of 13792 Tc. (7.015 usec) for 120 kHz SCS; FFS on other SCS
	+ GNB Beam switch time (beam direction switch only) : RAN4 tentatively agrees [59 ns] with the understanding that the value can be confirmed once open issues related to BS output power are resolved
	+ TX ON-ON and TX ON-OFF transient period: Re-use UE transient time from current FR2 for 120 kHz SCS; FFS on other SCS

LS on UE OTA test metod in 52.6 – 71 GHz (R4-2107878) was approved.

LS on FR definition on 52.6 – 71 GHz (R4-2107879) was approved.

LS reply on maximum UE EIRP and conducted power (R4-2107950) was approved.

#### 2.4.2 Remaining Open issues

RAN4 objectives from WID:

* Core specifications for UE, gNB and RRM requirements [RAN4]:
	+ Specify new band(s) for the frequency range from 52.6GHz-71GHz. The band(s) definition should include UL/DL operation and excludes ITS spectrum in this frequency range.
	+ Specify gNB and UE RF core requirements for the band(s) in the above frequency range, including a limited set of example band combinations (see Note 1).
	+ Specify RRM/RLM/BM core requirements.
* Specify the following requirements [RAN4]
	+ Base station demodulation performance requirements
	+ UE demodulation performance requirements
	+ Radio Resource Management performance requirements, including RRM/RLM test cases
	+ Base station conformance testing

### 2.5 RAN5

#### 2.5.1 Agreements

#### 2.5.2 Remaining Open issues

#### 2.5.3 Remaining Open issues with cross-WG dependencies

### 2.6 RAN6

#### 2.6.1 Agreements

#### 2.6.2 Remaining Open issues

## 3. Detailed progress in SA/CT WGs since last TSG meeting (for all involved WGs)

NOTE: This section only needs to be filled in for WI/SIs where there is a corresponding relevant WI/SI in SA/CT.

## 3.1 SAx/CTs

#### 3.1.1 Agreements with cross-TSG impacts

#### 3.1.2 Remaining Open issues with cross-TSG impacts

NOTE: This section should also flag any critical dependencies that need TSG attention.

## 4. References

NOTE: This can be e.g. a list of all related Tdocs in the affected WGs since last TSG, references to LSs, produced TRs/TSs, the work/study item description or status reports of previous TSGs.

 20.04.2020 minor adaptations for RAN #88e

 18.02.2020 minor adaptations for RAN #87e

 14.11.2019 minor adaptations for RAN #86

 18.08.2019 minor adaptations for RAN #85

 12.05.2019 minor adaptations for RAN #84

 27.02.2019 minor adaptations for RAN #83

 21.11.2018 completion levels with colours added (for RAN #82)

v04.81 31.07.2018 simplification of template and addition of cross-TSG aspects (for RAN #81)

v04.80 21.05.2018 minor adaptations for RAN #80

v04.79 26.02.2018 minor adaptations for RAN #79

v04.78 18.11.2017 minor adaptations for RAN #78

v04.77 06.08.2017 minor adaptations for RAN #77

v04.76 15.05.2017 minor adaptations for RAN #76

v04.75 31.01.2017 minor adaptations for RAN #75

v04.74 28.10.2016 minor adaptations for RAN #74

v04.73 01.09.2016 adaptations for RAN #73 (time units in extra Excel table, RAN6 reporting included)

v04.72 26.05.2016 adaptations for RAN #72 (introduction of NR & GERAN TUs)

v04.71 10.02.2016 minor adaptations for RAN #71

v04.70 30.10.2015 minor adaptations for RAN #70

v04.69 12.08.2015 minor adaptations for RAN #69

v04.68 21.05.2015 minor adaptations for RAN #68

v04.67 01.02.2015 minor adaptations for RAN #67

v04.66 16.11.2014 minor adaptations for RAN #66

v04.65 16.08.2014 minor adaptations for RAN #65

v04.64 22.05.2014 minor adaptations for RAN #64

v04.63 24.01.2014 restructuring for RAN #63 to cover Core & Perf. in one doc file

v03.62 11.11.2013 section 1.2.3 adapted for RAN #62

v03 11.08.2013 section 1.2.3 added on time budget

v02 07.05.2010 history added, some spelling corrections

v01 13.11.2009 First version of the template