**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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| --- | --- |
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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. |
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### **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. |
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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. |
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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. |
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[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. |
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### **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 |  |
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**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. |
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### **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 |  |
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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. |
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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. |
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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. |
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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. |
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### **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. |
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### **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 |
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# Conclusions

*To be added…*

# 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