## 8.2 Supporting NR from 52.6GHz to 71 GHz

From updated WID RP-211584:

According to the outcome of the study item on Supporting NR above 52.6GHz and leveraging FR2 design to the extent possible, this WI extends NR operation up to 71GHz considering, both, licensed and unlicensed operation, with the following objectives:

* 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 (480kHz, 960kHz) for SSB for cases other than initial access.
		- Note: coverage enhancement for SSB is not pursued.
	+ In addition to 120kHz, support 480 kHz SSB for initial access with support of CORESET#0/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 + n257 is 599). If the assumption cannot be satisfied, it’s up to RAN4 to decide its applicability to bands in 52.6 – 71 GHz.
		- only 480kHz CORESET#0/Type0-PDCCH SCS supported for 480 kHz SSB SCS.
		- Prioritize support SSB-CORESET#0 multiplexing pattern 1. Other patterns discussed on a best effort basis.
		- 960 kHz numerology for the SSB is not supported by the UE for initial access in Rel-17.
		- 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: 480 kHz is an optional SSB numerology for initial access for the UE. A UE supporting a band in 52.6-71 GHz must at least support 120 kHz SCS (for initial access and after initial access)
		- Note: Dependency or lack thereof for a UE supporting 480kHz and/or 960kHz numerology for data and control to also support 480kHz SSB numerology for initial access is to be tackled as part of UE capability discussion.
	+ Support ANR and PCI confusion detection for 120, 480 and 960kHz SCS based SSB, support CORESET#0/Type0-PDCCH configuration in MIB of 120, 480 and 960kHz SSB
		- FFS: additional method(s) to enable support to obtain neighbour cell SIB1 contents related to CGI reporting
		- Only 1 CORESET#0/Type0-PDCCH SCS supported for each SSB SCS, i.e., (120, 120), (480, 480) and (960, 960).
		- Prioritize support SSB-CORESET#0 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.
	+ 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
		- Rel-15/16 and any Rel-17 beam management enhancements can be considered for 52.6-71 GHz. Whether particular features should be excluded for 52.6-71 GHz can be further discussed
		- Note: As per usual procedure, duplication of work between work items in Rel-17 should be avoided
	+ 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
* 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.
	+ Note: RAN2 is to prioritize protocol support of RAN1 design and not on optimizations on items not discussed in RAN1.
* 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.

Note 1: The WI can be completed provided requirements for at least one band combination involving a new NR-U band is specified as long as it is in line with country-specific regulatory directives.

Note 2: UEs supporting a band in the range of 52.6GHz-71GHz are not required to support 480kHz SCS and 960kHz SCS.

Note 3: The maximum FFT size required to operate the system in 52.6GHz-71GHz frequency is 4096, and the maximum of RBs per carrier is 275 RBs.

Note 4: the system is designed to support both single-carrier and multi-carrier operation.

Note 5: FR2 is extended to cover 24.25GHz to 71GHz with FR2-1 for 24.25-52.6GHz and FR2-2 for 52.6-71GHz.

* + The related UE capabilities and their applicability to the frequency range 52.6 to 71 GHz will have to be analysed on a case by case basis
	+ The application of any of the UE feature introduced for 52.6-71 GHz to existing FR1/FR2 should be discussed case by case.
	+ TSG RAN specifications shall make it very clear (to readers) that frequency bands in the 52.6-71GHz range are only Release-independent from Rel-17 onwards, to ensure that there is clear industry understanding about which FR2 features are applicable for operation in 52.6-71GHz range.

NOTE 5a: Whenever the FR2 is referred, both FR2-1 and FR2-2 frequency sub-ranges shall be considered in this release, unless otherwise stated.

NOTE 5b: The designations FR2-1 and FR2-2 should only be used when needed.

Similar to regular NR and NR-U operations below 52.6GHz, NR/NR-U operation in the 52.6GHz to 71GHz can be in stand-alone or aggregated via CA or DC with an anchor carrier.

### 8.2.1 Initial access aspects

#### 104-e

[**R1-2102073**](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104/Docs/R1-2102073.zip) [Draft] LS on beam switching gap for 60 GHz band Intel Corporation

Final LS endorsed in [R1-2102202](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104/Docs/R1-2102202.zip)

Agreement:

Send an LS to RAN4 to get input on gap required for gNBs and UEs for beam switching and for UL/DL and DL/UL switching.

Agreement:

Whether or not to support 240 kHz, 480kHz and 960kHz SCS for SSB and the conditions under which SSB for 240 kHz, 480 kHz and 960 kHz may be supported will be decided no later than RAN1#104bis-e.

Agreement:

For an unlicensed band that requires LBT, further study whether/how to support discovery burst (DB) and discovery burst transmission window (DBTW) at least for 120 kHz SSB SCS

* If DB supported
	+ FFS: What signals/channels are included in DB other than SS/PBCH block
* If DBTW is supported
	+ 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.
	+ 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
* The following points are additionally FFS:
	+ How to indicate candidate SSB indices and QCL relation without exceeding limit on PBCH payload size
	+ Details of the mechanism for enabling/disabling DBTW considering LBT exempt operation and overlapping licensed/unlicensed bands
	+ Whether or not to support DBTW for SSB SCS(s) other than 120 kHz if other SSB SCS(s) are supported

Agreement:

For CORESET#0 and Type0-PDCCH search space configured in MIB:

* Support {SS/PBCH Block, CORESET#0 for Type0-PDCCH} SCS equal to {120, 120} kHz
	+ Support at least SSB and CORESET#0 multiplexing patterns, number of RBs for CORESET#0, number of symbols (duration of CORESET#0) that are supported in Rel-15/16 for {SS/PBCH Block, CORESET#0 for Type0-PDCCH} SCS = {120, 120} kHz.
		- FFS: Supporting additional values
	+ FFS: Supported values for SSB to CORESET#0 offset RBs
* If 480kHz SSB SCS that configures CORESET#0 and Type0-PDCCH CSS in MIB is agreed to be supported,
	+ Support {SS/PBCH Block, CORESET#0 for Type0-PDCCH} SCS equal to {480, 480} kHz
* If 960 kHz SSB SCS that configures CORESET#0 and Type0-PDCCH CSS in MIB is agreed to be supported,
	+ Support {SS/PBCH Block, CORESET#0 for Type0-PDCCH} SCS equal to {960, 960} kHz
* If 240 kHz SSB SCS is agreed to be supported,
	+ Support {SS/PBCH Block, CORESET#0 for Type0-PDCCH} SCS equal to {240, 120} kHz
* FFS: any other combinations between one of SSB SCS (120, 240, 480, 960) and one of CORESET#0 SCS (120, 480, 960)
	+ FFS: initial timing resolution based on low SCS (120 kHz) and its impact on the performance of higher SCS (480/960 kHz)

Agreement:

For 480 kHz and 960 kHz SSB SCS (if agreed)

* Study further on reserving symbol gap between SSB positions with different SSB index (and possibly between SSB position and other signal/channels)
	+ FFS: whether symbol gap is needed for only 960 kHz or both 480 and 960 kHz.
* Study further on reserving gap for UL/DL switching within the pattern accounting possibility for reserving UL transmission occasions in the SSB pattern
* Study should account for inputs from RAN4

Agreement:

* For initial access and non-initial access use cases, support 120kHz PRACH SCS with sequence length L=571, 1151 (in addition to L=139) for PRACH Formats A1~A3, B1~B4, C0, and C2.
* For non-initial access use cases,
	+ if 480kHz and/or 960 kHz SSB SCS is agreed to be supported, support 480 and/or 960 kHz PRACH SCS with sequence length L=139 for PRACH Formats A1~A3, B1~B4, C0, and C2, respectively.
		- FFS: support of sequence length L = 571, 1151
* FFS: Support of 480 and/or 960 kHz PRACH SCS for initial access use cases, if 480 and/or 960 kHz SSB SCS is agreed to be supported for initial access

Agreement:

If 480 and/or 960 kHz PRACH SCS is supported, RAN1 should study whether or not the current RA-RNTI calculation and PRACH identification in RAR correctly provides unique identification of PRACH.

#### 104b-e

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

#### 105-e

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)

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, , corresponds to one of the starting 480/960 kHz PRACH slots within the reference slot.
		- FFS: supported values of the starting PRACH slot index 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,  , 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
		- 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  in MIB and DBTW length after UE reads SIB1 or by comparing the value of  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 at least for 120kHz SSB
		- In this case, the total number of values of 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

#### 106-e

Conclusion:

RAN1 will continue discussions to develop solutions for supporting DBTW

Agreement:

* For 480 and 960kHz PRACH:
	+ The reference slot duration corresponds to 60 kHz SCS. A PRACH slot index, , corresponds to one of the starting 480/960 kHz PRACH slots within the reference slot.

Agreement:

* For 480kHz and 960kHz sub-carrier spacing, first symbols of the candidate SSB have index {2, X} + 14\*n, where index 0 corresponds to the first symbol of the first slot in a half-frame.



* Alt 1: X = 8
* Alt 2: X = 9

Working assumption:

For 120kHz SSB, the number of candidates SSBs in a half frame is 64.

Agreement:

For 480kHz and 960kHz sub-carrier spacing, first symbols of the candidate SSB have index {2, 9} + 14\*n, where index 0 corresponds to the first symbol of the first slot in a half-frame.

Agreement:

For DBTW with 120kHz SCS (if supported), support DBTW lengths {0.5, 1, 2, 3, 4, 5} msec

* Note: this should be the same as Rel-16 NR-U DBTW lengths.

Agreement:

For ‘controlResourceSetZero’ configuration for {SSB, CORESET#0/Type0-PDCCH} = {480, 480} kHz and {960, 960} kHz,

* Support the following set of parameters.

|  |  |  |
| --- | --- | --- |
| SS/PBCH block and CORESET multiplexing pattern  | Number of RBs  | Number of Symbols   |
| 1  | 24 | 2 |
| 1  | 48 | 1 |
| 1  | 48 | 2 |

* + Note: the number of entries corresponding the same {mux pattern, number of RB, number of symbol} tuple (listed above) will depend on required RB offsets that needs to be supported based on channel and sync raster design.
* FFS: addition other set of parameters

Agreement:

Do not support PRACH length L=571, 1151 for 960kHz PRACH and at least L =1151 for 480kHz PRACH.

Agreement:

For 480 and 960kHz PRACH:

* At least the same RO density in time domain (i.e. number of specified RO per reference slot according the PRACH configuration index) as for 120kHz PRACH in FR2 is supported
	+ FFS: Support gap between consecutive ROs in time domain and the details to derive the gap

Agreement:

For 480 and 960kHz PRACH,

* When a PRACH slot can contain all time domain PRACH occasions corresponding to a PRACH Config. Index in Table 6.3.3.2-4 of 38.211 including gap(s) between consecutive PRACH occasions (if supported) to account for LBT and/or beam switching,
	+ and when number of PRACH slots in a reference slot is 1,
		- for 480kHz and for 960kHz PRACH
	+ and when the number of PRACH slots in a reference slot is 2,
		- for 480kHz and for 960kHz PRACH
* FFS: values, when a PRACH slot cannot contain all time domain PRACH occasions~~,~~ corresponding to a PRACH Config. Index in Table 6.3.3.2-4 of 38.211 including gap(s) between consecutive PRACH occasions (if supported) to account for LBT and/or beam switching.
* FFS: whether to allow for additional values if the maximum that can be configured for the number of FD RO’s is less than 8 (due to BW limitation)

#### 106b-e

Working assumption:

Support DBTW for 120 kHz.

* FFS: Support for 480 kHz and 960 kHz

Conclusion:

Do not support gap between consecutive ROs for 480kHz and 960kHz

Agreement:

Same DCI size for DCI 1\_0 in CSS regardless of channel access mode (i.e., LBT on/off).

* Existing DCI size alignment in TS38.212 applies to DCI 1\_0 and 0\_0 in CSS.

Agreement:

* Indication of licensed and unlicensed operation is not explicitly indicated in MIB or PBCH payload.
	+ FFS: Whether or not to indicate licensed regime by different synchronization raster entries.
* Indication of use of LBT or no-LBT is not explicitly indicated in MIB or PBCH payload.

Agreement:

No other values of n other than agreed previously is supported for 120kHz SCS, where parameter ‘n’ is the set of values to determine the first symbols of the candidate SSB blocks for 120kHz SCS in agreement from RAN1 #104-bis-e.

Working assumption:

* For {SSB, CORESET#0/Type0-PDCCH} = {120, 120} kHz, support multiplexing pattern 1 with 96 PRB CORESET#0, and {1, 2} symbol durations
* Note: the working assumption can be confirmed once RAN1 agrees on the number of needed SSB-CORESET0 offsets for 24 and 48 RB CORESET0 based on RAN4 channelization design

Agreement:

Additionally, support PRACH length L=571 for 480kHz

Agreement:

Support 120 kHz and 480 kHz subcarrier spacing for initial UL BWP for PCell.

Working assumption:

For SCS that DBTW is supported, the following fields are used to indicate parameters related to operation of DBTW

* If only 1 bit is needed: subCarrierSpacingCommon
* If 2 bits is needed: subCarrierSpacingCommon, and 1 bit from pdcch-ConfigSIB1 (pending CORESET0 or search space design would allows for this bit), else, use the spare-bit (not the Msg Extension bit)
	+ The design of CORESET0 and search space shall be done without any consideration to this proposal
	+ If 2 bits are needed for both 120kHz and 480/960kHz cases, then use the same bit field combination (i.e. use pdcch-ConfigSIB1 bit for 120/480/960 kHz or spare-bit for 120/480.960 kHz)
	+ Note: If pdcch-ConfigSIB1 bit is used, the use of controlResourceSetZero (searchSpaceZero) for 120 kHz and   searchSpaceZero (controlResourceSetZero) for 480/960 kHz is not precluded
* FFS: if 3 bits are required
* Note: the working assumption can be confirmed after RAN1 agrees on the number of needed SSB-CORESET0 offsets based on RAN4 channelization design

Agreement:

For 120kHz SCS, for  values:

* If 2 bits are available in MIB for , at least support {16, 32, 64}

* If 1 bit is available in MIB for , support {32, 64}

* + FFS: methods to indicate more  values without increasing used number of bits, e.g., {16, 32, 64}

* Note: value  < 64 indicates DBTW enabled/supported and operation with shared spectrum.

* Note: For operation without shared spectrum channel access, a UE expects to be configured with  = 64. Use of =64 in shared spectrum is not precluded.

* FFS: 1 bit or 2 bits used for



Agreement:

Supported value of n for 480/960kHz SSB slot pattern:

* ALT A) non-contiguous, N slot gap (slots that do not contain SSB) every M slots that contain SSB
	+ same pattern will apply to 480kHz and 960kHz (i.e same N and M for 480 and 960 kHz)
	+ N = 2, M = 8
	+ FFS: starting position of n
* ALT B) non-contiguous, N slot gap (slots that do not contain SSB) every M slots that contain SSB
	+ scaled version pattern will apply between 480 and 960 kHz (i.e. N and M for 480kHz, 2N and 2M for 960 kHz)
	+ N = 2, M = 8
	+ FFS: starting position of n
* ALT C) slots that do not contain SSB correspond to the slots that do not contain SSB in 120 kHz Case D.
	+ Note: ALT 4 means that only slots 32-39 for 480 kHz SSB pattern are reserved for UL and 960 kHz SSB pattern is contiguous.

Agreement:

For ‘searchSpaceZero’ configuration for {SSB, CORESET#0/Type0-PDCCH} = {480, 480} kHz and {960, 960} kHz, use the following table for multiplexing pattern 1:

* FFS: The value of X (>≥ 0)
* FFS: whether or not to use different X value depending on whether DBTW is ON/OFF
* FFS: whether or not to use same or different X value for 480 and 960 kHz
* FFS: whether Y = , or Y=, or whether to remove entries with Y



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Index** |  | **Number of search space sets per slot** |  | **First symbol index** |
| 0 | 0 | 1 | 1 | 0 |
| 1 | 0 | 2 | 1/2 | {0, if  is even}, {7, if  is odd} |
| 2 | 2.5 X | 1 | 1 | 0 |
| 3 | 2.5 X | 2 | 1/2 | {0, if  is even}, {7, if  is odd} |
| 4 | 5 | 1 | 1 | 0 |
| 5 | 5 | 2 | 1/2 | {0, if  is even}, {7, if  is odd} |
| 6 | 0 | 2 | 1/2 | {0, if  is even}, {Y, if  is odd} |
| 7 | 2.5 X | 2 | 1/2 | {0, if  is even}, {Y, if  is odd} |
| 8 | 5 | 2 | 1/2 | {0, if  is even}, {Y, if  is odd} |
| 9 | 7.5 5 + X | 1 | 1 | 0 |
| 10 | 7.5 5 + X | 2 | 1/2 | {0, if  is even}, {7, if  is odd} |
| 11 | 7.5 5 + X | 2 | 1/2 | {0, if  is even}, {Y, if  is odd} |
| 12 | 0 | 1 | 2 | 0 |
| 13 | 5 | 1 | 2 | 0 |
| 14 | Reserved |
| 15 | Reserved |

#### 107-e

### 8.2.2 PDCCH monitoring enhancements

#### 104-e

Agreement:

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

* Alt 1: A fixed pattern of N slots.
* Alt 2: Use the Rel-16 capability (*pdcch-Monitoring-r16*, (X, Y) span) as the baseline to define the new capability
	+ FFS: Values of X and Y and units in which they are defined
	+ FFS: Whether number of slots within which the number of monitoring occasions is counted is needed and if needed, the value of the number of slots
* Alt 3: A sliding window of N slots for defining multi-slot PDCCH monitoring capability.
	+ FFS: Increments in which sliding occurs
* Specific numbers for X, Y and N may depend on UE capability and gNB configuration
	+ Examples:
		- N = [4] slots for 480 kHz SCS and N = [8] slots for 960 kHz SCS
		- X = [4] slots for 480 kHz SCS and X = [8] slots for 960 kHz SCS

#### 104b-e

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.

#### 105-e

#### 106-e

Agreement:

For reporting the multi-slot PDCCH monitoring capability, at least the following values are supported:

* X=4 slots for SCS 480 kHz
* X=8 slots for SCS 960 kHz

Agreement:

* Revise Alt 1 in previous agreement to the following (this agreement does not select Alt. 1):
* 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 slots in each slot group separately
	+ Further discuss down-selection of Y within 1<=Y<=X/2 (both in units of slot) when X>1
	+ ~~FFS: Supported values/constraints of X and Y, e.g. Y<=X, Y=X~~
	+ FFS: Restrictions on location of the Y slots within a slot group, e.g. the Y slots always start at the first slot within a slot group
	+ FFS: Further definition of capabilities
* FFS: What the UE capability defines for monitoring within the Y slots

Agreement:

Revise prior agreement including modifications to Alt. 1 as follows:

* 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 slots in each slot group ~~separately~~
		- The location of the Y slots within the X slots is maintained across different slot groups
	+ Further discuss down-selection of Y within 1<=Y<=X/2 (both in units of slot) when X>1
	+ ~~FFS: Restrictions on location of the Y slots within a slot group, e.g. the Y slots always start at the first slot within a slot group~~
	+ FFS: Further definition of capabilities
* FFS: The following issues for the search space configuration discussion
	+ Whether a slot group is aligned with a slot boundary
	+ Restrictions on location of the Y slots within a slot group, e.g. whether to restrict the location of a SS to be within the first Y slots within a slot group
* FFS: What the UE capability defines for monitoring within the Y slots

Agreement:

* A UE supporting 480 kHz SCS supports multi-slot PDCCH monitoring for 480 kHz SCS.
* A UE supporting 960 kHz SCS supports multi-slot PDCCH monitoring for 960 kHz SCS.
* FFS: whether to apply multi-slot PDCCH monitoring at all times and for all search spaces.

#### 106b-e

Agreement:

* Multi-slot PDCCH monitoring is based on slots within a slot group
	+ Each slot group consists of X consecutive slots
		- Slot groups are consecutive and non-overlapping
		- The start of the first slot group in a subframe is aligned with the subframe boundary
		- The start of each slot group is aligned with a slot boundary
		- Reporting the BD/CCE budget for X=4/8 slots (for 480/960 kHz resp.) is mandatory (if UE supports the corresponding SCS), and is optional for X=[2]/4 slots (for 480/960 kHz resp.)
* There is a common BD budget for all search spaces
* FFS: Search space configuration
	+ For Group (1) SS
		- A SS is configured to be within YGroup1 consecutive slots within a slot group of X slots
		- The location of the YGroup1 consecutive slots within a slot group of X slots is based on a time offset within the slot group based on slot index n0 determined for Group (2) monitoring such that the YGroup1 slots overlap the YGroup2 slots
		- The location of the YGroup1 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)
		- BD attempts for all Group (1) SSs are restricted to fall within the same YGroup1 consecutive slots
	+ For Group (2) SS
		- A SS is configured to be within YGroup2 consecutive slots within a slot group of X slots
		- The location of the YGroup2 consecutive slots within a slot group of X slots is maintained across different slot groups (unless n0 changes)
	+ The reported capability indicates the BD/CCE budget within Y=max(YGroup1, 2) slots per slot group
	+ Support the following values of YGroup1 and YGroup2
		- For X=8: (YGroup1,YGroup2) = (4,2), (2,2), (1,[1 or 2])
		- For X=4: (YGroup1,YGroup2) = (2,2), (1,[1 or 2])
		- For X=2: (YGroup1,YGroup2) = (1,[1 or 2])
	+ Group (1) SS: Type 1 CSS with dedicated RRC configuration and type 3 CSS, UE specific SS
	+ Group (2) SS: Type 1 CSS without dedicated RRC configuration and type 0, 0A, and 2 CSS

#### 107-e

### 8.2.3 Enhancements for PUCCH formats 0/1/4

#### 104-e

Agreement:

Tables 1, 2, and 3 in Section 2.3 of [R1-2102127](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104/Docs/R1-2102127.zip) are agreed as a common set of assumptions for link level simulations and link budget calculations for evaluating enhancements to PUCCH formats 0/1/4

Note: Other parameters can be additionally considered in the evaluations

Agreement:

For enhanced (multi-RB) PUCCH Formats 0/1/4 for 120/480/960 kHz SCS, support allocation of N\_RB contiguous RBs

* FFS: Values of N\_RB for each SCS
* For 480/960 kHz SCS, all REs within each RB are mapped
	+ Note: PRB and sub-PRB interlaced mapping is not considered further
* For 120 kHz SCS, further discuss the following two alternatives:
	+ Alt-1: All REs within each RB are mapped
		- Note: PRB and sub-PRB interlaced mapping is not considered further
	+ Alt-2: Subset of REs within each RB are mapped (sub-PRB interlaced mapping)

Agreement:

* The configured number of RBs for enhanced PF 0/1/4 is denoted NRB
	+ The minimum value of NRB is 1 for PF 0/1/4 for all subcarrier spacings
	+ The maximum value of NRB depends on subcarrier spacing
		- FFS: maximum value for each SCS and each of PF0/1/4
	+ FFS: Allowed values of NRB within the [min/max] range
	+ FFS: Details of indication of NRB by cell-specific (for PF0/1) and dedicated signaling (PF0/1/4)
	+ FFS: Whether or not multiplexing of users with misaligned RB allocations is supported, where "misaligned" also includes users with different # of RBs.
	+ For PF4:
		- The actual number of RBs used for a PUCCH transmission is equal to NRB, i.e., the actual number of RBs does not vary dynamically based on PUCCH payload
		- NRB fulfils the following: where is a set of non-negative integers
* Note: if frequency hopping is enabled, NRB is the number of RBs per hop
* Note: decisions on the maximum value of NRB for each SCS and PUCCH format shall take into account link budgets based at least on the agreed evaluation assumptions

Agreement:

* For enhanced PF0/1, support Type-1 low PAPR sequences. Further study and strive to select one of the following alternatives:
	+ Alt-1: A single sequence of length equal to the total number of mapped REs of of the PUCCH resource is used. Cyclic shifts for PF0/1 are defined in the same way as Rel-16 for the case that *useInterlacePUCCH-PUSCH* is not configured.
	+ Alt-2: A single sequence of length equal to the number of mapped REs per RB of the PUCCH resource is used, and the sequence is repeated in each RB. At least the following scheme is considered for PAPR/CM reduction:
		- Cycling of cyclic shifts across RBs in a similar way as for Rel-16 for PF0/1 for the case that *useInterlacePUCCH-PUSCH* is configured
* At least the following aspects should be considered in the study
	+ Coverage (maximum isotropic loss (MIL)), including
		- Required SNR to fulfil PUCCH detection criterion
		- PAPR/CM as a function of N\_RB
	+ Specification impact

Agreement:

* For DMRS of enhanced PF4, support Type-1 low PAPR sequences. Further study and strive to select one of the following alternatives for sequence construction:
	+ Alt-1: A single 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-2: A single sequence of length equal to the number of mapped Res per PRB of the PUCCH resource is used, and the sequence is repeated in each PRB. At least the following scheme is considered for PAPR/CM reduction:
		- Cycling of cyclic shifts across RBs in a similar way as for Rel-16 for PF0/1 for the case that *useInterlacePUCCH-PUSCH* is configured
* At least the following aspects should be considered in the study
	+ Coverage (maximum isotropic loss (MIL)), including
		- Required SNR to fulfil PUCCH detection criterion
		- PAPR/CM as a function of N\_RB
	+ Specification impact

Agreement:

* For UCI of enhanced PF4, support pre-DFT blockwise spreading using OCCs of length 2 and 4 as defined for Rel-16 PF4
* Further study the following and decide in RAN1#104-b:
	+ Whether or not additional OCC lengths are supported
	+ Down-select to one of the following alternatives for blockwise spreading
		- Alt-1: Blockwise spreading is performed across all allocated RBs
		- Alt-2: Blockwise spreading and DFT is performed per-RB followed by per-RB PAPR/CM reduction mechanism.
* At least the following aspects should be considered in the study
	+ Coverage (maximum isotropic loss (MIL)), including
		- Required SNR to fulfil PUCCH detection criterion
		- PAPR/CM as a function of N\_RB
	+ Specification impact

#### 104b-e

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, , for enhanced PUCCH formats 0/1/4:

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

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.

R1-2104060 [DRAFT] LS to RAN4 on maximum UE conducted power and maximum UE EIRP for operation in the 52.6 – 71 GHz band

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.

#### 105-e

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.

#### 106-e

Conclusion:

For enhanced (multi-RB) PF4, maintain the same maximum UCI payload limit as in Rel-15/16 (115 bits).

Agreement:

* For enhanced (multi-RB) PF4, the UCI payload is rate matched to the configured number of RBs, N\_RB
* Note: This is analogous to Rel-16 for PF2/3 when interlacing is configured when there is a fixed number of RBs for the configured interlace(s).

Agreement:

* Support an RRC parameter to configure the number of RBs for a PUCCH resource for each of enhanced PUCCH formats 0, 1, and 4
* The parameter is provided by dedicated signaling (per UE) per BWP

Agreement:

For PF0/1 for PUCCH resource sets prior to RRC configuration, Alt-2 (sub-PRB interlaced mapping) is not supported.

Agreement:

In the following, Alt-1 and Alt-2 refer to the RE mapping agreement for 120 kHz from RAN1#105-e:

* For enhanced PF0/1, for PUCCH resources after RRC configuration, Alt-2 (sub-PRB interlaced mapping) is not supported.
* For DMRS of enhanced PF4, only Alt-1 is supported (all REs within each RB are mapped).
* Note: optimization of user multiplexing for enhanced PUCCH format 0/1/4 is not considered in Rel-17.

Agreement:

* For PUCCH resource sets prior to RRC configuration, support a parameter in SIB1 that indicates the number of RBs for enhanced (multi-RB) PUCCH format 0/1

Agreement:

The maximum configured number of RBs, N\_RB, for enhanced PF 0/1/4 is given by 16 RBs for 120 kHz SCS

Agreement:

For the agreed RRC parameter that configures the number of RBs for a PUCCH resource, the value range is given by the following, where N\_RB\_Max is the maximum number of RBs per SCS value

* For enhanced PF0/1
	+ All integer values in the range [1 .. N\_RB\_Max]
* For enhanced PF4
	+ All integer values in the range [1 .. N\_RB\_Max] that fulfil the requirement where is a set of non-negative integers

Agreement:

The maximum configured number of RBs, N\_RB, for enhanced PF 0/1/4 is given by 16 RBs for 480 and 960 kHz SCS (same as for 120 kHz SCS).

Agreement:

For enhanced PF0/1 support a single sequence of length equal to the total number of mapped Res of of the PUCCH resource is used. Cyclic shifts for PF0/1 are defined in the same way as Rel-16 for the case that *useInterlacePUCCH-PUSCH* is not configured.

* Note: this is Alt-1 from the RAN1#104 agreement

#### 106b-e

Conclusion:

* Do not re-open the discussion potential RB shortage and frequency hopping distance issues for common PUCCH resource sets prior to dedicated PUCCH resource configuration.
* Note: Whether or not the spec explicitly captures error cases related to a potential RB shortage issue will be separately discussed.

Agreement:

* Reuse the existing Rel-15/16 PUCCH configuration Table 9.2.1-1 in 38.213 for configuration of PUCCH resource sets prior to dedicated PUCCH configuration for multi-RB PUCCH formats 0/1
* As previously agreed, the number of RBs for each PUCCH resource in a set is N\_RB which is signaled in SIB1
* The lowest-indexed RB for each PUCCH resource is a function of N\_RB
* The following example change to 38.213 Section 9.2.1 can be recommended to the editor of 38.213 to use at the editor’s discretion (subject to resolution of the below FFS on the value of X)

---- Start ----

If and a UE is provided a PUCCH resource by *pucch-ResourceCommon* and is not provided *useInterlacePUCCH-PUSCH* in *BWP-UplinkCommon*

- the UE determines the lowest PRB index of the PUCCH transmission in the first hop as and the lowest PRB index of the PUCCH transmission in the second hop as , where is the total number of initial cyclic shift indexes in the set of initial cyclic shift indexes

- the UE determines the initial cyclic shift index in the set of initial cyclic shift indexes as

If and a UE is provided a PUCCH resource by *pucch-ResourceCommon* and is not provided *useInterlacePUCCH-PUSCH* in *BWP-UplinkCommon*

- the UE determines the lowest PRB index of the PUCCH transmission in the first hop as and the lowest PRB index of the PUCCH transmission in the second hop as

- the UE determines the initial cyclic shift index in the set of initial cyclic shift indexes as 

 ---- End ----

* FFS: Supported value of X. Down-select to one of the following alternatives:
	+ Alt-1: X = N\_RB
		- Note: This alternative is mathematically equivalent to Example Construction 1 discussed in RAN1#106-e.
	+ Alt-2a: X is a fixed value less than N\_RB, e.g., 1, N\_RB / 2, …
	+ Alt-2b: X is configurable, e.g., via SIB1
* FFS: Whether or not the spec explicitly captures either or both of the following error cases related to a potential RB shortage issue:
	+ Case 1: Some of the RBs of a PUCCH resource fall outside the initial UL BWP
	+ Case 2: An indicated PUCCH resource with r\_PUCCH ≥ 8 overlaps the RBs of a PUCCH resource with r\_PUCCH < 8.
* FFS: Whether or not special handling for PUCCH resource set index 15 is necessary.

Agreement:

* Update the following RAN1#106-e agreement to clarify that the number of RBs can be configured separately per PUCCH resource

Update of RAN1#106-e Agreement:

* Support an RRC parameter to configure the number of RBs ~~for a~~ per PUCCH resource for each of enhanced PUCCH formats 0, 1, and 4
* The parameter is provided by dedicated signaling (per UE) per BWP
* Update the description of the RRC parameter accordingly within the RRC parameter email thread

Agreement:

* In the RAN1#106bis-e agreement on construction of PUCCH resource sets prior to dedicated PUCCH configuration, the following is supported at least for PUCCH resource set indices 0 .. 14 in Table 9.2.1-1 (Alt-1 in the agreement):
* FFS: Down select to one of the following alternatives for PUCCH resource set index 15
	+ Alt-a:
	+ Alt-b: Alternative handling (to be defined)

Conclusion:

* For a common PUCCH resource set prior to dedicated PUCCH resource configuration, for some values of r\_PUCCH, the corresponding PUCCH resource may not be fully contained within the initial UL BWP. The UE does not expect to receive a PRI and determine a value of r\_PUCCH for which the corresponding PUCCH resource is not fully contained within the initial UL BWP
* It is left to gNB implementation to avoid such an error case, i.e., this is not explicitly captured in specifications

Conclusion:

For enhanced (multi-RB) PF0/1, enhancement to the cyclic shift definition is not supported in Rel-17.

#### 107-e

### 8.2.4 Beam management for new SCSs

#### 104-e

Agreement:

* For NR operation in 52.6-71GHz with new SCSs, new parameter values for at least the following timing parameters are needed:
* timeDurationForQCL
* beamSwitchTiming
* beamReportTiming
* Companies are encouraged to provide preferred values on timeDurationForQCL, beamSwitchTiming and beamReportTiming

Agreement:

Rel-15/16 and any Rel-17 beam management enhancements can be considered for 52.6-71 GHz. Whether particular features should be excluded for 52.6-71 GHz can be further discussed.

* Note: As per usual procedure, duplication of work between work items in Rel-17 should be avoided

Agreement:

* Further study new parameter values for at least the following parameters:
	+ maxNumberRxTxBeamSwitchDL
	+ Additional beam switching time delay d for triggering AP-CSI-RS when triggering PDCCH with 120kHz or 480kHz has a smaller subcarrier spacing than AP-CSI-RS
* Study whether/how to introduce a beam switching gap between signals/channels
	+ FFS: condition to apply including potential UE capability definition
	+ Study should account for inputs from RAN4

Agreement:

Further study the following:

* For multi-PDSCH scheduling with a single DCI, study the QCL assumption(s) the UE should apply for each PDSCH for the case when some of the scheduled PDSCHs have scheduling offset less than timeDurationForQCL while some have scheduling offset equal to or greater than timeDurationForQCL.
* For multi-PDSCH scheduling with a single DCI, study the QCL assumption(s) the UE should apply for each PDSCH for the case when all of the scheduled PDSCHs have scheduling offset less than timeDurationForQCL
* Note: If the current Rel-16 behavior would be extended to multiple-PDSCH scheduling, it could result in a different QCL assumption for each PDSCH due to the fact the that the CORESET with the lowest ID can be different for different slots, resulting in a potentially different TCI state for each slot
* Note: Applicability to multi-TRP can be discussed further

Agreement:

Further study the following:

* For multi-PDSCH scheduling with a single DCI, study whether or not it is needed to indicate a separate TCI state for each scheduled PDSCH
* For multi-PUSCH scheduling with a single DCI, study whether or not it is needed to indicate a separate SRI (indication of TCI can be further discussed) for each scheduled PUSCH
* Note: the study should take into account DCI overhead aspects
* Note: Applicability to multi-TRP can be discussed further

#### 104b-e

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

#### 105-e

#### 106-e

Agreement:

For maxNumberRxTxBeamSwitchDL,

* Support at least 2 and 4 as candidate values for 480 kHz
	+ FFS: 7
* Support at least 2 as a candidate value for 960 kHz
	+ FFS: Support for additional candidate value(s) including 4

Agreement:

For the threshold values 48 or 48+ mentioned in Clauses 5.2.1.5.1 and 5.2.1.5.1a of 38.214, scale 48 to 4\*48 for 480 kHz and 8\*48 for 960 kHz.

Agreement:

For maxNumberRxTxBeamSwitchDL,

* For 480 kHz, support 7 as a candidate value for 480 kHz in addition to the agreed candidate values 2 and 4
* For 960 kHz, support one of the following alternatives
	+ Alt-1: Support 1, 4 and [7] as candidate values for 960 kHz in addition to the agreed candidate values 2
	+ Alt-2: Support 4 as a candidate value for 960 kHz in addition to the agreed candidate values 2
* No additional candidate values are supported

Working assumption:

For multi-PDSCH scheduling for multi-TRPs, support a single DCI field ‘Transmission Configuration Indication’ as in Rel-16 TCI state indication mechanism for multi-TRPs

* The single DCI field ‘Transmission Configuration Indication’ indicates one or two TCI states associated with a code point for single DCI based multi-TRP mechanism
* The single DCI field ‘Transmission Configuration Indication’ indicates only one TCI state associated with a code point for multi-DCI based multi-TRP mechanism
* Reuse Rel-16 RRC configuration and MAC CE activation/deactivation methods for the one or two TCI states
* FFS: Details of multiple TCI state association with multiple PDSCHs

Agreement:

For the single TRP case, For multi-PDSCHs scheduled by a single DCI with a single DCI field ‘Transmission Configuration Indication’ that indicates a single TCI state (if the DCI field is present),

* Case 1: PDSCH scheduling offset for all PDSCHs ≥ *timeDurationForQCL*
	+ Case 1-1: *tci-PresentInDCI* enabled
		- Single QCL assumption based on the indicated codepoint of the single DCI field ‘Transmission Configuration Indication’ is applied for all scheduled PDSCHs
	+ Case 1-2: *tci-PresentInDCI* not present
		- Single QCL assumption of the single scheduling DCI scheduled multi-PDSCHs is applied for all scheduled PDSCHs
* Case 2: PDSCH scheduling offset for any scheduled PDSCH < *timeDurationForQCL*
	+ Down select one of the following alternatives
		- Alt 1: Single QCL assumption is applied for all scheduled PDSCHs
			* FFS: Details of single QCL assumption
		- Alt 2: multiple QCL assumptions are applied
			* FFS: Details of multiple QCL assumptions
* FFS: When some of PDSCHs are collided with semi-static UL symbols and then skipped
* FFS: The multi-TRP case

Agreement:

For candidate values of timeDurationForQCL, beamSwitchTiming and beamReportTiming,

* Support one of the following alternatives
	+ Alt-1: No additional candidate values are supported for 120 kHz, 480 kHz and 960 kHz
	+ Alt-2: 28 and 56 symbols are supported as additional candidate values for 480 kHz and 960 kHz, respectively
* For UE capability signaling, UE reports one value of the candidate values in OFDM symbols per each SCS

Agreement:

* For additional beam switching time delay d of 120 kHz, support one of the following alternatives
	+ Alt-1: 14 symbols
	+ Alt-2: 28 symbols
* FFS: value for 480 kHz

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Agreement:

For maxNumberRxTxBeamSwitchDL, support 1, 4 and 7 as candidate values for 960 kHz in addition to the agreed candidate value 2.

* Note: this is Alt-1 from the RAN1#106 agreement.

Agreement:

For additional beam switching time delay d of 120 kHz, support 28 symbols.

* Note: this is Alt-2 from the RAN1#106 agreement.

Agreement:

For additional beam switching time delay d of 480 kHz, introduce UE capability signalling which indicates 56 symbols or 112 symbols.

Conclusion:

For candidate values of timeDurationForQCL, beamSwitchTiming and beamReportTiming,

* No additional candidate values are supported for 120 kHz, 480 kHz and 960 kHz
* Note: this is Alt-1 from the RAN1#106 agreement.

Agreement:

Like in Rel-15, a minimum guard period Y between two SRS resources of an SRS resource set for antenna switching is supported for 480 kHz and 960 kHz

* FFS: Whether to define different values of Y for 480 kHz and 960 kHz or not
* FFS: Values of Y dependent on RAN4 feedback on the switching time requirement

Agreement:

The working assumption in RAN1#106-e is confirmed with the following update:

For multi-PDSCH scheduling for multi-TRPs, support a single DCI field ‘Transmission Configuration Indication’ as in Rel-16 TCI state indication mechanism for multi-TRPs

* The single DCI field ‘Transmission Configuration Indication’ indicates one or two TCI states associated with a code point for single DCI based multi-TRP mechanism
	+ When two TCI states are indicated, reuse Rel-16 association rules to apply the two TCI states for each PDSCH scheduled by a multi-PDSCH scheduling DCI
* The single DCI field ‘Transmission Configuration Indication’ indicates only one TCI state associated with a code point for multi-DCI based multi-TRP mechanism
* Reuse Rel-16 RRC configuration and MAC CE activation/deactivation methods for the one or two TCI states
* ~~FFS: Details of multiple TCI state association with multiple PDSCHs~~
* Within the TDRA table for multi-PDSCH scheduling, the UE does not expect to be configured with the higher layer parameter repetitionNumber

#### 107-e

### 8.2.5 PDSCH/PUSCH enhancements

#### 104-e

[**R1-2102090**](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104/Docs/R1-2102090.zip) [Draft] LS on the maximum/minimum channel bandwidth and channelization for NR operation in 52.6 to 71 GHz vivo

Final LS endorsed in [R1-2102128](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104/Docs/R1-2102128.zip)

Agreement:

* From RAN1 perspective, for NR operation in 52.6 GHz to 71 GHz,
	+ The maximum channel bandwidth for 120 kHz SCS is 400 MHz
	+ The maximum channel bandwidth for 480 kHz SCS is 1600 MHz
	+ The maximum channel bandwidth for 960 kHz SCS is one of the following options
		- 2000 MHz
		- 2160 MHz
* Send LS to RAN4 to inform about RAN1’s agreement of maximum channel bandwidth and ask RAN4 to decide and feedback the exact value of maximum channel bandwidth for 960 kHz SCS, the corresponding numbers of RBs for the maximum channel bandwidth of SCS(s) supported in 52.6 GHz to 71 GHz.

Agreement:

* From RAN1 perspective, for NR operation in 52.6 GHz to 71 GHz, at least the following options on minimum channel bandwidth are identified.
	+ for 120 kHz SCS
		- Option 1-1: 100 MHz
		- Option 1-2: 200 MHz
		- Option 1-3: 400 MHz
	+ for 480 kHz SCS
		- Option 2-1: 200 MHz
		- Option 2-2: 400 MHz
	+ for 960 kHz SCS
		- Option 3-1: 400 MHz
		- Option 3-2: 800 MHz
		- Option 3-3: same value as the maximum channel bandwidth for 960 kHz SCS
* Further study in RAN1 the above options’ implications on RAN1 design and specification
* Send LS to RAN4 to inform about RAN1’s identified options of minimum channel bandwidth and ask RAN4 to decide and feedback the minimum channel bandwidth

Agreement:

* RAN1 use the absolute time duration for 120 kHz SCS as the upper bound for the discussion of UE processing timelines (not related to PDCCH monitoring) for 480 kHz and 960 kHz SCS for NR operation in 52.6 to 71 GHz
	+ RAN1 strives to reduce the absolute time durations from the upper bound if feasible
* FFS: How to derive timeline values
	+ Case by case study
	+ FFS: model-based approach for selected timelines, e.g. exponential models, projection based on log-linear regression, etc.

Agreement:

Proposal 5-1a in [R1-2102072](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104/Docs/R1-2102072.zip) is agreed with the following modification:

* In the row for PTRS configuration, change the text to “Companies are asked to report details of PN compensation method(s) with corresponding receiver complexity and details of PTRS enhancement (including any modifications to sequences) for CP-OFDM if evaluated. For example, for block-based PTRS enhancement, the number of PTRS blocks per OFDM symbol, the number of PTRS REs per block, and the placement of PTRS blocks in each OFDM symbol are required to be provided if evaluated”

Agreement:

Further study at least the following aspects of timelines to support both single PDSCH/PUSCH and multi-PDSCH/PUSCH scheduling for NR operation in 52.6 GHz to 71 GHz.

* Time unit and applicability to selected timelines
* Value and/or range of value
* Potential impact on UE capability

Agreement:

* The following UE processing timelines are prioritized for discussion
	+ PDSCH processing time (N1), PUSCH preparation time (N2), HARQ-ACK multiplexing timeline (N3)
	+ configuration(s)/default values of k0 (PDSCH), k1 (HARQ), k2 (PUSCH)
	+ CSI processing time, Z1, Z2, and Z3, and CSI processing units
	+ Note: the order of the above sub-bullets represents the priority for discussion in descending order
* Companies are encouraged to provide preferred values/ranges of timelines for discussion

Agreement:

FFS: The need for enhancements and standardization, of the following additional processing timelines:

* UE PDSCH reception preparation time with cross carrier scheduling with different subcarrier spacings for PDCCH and PDSCH
* SRS, PUCCH, PUSCH, PRACH cancellation with dynamic SFI
* ZP CSI Resource set activation/deactivation
* Application delay of the minimum scheduling offset restriction
* timing aspects related to cross carrier operation

Agreement:

* At least existing PTRS design for CP-OFDM is supported for NR operation in 52.6 to 71 GHz.
* Companies are encouraged to study the need of potential PTRS enhancement for CP-OFDM with respect to phase noise compensation performance considering at least the following aspects:
	+ PTRS density/pattern (e.g. distributed, block-based) and sequence (e.g. cyclic sequence)
	+ Frequency domain power boosting and its impact to PDSCH performance and PDSCH to DMRS EPRE
	+ Receiver complexity, including possible aspects related to supporting both existing PTRS design and potential PTRS enhancement
	+ Possible specification impact of supporting potential PTRS enhancement in addition to existing PTRS design
	+ Note: PTRS overhead should be accounted for in the evaluations, e.g. by showing spectral efficiency results and/or reporting effective coding rate
* Note: the decision to support potential enhanced PTRS design in addition to existing PTRS design will be made based on performance benefit, receiver complexity and specification effort aspects of enhanced PTRS design together and not purely on the considerations of the specification effort caused by supporting potential enhanced PTRS design in addition to existing PTRS design.

Agreement:

Companies are encouraged to 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

Agreement:

* Existing DMRS patterns are supported for NR operation in 52.6 to 71 GHz with 120 kHz SCS.
* At least existing DMRS patterns are supported for NR operation in 52.6 to 71 GHz with 480 kHz and/or 960 kHz SCS
* Further study on whether to introduce different DMRS pattern with increased frequency domain density (in number of subcarriers) than the existing DMRS patterns for NR operation in 52.6 to 71 GHz with 480 kHz and/or 960 kHz SCS
* Further study on whether and how to restrict DMRS port configuration (e.g., the number of DMRS ports) as in FR2 for NR operation in 52.6 to 71 GHz with 480 kHz and/or 960 kHz SCS

Agreement:

Further study on at least the following aspects of potential DMRS enhancement with respect to FD-OCC:

* whether to support a configuration of DMRS in which FD-OCC is not applied for 480 kHz and 960 kHz SCS
	+ Applicability to Type-1 and/or Type-2 DMRS
	+ Details on whether and how to indicate that FD-OCC is not applied to DMRS port
	+ Impact to UE multiplexing capacity and inter-UE interference in MU-MIMO

Agreement:

* For a UE and for a serving cell, scheduling multiple PDSCHs by single DL DCI and scheduling multiple PUSCHs by single UL DCI are supported.
	+ Each PDSCH or PUSCH has individual/separate TB(s) and each PDSCH/PUSCH is confined within a slot.
	+ FFS: The maximum number of PDSCHs or PUSCHs that can be scheduled with a single DCI
	+ FFS: Whether multiple PDSCH scheduling applies to 120 kHz in addition to 480 and 960 kHz
	+ At least for 120 kHz SCS, single-slot scheduling with slot-based monitoring will still be supported as specified in Rel-15/Rel-16
* The followings will not be considered in this WI.
	+ Single DCI to schedule both PDSCH(s) and PUSCH(s)
	+ Single DCI to schedule one or multiple TBs where any single TB can be mapped over multiple slots, where mapping is not by repetition
	+ Single DCI to schedule N TBs (N>1) where a TB can be repeated over multiple slots (or mini-slots)
* Note: This does not imply that existing slot aggregation and/or repetition for PDSCH and PUSCH by single DCI is precluded for the serving cell.

Agreement:

* For a DCI scheduling multiple PDSCHs, HARQ-ACK information corresponding to PDSCHs scheduled by the DCI is multiplexed with a single PUCCH in a slot that is determined based on K1,
	+ where K1 (indicated by the PDSCH-to-HARQ\_feedback timing indicator field in the DCI or provided by *dl-DataToUL-ACK* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in the DCI) indicates the slot offset between the slot of the last PDSCH scheduled by the DCI and the slot carrying the HARQ-ACK information corresponding to the scheduled PDSCHs.
		- It is noted that granularity of K1 can be separately discussed.
* FFS: If needed, further discuss whether or not HARQ-ACK information corresponding to different PDSCHs scheduled by the DCI can be carried by different PUCCH(s)

Agreement:

For generating type-2 HARQ-ACK codebook corresponding to DCI that can schedule multiple PDSCHs, the following alternatives can be considered to DAI counting and will be down-selected in RAN1#104bis-e.

* Alt 1: C-DAI/T-DAI is counted per DCI.
* Alt 2: C-DAI/T-DAI is counted per PDSCH.
* Alt 3: C-DAI/T-DAI is counted per M scheduled PDSCH(s), where M is configurable (e.g., 1, 2, 4, …).
* FFS: Codebook generation details
* FFS: How to signal DAI values (e.g., increase of DAI bits for Alt 2 and Alt 3)
* FFS: Whether to apply time domain bundling of HARQ-ACK feedback

Agreement:

The multi-PUSCH scheduling defined in Rel-16 NR-U is the baseline for multi-PUSCH scheduling in Rel-17.

* FFS: Applicability to multi-PDSCH scheduling.

Agreement:

* For the multi-PUSCH scheduling in Rel-17, study the enhancement of the following in addition to Rel-16 multi-PUSCH scheduling.
	+ CBGTI: Whether or not CBG (re)transmission is supported when more than one PUSCHs are scheduled (Already supported when only one PUSCH is scheduled).
	+ CSI-request: Whether to apply same or different rule compared to Rel-16 (e.g., the PUSCH that carries the AP-CSI feedback is the first PUSCH that satisfies the multiplexing timeline).
	+ TDRA: Down-select among
		- Alt 1: TDRA table is extended such that each row indicates up to [X, FFS for X] multiple PUSCHs (continuous in time-domain). Each PUSCH has a separate SLIV and mapping type. The number of scheduled PUSCHs is signalled by the number of indicated valid SLIVs in the row of the TDRA table signalled in DCI.
		- Alt 2: TDRA table is extended such that each row indicates up to [X, FFS for X] 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 signalled by the number of indicated valid SLIVs in the row of the TDRA table signalled in DCI.
		- Alt 3: TDRA table is extended such that each row indicates up to 8 multiple PUSCH groups (that can be non-continuous between PUSCH groups). Each PUSCH group has a separate SLIV, mapping type and number of slots/PUSCHs N. Within each PUSCH group, N PUSCHs occupy the same OFDM symbols indicated by the SLIV and mapping type. The number of scheduled PUSCHs is the sum of number of PUSCHs in all PUSCH groups in the row of the TDRA table signalled in DCI.
	+ FDRA: Whether/how to enhance FDRA e.g., by increasing RBG size or changing allocation granularity
	+ Frequency hopping: Whether/how to support frequency hopping for scheduled PUSCHs, e.g., inter-PUSCH/intra-PUSCH hopping
	+ URLLC related fields such as priority indicator and open-loop power control parameter set indication: Whether/how to apply URLLC related fields for scheduled PUSCHs
	+ Applicability to multi-PDSCH scheduling in Rel-17.
	+ Note: Other enhancements are not precluded.

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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

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

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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

#### 106-e

Agreement:

For NR operation with 480 kHz and/or 960 kHz SCS, value(s) for PDSCH processing time (N1) for PDSCH processing capability 1 and PUSCH preparation time (N2) are to be defined for PDSCH/PUSCH timing capability 1 only.

Agreement:

For NR operation with 480 kHz and/or 960 kHz SCS, only value(s) for CSI computation delay requirement 2 are to be defined.

* FFS: The specific values

Agreement:

When defining value ranges and/or default values for k0/k1/k2 for NR operation with 480 and 960 kHz SCS, RAN1 assumes the following definitions (this agreement does not define the following and these definitions may be updated later)

* The value of k0 indicates the slot offset between DCI and its scheduled PDSCH in number of slots
* The value of k1 indicates the slot offset between the slot of the last PDSCH scheduled by the DCI and the slot carrying the HARQ-ACK information corresponding to the scheduled PDSCHs in number of slots
* The value of k2 indicates the slot offset between DCI and its scheduled PUSCH in number of slots
* Note: Default values are indicated by DCI format 1\_0 and 0\_0

Agreement:

* For 480 kHz and/or 960 kHz SCS, for rank 1 PDSCH at least with DMRS type-1, support a configuration of DMRS where the UE is able to assume that FD-OCC is not applied.
	+ Note: “FD-OCC is not applied” refers to the UE may assume that a set of remaining orthogonal antenna ports are not associated with the PDSCH to another UE, wherein the set of remaining orthogonal antenna ports are within the same CDM group and have different FD-OCC
	+ FFS whether applies to DMRS type-2
	+ Down select between the following options for the indication to UE
		- RRC configuration
		- antenna port(s) field in DCI scheduling the rank 1 PDSCH

Agreement:

For NR operation with 480 and 960 kHz SCS, adopt at least the values of N1, N2 and N3 as in the following tables for single and multi-PDSCH/PUSCH scheduling.

* Note: N1/N2 applies to any PDSCH/PUSCH for multi-PDSCH/PUSCH scheduling
* RAN1 to study (until RAN1#106b-e) and possibly introduce smaller values considering at least the following factors
	+ PDCCH monitoring capability
	+ Mix numerology scheduling
	+ Multi-PDSCH/PUSCH scheduling
	+ Cross-carrier scheduling
* Note: The decision for the number of HARQ processes should take this agreement into account.

Table 2-2.1 PDSCH processing time arrange for PDSCH processing capability 1

|  |  |
| --- | --- |
|  | PDSCH decoding time *N1* [symbols] |
| *dmrs-AdditionalPosition* = pos0 in *DMRS-DownlinkConfig* in both of *dmrs-DownlinkForPDSCH-MappingTypeA*, *dmrs-DownlinkForPDSCH-MappingTypeB* | *dmrs-AdditionalPosition* ≠ pos0 in *DMRS-DownlinkConfig* in either of *dmrs-DownlinkForPDSCH-MappingTypeA*, *dmrs-DownlinkForPDSCH-MappingTypeB**or if the higher layer parameter is not configured* |
| 3 (120 kHz) | 20 | 24 |
| 5 (480 kHz) | 80 |  96 |
| 6 (960 kHz) | 160 | 192 |

Table 2-2.2 PUSCH preparation time for PUSCH timing capability 1

|  |  |
| --- | --- |
|  | PUSCH preparation time *N2* [symbols] |
| 3 (120 kHz) | 36 |
| 5 (480 kHz) | 144  |
| 6 (960 kHz) | 288 |

Table 2-2.3 Minimum gap between the second detected DCI and the beginning of the first PUCCH resources

|  |  |
| --- | --- |
|  | HARQ-ACK multiplexing timeline *N3* [symbols] |
| 3 (120 kHz) | 20 |
| 5 (480 kHz) | 80 |
| 6 (960 kHz) | 160 |

Agreement:

Further study and conclude on whether to introduce any PTRS enhancement for CP-OFDM by RAN1#106b.

* Note: details of specification impact for any proposed PTRS enhancement shall be provided to facilitate drawing conclusion in RAN1#106b

Agreement:

Further study and conclude on whether to introduce K=1 for Rel-15 PTRS pattern for CP-OFDM with small (< =32) RB allocation by RAN1#106b.

Agreement:

Further study and conclude on whether to introduce (Ng = 16, Ns = 2, L = 1) and/or (Ng = 16, Ns = 4, L = 1) for DFT-s-OFDM by RAN1#106b.

* 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
* FFS applicable to which RB allocation(s) if agreed to introduce (Ng = 16, Ns = 2, L = 1) and/or (Ng = 16, Ns = 4, L = 1)

Agreement:

For NR operation with 480 and 960 kHz SCS, adopt at least the values of Z1, Z2 and Z3 as in the following table for single and multi-PDSCH/PUSCH scheduling to maintain the same absolute time duration as that of 120 kHz SCS in FR2.

* Note: is UE reported capability *beamReportTiming*; KB3 and KB4 is UE reported capability *beamSwitchTiming* for 480 and 960 kHz SCS respectively.
* RAN1 to study (until RAN1#106b-e) and possibly introduce smaller values for CSI computation delay requirement

Table 2-4. CSI computation delay requirement 2

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Z1* [symbols]** | ***Z2* [symbols]** | ***Z3* [symbols]** |
| *Z1* | *Z'1* | *Z2* | *Z'2* | *Z3* | *Z'3* |
| 3 | 97 | 85 | 152 | 140 | min(97, *X*3+ KB2) | *X*3 |
| 5 | 388 | 340 | 608 | 560 | [min(388, *X*5+ KB3)] | [*X*5] |
| 6 | 776 | 680 | 1216 | 1120 | [min(776, *X*6+ KB4)] | [*X*6] |

Conclusion:

In Rel-17, for NR operation with 480 kHz and/or 960 kHz SCS, new DMRS pattern with increased frequency domain density is not supported.

Working assumption:

Scheduling multiple PDSCHs by single DL DCI applies to 120 kHz in addition to 480 and 960 kHz at least in FR2-2.

* FFS: Further limitations on maximum number of PDSCHs

Agreement:

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

Agreement:

* The maximum number of PDSCHs/PUSCHs that can be scheduled with a single DCI in Rel-17 is 8 for SCS of 120, 480 and 960 kHz.
* FFS: Whether UE capability is introduced for restricting the maximum number of PDSCHs or PUSCHs that can be scheduled with a single DCI

Agreement:

If a scheduled PDSCH/PUSCH is dropped due to collision with UL/DL symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, HARQ process number increment is skipped for the PDSCH/PUSCH and applied only for valid PDSCH(s)/PUSCH(s).

* FFS: HARQ process number determination for the case where a scheduled PDSCH/PUSCH collides with a flexible symbol (indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*) if the UE is configured to monitor DCI format 2\_0.

Agreement:

* For a DCI that can schedule multiple PUSCHs,
	+ Priority indicator and open loop power control parameter set indication fields are applied to all of scheduled PUSCHs.
* For a DCI that can schedule multiple PDSCHs,
	+ Priority indicator field is applied to all of scheduled PDSCHs.

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, by configuring {SLIV, mapping type, scheduling offset K0 (or K2)} for each PDSCH (or PUSCH) in the row of TDRA table.
* Note: Whether and how to reduce RRC overhead is left to RAN2.

Agreement:

For a DCI that can schedule multiple PDSCHs,

* Each of VRB-to-PRB mapping, PRB bundling size indicator, ZP-CSI-RS trigger, and rate matching indicator fields appears only once in the DCI.
* VRB-to-PRB mapping and PRB bundling size indicator fields are applied to all the PDSCHs scheduled by the DCI.
* For ZP-CSI-RS trigger field, the triggered aperiodic ZP CSI-RS is applied to all the slot(s) in which the PDSCH(s) scheduled by the DCI are contained.
* When receiving a PDSCH scheduled by the DCI, the REs corresponding to configured resources in *rateMatchPatternGroup1* or *rateMatchPatternGroup2* (according to indication of rate matching indicator field) are not available for the scheduled PDSCH.

Working assumption:

For NR FR2-2, two codeword transmission is supported, subject to UE capability.

* RRC parameter configures whether two codeword transmission is enabled or disabled.
	+ FFS: Details on signaling of MCS/NDI/RV for the second TB in a DCI that can schedule multiple PDSCHs when two codeword transmission is enabled
	+ FFS: Whether unified or separate parameter to enable/disable 2-TB for single and for multiple PDSCH scheduling
	+ Strive to minimize the increase in the number of bits in the DCI needed to support this feature

Agreement:

* For single TRP operation, for 480/960 kHz SCS,
	+ FFS: A UE does not expect to be scheduled with more than one PDSCH in a slot, by a single DCI or multiple DCIs.
	+ FFS: A UE does not expect to be scheduled with more than one PUSCH in a slot, by a single DCI or multiple DCIs.
* For single TRP operation, for 120 kHz SCS (same as current specification for FR2-1 for PUSCH),
	+ Subject to UE capability, a UE can be scheduled with more than one PDSCH in a slot, by a single DCI or multiple DCIs.
	+ Subject to UE capability, a UE can be scheduled with more than one PUSCH in a slot, by a single DCI or multiple DCIs.
* FFS for multi-TRP operation
* Note: The optimization of HARQ codebook size for Type 1 or Type 2 codebook design is considered as a low priority in Rel-17 (this does not preclude HARQ ACK bundling in time domain).
* The agreement made in RAN1#105-e is revised as follows.

|  |
| --- |
| Agreement: (RAN1#105-e)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 contains all the unique DL slots determined by considering all combinations of the configured K1 values and the configured rows of the TDRA table.
* The set of SLIVs corresponding to a DL slot (belonging to the set of DL slots) contains all the SLIVs for that slot determined by considering all combinations of the configured K1 values and the configured rows of the TDRA table.
* The Rel-16 procedure is reused for determining the candidate PDSCH reception occasions for the set of SLIVs corresponding to each DL slot belonging to the set of DL slots
	+ Note: The Rel-16 procedure already handles pruning of multiple SLIVs corresponding to a DL slot, for both UEs that are and are not capable of receiving multiple PDSCHs per slot
	+ FFS impact of time domain bundling, if supported
 |

Agreement:

Consider the following options to construct type-2 HARQ-ACK codebook when CBG operation is configured, and down-select to one of the following options in RAN1#106bis-e.

* Option 1: HARQ-ACK bits corresponding to CBG-based PDSCH reception and multi-PDSCH reception are merged into the same sub-codebook.
* Option 2: HARQ-ACK bits corresponding to CBG-based PDSCH reception and HARQ-ACK bits corresponding to multi-PDSCH reception are contained in separate sub-codebooks.
* Option 3: UE does not expect to be configured with both of CBG operation and multi-PDSCH scheduling in the same PUCCH cell group.
* Note: Multi-PDSCH reception refers to the case where multiple PDSCHs are scheduled by a DCI that is configured with TDRA table containing at least one row with multiple SLIVs.

Agreement:

For NR FR2-2 at least for 480/960 kHz SCS, support 32 as the maximum number of HARQ processes for DL and UL, subject to UE capability.

* Note: Up to 32 maximal supported HARQ process number is already agreed in Rel-17 NTN WI.
* Working assumption: The same solution to support up to 32 HARQ process number in Rel-17 NTN WI is reused for NR FR2-2.

#### 106b-e

Agreement:

For 480 kHz and/or 960 kHz SCS, for rank 1 PDSCH with type-1 or type-2 DMRS, support a configuration of DMRS where the UE is able to assume that FD-OCC is not applied.

* Note: “FD-OCC is not applied” refers to the UE may assume that a set of remaining orthogonal antenna ports are not associated with the PDSCH to another UE, wherein the set of remaining orthogonal antenna ports are within the same CDM group and have different FD-OCC
* Note: The same UE indication method is used for both type-1 and type-2 DMRS

Agreement:

Support an indication to the UE via RRC where the UE is able to assume that FD-OCC is not applied to all the antenna port(s) for DMRS which is(are) applicable for rank 1 PDSCH.

Agreement:

For NR operation with 480 kHz and/or 960 kHz SCS, the value range of k0 is 0 ~ 128.

Agreement:

For NR operation with 480 kHz and/or 960 kHz SCS, the value range for k2 is 0 ~ 128.

Agreement:

For NR operation with 480 kHz and/or 960 kHz SCS, the value range of k1 indicated in RRC is -1 ~ 127 for DCI format 1\_1 and 0 ~ 127 for DCI format 1\_2.

* Note: this does not imply that DCI format 1\_2 supports multi-PDSCH scheduling

Agreement:

* For NR operation with 480 kHz and/or 960 kHz SCS, *j* = 11 for 480 kHz and *j* = 21 for 960 kHz for determination of the default PUSCH time domain resource allocation (in 38.214 Section 6.1.2.1.1).
* When the field k2 is absent in RRC, the UE applies the value 11 when PUSCH SCS is 480 kHz; and the value 21 when PUSCH SCS is 960 kHz for k2.

Conclusion:

There’s no consensus in RAN1 to introduce other values of N1, N2 and N3 for NR operation with 480 and/or 960 kHz SCS in Rel-17.

Conclusion:

There’s no consensus in RAN1 to introduce (Ng = 16, Ns = 2, L = 1) and/or (Ng = 16, Ns = 4, L = 1) for NR operation in FR2-2 with DFT-s-OFDM in Rel-17.

* 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

Agreement:

For NR operation with 480 kHz and/or 960 kHz SCS, decide the set of values for PDSCH-to-HARQ\_feedback timing indicator field in DCI format 1\_0in RAN1#107-e.

* Option 1: {4, 8, 12, 16, 20, 24, 28, 32} for 480 kHz and {8, 16, 24, 32, 40, 48, 56, 64} for 960 kHz
* Option 2: {7, 8, 9, 10, 11, 12, 13, 14} for 480 kHz and {13, 14, 15, 16, 17, 18, 19, 20} for 960 kHz
* Option 2a: {1, 2, 3, 4, 5, 6, 7, 8} (same as in existing specification)
	+ Note: the actual slot offset of k1 is the indicated value + offset where offset is ceil(N1/14)
* Other options are not precluded

Agreement:

Remove [] from previous agreed Z3 values for NR operation with 480 and 960 kHz SCS. That is,

For NR operation with 480 and 960 kHz SCS, adopt at least the values of Z1, Z2 and Z3 as in the following table for single and multi-PDSCH/PUSCH scheduling to maintain the same absolute time duration as that of 120 kHz SCS in FR2.

* Note: is UE reported capability *beamReportTiming*; KB3 and KB4 is UE reported capability *beamSwitchTiming* for 480 and 960 kHz SCS respectively.

Table:  CSI computation delay requirement 2

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Z1* [symbols]** | ***Z2* [symbols]** | ***Z3* [symbols]** |
| *Z1* | *Z’1* | *Z2* | *Z’2* | *Z3* | *Z’3* |
| 5 | 388 | 340 | 608 | 560 | min(388, *X*5+ KB3) | *X*5 |
| 6 | 776 | 680 | 1216 | 1120 | min(776, *X*6+ KB4) | *X*6 |

Agreement:

For NR operation with 480 kHz and/or 960 kHz SCS, CSI computation delay requirement 2 is always applied at least for the case of same SCS operation.

* FFS: whether CSI computation delay requirement 2 is always applied in the case of mixed SCS of PDCCH, CSI-RS and PUSCH.

Conclusion:

In Rel-17, for NR operation with 480 and/or 960 kHz SCS, no other values of Z1, Z2 and Z3 is supported.

Conclusion:

In Rel-17, for NR operation in FR2-2, increased PTRS frequency density for Rel-15 PTRS pattern is not supported for CP-OFDM when the allocated number of RB <= 32.

Conclusion:

In Rel-17, for NR operation in FR2-2, PTRS enhancement is not supported for CP-OFDM.

Agreement:

Confirm the working assumption from RAN1#106-e with the following modification.

Working assumption: (RAN1#106-e)

Scheduling multiple PDSCHs by single DL DCI applies to 120 kHz in addition to 480 and 960 kHz at least in FR2-2.

* ~~FFS: Further limitations on maximum number of PDSCHs~~
* Note: Further limitations (in addition to what was agreed earlier) on the maximum number of PDSCHs or PUSCHs can be separately discussed for all SCSs.

Working assumption:

UE does not expect to be configured with both of CBG operation and multi-PDSCH scheduling in the same PUCCH cell group with a Type 2 codebook.

* If time bundling operation is supported, this working assumption can be revisited

Agreement:

For a PDSCH that is scheduled by multi-PDSCH scheduling DCI and is skipped due to collision with semi-static UL symbol(s),

* For Type-1 HARQ-ACK codebook generation, the PDSCH is not considered and the HARQ-ACK bit corresponding to the PDSCH is not reported by UE.
	+ Note: Rel-16 procedure can be reused to handle this case.
* For Type-2 HARQ-ACK codebook generation, UE reports NACK for the PDSCH.
	+ FFS on HARQ-ACK bit ordering
* Note: Codebook generation in case time domain bundling is enabled can be separately discussed if time domain bundling is supported.

Agreement:

For generating type-2 HARQ-ACK codebook corresponding to a DCI that can schedule multiple PDSCHs,

* HARQ-ACK bit corresponding to SPS PDSCH release or SCell dormancy indication without scheduled PDSCH, belongs to the first sub-codebook (which is defined in the previous agreement made in RAN1#105-e)

Agreement:

For two multi-PDSCH (or two multi-PUSCH) scheduling DCIs, UE does not expect any of the scheduled PDSCHs (or PUSCHs) and the scheduling DCI to lead to out-of-order scheduling.

* FFS: whether to allow OOO scheduling for the following two cases:
	+ for the case of one multi-PDSCH (or multi-PUSCH) scheduling DCI and one single-PDSCH (or single-PUSCH) scheduling DCI, where multi-PDSCH (or multi-PUSCH) scheduling DCI schedules more than one PDSCH (or PUSCH)
	+ for the case where two multi-PDSCH (or multi-PUSCH) scheduling DCIs end in the same symbol but two multi-PDSCH (or multi-PUSCH) scheduling DCIs have overlapping spans, where the span is defined from the beginning of the first scheduled SLIV till the end of the last scheduled SLIV
* Note: The above FFS aspect applies only to multi-PDSCH and multi-PUSCH scheduling with single DCI

Agreement:

For multiple PDSCHs (or PUSCHs) scheduled by a single DCI,

* Rel-15/16 behavior that is described in TS 38.213 Clauses 11 and 11.1 for a PDSCH (or PUSCH) indicated by DCI also applies for multiple PDSCHs (or PUSCHs) schedule by a single DCI.
* If one of multiple PDSCHs (or PUSCHs) scheduled by the DCI collides with a flexible symbol (indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*),
	+ If that PUSCH is collided with SSB symbols indicated by *ssb-PositionsInBurst* [or symbol(s) indicated by *pdcch-ConfigSIB1* in *MIB* for a CORESET for Type0-PDCCH CSS set], the HARQ process number increment is skipped for the PUSCH.
	+ Otherwise, the HARQ process number increment is not skipped for that PDSCH (or PUSCH).

Conclusion:

For a DCI that can scheduled multiple PDSCHs (or PUSCHs), HARQ process number indicated in the DCI is applied to the first valid PDSCH (or PUSCH).

* Note: This is the consequence of previous agreements.

Agreement:

For single TRP operation, for 480/960 kHz SCS,

* A UE does not expect to be scheduled with more than one unicast PDSCH in a slot, by a single DCI or multiple DCIs.
* A UE does not expect to be scheduled with more than one PUSCH in a slot, by a single DCI or multiple DCIs.

Agreement:

For a DCI that can schedule multiple PDSCHs, and if RRC parameter configures that two codeword transmission is enabled,

* MCS for the 2nd TB: This appears only once in the DCI and applies commonly to the 2nd TB of each PDSCH
* NDI for the 2nd TB: This is signaled per PDSCH and applies to the 2nd TB of each PDSCH
* RV for the 2nd 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 2nd TB of each PDSCH
* FFS: the maximum number of PDSCHs when 2 TB is enabled or when 2 TB is scheduled

#### 107-e

### 8.2.6 Channel access mechanism

#### 104-e

Agreement:

The baseline ED threshold can be computed as

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

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

Agreement:

For LBT for single carrier transmission, consider the following alternatives

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

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

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

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

Agreement:

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

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

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

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

Agreement:

On maximum gap within a COT to allow COT sharing without LBT, down-select from

* Alt 1. No maximum gap defined. A later transmission can share the COT without LBT with any gap within the maximum COT duration
* Alt 2. Define a maximum gap X, such that a later transmission can share the COT without LBT only if the later transmission starts within X from the end of the earlier transmission
	+ FFS: Value for X
* Alt 3. Define a maximum gap Y, such that a later transmission can share the COT without LBT only if the later transmission starts within Y from the end of the earlier transmission. If the later transmission starts after Y from the end of the earlier transmission, an one-shot LBT is needed to share the COT
	+ FFS: Value for Y
	+ FFS:  How to define the one-shot LBT

Agreement:

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

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

Agreement:

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

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

Other use cases not precluded.

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

Agreement:

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

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

Agreement:

For a COT with MU-MIMO (SDM) transmission, further consider the follow alternatives (down-select or support both)

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

Agreement:

Within a COT with TDM of beams with beam switching, down-select one or more of the following LBT operations

* Alt 1: Single LBT sensing with wide beam ‘cover’ all beams to be used in the COT with appropriate ED threshold
	+ FFS: Details on the definition of "cover"
* Alt 2: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT
* Alt 3: Independent per-beam LBT sensing at the start of COT is performed for beams used in the COT with additional requirement on Cat 2 LBT before beam switch

Agreement:

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

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

Down-selection between

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

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

Agreement:

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

#### 104b-e

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.

#### 105-e

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 ~~and/or msg3~~ for the 4 step RACH and MsgA for the 2-step RACH for all supported SCS.
	+ Note restriction for short control signalling transmissions apply (10% over any 100ms intervals)
	+ Alt 1: The 10% over any 100ms interval restriction is applicable to all available msg1/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/~~msg3~~/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

#### 106-e

Agreement:

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

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

Conclusion:

There is no consensus in RAN1 to support the functionality of accessing a carrier if there is interference in part of the carrier in frequency.

Agreement:

On COT sharing from an initiating device transmission to responding device transmission, support both of the following two alternatives

* Alt 1: No maximum gap defined between the initiating device transmission and responding device transmission. A responding device transmission can occur without LBT with any gap within the maximum COT duration
* Alt 3: Define a maximum gap Y, such that a responding device transmission can occur without LBT only if the transmission starts within Y from the end of the initiating device transmission. If the responding device transmission starts after Y from the end of the initiating device transmission, a Cat 2 LBT is needed before the responding device transmission.
	+ The Cat 2 LBT uses the same sensing structure as the 8 us initial deferral period as in eCCA
	+ Further down-select between the following options:
		- Option 1: Y=8 us (motivated by need to operate in all regions)
		- Option 2: Y=a multiple number of OFDM symbols
		- Option 3: gNB determines Y (for example, according to local regulation)
	+ Cat. 2 LBT is a UE capability
* The usage of the two alternatives is a gNB choice and depends at least on local regulations.

Note: Alt. 3 is motivated by the regulations in Japan, but use of Cat. 3 LBT is also an option for operation in Japan and Cat. 2 LBT is not restricted for use only in Japan.

Note: Maximum gap allowed without Cat 2 LBT between two initiating device transmissions is to be separately discussed

Note: Other use cases of Cat 2 LBT will be separately discussed

Agreement:

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

Agreement:

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

Agreement:

3GPP specification consider defining at least the relative relationship between all applicable sensing beam(s) and the transmission beam(s) to define sensing beam for LBT, where at least sensing beam(s) “covers” the transmission beam(s), considering following alternatives. Target down-selection by RAN1 #106bis-e

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

No testing or enforcement introduced in 3GPP spec for this option

* + - * + Option 2: gNB indication.

FFS details.

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

Agreement:

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

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

#### 106b-e

Agreement:

* When UE indicates a capability for beam correspondence with beamCorrespondenceWithoutUL-BeamSweeping ={1}, support the following behaviors
* If the UE is indicated to transmit with a beam corresponding to a certain SRI, the UE can use the same beam for sensing
* Assuming Rel.17 unified TCI framework, if the UE is indicated to transmit with a beam corresponding to a certain unified TCI, the UE can use the reception beam corresponding to the TCI for sensing
* FFS: The case when UE does not indicate a capability for beam correspondence
* Note: The UE should meet local regulatory requirements

Conclusion:

There is no consensus to support explicitly introducing in the spec using single LBT covering multiple CCs under CA.

* Note: This does not rule out gNB/UE implementation to perform single LBT to cover multiple CCs. However, the EDT needs to be selected such that if interference on one of the CCs exceeds the CC EDT, the LBT is declared as failed

Agreement:

Confirm the WA with the following updates:

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.

Conclusion:

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

Agreement:

Support extending Rel.16 L3-RSSI to unlicensed operation in FR2-2

* Introduce RRC configuration for reference SCS, measurement duration, and measurement bandwidth
	+ Extend the reference SCS/CP field (*ref-SCS-CP-r16*) and measurement duration field (*measDurationSymbols-r16*) in *RMTC-Config*
		- FFS value range and valid combinations for *ref-SCS-CP-r16* and *measDurationSymbols-r16*
	+ Introduce parameter in *RMTC-Config* to indicate the measurement bandwidth
		- FFS: Value range for measurement bandwidth
* For the QCL Type-D of L3-RSSI measurement, down-select one or both of the following alternatives
	+ Alt 1: gNB configures the beam when configures the L3-RSSI measurement
	+ Alt 2: Use the QCL type-D of the latest received PDSCH and the latest monitored CORESET

Conclusion:

There is no consensus to support per beam LBT mode or no-LBT mode UE specific gNB indication.

Conclusion:

For regions where LBT is not mandated, there is no consensus to introduce L1 signalling for gNB to indicate to the UE if the operation is in LBT mode or no-LBT mode. Note this is different from the DCI field indicate the LBT type for UL transmission.

Conclusion:

There is no consensus to introduce CWS Adjustment for unlicensed operation in FR2-2

Conclusion:

There is no consensus to introduce CAPC for unlicensed operation in FR2-2

#### 107-e

### 8.2.7 Others