**3GPP TSG-RAN WG2 Meeting #117-e R2-220xxxx**

**Online, 21 February - 03 March 2022**

**Agenda Item: 6.1.4.3**

**Source: Huawei, HiSilicon**

**Title: Summary of [AT117-e][035][NR1615] UE capabilities II**

**Document for: Discussion and decision**

# Introduction

This document summarizes the following offline discussion.

* [AT117-e][035][NR1615] UE capabilities II (Huawei)

Scope: Treat R2-2202810, R2-2202811, R2-2203268, R2-2203492, R2-2202229, R2-2202108, R2-2203510, R2-2203490, R2-2203491, R2-2203409, R2-2202525, R2-2202526. Ph1 Determine agreeable parts, Ph2 for agreeable parts, progress CRs.

Intended outcome: Report, Agreed CRs.

Deadline: Schedule 1

# Contact from companies

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# Discussion

## Part 1: Intended to determine agreeable parts

### **UL MIMO coherence for UL TX Switching**

[R2-2202810](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2202810.zip) Adding UE capability of UL MIMO coherence for UL Tx switching Huawei, HiSilicon, China Telecom, Apple CR Rel-16 38.306 16.7.0 0635 2 F NR\_RF\_FR1-Core R2-2110483

[R2-2202811](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2202811.zip) Adding UE capability of UL MIMO coherence for UL Tx switching Huawei, HiSilicon, China Telecom, Apple CR Rel-16 38.331 16.7.0 2786 2 F NR\_RF\_FR1-Core R2-2110484

The above two CRs[1][2] are update of R2-2110483 and R2-2110484, which were both endorsed in RAN2#116e. It has been agreed to revisit the CRs after RAN1 discussion on the legacy MIMO coherence capability. In this meeting, it is confirmed from RAN1 that no new capability will be introduced for UL MIMO coherence in Rel-16 according to LS R2-2202107/R1-2112778. Now the two endorsed CRs are ready to be agreed.

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| Agreements in RAN2#116e   * [013] Both endorsed, not for RP, final version later. The CRs R2-2110483 and R2-2110484 correctly captures RAN4 request in their LS. CRs can be revisited after RAN1 discussion on the legacy MIMO coherence capability. |

**Q1 Do companies agree that the two endorsed CRs(R2-2202810/R2-2202811) can be agreed?**

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| **Company** | **Yes or No** | **Comments** |
| Nokia, Nokia Shanghai Bell | No (CR wording has some issues. Additionally, RAN1 is still discussing the UL MIMO coherence for Rel-17, which could also impact this topic) | We agree with the intent but reading the CRs again, the capability description seems to be confusing:   * Capabilities don't normally indicate UE configuration. so we don't see why it is necessary to indicate UE is configured with the configuration that determines UL Tx switching. So that part can be just removed. * Why does the capability talk about "antenna connectors"? Normally RAN2 specifications only consider antenna ports, and "connectors" are only used in RAN4 specifications. Since the capability refers to RAN4 specifications, this doesn't seem necessary. Is the sentence needed at all? * The absence condition should indicate UE capability, not configuration actions. * "UE indicated" should be "UE indica**ting**" * Since this capability refers to the capability pusch-TransCoherence, it seems that UE always has to indicate that capability (especially if this field is absent). Since that doesn't have any reference to this field, we wonder if there should be an additional clarification added to the gbasic UL Tx switching capability, too (i.e. ULTxSwitchingBandPair-r16). Or is the intent that if this new capability is absent, only then the legacy capability has to be present?   Taking the above comments into account, the capability description becomes as shown below (changed parts highlighted):  ***uplinkTxSwitching-PUSCH-TransCoherence-r16***  Indicates support of the uplink codebook subset when uplink Tx switching is triggered between last transmitted SRS and scheduled PUSCH transmission, as specified in TS 38.101-1 [2].  UE indicating support of full coherent codebook subset shall also support non-coherent codebook subset.  If absent, uplink codebook subset support indicated by *pusch-TransCoherence* applies when the uplink switching is triggered between last transmitted SRS and scheduled transmission.  ***ULTxSwitchingBandPair-r16***  Indicates UE supports dynamic UL Tx switching in case of inter-band CA, SUL, and (NG)EN-DC as defined in TS 38.214 [12], TS 38.101-1 [2] and TS 38.101-3 [4]. The capability signalling comprises of the following parameters:  - *bandIndexUL1-r16* and *bandIndexUL2-r16* indicate the band pair on which UE supports dynamic UL Tx switching. *bandindexUL1*/*bandindexUL2* xx refers to the xxth band entry in the band combination. UE shall indicate support for 2-layer UL MIMO capabilities on one of the indicated two bands in each FeatureSet entry supporting UL 1Tx-2Tx switching, and only the band where UE supports 2-layer UL MIMO capability can work as carrier2 as defined in TS 38.101-1 [2] and TS 38.101-3 [4].  - *uplinkTxSwitchingPeriod-r16* indicates the length of UL Tx switching period per pair of UL bands per band combination when dynamic UL Tx switching is configured, as specified in TS 38.101-1 [2] and TS 38.101-3 [4]. UE shall not report the value n210us for EN-DC band combinations. n35us represents 35 us, n140us represents 140us, and so on, as specified in TS 38.101-1 [2] and TS 38.101-3 [4].  - *uplinkTxSwitching-DL-Interruption-r16* indicates that DL interruption on the band will occur during UL Tx switching, as specified in TS 38.133 [5] and in TS 36.133 [27]. UE is not allowed to set this field for the band combination of SUL band+TDD band, for which no DL interruption is allowed.  Field encoded as a bit map, where bit N is set to "1" if DL interruption on band N will occur during uplink Tx switching as specified in TS 38.133 [5] and in TS 36.133 [27]. The leading / leftmost bit (bit 0) corresponds to the first band of this band combination, the next bit corresponds to the second band of this band combination and so on. The capability is not applicable to the following band combinations, in which DL reception interruption is not allowed:  - TDD+TDD CA with the same UL-DL pattern  - TDD+TDD EN-DC with the same UL-DL pattern  The UE indicating support of this feature shall also indicate support of *pusch-TransCoherence*. |
| Qualcomm Incorporated | Yes | We understand the current proposed text in 38.306 CR is from what RAN2 received from RAN4. We are fine with Nokia’s suggestion above. |
| Ericsson | Yes, but | We agree with Nokia suggestions. On tops of that, we noticed that the CRs actually use the extension marker added within BandCombination-UplinkTxSwitch. We wonder whether this extension marker should be use at all? This will add some extra overhead to every BC instantiate in UL TX swtighing list. We should rather use parallel extension list instead. |
| OPPO | Yes | Fine with Nokia suggestion above. |
| ZTE | Yes | We are fine with Nokia’s suggestion. |
| Samsung | Yes |  |
| Intel | Yes | We are also fine with Nokia’s suggestion. |
| China Telecom | Yes | We are fine with Nokia’s suggestion on the wording of ***uplinkTxSwitching-PUSCH-TransCoherence-r16***, but we have some concern on the following sentence added in ***ULTxSwitchingBandPair-r16***.  “The UE indicating support of this feature shall also indicate support of *pusch-TransCoherence*.”  In our understanding, the support of the feature UL Tx switching has no relation to the support of *pusch-TransCoherence*. The intention of RAN4 is to allow the UE to indicate a different UL MIMO coherence capability when UL Tx switching is configured. The capability reporting of *uplinkTxSwitching-PUSCH-TransCoherence-r16* shall not influnce the legacy capability reporting of *pusch-TransCoherence.* |
| Huawei, HiSilicon | Yes | In response to Nokia’s comments:  1. The related Rel-16 discussion on the legacy pusch-TransCoherence has been concluded in last RAN1 meeting, as indicated in RAN1 LS R1-2112778. Thus RAN2 should proceed the CR to capture RAN4 agreement.  2. For the suggestions on CR content, we are fine with the change #1-3, but for the last one we understand it will exclude the non-codebook based PUSCH transmission, which is not the intention of RAN4. And we think the sentence “If absent, uplink codebook subset support indicated by *pusch-TransCoherence* applies” already clear, i.e. if pusch-TransCoherence is reported then the same capability applies to UL Tx switching, otherwise UE do not support related UE capability for both of non-Tx switching case and Tx switching case. |
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| Summary  Most of the companies agree that the two endorsed CRs(R2-2202810/R2-2202811) can be agreed with some corrections on the wording of field description. One company comments on the usage of extension maker. Several companies suggest to improve the wording.  Proposal 1: The endorsed CRs R2-2202810 and R2-2202811 will be revised for approval in the next phase, taking the comments in Phase 1 into account. |

### **eMIMO**

[R2-2203268](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2203268.zip) UE capabilities for UL full power modes Nokia, Nokia Shanghai Bell discussion Rel-16 NR\_eMIMO-Core

The paper in [3] discussed about the UL full power capability reporting. The proposals are listed below.

**Proposal 1:** RAN2 to clarify whether the UE should always indicate UL full power capabilities consistently across the (UL) featureSets linked to the same band combination entry.

**Proposal 2:** RAN2 to clarify whether UE is allowed to report multiple UL full power mode capabilities per BC.

**Proposal 3:** RAN2 to discuss what is the typical case where UE would support UL full power mode for a BC.

**Proposal 4:** RAN2 to discuss whether the current description of dependencies between the UL full power mode capabilities should be clarified.

**Q2 Do companies agree with the intention to clarify in RAN2 whether the UL full power capabilities should be indicated consistently across the (UL) FeatureSets linked to the same band combination entry by UE?**

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| **Company** | **Yes or No** | **Comments** |
| Nokia, Nokia Shanghai Bell | Yes (proponent) | We would like to understand the technical reasons why UE could support more than one UL full power mode per BC. |
| Qualcomm Incorporated | Not yet | We need more time to check intended implementation of the feature, before applying any restriction in the standard.  Besides, we do not think the current signalling is broken. RF implementation can be different per band (hence the placement in FeatureSet) and RRC configuration provides the flexibility to configure the feature per BWP. |
| Ericsson | No | While we are supportive of simplifying the signaling when possible, given it would be a late change and that this capabilities is already defined per featuerset, if the configuration of this feature is per serving cell anyway, the network just needs to know if the UE supports the feature for a particular featureSet, so whether the values are consistent or not among feature sets should not matter. |
| Apple | No | We do not agree to the proposals, and have similar views as Qualcomm in that RF implementations can have diff per-band placement. |
| Huawei, HiSilicon | No | We agree with Qualcomm that from signalling perspective, there is no such restriction since the UL full power modes are reported in FeatureSet level. To be future-proof, we suggest not to add such restriction in RAN2 spec.  Besides, we understand there may be cases that UE indicates different UL full power modes for a BC, which should be discussed by RAN1. |
| ZTE | No | We share the similar view with Qualcomm. And consider this is the late stage of R-16, we suggest not to correct if nothing critical is found in the real deployment scenario |
| Samsung |  | We have assumed that UE full power mode capability is currently handled per CC, and thus, either "consistently reported across FSs linked to different band within the same BC" or "reported per CC per BC" is reasonable. |
| Intel | See comments | From our understadning, The UE may indicate one or multiple FSs per band and per BC, which means that gNB should consider all possible FS combinations. If there is any technical constraint, it should be discussed in RAN1 or RAN4. |
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**Q3 Do companies agree with the intention that multiple UL full power mode capabilities are allowed to be reported for a BC?**

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| **Company** | **Yes or No** | **Comments** |
| Nokia, Nokia Shanghai Bell | Yes but | This is allowed by signalling, but we don't see the need for it as this is RF capability. It seems very unlikely that any UE would ever support more than one UL full power mode for a given BC (as this depends on RF capabilities for the BC, which are either there or they are not). |
| Ericsson | No | See comments for Q1. |
| Samsung | No | The network currently considers that UE reports only 1 full power mode. Furthermore, UE doesn’t support multiple modes simultaneously.  It is unclear about benefit of reporting multiple full power modes. |
| Intel | See comments | From signaling pov, multiple UL full power mode capabilities should be allowed. Again, if there is any technical constraint, it should be discussed in RAN1 or RAN4. |
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**Q4 Do companies agree with the need to further discuss in RAN2 the typical case where UE would support UL full power mode for a BC, and the potential description of dependencies between the UL full power mode capabilities?**

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| **Company** | **Yes or No** | **Comments** |
| Nokia, Nokia Shanghai Bell | Maybe | See previous answer. However, we do acknowledge that doing NBC changes is not good so we would first like to understand what could be the problem if UE was restricted to just one UL full power mode per BC.  Note that we would have raised this up in RAN1, but as it relates to UE capabilities, RAN2 was a clearer starting point. |
| Ericsson |  | We think this should be discussed in RAN1/RAN4. |
| Intel | See comments | See our comment to Q1 and 2 |
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| Summary  Most of the companies think there is no restriction from signalling perspective that UE indicates UL full power capabilities consistently for a band combination. Three companies think that the technical issue should be discussed in RAN1/RAN4.Three companies indicate that RF implementation can be different per band for UL power modes. Two companies mentioned that a late change of Rel-16 should be avoided. It is also the moderator’s observation that this discussion seems out of RAN2 scope and thus it is suggested to note the paper and if there is uncertainties, companies can bring papers to RAN1/RAN4.  Proposal 2: The discussion paper [R2-2203268](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2203268.zip) is noted. |

[R2-2203492](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2203492.zip) Correction on ssb-csirs-SINR-measurement-r16 capability Huawei, HiSilicon CR Rel-16 38.306 16.7.0 0695 - F NR\_eMIMO-Core

In above CR [4], it is pointed out that there is mismatch between RAN1 feature list and 38.306 on the *ssb-csirs-SINR-measurement-r16* capability. The proposed changes in above CR include:

1) Correct that if *ssb-csirs-SINR-measurement-r16* is indicated by UE, the UE shall support CSI-RS as CMR with dedicated CSI-IM.

2) Clarify that the maximum numbers reported within ssb-csirs-SINR-measurement-r16 are across all the CCs in the band.

3) Remove the undefined MD\_1 in the field description.

**Q5 Do companies agree with the intention of the CR above on the three corrections?**

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| **Company** | **Yes or No** | **Comments** |
| Nokia | Partly | We think 1) is okay but not sure 2) really needs to be clarified as this is rather clear that the capability is across CC’s. Change 3) is editorial and is okay. |
| Qualcomm Incorporated | Yes | We agree with the technical content of the CR. |
| Ericsson | Yes, with comments | We should change “across all CCs” to “across all CCs within a band” to be consistent with the terminology. To the same end we should also change “UE supporting this feature shall always support CSI-RS as CMR with dedicated CSI-IM.” to “UE supporting this feature shall ~~always~~ also indicate support of CSI-RS as CMR with dedicated CSI-IM.”. We can also just add “of” to the sentence more below we also have in this field description. |
| Apple | Ok with the CR |  |
| Samsung | Yes |  |
| Intel | Yes |  |
| Huawei, HiSilicon | Yes |  |
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| Summary  Most of the companies agree with the intention of the CR. One company comments on the terminology of the CR wording.  Proposal 3: The CR R2-2203492 can be pursued, taking the comments from Phase 1 discussion into account. |

### **BWP**

[R2-2202229](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2202229.zip) Discussion on BWP operation without bandwidth restriction Qualcomm Incorporated, ZTE Corporation discussion Rel-16 TEI16

In the discussion paper [5], the feature “BWP operation without bandwidth restriction” was discussed for non-RedCap UE. The proposals in the paper are as follows.

**Proposal 1:** RAN2 to clarify the BM/RLM/BFD requirements for a UE supporting BWP operation without bandwidth restriction (FG6-1a), but not supporting CSI-RS based RLM/BFD (FG1-7, 1-8 and 2-31).

**Proposal 2:** To confirm a UE with the capability of proposal 1 shall be able to perform SSB-based BM/RLM/BFD without measurement gaps, even if the active DL BWP does not contain the SSB associated to the initial DL BWP.

**Q6 Do companies agree that the current specification is not clear, and there are cases where a UE supporting BWP operation without bandwidth restriction, but not supporting CSI-RS based RLM/BFD?**

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| **Company** | **Yes or No** | **Comments** |
| Nokia, Nokia Shanghai Bell | Maybe | We agree with the intention of the P1, and are open to discuss how to clarify it. |
| Qualcomm Incorporated | Yes (Proponent) |  |
| Ericsson | Yes |  |
| Apple | Not quite. Pls see comments | Even if UE supports FG6-1a, RAN4 didn’t conclude to assume that imply UE can do SSB based RLM/CBD/BFD if the SSB is not in an active BWP. RAN4 still have a principle in all RLM/BFD/CBD requirement applicability that:   1. UE is not required to perform RLM outside the active DL BWP. (Section 8.1 TS38.133) 2. UE is not required to perform beam failure detection outside the active DL BWP.  (Section 8.5.1 TS38.133) 3. UE is not required to perform candidate beam detection outside the active DL BWP.  (Section 8.5.1 TS38.133)   So in effect, it is clear that even for FG6-a UE, SSB is needed. |
| OPPO | Maybe | We are open to discuss how to clarify it. |
| Huawei, HiSilicon | See comments | We have similar observation as Apple that in 38.133, it is stated for RLM/BFD/BM that the UE is not required to perform these tasks outside the active DL BWP.  In general we think this discussion needs involvement of RAN1/RAN4, seems RAN2 cannot purely decide by ourselves. |
| ZTE | Yes | Proponent.  The current spec does not mandate a FG6-a UE to support CSI-RS based RLM/BFD, and it is not reasonable to do that. |
| MediaTek | Maybe | We tend to agree that the description of FG6-1a is unclear. However, we are actually wonder is there already UEs in the field that support FG6-1a but not CSI-RS based RLM/BFD? What would NW do for this kind of UE? |
| Samsung | Yes | Need to clarify. This capability is related to the BW of "UE-specific RRC configured BWP". Thus, in that concerned case, BM/RLM/BFD should be performed based on the common BWP configuration of initial BWP? |
| Intel | Yes | Our understanding is that CSI-RS for RLM/RLF feature was not specifically developed in Rel-15 for cases when UE supports non-restrictive BWPs. |

**Q7 If the answer to Q6 is Yes, do companies agree with P2?**

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| **Company** | **Yes or No** | **Comments** |
| Nokia, Nokia Shanghai Bell | Yes | This seems reasonable to us. How this is captured can be firther discussed. |
| Qualcomm Incorporated | Yes (Proponent) | It should be noted that RAN2 introduced the following UE capability in release-16.  ***gapIndicationIntra***  Indicates whether measurement gap is required for the UE to perform intra-frequency SSB based measurements on the concerned serving cell. Value *gap* indicates that a measurement gap is needed if any of the UE configured BWPs do not contain the frequency domain resources of the SSB associated to the initial DL BWP. Value *no-gap* indicates a measurement gap is not needed to measure the SSB associated to the initial DL BWP for all configured BWPs, no matter the SSB is within the configured BWP or not.  This essentially enables gap-less SSB-based **RRM** measurements when the active BWP does not contain SSB of the serving cell. The question remains what the UE can do for BM/RLM/BFD. If we anyway need CSI-RS for **BM/RLM/BFD**, then the gap-less SSB-based RRM may not provide enough value.  So this proposal allows SSB based RRM and BM/RLM/BFD to work when the active BWP does not contain the serving cell SSB. |
| Ericsson | Yes | We can confirm those agreements with RAN1. If there is any concern with the approach taken we think it is also possible to introduce this as a new UE capability as well. |
| Apple | No | In our view, the UE is not expected to do RLM/BFD/CBD. There are no RAN4 requirements otherwise. RAN2 introducing a capability does not resolve this. |
| OPPO | See comment | Based on the reply above, we understand it would be good to consult R1 and R4 on this. |
| Huawei, HiSilicon | See comment | Similar observation as Apple, better to discuss with RAN1 and RAN4 first. |
| ZTE | Yes | Proponent, same view as Qualcomm.  In case a FG6-1a UE does not support CSI-RS based RLM/BFD, we think Proposal 2 is the only way out. If RRM works in this scenario, then RLM/BFD should be the same.  We understand the concern from companies on RAN4 requirements, it is ok to consult RAN4 and ask if existing RAN4 requirements can be applied also in this case. |
| MediaTek | See comment | We think it is better to discuss this in RAN4 and RAN1. |
| Samsung |  | Depending on conclusion in Q6 |
| Intel | Yes | For UE that is able to support non-restrictive BWPs, we expect that they are more advanced UEs, and therefore seems reasonable to assume they can support SSB based RLM/RLF beyond the active BWP. |
| Huawei, HiSilicon |  | A second comment after reading comments from others.  First, we think the RAN4 requirements are already there, which do not require UEs to perform BM/RLM/BFD outside the DL active BWP, thus to directly deduce that the UE supporting gapless SSB RRM can support gapless SSB BM/RLM/BFD is too strong.  In our understanding, the UE support BWP without SSB should also support L1 CSI-RS to avoid such cases happening. The CSI-RS capability is already defined as mandatory with capability signaling, and thus we think this is the best way forward.  If there exist UEs in the field which report support of BWP without SSB but no support of CSI-RS for BM/RLM/BFD, we think the major issue here is whether the network is allowed to configure BWP without SSB while leaving BM/RLM/BFD to UE implementation. So we are open to discuss whether we simply allow such NW configuration without mandating any UE capabilities.  As these features are defined by RAN1/RAN4, we suggest to raise this issue and send LS to RAN1/RAN4 to understand their interpretation first, and decide which way to go in RAN2 at next meeting. |

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| Summary  Most of the companies agree that the current spec is not crystally clear on the case that a UE supports BWP operation without bandwidth restriction, but not supports CSI-RS based RLM/BFD. As these features are defined by RAN1/RAN4, many companies agree to discuss the issue in RAN1/RAN4 first. Some companies support that UE shall be able to perform SSB-based BM/RLM/BFD when the active DL BWP does not contain the SSB, while some companies pointed out that in RAN4 the UEs are not required to perform so outside the active DL BWP.  It seems that the uncertainty on how to interpret the existing features and how to solve this uncertainty need to be further discussed, and RAN1/RAN4 inputs are needed. Rapp therefore suggest to send LS to RAN1/RAN4 describing the current issue, and ask RAN1/RAN4’s feedback on their understanding. RAN2 can continue the discussion in the next meeting.  Proposal 4: Send a LS to RAN1/RAN4 describing the issue and ask RAN1/RAN4 provide their view. RAN2 continue to discuss this issue after getting inputs from RAN1/RAN4. |

### **PDCCH blind detection**

[R2-2202108](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2202108.zip) Reply LS on PDCCH Blind Detection in CA (R1-2112833; contact: Huawei) RAN1 LS in Rel-16 To:RAN2

[R2-2203489](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2203489.zip) Discussion on PDCCH Blind Detection in CA Huawei, HiSilicon discussion Rel-16 NR\_L1enh\_URLLC-Core

=> Revised in R2-2203510

[R2-2203510](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2203510.zip) Discussion on PDCCH Blind Detection in CA Huawei, HiSilicon discussion Rel-16 NR\_L1enh\_URLLC-Core R2-2203489 Late

[R2-2203490](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2203490.zip) Correction on PDCCH Blind Detection in CA Huawei, HiSilicon CR Rel-16 38.331 16.7.0 2961 - F NR\_L1enh\_URLLC-Core

[R2-2203491](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2203491.zip) Correction on PDCCH Blind Detection in CA Huawei, HiSilicon CR Rel-16 38.306 16.7.0 0694 - F NR\_L1enh\_URLLC-Core

According to the latest RAN1 reply LS[6], multiple combinations of a mix of Rel-16 and Rel-15 PDCCH monitoring capabilities on different serving cells can be reported by UE for FG 11-2c, FG 11-2g and FG 11-2e. The maximum number of combinations suggested by RAN1 is 8.

In the CRs [8][9], to allow UE to report more than one combination for these features, and to avoid non-backward compatible issue, additional lists of SEQUENCE type were added in ASN.1 to report multiple combinations for these features.

**Q8 Do companies agree with the intention of the CRs above?**

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| **Company** | **Yes or No** | **Comments** |
| Qualcomm Incorporated | Yes |  |
| Apple | Ok |  |
| ZTE(Wenting) | Yes |  |
| Intel | Yes |  |
| Huawei, HiSilicon | Yes |  |
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In the reply LS, there is a note from RAN1 that one combination of (*pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16*) reported by a UE for FG 11-2e corresponds to one combination of (*pdcch-BlindDetectionCA-r15, pdcch-BlindDetectionCA-r16*) reported by the UE for FG 11-2c or FG 11-2g.

In current RAN2 spec, there is no restriction to report the mixed blind detection capability for MCG and SCG at the same time. In discussion paper [7], it is proposed to send a LS to RAN1 asking to clarify whether there is a requirement to report the mixed PDCCH blind detection capability for MCG and SCG together by UE, and inform RAN1 the possible NBC problem in the LS.

**Proposal 1:** RAN2 sends a LS to RAN1 asking to clarify whether there is a requirement to report the mixed PDCCH blind detection capability for MCG and SCG together by UE, and inform RAN1 the possible NBC problem in the LS.

**Q9 Do companies agree there is an NBC change if mixed blind detection capability is required to report together for MCG and SCG?**

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| **Company** | **Yes or No** | **Comments** |
| Qualcomm Incorporated | No | Note 2 in RAN1 LS is indeed unclear, but looking at clause 10 in TS 38.213 (as noted by RAN1 as well), they define the interaction between those capabilities (ND-DC vs CA). So it seems RAN2 does not have to capture anything.  We understand note 3 and note 4 can be seen NBC, but assumes RAN1 looked at backward compatibility. |
| Apple | Ok to send an LS if majority agree. |  |
| ZTE(Wenting) | FFS | First, we need to confirm the intention of the Note 2. It seems to define the interaction between the capabilities of the NR-DC and CA. However, in 38213 chapter 10, there have been clear description on it. We are not sure we need to capture it again in the RAN2 spec. Before confirming the intention of Note 2, it’s hard to say whether its NBC or not. |
| Intel | OK to send a LS if majority agrees. | Maybe it would be good to check directly with RAN1 on the intention of the note before adding such note. |
| Huawei, HiSilicon | Yes | We understand if there is a requirement to report the MCG and SCG capability together from RAN1, that will have an impact on capability reporting, which should be captured in RAN2 spec. We are fine to ask RAN1 first on their intention. |
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**Q9a If the answer to Q9 is Yes, do companies agree to send a LS to RAN1 asking to clarify the intention and inform RAN1 about the possible NBC change?**

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| **Company** | **Yes or No** | **Comments** |
| Qualcomm Incorporated |  | We can accept sending LS to RAN1 to confirm. |
| ZTE | Ok to send an LS if majority agree. |  |
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In RAN1 reply LS, it is required that only one from FG 11-2c and FG 11-2g can be reported by UE if reported, and only one from FG 11-2a and FG 11-2f can be reported by UE if reported. However, that will be an NBC change since there is no such restriction in current RAN2 spec.

It is proposed in [7] that a higher capability can be considered by the network if both FG 11-2a and FG 11-2f are reported by UE, or if both FG 11-2c and FG 11-2g are reported by UE. A LS should be sent to RAN1 to confirm the understanding above.

**Proposal 2:** RAN2 asks RAN1 whether a higher capability can be considered by the network if both FG11-2a and FG 11-2f are reported by the UE, or if both FG11-2c and FG 11-2g are reported by UE.

**Q10 Do companies agree a higher capability can be considered by the network if both FG11-2a and FG 11-2f are reported by the UE, or if both FG11-2c and FG 11-2g are reported by the UE?**

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| **Company** | **Yes or No** | **Comments** |
| Qualcomm Incorporated | No | This is conditional to what RAN1 says about backward compatibility of note 3 / note4. It is not even very clear what is “higher capability” in this context. |
| ZTE |  | We share the similar view as Qualcomm |
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**Q10a If the answer to Q10 is Yes, do companies agree to send a LS to RAN1 to confirm such understanding?**

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| **Company** | **Yes or No** | **Comments** |
| Qualcomm Incorporated | No | This is conditional to what RAN1 says about backward compatibility of note3/note4. We could ask how the network picks UE capability if both have to be reported to avoid NBC. |
| ZTE |  | We share the similar view as Qualcomm |
| Intel | OK to send a LS if majority agrees. | Maybe it would be good to check directly with RAN1 on the intention of the note before adding such notes and making changes. |
| Huawei, HiSilicon |  | We are fine to check with RAN1 on the backward compatibility of note3/4. |
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| Summary  All the companies agree with the intention of the CR R2-2203490/R2-2203491. For the possible NBC issue, companies agree to send a LS to RAN1 asking to clarify the intention and the backward compatibility in their LS NOTE2/3/4.  Proposal 5: Send a LS to RAN1 asking to clarify the intention and the backward compatibility in their LS NOTE2/3/4. CRs [R2-2203490](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2203490.zip), [R2-2203491](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2203490.zip) are postponed. |

### **BCS**

[R2-2203409](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2203409.zip) BCS for non-CA band combination Ericsson CR Rel-16 38.331 16.7.0 2956 - F NR\_newRAT-Core, TEI16

The above CR [10] intends to clarify the field description for *supportedBandwidthCombinationSet* capability. The CR includes the following change:

Add a clarification to the field description of the *supportedBandwidthCombinationSet* that the field does not restrict the bandwidths configured for a single CC (i.e. non-CA case).

**Q11 Do companies agree with the intention of the CR?**

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| **Company** | **Yes or No** | **Comments** |
| Nokia | No | By definition this should be the understanding, we don’t see a need to clarify this. |
| Qualcomm Incorporated |  | The proposal is technically correct. No strong view if any clarification is needed. |
| Ericsson | Yes | Proponent. The topic was raised in RAN2 email discussion [AT116bis-e][040][NR17] BCS4/BCS5, ([R2-2201911](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs/R2-2201911.zip)). There were no objections by companies, but the email discussion concluded the topic was general to BCS and that a separate discussion was needed. |
| Apple | No strong view |  |
| OPPO | Yes | At least intention agreeable. |
| Huawei, HiSilicon | No | There is no need to add such clarification since it is clear in RAN4 spec that a BCS is defined for CA case, but not for sinlge CC. That is a common understanding for both UE and network vendors, and no issue was found in real network.  Besides, for the bandwidth of a fallback single CC, we understand the principle as agreed in RAN2#115e meeting should be applicable as well, that   |  | | --- | | => **RAN2 confirms that the channel bandwidths of a (not signalled) fallback BC are determined by the bandwidth combination set (BCS) that the UE supports for the explicitly signalled parent BC. In other words, the NW interprets a BCS ID only in combination with the table row that the signalled BC refers to.** |   In our view, there is no need to have any change based on the current spec. The proposed clarification in above CR only makes the spec more confusing to understand. |
| ZTE | Yes | We tend to agree this CR. In the last meeting, when discuss BCS4/5, there were also several companies support this modification with a separate CR. |
| MediaTek | No strong view |  |
| Samsung | No | Not sure if it’s essential |
| Intel | No strong view |  |
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| Summary  Three companies agree with the intention of the CR. Three companies think it is not essential, and one company has explicit concern that the proposed CR will make the spec more confusing on fallback bandwidth understanding. Four companies have no strong view.  Proposal 6: Further discuss whether the CR R2-2203409 is needed at next phase. |

### **R15 DC combination without CA**

[R2-2202525](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2202525.zip) Support of DC combination without CA Apple CR Rel-15 38.306 15.16.0 0680 - F NR\_newRAT-Core

[R2-2202526](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2202526.zip) Support of DC combination without CA Apple CR Rel-16 38.306 16.7.0 0681 - A NR\_newRAT-Core

The intention of CRs in [11][12] is to clarify in the field description of ca-ParametersNRDC that the presence of this field in the UE capability for a particular combination that UE reported (using an entry of BandCombinationList) while the absence of ca-Parameters implies that the UE only support NR-DC for that particular combination and not CA.

**Q12 Do companies agree with the intention of the CRs above?**

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| **Company** | **Yes or No** | **Comments** |
| Nokia | No | If we remember something like this was already captured in the Chair notes. Maybe other companies do remember a discussion previously like this. |
| Qualcomm Incorporated | No | We do not think the proposal works because ca-ParametersNR is needed even in case of NR-DC.  Note that the following was agreed based on R2-2004436 (QC in RAN2#110), but RAN2 did not clarify how we do it in the standard.   * *RAN2 confirms that the current UE capability signalling allows the UE to declare band combinations where NR-DC is supported, but NR CA is not supported.*   We are open to add specification clarification based on the previous agreement though. |
| Ericsson | No | We already clarified this in RAN2#109-e below:  R2-2004436 Signalling of NR-DC only band combination Qualcomm Incorporated discussion Rel-15 NR\_newRAT-Core  [021] DISCUSSION and DEC  - RAP half time: The offline discussion [023] seems to be converging towards the same direction  [021] Half time: RAN2 confirms that the current UE capability signalling allows the UE to declare band combinations where NR-DC is supported, but NR CA is not supported.  [021] Noted |
| Apple (proponent) | Pls see comment | Thanks to Ericsson for pointing out the discussion/notes on this. This CR intends to show in which case that relevant chairman’s note is application.  To Qualcomm: *ca-ParametersNR* is indeed needed, but it would be defined as part of *ca-ParametersNRDC.*  Our view is to define when the UE/NW would know that the (already agreed possibility of) UE supports DC but not CA is signaled. |
| OPPO | See comment | We are open to clarify in which way the agreement from 110 can be applied in the spec (e.g., considering FSC is mandatory, how to understand the case “the UE to declare band combinations where NR-DC is supported, **but NR CA is not supported**”) |
| Huawei, HiSilicon | No | we have similiar views as Ericsson, the solution previously discussed was in R2-2004436 as below:  1. In the featureSetCombinationDC (for NR-DC), the UE can set FeatureSetUplinkId and FeatureSetDownlinkId for each band to non-zero value, i.e. pointing to a valid feature set. 2. In the featureSetCombination (for CA, mandatory present), the UE can set FeatureSetUplinkId and FeatureSetDownlinkId to 0.  It was not reflected in the specification because to set featureset to 0 is already allowed in the current specification. Thus we don't think we need any new solutions here. |
| ZTE | No strong view | We don’t have strong view for that this issue has been discussed before and without any spec modification. We are OK to add more clarification if companies think that the current spec is not clear enough. |
| MediaTek | No strong view | We have similar understanding as Huawei on how to indicate NR-DC without supporting CA. We are open on whether to clarify this SPEC. |
| Samsung | No | Not sure if it’s essential |
| Intel | No strong view | It seems like there is already a way to indicate NR-DC and no CA. It would be good not to have duplicated ways of doing the same thing. However, we are open to clarification in the spec. |

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| Summary  Some companies indicate that this issue has been discussed in RAN2 previously and there has been a way to indicate NR-DC and no CA without any specification impact. Five companies intend not to have a cycle discussion, four companies have no strong view and open to clarification in the spec, and one company supports to have some clarification.  Proposal 7: Further discuss whether previous agreed way in R2-2004436 needs to be reflected in the specification at next phase. |

## Part 2

### **Further discussion on BCS**

During phase1 discussion, some companies support the clarification in the CR, some companies consider the CR as not essential, and other companies have no strong view. One company prefers to keep the wording in current spec, with the concern to bring unnecessary confusion on the bandwidth of fallback single CC. Since RAN2 has agreed that channel bandwidths of a (not signalled) fallback BC are determined by the bandwidth combination set (BCS) that the UE supports for the explicitly signalled parent BC, this principle is considered applicable for single CC as well.

**Q13 Do companies think the above issue exists as indicated in phase1 discussion?**

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| **Company** | **Yes or No** | **Comments** |
| Huawei, HiSilicon | Yes | We think according to the current spec, for a not signalled fallback single CC, it shall support the same channel bandwidths determined by the bandwidth combination set (BCS) that the UE supports for the explicitly signalled parent BC. It could be considered as a requirement but not a restriction on specific channel bandwidths. Except for this, there is no BCS related restriction defined for single CC case in current spec. |
| Ericsson | Yes | It is wise to capture this in 38.306 spec, although we agree there is no BCS-related restriction specified for non-ca case.  But, strictly according to current spec, UE is required to indicate additional non-CA BCs explicitly to avoid that networks assume bandwidth limitations. |
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**Q14 Do companies agree to pursue the CR R2-2203409?**

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| **Company** | **Yes or No** | **Comments** |
| Huawei, HiSilicon | No | There is no restriction on BCS for non-CA case in current spec thus no clarification is needed. |
| Ericsson | Yes | We prefer to have this clear in specifications.  We have agreed to add the corresponding clarification for the new BCS5 fields supportedMinBandwidthUL/DL in IPA CR in R2-2203124, so strange if not also clarified for supportedBandwidthCombinationSet |
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### **Further discussion on R15 DC combination without CA**

During phase 1 discussion, some companies indicate that this issue has been discussed in RAN2 previously and there has been a way to indicate NR-DC and no CA.

1. In the featureSetCombinationDC (for NR-DC), the UE can set FeatureSetUplinkId and FeatureSetDownlinkId for each band to non-zero value, i.e. pointing to a valid feature set.

2. In the featureSetCombination (for CA, mandatory present), the UE can set FeatureSetUplinkId and FeatureSetDownlinkId to 0.

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| R2-2004436 Signalling of NR-DC only band combination Qualcomm Incorporated discussion Rel-15 NR\_newRAT-Core  [021] DISCUSSION and DEC  - RAP half time: The offline discussion [023] seems to be converging towards the same direction  [021] Half time: RAN2 confirms that the current UE capability signalling allows the UE to declare band combinations where NR-DC is supported, but NR CA is not supported.  [021] Noted |

**Q15 Do companies agree the previous agreed way in R2-2004436 needs to be reflected in the specification?**

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| **Company** | **Yes or No** | **Comments** |
| Apple | Need a clarification in the spec. | We understand companies think that this is already possible, and are ok with this.  We have a couple of comments:   * In the case where the NW only supports CA, but not DC, we hope that NW implementations are ok to see that UE has reported featureSetU/D as 0 – in the case where the NW intends to use the fallback of this CA as configuration. * There are some per-BC capabilities reported using CA-parametersNR that are not needed if the UE does not support CA. Should the UE report this field or NW implementations are ok if the UE does not, and only reports CA-parametersNRDC..?   We think some clarification needs to be captured in the specification, as there are open items that are ambiguous otherwise. |
| Huawei, HiSilicon | No | We think it is already possible to indicate DC without CA by setting FS ID to zero without spec impact. There is no strong motivation to have further clarification in spec. But we are open on this.  For ca-ParametersNR, we think it is up to UE implementation whether to include it or not. That has no impact on determining whether the BC has CA capability or not.  If reported, the network will understand the corresponding fields according to the principle in current spec as below. If not reported, there is no problem for the network to understand ca-ParameterrsNR-forDC field instead. We think no other clarification is needed on this.  ***ca-ParametersNR-forDC (with and without suffix)***  If this field is present for a band combination, it reports the UE capabilities when NR-DC is configured with the band combination. If a version of this field (i.e., with or without suffix) is absent for a band combination, the corresponding *ca-ParametersNR* field version in *BandCombination* is applicable to the UE configured with NR-DC for the band combination. If a version of this field (i.e., with or without suffix) is present for a band combination but does not contain any parameters, the UE does not support the corresponding field version when configured with NR-DC for the band combination. |
| Ericsson | No | We think the way presented in R2-2004436 is already possible in the specifications and confirmed in meeting notes in RAN2 – even to derive a fallback BC, what the UE supports would ultimately be indicated on featureSetU/D; if those were set to 0, the UE does not support that band entry on the corresponding “line of feature sets” where the 0 was indicated.  On the comment on CA-parametersNR vs ca-ParametersNR-forDC, we should follow the derivation of ca-ParametersNR-forDC as we captured in its field description in 38.331:  ca-ParametersNR-forDC (with and without suffix)  If this field is present for a band combination, it reports the UE capabilities when NR-DC is configured with the band combination. If a version of this field (i.e., with or without suffix) is absent for a band combination, the corresponding ca-ParametersNR field version in BandCombination is applicable to the UE configured with NR-DC for the band combination. If a version of this field (i.e., with or without suffix) is present for a band combination but does not contain any parameters, the UE does not support the corresponding field version when configured with NR-DC for the band combination. |
| Apple2 | Suggestion | To progress can we capture in the chair notes as below: (?)  **It is RAN2 understanding that if the UE intends to report the support of DC but not CA for a combination, the UE can do as below, which would be spec compliant:**  **1. In the featureSetCombinationDC (for NR-DC), the UE can set FeatureSetUplinkId and FeatureSetDownlinkId for each band to non-zero value, i.e. pointing to a valid feature set. 2. In the featureSetCombination (for CA, mandatory present), the UE can set FeatureSetUplinkId and FeatureSetDownlinkId to 0.** |
| Ericsson2 |  | Fine with Apple’s suggestion. Just some further clarifications in red (since the UE would still support single carrier on the CA branch):  **It is RAN2 understanding that if the UE intends to report the support of DC but not CA for a band combination, the UE can do as below, which would be spec compliant:**  **1. In the featureSetCombinationDC (for NR-DC), the UE can set FeatureSetUplinkId and FeatureSetDownlinkId for each band to non-zero value, i.e. pointing to a valid feature set. 2. In the featureSetCombination (for CA, mandatory present), the UE can set FeatureSetUplinkId and FeatureSetDownlinkId for one band to non-zero value, while setting FeatureSetUplinkId and FeatureSetDownlinkId for other bands to 0.** |
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# Conclusions

**Part1:**

**Proposal 1: The endorsed CRs R2-2202810 and R2-2202811 will be revised for approval in the next phase, taking the comments in Phase 1 into account.**

**Proposal 2: The discussion paper R2-2203268 is noted.**

**Proposal 3: The CR R2-2203492 can be pursued, taking the comments from Phase 1 discussion into account.**

**Proposal 4: Send a LS to RAN1/RAN4 describing the issue and ask RAN1/RAN4 provide their view. RAN2 continue to discuss this issue after getting inputs from RAN1/RAN4.**

**Proposal 5: Send a LS to RAN1 asking to clarify the intention and the backward compatibility in their LS NOTE2/3/4. CRs** [**R2-2203490**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2203490.zip)**,** [**R2-2203491**](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_117-e/Docs/R2-2203490.zip) **are postponed.**

**Proposal 6: Further discuss whether the CR R2-2203409 is needed at next phase.**

**Proposal 7: Further discuss whether previous agreed way in R2-2004436 needs to be reflected in the specification at next phase.**

# References

1. R2-2202810 Adding UE capability of UL MIMO coherence for UL Tx switching Huawei, HiSilicon, China Telecom, Apple CR Rel-16 38.306 16.7.0 0635 2 F NR\_RF\_FR1-Core R2-2110483
2. R2-2202811 Adding UE capability of UL MIMO coherence for UL Tx switching Huawei, HiSilicon, China Telecom, Apple CR Rel-16 38.331 16.7.0 2786 2 F NR\_RF\_FR1-Core R2-2110484
3. R2-2203268 UE capabilities for UL full power modes Nokia, Nokia Shanghai Bell discussion Rel-16 NR\_eMIMO-Core
4. R2-2203492 Correction on ssb-csirs-SINR-measurement-r16 capability Huawei, HiSilicon CR Rel-16 38.306 16.7.0 0695 - F NR\_eMIMO-Core
5. R2-2202229 Discussion on BWP operation without bandwidth restriction Qualcomm Incorporated, ZTE Corporation discussion Rel-16 TEI16
6. R2-2202108 Reply LS on PDCCH Blind Detection in CA (R1-2112833; contact: Huawei) RAN1 LS in Rel-16 To:RAN2
7. R2-2203510 Discussion on PDCCH Blind Detection in CA Huawei, HiSilicon discussion Rel-16 NR\_L1enh\_URLLC-Core R2-2203489 Late
8. R2-2203490 Correction on PDCCH Blind Detection in CA Huawei, HiSilicon CR Rel-16 38.331 16.7.0 2961 - F NR\_L1enh\_URLLC-Core
9. R2-2203491 Correction on PDCCH Blind Detection in CA Huawei, HiSilicon CR Rel-16 38.306 16.7.0 0694 - F NR\_L1enh\_URLLC-Core
10. R2-2203409 BCS for non-CA band combination Ericsson CR Rel-16 38.331 16.7.0 2956 - F NR\_newRAT-Core, TEI16
11. R2-2202525 Support of DC combination without CA Apple CR Rel-15 38.306 15.16.0 0680 - F NR\_newRAT-Core
12. R2-2202526 Support of DC combination without CA Apple CR Rel-16 38.306 16.7.0 0681 - A NR\_newRAT-Core