**3GPP TSG RAN WG1 #101 R1-200xxxx**

**e-Meeting, May 25th – June 5th, 2020**

**Agenda Item:** 7.2.2.2.5

**Source:** Moderator (LG Electronics)

**Title:** Summary on maintenance of wide-band operation for NR-U

**Document for:** Discussion and decision

# Introduction

This is the summary document for 7.2.2.2.5 on remaining issues of wide-band operation for NR-U, based on the contributions listed in reference section. The identified topics are categorized into three issues, as follows:

* Issue A: RB set and intra-cell guard bands
* Issue B: CORESET and search space configuration
* Issue C: DL reception or UL transmission on RB set(s)

Further details for the above issues and preliminary views on the priority for each sub-issue are provided in Sections 2 to 4. The priority for each specific issue is summarized in Section 5. Text proposals corresponding to sub-issues are collected in Appendix A.

# Issue A: RB set and intra-cell guard bands

## Issue A1: No guard band configuration

One open issue is 1) how to configure a DL cell without intra-cell guard bands and 2) how to define RB set for the DL cell.

For 1) how to configure a DL cell without intra-cell guard bands, several companies (vivo [1] and Sharp [10]) suggested to configure the size of all intra-cell guard bands as zero, same as for a UL cell without intra-cell guard bands, while one company (LG Electronics [7]) suggested to be left up to RAN2 decision.

For 2) how to define RB set for a DL cell without intra-cell guard bands, one company (LG Electronics [7]) suggested not to define RB set for the DL cell.

One company (MediaTek [4]) proposed text proposals for PDCCH monitoring and CSI-RS reception behaviours based on RB set indicator, which may need to add the description considering RB set indicator has one bit field for a DL cell without intra-cell guard bands.

In addition, one company (Ericsson [5]) addressed an issue on how to configure a DL/UL cell with a single RB set (i.e., 20 MHz cell). The issue can be resolved by using default RB set configuration (defined in 38.101-1) and defining only RB set index 0 for UL carrier configured with interlaced PUSCH/PUCCH.

**Comments for priority**

|  |  |  |
| --- | --- | --- |
| Company | Priority (High or Low) | Comments |
| LG Electronics | High for DL cell without intra-cell guard bands | Clarification for 20 MHz carrier can be discussed if current specification is not clear. |
| MediaTek | High for the some identified issues | High: PDCCH monitoring and CSI-RS reception behaviours based on RB set indicator, spec has to be corrected to align with RAN1 agreement for a DL cell without intra-cell guard bands.  Low: How to configure a DL cell without intra-cell guard bands could be left up to RAN2 decision.  High: How to define a single RB set for a 20 MHz UL cell should be discussed in this meeting |

## Issue A2: BWP configuration for UL cell without intra-cell guard bands

To figure out FFS point (FFS: Whether BWP can be configured to be partially overlapping with a RB set) for the agreement made in RAN1#100bis-e,

* Alt 1: UL BWP can be configured to include parts of a RB set, with some restriction such as at least 10 RBs in [at least one or each] RB set.
  + Supported by vivo [1], ZTE [2], Ericsson [5], Samsung [6], LG Electronics [7], Sharp [10]
* Alt 2: The UE does not expect that the BWP is configured to include parts of a RB set, same as for a carrier with intra-cell guard bands.
  + Supported by Huawei [3], Nokia [9]

**Comments for priority**

|  |  |  |
| --- | --- | --- |
| Company | Priority (High or Low) | Comments |
| LG Electronics | High |  |
|  |  |  |

## Issue A3: Details on RRC parameters for intra-cell guard bands

Several companies (Ericsson [5] and Nokia [9]) suggested to add *intraCellGuardBandUL-r16* or *intraCellGuardBandDL-r16* to *ServingCellConfig* IE, in addition to *ServingCellConfigCommon* IE which is captured in current TS 38.331 specification.

One company (LG Electronics [7]) addressed an issue to resolve FFS values for RRC parameters regarding RB set configuration. As captured below from running CR for TS 38.331, it is observed that there are still FFS points for RRC parameters related to intra-cell guard band configuration.

IntraCellGuardBand-r16 ::= SEQUENCE (SIZE (1..ffsValue)) OF GuardBand-r16 -- FFS upper size 4, assuming 100Mhz cell

GuardBand-r16 ::= SEQUENCE {

startCRB-r16 INTEGER (0..ffsValue), --FFS upper range 275

nrofCRBs-r16 INTEGER (0..ffsValue)

}

For *IntraCellGuardBand-r16*,

* The number of entries of *GuardBand-r16* can be up to 4 considering 100 MHz is the maximum carrier bandwidth for FR1.

For *GuardBand-r16*,

* The value range of *startCRB-r16* is from 0 to 2474 (=2199+275), considering that
  + The value range of *offsetToCarrier* RRC parameter indicating offset in frequency domain between Point A (lowest subcarrier of common RB 0) and the lowest usable subcarrier on the carrier in number of PRBs (using the *subcarrierSpacing* defined for this carrier) is defined from 0 to 2199 (=275\*8-1), and
  + The value range of *carrierBandwidth* RRC parameter indicating the width of a carrier in number of PRBs is defined from 1 to 275
* The value range of *nrofCRBs-r16* is from 0 to [10], considering the agreement made in RAN1#100bis-e and the table below captured from RAN4 agreement made in RAN4#93.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 15 kHz | | 30 kHz | | 60 kHz | |
| Usable RBs | Guard RBs | Usable RBs | Guard RBs | Usable RBs | Guard RBs |
| 104, 105 | 6, 7 | 49, 50, 51 | 5, 6, 7 | [22, 23, 24] | [3, 4, 5] |

Therefore, above RRC parameters can be updated as follows:

IntraCellGuardBand-r16 ::= SEQUENCE (SIZE (1..4)) OF GuardBand-r16 -- FFS upper size 4, assuming 100Mhz cell

GuardBand-r16 ::= SEQUENCE {

startCRB-r16 INTEGER (0..2474), --FFS upper range 275

nrofCRBs-r16 INTEGER (0..[10])

}

**Comments for priority**

|  |  |  |
| --- | --- | --- |
| Company | Priority (High or Low) | Comments |
| LG Electronics | High for value ranges of RRC parameters | Detailed value ranges can be changed based on discussion. It would be preferable that RAN1 determine value ranges for those RRC parameters and recommend to RAN2 what RAN1 decide.  Whether to add *intraCellGuardBandUL-r16* or *intraCellGuardBandDL-r16* to *ServingCellConfig* IE can be decided by RAN2. |
| MediaTek | High for all identified issues | High: Inform RAN2 to add intraCellGuardBandUL-r16/ intraCellGuardBandDL-r16 to *ServingCellConfig* IE  High: Decide the detailed value ranges and inform RAN2 the RAN1 decision |

## Issue A4: UE capability for intra-cell guard bands

One company (OPPO [8]) suggested to define NEW UE capability to support guard band size smaller than default guard band size. In other words, a UE without this capability only supports guard band size not less than default guard band size defined in RAN4 specification.

**Comments for priority**

|  |  |  |
| --- | --- | --- |
| Company | Priority (High or Low) | Comments |
| LG Electronics | High | Need to resolve this issue since it’s related to UE capability signalling. |
| MediaTek | High | Capability signalling may not be needed. Instead, specify that UE doesn't expect size of intra-cell guard band is smaller than the default guard band size defined in RAN4 when intra-cell guard band is configured. |

## Issue A5: Corrections for TS 38.214

Several companies proposed to capture the previous RAN1 or RAN2 agreements.

* LG Electronics [7]: To capture RAN1 agreements for a UL cell without intra-cell guard bands.
* OPPO [8]: To capture RAN1 agreement that the configured RB set shall not be partially overlapped with a LBT subband in unlicensed spectrum.
* Nokia [9]: To remove brackets sub-clause 7 in TS38.214

**Comments for priority**

|  |  |  |
| --- | --- | --- |
| Company | Priority (High or Low) | Comments |
| LG Electronics | Low | For LG’s TP, it seems better to handle the TP once all of related remaining issues settle down.  For OPPO’s TP, it’s already captured in current 214 specification.  For Nokia’s TP, it seems editorial and can be provided to the editor directly. |
| MediaTek | High for Nokia’s TP  Low for other TPs |  |

# Issue B: CORESET and search space configuration

## Issue B1: Dropping rule for search space configured with freqMonitorLocations-r16

|  |  |
| --- | --- |
| Company | Views |
| Huawei [3] | Proposal 2: UE can drop PDCCH BD per monitoring location in a search space. The corresponding text proposal is in TP#1 in the appendix. |
| Panasonic [12] | Proposal 1: If DCI format 2\_0 indicates one or more RB sets are unavailable, starting from a first slot that is at least P symbols after the last symbol of GC-PDCCH carrying DCI format 2\_0, PDCCH candidates and the corresponding non-overlapping CCEs in the indicated unavailable RB sets are not allocated. |

**Comments for priority**

|  |  |  |
| --- | --- | --- |
| Company | Priority (High or Low) | Comments |
| LG Electronics | Low | TP proposed by Huawei [3] seems optimization.  TP proposed by Panasonic [12] is understood that PDCCH overbooking rule can be impacted by dynamic information from RB set indicator, which is not aligned with the understanding that PDCCH overbooking rule is semi-statically pre-determined based on search space set configuration. |
| MediaTek | Low |  |

## Issue B2: Clarifications for CORESET configuration

|  |  |
| --- | --- |
| Company | Views |
| Samsung [6] | Proposal 2: A UE does not expect a CORESET to be associated with a search space set configured with *freqMonitorLocations-r16* and another search space set not configured with *freqMonitorLocations-r16*  Proposal 3: When a configured RB set contains different size of RBs than RB set 0, select one of the alternatives to resolve potential CORESET resource bitmap misalignment in the configured RB set:   * Alternative 1: UE ignores the PDCCH candidates which are not fully overlapped with the RB set. * Alternative 2: UE does not expect a CORESET configuration which has CORESET resource not confined within any of the configured RB set in *freqMonitorLocations-r16* |

**Comments for priority**

|  |  |  |
| --- | --- | --- |
| Company | Priority (High or Low) | Comments |
| LG Electronics | Low | Proposal 2 is not necessary. According to the agreement made in RAN1#100-e meeting, if a CORESET is configured with at least one search space with *freqMonitorLocations-r16*, the CORESET f-domain resource is determined based on *rb-Offset-r16* (or default value 0 if not provided) regardless of whether the associated search space is configured with *freqMonitorLocations-r16* or not.  For Proposal 3, a clarification can be needed. The understanding is that gNB has to (or UE is expected to) set ‘0’ for RBs outside of the first RB set if the corresponding CORESET would be associated with a search space with *freqMonitorLocations-r16*. |
| MediaTek | High (for proposal 3 in [6]) |  |

## Issue B3: Corrections for TS 38.213

One company (Huawei [3]) suggested a text proposal to capture the agreement that the number of PDCCH candidates per aggregation level configured by *nrofCandidates* or *nrofCandidates-SFI* within a *SearchSpace* IE applies to each of RB sets configured by *freqMonitorLocations-r16*.

**Comments for priority**

|  |  |  |
| --- | --- | --- |
| Company | Priority (High or Low) | Comments |
| LG Electronics | Low | It was clarified by spec editor in the previous meeting that the corresponding agreement is already captured in current specification. |
| MediaTek | Low |  |

# Issue C: DL reception or UL transmission on RB set(s)

## Issue C1: RB set indicator in DCI format 2\_0

One company (Qualcomm [11]) suggested the followings regarding RB set indicator in DCI format 2\_0 and provided the corresponding text proposal for TS 38.213,

* All zero state of RB set indicator in DCI format 2\_0 is considered as unknown.
* If RB set indicator is not configured, UE considers all RB sets are available for DL reception when DCI format 2\_0 is detected.

**Comments for priority**

|  |  |  |
| --- | --- | --- |
| Company | Priority (High or Low) | Comments |
| LG Electronics | Low | It would be preferable to discuss under DL signal/channel agenda item (7.2.2.1.2), if deemed necessary. |
| MediaTek | Low |  |

## Issue C2: CSI-RS configuration

One company (OPPO [8]) proposed that the configured CSI-RS resource for tracking in unlicensed band shall be restricted within a RB set.

**Comments for priority**

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| --- | --- | --- |
| Company | Priority (High or Low) | Comments |
| LG Electronics | Low | Up to gNB configuration |
| MediaTek | Low |  |

## Issue C3: PUSCH transmission

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| --- | --- |
| Company | Views |
| Huawei [3] | Proposal 4: The intersection of the resource blocks of the indicated interlaces and the indicated set of RB sets and intra-cell guard bands defined in Clause 7 between the indicated RB sets will result zero frequency resource allocation. The text should be reworded as TP#2.  Proposal 5: For resource allocation type 0, the UE shall determine the resource allocation in frequency domain as an intersection of the resource blocks of the indicated RBG(s) and union of RB set(s) overlapping with the indicated RBG(s) and intra cell guard bands between the adjacent RB sets overlapping with the indicated RBG(s), if any. The corresponding text proposal is in TP#2 in the appendix. |

**Comments for priority**

|  |  |  |
| --- | --- | --- |
| Company | Priority (High or Low) | Comments |
| LG Electronics | Low | It would be preferable to discuss under UL signal/channel agenda item (7.2.2.1.3), if deemed necessary. |
| MediaTek | Low |  |

# Summary on the priority for the remaining issues

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| --- | --- | --- |
| Issue | HIGH priority | LOW priority |
| Issue A: RB set and intra-cell guard bands |  |  |
| Issue A1: No guard band configuration | LG Electronics (for DL cell without intra-cell guard bands), MediaTek (PDCCH monitoring and CSI-RS reception behaviours based on RB set indicator, define a single RB set for a 20 MHz UL cell) | MediaTek (how to configure a DL cell without intra-cell guard bands) |
| Issue A2: BWP configuration for UL cell without intra-cell guard bands | LG Electronics |  |
| Issue A3: Details on RRC parameters for intra-cell guard bands | LG Electronics (for value ranges of RRC parameters), MediaTek (for all identified issues) |  |
| Issue A4: UE capability for intra-cell guard bands | LG Electronics, MediaTek (for discussion on the identified issue) |  |
| Issue A5: Corrections for TS 38.214 | MediaTek (Nokia’s TP) | LG Electronics, MediaTek (others) |
| Issue B: CORESET and search space configuration |  |  |
| Issue B1: Dropping rule for search space configured with *freqMonitorLocations-r16* |  | LG Electronics, MediaTek |
| Issue B2: Clarifications for CORESET configuration | High (for proposal 3 in [6]) | LG Electronics |
| Issue B3: Corrections for TS 38.213 |  | LG Electronics, MediaTek |
| Issue C: DL reception or UL transmission on RB set(s) |  |  |
| Issue C1: RB set indicator in DCI format 2\_0 |  | LG Electronics, MediaTek |
| Issue C2: CSI-RS configuration |  | LG Electronics, MediaTek |
| Issue C3: PUSCH transmission |  | LG Electronics, MediaTek |

# Reference

1. R1-2003374 Remaining issues on wideband operation in NR-U vivo
2. R1-2003454 Remaining issues on the wideband operation for NR-U ZTE, Sanechips
3. R1-2003516 Maintenance on the wideband operation procedures Huawei, HiSilicon
4. R1-2003659 Remaining issues on wideband operation for NR-U MediaTek Inc.
5. R1-2003847 Wideband operation Ericsson
6. R1-2003864 Wide-band operation for NR-U Samsung
7. R1-2004017 Remaining issues of wide-band operation for NR-U LG Electronics
8. R1-2004089 Discussion on the remaining issues of wide-band operations OPPO
9. R1-2004256 Remaining issues on Wideband operation in NR-U Nokia, Nokia Shanghai Bell
10. R1-2004324 Remaining issues on wideband operation for NR-U Sharp
11. R1-2004447 TP for Wideband operation for NR-U operation Qualcomm Incorporated
12. R1-2004511 Remaining issues on Rel-16 NR-U wideband operations Panasonic

# Appendix A: Text proposals corresponding to sub-issues

## Issue A1

### From MediaTek [4],

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| --- |
| ================================**Text Proposal 1 Starts**==================================  10 UE procedure for receiving control information  **<Unchanged parts are omitted>**  If a UE is provided *availableRB-SetPerCell-r16* for a serving cell*,* and   * if *intraCellGuardBandDL-r16* for the serving cell indicates no intra-cell guard-bands are configured, the UE is not required to monitor PDCCH candidates on the serving cell that are indicated as unavailable for receptions by DCI format 2\_0 as described in Clause 11.1.1. * if *intraCellGuardBandDL-r16* for the serving cell indicates intra-cell guard-bands are configured, the UE is not required to monitor PDCCH candidates that overlap with any RB from RB sets on the serving cell that are indicated as unavailable for receptions by DCI format 2\_0 as described in Clause 11.1.1.   **<Unchanged parts are omitted>**  =============================== **Text Proposal 1 Ends**===================================  ================================**Text Proposal 2 Starts**==================================  11.1.1 UE procedure for determining slot format  **<Unchanged parts are omitted>**  If *intraCellGuardBandDL-r16* for a serving cell indicates intra-cell guard-bands are configured and a UE is configured by higher layers to receive a CSI-RS or detects a DCI format 0\_1 indicating to the UE to receive a CSI-RS in one or more RB sets and a set of symbols of a slot in the serving cell, and the UE detects a DCI format 2\_0 with bitmap indicating that any RB set from the one or more RB sets is not available for reception, the UE cancels the CSI-RS reception in the set of symbols of the slot in the serving cell.  If *intraCellGuardBandDL-r16* for a serving cell indicates no intra-cell guard-bands are configured and a UE is configured by higher layers to receive a CSI-RS or detects a DCI format 0\_1 indicating to the UE to receive a CSI-RS in a set of symbols of a slot in the serving cell, and the UE detects a DCI format 2\_0 with one bit indicating that the serving cell is not available for reception, the UE cancels the CSI-RS reception in the set of symbols of the slot in the serving cell.  **<Unchanged parts are omitted>**  =============================== **Text Proposal 2 Ends**=================================== |

### From Ericsson [5],

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| --- |
| ------------------------------------------ Text Proposal (TP#1) for 38.214, Section 7 -----------------------------------  \*\*\* Unchanged text omitted \*\*\*  7 UE procedures for transmitting and receiving on a carrier with intra-cell guard bands  For operation with shared spectrum channel access, when the UE is configured with any of *intraCellGuardBandUL-r16* for UL carrier and *intraCellGuardBandDL-r16* for DL carrier, the UE is provided with intra-cell guard bands on a carrier, each defined by start CRB and size in number of CRBs, and , provided by higher layer parameters *startCRB-r16* and *nrofCRBs-r16*, respectively. The subscript *x* is set to DL and UL for the downlink and uplink, respectively. Where there is no risk of confusion, the subscript *x* can be dropped. The intra-cell guard bands separate RB sets, each defined by start and end CRB, and , respectively. UE determines , , and the remaining start and end CRBs as and . The RB set *s* consists of resource blocks where . When the UE is not configured with *intraCellGuardBandUL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the [default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size ]. For for , respectively, the UE determines only a single UL RB set and no guard bands. When the UE is not configured with *intraCellGuardBandDL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the [default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size ]. For for , respectively, the UE determines only a single UL RB set and no guard bands.  For a carrier with intra-cell guard band(s) or for an UL carrier with for , respectively, and *useInterlacePUCCH-PUCCH* is configured in any of *BWP-UplinkCommon* and *BWP-UplinkDedicated*, the UE expects , and where for a BWP *i* configured by *BWP-Downlink* or *BWP-Uplink*. Within the BWP *i*, RB sets are numbered in increasing order from 0 to where is the number of RB sets contained in the BWP *i* and RB set 0 within the BWP *i* corresponds to RB set in the carrier and RB set within the BWP *i* corresponds to RB set in the carrier.  [The configuration of *intraCellGuardBandDL-r16* and *intraCellGuardBandUL-r16* can indicate to the UE that no intra-cell guard-bands are configured.]  \*\*\* Unchanged text omitted \*\*\*  -------------------------------------------------------- End Text Proposal -------------------------------------------------------- |

### From Nokia [9],

|  |
| --- |
| 7 UE procedures for transmitting and receiving on a carrier with intra-cell guard bands  This sub-clause applies to carrier operating with shared spectrum channel access.  ~~For operation with shared spectrum channel access, w~~When the UE is configured with any of *intraCellGuardBandUL-r16* for UL carrier and *intraCellGuardBandDL-r16* for DL carrier, the UE is provided with intra-cell guard bands on a carrier, each defined by start CRB and size in number of CRBs, and , provided by higher layer parameters *startCRB-r16* and *nrofCRBs-r16*, respectively. The subscript *x* is set to DL and UL for the downlink and uplink, respectively. Where there is no risk of confusion, the subscript *x* can be dropped. When UE is provided *nrofCRBs-r16=0,* carrier does not include intra-cell guard bands.  The intra-cell guard bands separate RB sets, each defined by start and end CRB, and , respectively. UE determines , , and the remaining start and end CRBs as and . The RB set *s* consists of resource blocks where . When the UE is not configured with *intraCellGuardBandUL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size . When the UE is not configured with *intraCellGuardBandDL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the [default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size . When UE is provided *nrofCRBs-r16=0* in *intraCellGuardBandUL-r16,* UE expects RB set to include 10 or 11 RBs for each interlace index defined in Clause 4.4.4.6 in [4, TS 38.211]. When UE is provided *nrofCRBs-r16=0* in *intraCellGuardBandDL-r16,* there are no RB sets present on the carrier.  For a carrier ~~with intra-cell guard band(s)~~, the UE expects , and where for a BWP *i* configured by *BWP-Downlink* or *BWP-Uplink*. Within the BWP *i*, RB sets are numbered in increasing order from 0 to where is the number of RB sets contained in the BWP *i* and RB set 0 within the BWP *i* corresponds to RB set in the carrier and RB set within the BWP *i* corresponds to RB set in the carrier.  ~~[The configuration of~~ *~~intraCellGuardBandDL-r16~~* ~~and~~ *~~intraCellGuardBandUL-r16~~* ~~can indicate to the UE that no intra-cell guard-bands are configured.]~~  <unchanged text omitted> |

## Issue A2

### From Sharp [10],

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| --- |
| **Text proposal#1**  --------- beginning of text proposal for TS 38.214  6.1.2.2.3 Uplink resource allocation type 2  In uplink resource allocation of type 2, the resource block assignment information defined in [5, TS 38.212] indicates to a UE a set of up to *M* interlace indices, and for DCI 0\_0 monitored in a UE-specific search space and DCI 0\_1 a set of up to contiguous RB sets, where *M* and interlace indexing are defined in Clause 4.4.4.6 in [4, TS 38.211]. For DCI 0\_0 monitored in a UE-specific search space and DCI 0\_1, the UE shall determine the resource allocation in frequency domain within the active uplink BWP as an intersection of the resource blocks of the indicated interlaces and the indicated set of RB sets and intra-cell guard bands defined in Clause 7 between the indicated RB sets, if any. For DCI 0\_0 monitored in a common search space, the UE shall determine the resource allocation in frequency domain within the active uplink BWP as an intersection of the resource blocks of the indicated interlaces and a single uplink RB set of the active UL BWP. The uplink RB set is the one that intersects with the downlink RB set of the active downlink BWP in which the UE detects the DCI 0\_0. If there is no intersection, the uplink RB set is RB set 0 in the active uplink BWP.  -------- Unchanged contents are omitted  --------- end of text proposal |
| Text proposal#2  --------- beginning of text proposal for TS 38.214  7 UE procedures for transmitting and receiving on a carrier with intra-cell guard bands  For operation with shared spectrum channel access, when the UE is configured with any of *intraCellGuardBandUL-r16* for UL carrier and *intraCellGuardBandDL-r16* for DL carrier, the UE is provided with intra-cell guard bands on a carrier, each defined by start CRB and size in number of CRBs, and , provided by higher layer parameters *startCRB-r16* and *nrofCRBs-r16*, respectively. The subscript *x* is set to DL and UL for the downlink and uplink, respectively. Where there is no risk of confusion, the subscript *x* can be dropped. The intra-cell guard bands separate RB sets, each defined by start and end CRB, and , respectively. UE determines , , and the remaining start and end CRBs as and . The RB set *s* consists of resource blocks where . When the UE is not configured with *intraCellGuardBandUL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size . When the UE is not configured with *intraCellGuardBandDL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size .  For a carrier with intra-cell guard band(s), the UE expects , and where for a BWP *i* configured by *BWP-Downlink* or *BWP-Uplink*. Within the BWP *i*, RB sets are numbered in increasing order from 0 to where is the number of RB sets contained in the BWP *i* and RB set 0 within the BWP *i* corresponds to RB set in the carrier and RB set within the BWP *i* corresponds to RB set in the carrier.  For a carrier without intra-cell guard band(s), RB sets that overlaps at least partially with the BWP *i* are numbered in increasing order from 0 to . The UE shall adjust to when is larger than . The UE shall adjust to when is smaller than .  [  -------- Unchanged contents are omitted  --------- end of text proposal |

## Issue A5

### From LG Electronics [7],

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| --- |
| 7 UE procedures for transmitting and receiving on a carrier with intra-cell guard bands  For operation with shared spectrum channel access, when the UE is configured with any of *intraCellGuardBandUL-r16* for UL carrier and *intraCellGuardBandDL-r16* for DL carrier, the UE is provided with intra-cell guard bands on a carrier, each defined by start CRB and size in number of CRBs, and , provided by higher layer parameters *startCRB-r16* and *nrofCRBs-r16*, respectively. The subscript *x* is set to DL and UL for the downlink and uplink, respectively. Where there is no risk of confusion, the subscript *x* can be dropped. The intra-cell guard bands separate RB sets, each defined by start and end CRB, and , respectively. UE determines , , and the remaining start and end CRBs as and . The RB set *s* consists of resource blocks where . When the UE is not configured with *intraCellGuardBandUL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the [default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size ]. When the UE is not configured with *intraCellGuardBandDL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the [default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size ].  For a carrier with intra-cell guard band(s), the UE expects , and where for a BWP *i* configured by *BWP-Downlink* or *BWP-Uplink*. Within the BWP *i*, RB sets are numbered in increasing order from 0 to where is the number of RB sets contained in the BWP *i* and RB set 0 within the BWP *i* corresponds to RB set in the carrier and RB set within the BWP *i* corresponds to RB set in the carrier.  [The configuration of *intraCellGuardBandDL-r16* and *intraCellGuardBandUL-r16* can indicate to the UE that no intra-cell guard-bands are configured.]  When a UE is provided with *nrofCRBs-r16=*0 for all intra-cell guard band(s) on an UL carrier configured with any of the higher layer parameters *useInterlacePUCCH-PUSCH* in *BWP-UplinkCommon* and *useInterlacePUCCH-PUSCH* in *BWP-UplinkDedicated*, the UE is indicated that no intra-cell guard-bands are configured for the UL carrier. For UL carrier with no intra-cell guard-bands, the UE expects that the number of common resource blocks in an interlace contained within a RB set *s* is no less than 10 and no more than 11. |

### From OPPO [8],

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| --- |
| ----------------------------------------TP1: Start of 38.214 section 7 --------------------------------------  7 UE procedures for transmitting and receiving on a carrier with intra-cell guard bands  For operation with shared spectrum channel access, when the UE is configured with any of *intraCellGuardBandUL-r16* for UL carrier and *intraCellGuardBandDL-r16* for DL carrier, the UE is provided with intra-cell guard bands on a carrier, each defined by start CRB and size in number of CRBs, and , provided by higher layer parameters *startCRB-r16* and *nrofCRBs-r16*, respectively. The subscript *x* is set to DL and UL for the downlink and uplink, respectively. Where there is no risk of confusion, the subscript *x* can be dropped. The intra-cell guard bands separate RB sets, each defined by start and end CRB, and , respectively. UE determines , , and the remaining start and end CRBs as and . The RB set *s* consists of resource blocks where . When the UE is not configured with *intraCellGuardBandUL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the [default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size ]. When the UE is not configured with *intraCellGuardBandDL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the [default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size ].  For a carrier with intra-cell guard band(s), the UE expects , and where for a BWP *i* configured by *BWP-Downlink* or *BWP-Uplink*. Within the BWP *i*, RB sets are numbered in increasing order from 0 to  For a carrier with intra-carrier guard band(s), the UE does not expect to receive a RB set configuration by *intraCellGuardBandDL-r16* or *intraCellGuardBandUL-r16* partially overlapping with a channel on which a channel access procedure is performed in shared spectrum [TS 37.213].  where is the number of RB sets contained in the BWP *i* and RB set 0 within the BWP *i* corresponds to RB set in the carrier and RB set within the BWP *i* corresponds to RB set in the carrier.  [The configuration of *intraCellGuardBandDL-r16* and *intraCellGuardBandUL-r16* can indicate to the UE that no intra-cell guard-bands are configured.]  ----------------------------------------End of 38.214 section 7 -------------------------------------- |

### From Nokia [9],

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| --- |
| 7 UE procedures for transmitting and receiving on a carrier with intra-cell guard bands  For operation with shared spectrum channel access, when the UE is configured with any of *intraCellGuardBandUL-r16* for UL carrier and *intraCellGuardBandDL-r16* for DL carrier, the UE is provided with intra-cell guard bands on a carrier, each defined by start CRB and size in number of CRBs, and , provided by higher layer parameters *startCRB-r16* and *nrofCRBs-r16*, respectively. The subscript *x* is set to DL and UL for the downlink and uplink, respectively. Where there is no risk of confusion, the subscript *x* can be dropped. The intra-cell guard bands separate RB sets, each defined by start and end CRB, and , respectively. UE determines , , and the remaining start and end CRBs as and . The RB set *s* consists of resource blocks where . When the UE is not configured with *intraCellGuardBandUL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the ~~[~~default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size ~~]~~. When the UE is not configured with *intraCellGuardBandDL-r16,* the UE determines intra-cell guard band and corresponding RB set according to the ~~[~~default intra-cell GB pattern from [8, TS 38.101-1] corresponding to and carrier size ~~]~~.  For a carrier with intra-cell guard band(s), the UE expects , and where for a BWP *i* configured by *BWP-Downlink* or *BWP-Uplink*. Within the BWP *i*, RB sets are numbered in increasing order from 0 to where is the number of RB sets contained in the BWP *i* and RB set 0 within the BWP *i* corresponds to RB set in the carrier and RB set within the BWP *i* corresponds to RB set in the carrier.  <omitted text> |

## Issue B1

### From Huawei [3],

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| TP#1: TS38.213 v16.1.010.1 UE procedure for determining physical downlink control channel assignment \*\*\* Unchanged text is omitted \*\*\*  For all search space sets within a slot , denote by  a set of CSS sets with cardinality of  and by  a set of USS sets with cardinality of . The location of USS sets , , in  is according to an ascending order of the search space set index.  Denote by , , the number of counted PDCCH candidates for monitoring for CSS set  and by , , the number of counted PDCCH candidates for monitoring for USS set . Denote by , the number of counted PDCCH candidates for each monitoring location for USS set , if *freqMonitorLocations-r16* is configured.  For the CSS sets, a UE monitors  PDCCH candidates requiring a total of  non-overlapping CCEs in a slot.  The UE allocates PDCCH candidates for monitoring to USS sets for the primary cell having an active DL BWP with SCS configuration  in a slot if the UE is not provided *PDCCHMonitoringCapabilityConfig* for the primary cell or if the UE is provided *PDCCHMonitoringCapabilityConfig* = *R15 PDCCH monitoring capability* for all serving cells, or in a span if the UE is provided *PDCCHMonitoringCapabilityConfig* = *R16 PDCCH monitoring capability* for the primary cell, according to the following pseudocode. If for the USS sets for scheduling on the primary cell the UE is not provided *CORESETPoolIndex* for first CORESETs, or is provided value 0 for first CORESETs, and is provided value 1 for second CORESETs, and if or , the following pseudocode applies only to USS sets associated with the first CORESETs. A UE does not expect to monitor PDCCH in a USS set without allocated PDCCH candidates for monitoring.  Denote by  the set of non-overlapping CCEs for search space set  and by  the cardinality of  where the non-overlapping CCEs for search space set  are determined considering the allocated PDCCH candidates for monitoring for the CSS sets and the allocated PDCCH candidates for monitoring for all search space sets , .  Set  Set  Set  while  AND  allocate  PDCCH candidates for monitoring to USS set  ;  ;  ;  end while  if *freqMonitorLocations-r16* is configured, there are monitoring locations in frequency domain in the search space set Denote by the set of non-overlapping CCEs in each monitoring location of search space set and by the cardinality of where the non-overlapping CCEs in each monitoring location of search space set are determined considering the allocated PDCCH candidates for monitoring for the CSS sets and the allocated PDCCH candidates for monitoring for all search space sets .  Set  ;  Set ;  Set ;  While AND  Set ;  While AND AND  end while  allocate PDCCH candidates for monitoring to USS set  ;  ;    end while  \*\*\* Unchanged text is omitted \*\*\* |

### From Panasonic [12],

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| …  The UE allocates PDCCH candidates for monitoring to USS sets for the primary cell having an active DL BWP with SCS configuration  in a slot if the UE is not provided *PDCCHMonitoringCapabilityConfig* for the primary cell or if the UE is provided *PDCCHMonitoringCapabilityConfig* = *R15 PDCCH monitoring capability* for all serving cells, or in a span if the UE is provided *PDCCHMonitoringCapabilityConfig* = *R16 PDCCH monitoring capability* for the primary cell, according to the following pseudocode. If for the USS sets for scheduling on the primary cell the UE is not provided *CORESETPoolIndex* for first CORESETs, or is provided *CORESETPoolIndex* with value 0 for first CORESETs, and is provided *CORESETPoolIndex* with value 1 for second CORESETs, and if or , the following pseudocode applies only to USS sets associated with the first CORESETs. A UE does not expect to monitor PDCCH in a USS set without allocated PDCCH candidates for monitoring.  If *freqMonitorLocations-r16* indicates to a UE to monitor the search space set over multiple RB sets and if DCI format 2\_0 indicates one or more RB sets are unavailable, PDCCH candidates and the corresponding non-overlapping CCEs are not allocated to the RB sets that are indicated as unavailable for DCI format 2\_0, starting from a first slot that is at least P symbols after the last symbol of GC-PDCCH carrying DCI format 2\_0.  **…** |

## Issue B2

### From Samsung [6],

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| 38.213 TP for proposal 2  10.1 UE procedure for determining physical downlink control channel assignment  ----omitted----  For each CORESET in a DL BWP of a serving cell, a respective *frequencyDomainResources* provides a bitmap.  - if a CORESET is not associated with any search space set configured with *freqMonitorLocation-r16*, the bits of the bitmap have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP bandwidth of PRBs with starting common RB position , where the first common RB of the first group of 6 PRBs has common RB index if *rb-Offset-r16* is not provided, or the first common RB of the first group of 6 PRBs has common RB index where is provided by *rb-Offset-r16.*  - if a CORESET is associated with search space set configured with *freqMonitorLocation-r16*, the first bits of the bitmap have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in each RB set in the DL BWP bandwidth of PRBs with starting common RB position where the first common RB of the first group of 6 PRBs has common RB index and *k* is indicated by *freqMonitoringLocations-r16* if provided for a search space set; otherwise, . , is a number of available PRBs in the RB set 0 for the DL BWP, and is provided by *rb-offset* or if *rb-offset* is not provided.A UE does not expect a CORESET to be associated with a search space set configured with *freqMonitorLocations-r16* and another search space set not configured with *freqMonitorLocations-r16.*  ----omitted---- |
| 38.213 TP for proposal 3 Alt 1  10. UE procedure for receiving control information  ----omitted----  If a UE monitors the PDCCH candidate for a Type0-PDCCH CSS set on the serving cell according to the procedure described in Clause 13, the UE may assume that no SS/PBCH block is transmitted in REs used for monitoring the PDCCH candidate on the serving cell.  If at least one RE of a PDCCH candidate for a UE on the serving cell overlaps with at least one RE of lte-CRS-ToMatchAround, or of LTE-CRS-PatternList-r16, the UE is not required to monitor the PDCCH candidate.  If a UE is provided *availableRB-SetPerCell-r16*, the UE is not required to monitor PDCCH candidates that overlap with any RB from RB sets that are indicated as unavailable for receptions by DCI format 2\_0 as described in Clause 11.1.1.  If a UE is provided *freqMonitorLocation-r16*, the UE is not required to monitor PDCCH candidates which are not confined within an RB set defined in Clause 7 TS 38.214.  ----omitted---- |
| 38.213 TP for proposal 3 Alt 2 10.1 UE procedure for determining physical downlink control channel assignment \*\*\* Unchanged text is omitted \*\*\*  For each CORESET in a DL BWP of a serving cell, a respective *frequencyDomainResources* provides a bitmap.  - if a CORESET is not associated with any search space set configured with *freqMonitorLocation-r16*, the bits of the bitmap have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP bandwidth of PRBs with starting common RB position , where the first common RB of the first group of 6 PRBs has common RB index if *rb-Offset-r16* is not provided, or the first common RB of the first group of 6 PRBs has common RB index where is provided by *rb-Offset-r16.*  - if a CORESET is associated with at least one search space set configured with *freqMonitorLocation-r16*, the first bits of the bitmap have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in each RB set in the DL BWP bandwidth of PRBs with starting common RB position [6, TS 38.214], where the first common RB of the first group of 6 PRBs has common RB index and *k* is indicated by *freqMonitoringLocations-r16* if provided for a search space set; otherwise, . , is a number of available PRBs in the RB set 0 for the DL BWP, and is provided by *rb-Offset-r16* or if *rb-Offset-r16* is not provided. A UE does not expect the CORESET is not confined in any RB set. |

## Issue B3

### From Huawei [3],

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| --- |
| TP#1: TS38.213 v16.1.010.1 UE procedure for determining physical downlink control channel assignment \*\*\* Unchanged text is omitted \*\*\*  - a number of PDCCH candidates  per CCE aggregation level  by *aggregationLevel1*, *aggregationLevel2*, *aggregationLevel4*, *aggregationLevel8*, and *aggregationLevel16*, for CCE aggregation level 1, CCE aggregation level 2, CCE aggregation level 4, CCE aggregation level 8, and CCE aggregation level 16, respectively; or a number of PDCCH candidates per CCE aggregation level per RB set if the UE is provided *freqMonitorLocation-r16* for the search space set.  \*\*\* Unchanged text is omitted \*\*\*  For a search space set associated with CORESET , the CCE indexes for aggregation level corresponding to PDCCH candidate of the search space set and per RB set if any in slot for an active DL BWP of a serving cell corresponding to carrier indicator field value are given by    where  for any CSS, ;  for a USS, , , for , for , for , and ;  ;  is the number of CCEs, numbered from 0 to , in CORESET and, if any, per RB set;  is the carrier indicator field value if the UE is configured with a carrier indicator field by *CrossCarrierSchedulingConfig* for the serving cell on which PDCCH is monitored; otherwise, including for any CSS, ;  , where is the number of PDCCH candidates the UE is configured to monitor for aggregation level of a search space set and per RB set if any for a serving cell corresponding to ;  for any CSS, ;  for a USS, is the maximum of over all configured values for a CCE aggregation level of search space set ;  the RNTI value used for is the C-RNTI.  A UE does not expect to be provided *freqMonitorLocations-r16* for a search space set in a serving cell if *intraCellGuardBandDL-r16* indicates that no intra-cell guard-bands are configured for the serving cell.  \*\*\* Unchanged text is omitted \*\*\*  For all search space sets within a slot , denote by  a set of CSS sets with cardinality of  and by  a set of USS sets with cardinality of . The location of USS sets , , in  is according to an ascending order of the search space set index.  Denote by , , the number of counted PDCCH candidates for monitoring for CSS set  and by , , the number of counted PDCCH candidates for monitoring for USS set . Denote by , the number of counted PDCCH candidates for each monitoring location for USS set , if *freqMonitorLocations-r16* is configured.  \*\*\* Unchanged text is omitted \*\*\* |

## Issue C1

### From Qualcomm [11],

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| --- |
| ============TP for 38.213 Section 11.1.1====================================  --Unchanged part omitted------------------------  For each serving cell in the set of serving cells, the UE can be provided:  - an identity of the serving cell by *servingCellId*  - a location of a SFI-index field in DCI format 2\_0 by *positionInDCI*  - a set of slot format combinations by *slotFormatCombinations*, where each slot format combination in the set of slot format combinations includes  - one or more slot formats indicated by a respective *slotFormats* for the slot format combination, and  - a mapping for the slot format combination provided by *slotFormats* to a corresponding SFI-index field value in DCI format 2\_0 provided by *slotFormatCombinationId*  - for unpaired spectrum operation, a reference SCS configuration  by *subcarrierSpacing* and, when a supplementary UL carrier is configured for the serving cell, a reference SCS configuration  by *subcarrierSpacing2* for the supplementary UL carrier  - for paired spectrum operation, a reference SCS configuration  for a DL BWP by *subcarrierSpacing* and a reference SCS configuration  for an UL BWP by *subcarrierSpacing2*  - a location of an available RB set indicator field in DCI format 2\_0 that is  - one bit, if *intraCellGuardBandDL-r16* for the serving cell indicates no intra-cell guard-bands are configured, where a value of '1' indicates that the serving cell is available for receptions, a value of '0' indicates that the serving cell is not available for receptions, by *availableRB-SetPerCell-r16*, and the serving cell remains available or unavailable for reception until the end of the indicated channel occupancy duration  - a bitmap having a one-to-one mapping with the RB sets [6, TS 38.214] of the serving cell, if *intraCellGuardBandDL-r16* for the serving cell indicates intra-cell guard-bands are configured, where the bitmap includes bits and is the number of RB sets in the serving cell, a value of '1' indicates that an RB set is available for receptions, a value of '0' indicates that an RB set is not available for receptions, by *availableRB-SetPerCell-r16*, and an RB set remains available or unavailable for receptions until the end of the indicated channel occupancy duration. When all bits in the bitmap are ‘0’, in the *availableRB-SetPerCell-r16*, the availability for all RB sets for reception are considered as unknown, till another DCI format 2\_0 is received.  - When *availableRB-SetPerCell-r16* is not configured for a serving cell configured with *CO-DurationPerCell-r16* or *slotFormatCombinations*, the UE considered all RB sets available for reception when the DCI format 2\_0 is detected  - a location of a channel occupancy duration field in DCI format 2\_0, by *CO-DurationPerCell-r16*, that indicates a remaining channel occupancy duration for the serving cell starting from a first symbol of a slot where the UE detects the DCI format 2\_0 by providing a value from *CO-DurationList-r16*. The channel occupancy duration field includes bits, where is the number of values provided by *CO-DurationList-r16*. If *CO-DurationPerCell-r16* is not provided, the remaining channel occupancy duration for the serving cell is a number of slots, starting from the slot where the UE detects the DCI format 2\_0, that the SFI-index field value provides corresponding slot formats  - a location of a search space set group switching field in DCI format 2\_0, by *SearchSpaceSwitchTrigger-r16*, that indicates a group from two groups of search space sets for PDCCH monitoring for scheduling on the serving cell as described in Clause 10.4.  --Unchanged part omitted------------------------  =============================================================== |

## Issue C2

### From OPPO [8],

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| --- |
| ----------------------------------------TP2: Start of 38.214 section 5.1.6.1.1 --------------------------------------  5.1.6.1.1 CSI-RS for tracking  **<Unchanged text is omitted>**  Each CSI-RS resource, defined in Subclause 7.4.1.5.3 of [4, TS 38.211], is configured by the higher layer parameter *NZP-CSI-RS-Resource* with the following restrictions:  - the time-domain locations of the two CSI-RS resources in a slot, or of the four CSI-RS resources in two consecutive slots (which are the same across two consecutive slots), as defined by higher layer parameter *CSI-RS-resourceMapping*, is given by one of  - , , or for frequency range 1 and frequency range 2,  - , , , , ,  or  for frequency range 2.  - a single port CSI-RS resource with density  given by Table 7.4.1.5.3-1 from [4, TS 38.211] and higher layer parameter *density* configured by *CSI-RS-ResourceMapping.*  - the bandwidth of the CSI-RS resource, as given by the higher layer parameter *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 52 and resource blocks, or is equal to resource blocks. For operation with shared spectrum channel access, *freqBand* configured by *CSI-RS-ResourceMapping*, is the minimum of 48 and resource blocks within a RB set, or is equal to resource blocks.  **<Unchanged text is omitted>**  ----------------------------------------End of 38.214 section 5.1.6.1.1 -------------------------------------- |

## Issue C3

### From Huawei [3],

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| --- |
| TP#2: TS38.214v16.0.0 6.1.2.2.1 Uplink resource allocation type 0  In uplink resource allocation of type 0, the resource block assignment information includes a bitmap indicating the Resource Block Groups (RBGs) that are allocated to the scheduled UE where a RBG is a set of consecutive virtual resource blocks defined by higher layer parameter *rbg-Size* configured in *pusch-Config* and the size of the bandwidth part as defined in Table 6.1.2.2.1-1. For operation with shared spectrum channel access mechansim, The UE shall determine the resource allocation in frequency domain as an intersection of the resource blocks of the indicated RBGs and the union of RB sets overlapping with the indicated RBGs and intra-cell guard bands defined in Clause 7 between the adjacent RB sets overlapping with the indicated RBGs, if any.  \*\*\* Unchanged text is omitted \*\*\*  6.1.2.2.3 Uplink resource allocation type 2  In uplink resource allocation of type 2, the resource block assignment information defined in [5, TS 38.212] indicates to a UE a set of up to *M* interlace indices, and a set of up to *N* RB sets, where *M* and interlace indexing are defined in Clause 4.4.4.6 in [4, TS 38.211]. The UE shall determine the resource allocation in frequency domain as an intersection of the resource blocks of the indicated interlaces and the union of indicated set of RB sets and intra-cell guard bands defined in Clause 7 between the indicated RB sets, if any.  \*\*\* Unchanged text is omitted \*\*\* |

# Appendix B: Previous agreements

Agreement: (RAN1#92bis)

* At least for band where absence of Wi-Fi cannot be guaranteed (e.g. by regulation), LBT can be performed in units of 20 MHz.
  + FFS: details on how to perform LBT for as single carrier with bandwidth greater than 20 MHz, i.e., integer multiples of 20 MHz.

Agreement: (RAN1#94bis)

* NR-U should support that a serving cell can be configured with bandwidth larger than 20 MHz.
  + For DL operation, the following options for BWP-based operation within a carrier with bandwidth larger than 20 MHz can be considered.
    - Option 1a: Multiple BWPs configured, multiple BWPs activated, transmission of PDSCH on one or more BWPs
    - Option 1b: Multiple BWPs configured, multiple BWPs activated, transmission of PDSCH on single BWP
    - Option 2: Multiple BWPs can be configured, single BWP activated, gNB transmits PDSCH on a single BWP if CCA is successful at gNB for the whole BWP
    - Option 3: Multiple BWPs can be configured, single BWP activated, gNB transmits PDSCH on parts or whole of single BWP where CCA is successful at gNB
  + Note: CCA is declared to be successful or not in multiples of 20 MHz.
  + FFS for UL operation including some or all of above options can be applied
* Note: Capture the following in TR only after further discussion for down-selecting from the options in RAN1#95.

Agreement: (RAN1#95)

* For wideband operation for both DL and UL,
  + Bandwidth larger than 20 MHz can be supported with multiple serving cells.
  + NR-U should support that a serving cell can be configured with bandwidth larger than 20 MHz.
* For DL operation, the following options for BWP-based operation within a carrier with bandwidth larger than 20 MHz can be considered.
  + Option 1a: Multiple BWPs configured, multiple BWPs activated, transmission of PDSCH on one or more BWPs
  + Option 1b: Multiple BWPs configured, multiple BWPs activated, transmission of PDSCH on single BWP
  + Option 2: Multiple BWPs can be configured, single BWP activated, gNB transmits PDSCH on a single BWP if CCA is successful at gNB for the whole BWP
  + Option 3: Multiple BWPs can be configured, single BWP activated, gNB transmits PDSCH on parts or whole of single BWP where CCA is successful at gNB
* For UL operation, the following options for BWP-based operation within a carrier with bandwidth larger than 20 MHz can be considered.
  + Option 1a: Multiple BWPs configured, multiple BWPs activated, transmission of PUSCH on one or more BWPs
  + Option 1b: Multiple BWPs configured, multiple BWPs activated, transmission of PUSCH on single BWP
  + Option 2: Multiple BWPs can be configured, single BWP activated, UE transmits PUSCH on a single BWP if CCA is successful at UE for the whole BWP
  + Option 3: Multiple BWPs can be configured, single BWP activated, UE transmits PUSCH on parts or whole of single BWP where CCA is successful at UE
* It is noted that CCA is declared to be successful or not in multiples of 20 MHz.
* Detailed design and potential selection from the above options can be further discussed when specifications are developed considering protocol and RF aspects.

Agreement: (RAN1#AH1901)

* For wideband operation in DL with a single serving cell operation within a carrier with bandwidth larger than 20 MHz
  + Multiple BWPs can be configured, single BWP activated, gNB may transmit PDSCH on parts or whole of single active BWP where CCA is successful at gNB (i.e., option 2 and 3 from previous agreement)
    - FFS: Restrictions on supportable gaps and combinations of gaps between discontiguous blocks where
      * each block spans contiguous (one or) multiple successful LBT sub-bands
      * each gap spans one or multiple contiguous unsuccessful LBT sub-bands
    - FFS: Transmission bandwidth adaptation delay, potentially different delay for e.g., different number of supported gaps, different transmission bandwidths and different positions of the LBT sub-bands where transmissions occur
    - FFS: Limit on the occupied LBT sub-bands due to regulation and coexistence considerations (not intended to imply that regulation and coexistence considerations will not be addressed)
    - FFS: Whether/how to indicate gNB’s transmitted LBT sub-bands
    - FFS: Enhancements to PDCCH/PDSCH configuration/transmission for the parts of BWP where gNB does not transmit due to CCA failure
* Send LS to RAN4 to inform above decision with the description that RAN1 requires RAN4’s feedback on the first three FFS parts in addition to what was requested in earlier LSs.

Agreement: (RAN1#AH1901)

Operation with multiple active BWPs for a carrier on unlicensed bands is not supported for DL or UL at least in Rel-16 NR-U WI.

* Inform RAN2 of this decision

**Agreement:** (RAN4#90bis)

* It is feasible to operate single carrier wideband operation when when LBT is successful in all LBT sub-bands
  + FFS whether guardbands are needed in between LBT sub-bands or not
* Mode 2 (Single wideband carrier when LBT is successful in a subset of the LBT sub-bands which are contiguous) is feasible at least if PRBs within the guardband of two contiguous LBT sub-bands are not scheduled by gNB.
  + FFS filter adaptation time if PRBs within the guardband of two contiguous LBT sub-bands are scheduled by gNB.
  + is feasible at least for WiFi-like requirements for in-carrier leakage (e.g. 20dbr).
  + FFS what regional regulatory requirements apply in LBT sub-bands where LBT fails.
    - RAN4 will investigate the feasibility whether regional regulatory requirements are met or not for in-carrier leakage.
* Mode 3 (Single wideband carrier when LBT is successful in a subset of the LBT sub-bands which are non-contiguous)
  + is feasible at least if PRBs within the guardband of two contiguous LBT sub-bands are not scheduled by gNB.
  + is feasible at least for WiFi-like requirements for in-carrier leakage (e.g. 20dbr).
  + FFS what regional regulatory requirements apply in LBT sub-bands where LBT fails.
    - RAN4 will investigate the feasibility whether regional regulatory requirements are met or not for in-carrier leakage.
  + FFS what level of in-carrier leakage and blocking requirements can be met at the BS and UE
  + FFS how to specify this in RAN4
  + FFS filter adaptation time if PRBs within the guardband of two contiguous LBT sub-bands are scheduled by gNB.

Agreement: (RAN1#96bis)

For UL transmissions in a serving cell with carrier bandwidth greater than LBT bandwidth, for the case where UE performs CCA before UL transmission, support at least Alt. 1 among the following alternatives

* Alt. 1: UE transmits the PUSCH only if CCA is successful at UE in all LBT bandwidths of the scheduled PUSCH.
* Alt. 2: UE transmits the PUSCH in all or a subset of LBT bandwidths of the scheduled PUSCH for which CCA is successful at the UE.
  + Decision on whether this alternative is supported will depend on feedback from RAN4
  + FFS on restrictions to the subset of LBT bandwidths, e.g., only contiguous LBT bandwidths allowed, based on feedback from RAN4
* Necessity of guard bands within the scheduled PUSCH should be determined by RAN4
* FFS: Whether this applies also to configured grant PUSCH
* FFS: Whether this applies also to PUCCH

Agreement: (RAN1#96bis)

* Support a mechanism for a UE to detect gNB is transmitting across
* Multiple carriers
* Multiple LBT bandwidths in a carrier.
* The following mechanisms are to be considered:
* Option 1: Explicit indication via PDCCH
  + FFS: The type of PDCCH (e.g., group common PDCCH or UE-specific PDCCH)
  + FFS: Signaling details of the indication
* Option 2: Explicit indication via selection of a PDCCH DM-RS sequence from a set of PDCCH DM-RS sequences
  + FFS: Details of the indication
* Option 3: Via UE implementation, i.e., implicit method based on NR-based signal such as DM-RS and/or corresponding PDCCH detection
  + FFS: Which signals/channels or combination of signals/channels could be used by the UE
* Note: Above options are not mutually exclusive

Agreement: (RAN1#97)

When GC-PDCCH is configured, explicit indication via GC-PDCCH is supported as a mechanism to inform the UE that one or more carriers and/or LBT bandwidths are not available or available for DL reception, at least for slot(s) that are not at the beginning of DL transmission burst.

* FFS: Signalling details of the indication, including e.g., the time domain validity of the indication
* FFS: Whether and how to support the mechanism at the beginning of DL transmission burst
* FFS: Whether and how to handle the case when GC-PDCCH is not configured or not received by the UE

Conclusion: (RAN1#97)

A UE can receive a PDSCH scheduled within an LBT bandwidth or over multiple LBT bandwidths as per Rel-15 and current agreements in Rel-16.

Conclusion: (RAN1#98)

The following are unchanged from Rel-15 for PDCCH.

* The maximum number of monitored PDCCH candidates per slot and per serving cell.
* The maximum number of non-overlapped CCEs per slot and per serving cell.
* CCE-to-REG mapping rule and hashing function.

Agreement: (RAN1#98)

For CORESET configuration in a serving cell with carrier bandwidth greater than LBT bandwidth,

* For the case where a CORESET is confined within a LBT bandwidth, the search space set configuration associated with the CORESET can have multiple monitoring locations in the frequency domain (per LBT bandwidth)
  + Send an LS to RAN2 informing them of this agreement and providing clarifications on the above if necessary
* Note: For scenarios in which gNB transmits PDCCH/PDSCH on a single BWP if CCA is successful at gNB for the whole BWP, CORESET(s) need not all be confined within an LBT bandwidth, and no specification impact is foreseen

Agreement: (RAN1#98bis)

For a search space set configuration associated with multiple monitoring locations in the frequency domain (as per the previous agreement defining such a search space set associated with a CORESET confined within an LBT bandwidth):

* PRBs allocated by *frequencyDomainResources* in the CORESET configuration are confined within one of LBT bandwidths within the BWP corresponding to the CORESET.
* Within the search space set configuration associated with the CORESET, each of the one or more monitoring locations in the frequency domain corresponds to (and is confined within) an LBT bandwidth and has a frequency domain resource allocation pattern that is replicated from the pattern configured in the CORESET.
* CORESET parameters other than frequency domain resource allocation pattern are identical for each of the one or more monitoring locations in the frequency domain.
* Include this and the prior agreement on this issue in an LS to RAN2

Agreement: (RAN1#98bis)

The intra-carrier guard bands on a carrier can be semi-statically adjusted with an RB level granularity. The RAN4 minimum guard band requirements are used as the guard bands when no semi-static adjustment is applied.

* The guard bands adjustments do not affect the already agreed restrictions on PUCCH resource allocation.
* FFS: Whether and how to handle the case where the intra-carrier guard bands are part of a resource allocation

Agreement: (RAN1#98bis)

* For UL transmissions in a serving cell with carrier bandwidth greater than the LBT bandwidth, for the case where UE performs CCA before UL transmission, UE transmits on the UL only if CCA is successful at UE in all LBT bandwidths that overlap with the resource allocation for the UL transmission
* The UE is not expected to receive resource allocations in discontiguous LBT bandwidths within a wideband carrier
  + This does not preclude such resource allocation in discontiguous LBT bandwidths being supported by specifications managed by RAN1 in Rel-16.

Agreement: (RAN1#99)

UE determines the number of RB sets (corresponding to LBT bandwidths) and the available PRBs in each RB set, both for DL and UL, based on,

* If configured, the RRC parameters *intraCellGuardBandDL-r16* and *intraCellGuardBandUL-r16* (if UL is configured)configure the lists of intra-carrier guard-bands per cell, e.g.,
  + If *intraCellGuardBandDL-r16* or *intraCellGuardBandUL-r16* are given as {, }, …, {, } where *GB* is given by CRB index, the UE determines
    - The number of RB sets for a cell: N
    - The available PRBs in each RB set: [, -1] for RB set #1, [+1, -1] for RB set #2,…, [+1, ] for RB set#N, where and corresponds to starting and ending RB index of cell, respectively.
    - Note: {, }, …, {, } may be provided separately for DL and UL
* If *intraCellGuardBandDL-r16* is not configured, then {, }, …, {, } is derived from the RAN4 specifications
  + Note: This supersedes a previous agreement
* If *intraCellGuardBandUL-r16* is not configured, then {, }, …, {, } is derived from the RAN4 specifications
  + Note: This supersedes a previous agreement
* Note: This addresses the FFS in sections 5.1.2.2 and 6.1.2.2 in 38.214.

Agreement: (RAN1#99)

For the frequency domain resource allocation that is provided with *frequencyDomainResources* in CORESET configuration,

* Introduce a new RRC parameter *rb-Offset* (with the value range of 0,1,…,5) in *ControlResoureSet* IE.
  + If *rb-Offset* is not configured, *rb-Offset* is 0
* The bits of the 45-bit bitmap *frequencyDomainResources* have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the BWP with the starting PRB position as {the first PRB index in the BWP + *rb-Offset*} for a CORESET.
* FFS: For multi-cluster CORESET configuration, *rb-Offset* also applies to the RB offset between the starting PRB index of the first 6 PRB group and the first PRB index in each RB set. Full 6 PRB groups are counted till the end of the RB set. The bits in *frequencyDomainResources* sequentially maps to the 6 RB groups in all RB sets in the BWP.
* Note: Cluster above implies a group of resource blocks that are not contiguous in frequency

Conclusion: (RAN1#99)

For a legacy CORESET configuration, the UE can expect to process PDCCH as per Rel-15 behaviour

Agreement: (RAN1#99)

For a search space set configuration with multiple monitoring locations in the frequency domain,

* Within the *SearchSpace* IE, the agreed RRC parameter *freqMonitorLocations-r16* provides a bitmap (where the first bit in the bitmap corresponds to the first RB set in the BWP, and the second bit corresponds to the second RB set, and so on). For a RB set indicated in the bitmap, the first PRB of the frequency domain monitoring location confined within the RB set is aligned with {the first PRB of the RB set + *rb-Offset* provided by the associated CORESET configuration}.
* The frequency domain resource allocation pattern for each monitoring location is determined based on the first A bits in *frequencyDomainResources* provided by the associated CORESET configuration, where A = floor({the number of available PRBs in the first RB set (accounting for *rb-Offset*) for the BWP}/6).

Agreement: (RAN1#99)

* The RRC parameters *intraCellGuardBandDL-r16* and *intraCellGuardBandUL-r16* include a mechanism to indicate that no intra-carrier guard-bands are configured
  + Note: This configuration may be used for the case where transmission only occurs in a BWP if LBT is successful in all RB sets within the BWP
* For a carrier with intra-carrier guard bands, the UE does not expect that the dedicated BWP is configured to include parts of a RB set.

Agreement: (RAN1#99)

If a UE is configured with a CSI-RS spanning over multiple LBT bandwidths,

* The UE assumes that the CSI-RS is not transmitted if the UE is monitoring DCI format 2\_0 carrying an LBT BW indication and detects the DCI format 2\_0 indicating any of corresponding LBT bandwidths is not available for DL reception.

Agreement: (RAN1#99)

For CSI-RS for tracking in unlicensed spectrum,

* Text proposal for section 5.1.6.1.1 in TS 38.214:
  + The bandwidth of the CSI-RS resource, as given by the higher layer parameter freqBand configured by CSI-RS-ResourceMapping, is the minimum of 48 and NBWP,i size resource blocks, or is equal to NBWP,i size resource blocks.

Agreement: (RAN1#100-e)

* If CORESET p is not configured with rb-offset, and is not associated with any search space set configured withfreqMonitorLocation-r16,
  + The bits of the 45-bit bitmap *frequencyDomainResources* of the CORESET *p* have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP with the starting common RB position , where the first common RB of the first group of 6 consecutive RBs has common RB index , i.e., same as in Rel-15.
* If CORESET p is not configured with rb-offset, and is associated with at least one search space set configured with freqMonitorLocation-r16,
  + The bits of the first A bits of the 45-bit bitmap *frequencyDomainResources* of the CORESET *p* have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP with the starting common RB position , where the first common RB of the first group of 6 consecutive RBs has common RB index , where the UE assumes the default value *rb-Offset* = 0.
* If CORESET p is configured with rb-offset, and is not associated with any search space set configured with freqMonitorLocation-r16,
  + The bits of the 45-bit bitmap *frequencyDomainResources* of the CORESET *p* have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP with the starting common RB position , where the first common RB of the first group of 6 consecutive RBs has common RB index .
* If CORESET p is configured with rb-offset, and is associated with at least one search space set configured with freqMonitorLocation-r16,
  + The bits of the first A bits of the 45-bit bitmap *frequencyDomainResources* of the CORESET *p* have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP with the starting common RB position , where the first common RB of the first group of 6 consecutive RBs has common RB index .
* Note: A bits in above bullets is defined as floor({the number of available PRBs in the first RB set (accounting for *rb-Offset*) for the BWP}/6), as per previous agreement.
* TS 38.213 editor to implement this agreement

Agreement: (RAN1#100bis-e)

For a DL cell without intra-cell guard bands

* The bit-width of available RB-set indicator (if configured) in DCI format 2\_0 is equal to 1
* UE does not expect to be configured with search space with *freqMonitorLocations-r16*

Agreement: (RAN1#100bis-e)

To support UL bandwidth part wider than 20 MHz with no intra-cell guard band, UE can be configured with zero GBs by setting GB width to 0 when configuring intraCellGuardBandUL-r16 (e.g., such gNB creates 4 RB-sets in 80MHz UL carrier).

* Inform RAN2 of this agreement

Agreement: (RAN1#100bis-e)

For an UL carrier without intra-cell guard bands when the parameter *useInterlacePUCCH-PUCCH* is configured in any of *BWP-UplinkCommon* and *BWP-UplinkDedicated*:

* The UL carrier can be configured with non-overlapping RB set(s)
* For each RB set except for RB set 0, the starting CRB index is given by *startCRB-r16*
  + For RB set 0, the starting CRB index is given by 
* The UE expects *nrofCRBs-r16* set to 0 for all GBs between two adjacent RB sets within the UL carrier.
* The UE expects N RBs contained in each interlace of each RB set, wherein 10 <= N <= 11.
  + For 30 kHz SCS, the number of RBs within any RB set is between 50 and 55, and for 15 kHz SCS, the number of RBs within any RB set is between 100 and 110
* Note: This configuration may be used for the case where transmission only occurs in a BWP if LBT is successful in all RB sets within the BWP (from RAN1#99 agreement)
* Note: It’s up to gNB’s configuration to fulfill RAN4 requirement with  e.g., on maximum transmission bandwidth configuration, spectral emission mask, and so on.
* Note: In order to reuse existing PUCCH/PUSCH resource allocation mechanisms, this proposal applies to all supported carrier bandwidths except 10 MHz
* FFS: Whether BWP can be configured to be partially overlapping with a RB set

Agreement: (RAN1#100bis-e)

The number of PDCCH candidates per aggregation level configured by *nrofCandidates* or *nrofCandidates-SFI* within a *SearchSpace* IE applies to each of RB sets configured by *freqMonitorLocations-r16*.

* *nrofCandidates-SFI* is 1 for a search space configured with freqMonitorLocations-r16