**S3GPP TSG-RAN WG2 Meeting #115-e R2-210xxxx**

**Online, Aug 16th – 27th, 2021**

**Agenda Item: 5.4.3**

**Source: Huawei, HiSilicon**

**Title: Summary of [AT115-e][016][NR15] UE Capabilities II**

**Document for: Discussion and decision**

# Introduction

This document summarizes the following offline discussion.

* [AT115-e][016][NR15] UE Capabilities II (Huawei)

Scope: Determine agreeable parts in a first phase, for agreeable parts agree on CRs. Treat R2-2108574, R2-2108575, R2-2107390, R2-2108578, R2-2108579, R2-2108580, R2-2106958, R2-2107980, R2-2106963, R2-2108572, R2-2108573, R2-2107130, R2-2107389,

Intended outcome: Report, agreed CRs if applicable

Deadline: Schedule 1

# Contact from companies

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| --- | --- |
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# Discussion

## Part 1: Intended to determine agreeable parts

### BW handling

[R2-2108574](file:///D:/Documents/3GPP/tsg_ran/WG2/RAN2/2108_R2_115-e/Docs/R2-2108574.zip) Introduction of NR channel bandwidth capability for LTE-to-NR HO case Huawei, HiSilicon CR Rel-15 36.331 15.14.0 4716 - F NR\_newRAT-Core

[R2-2108575](file:///D:/Documents/3GPP/tsg_ran/WG2/RAN2/2108_R2_115-e/Docs/R2-2108575.zip) Introduction of NR channel bandwidth capability for LTE-to-NR HO case Huawei, HiSilicon CR Rel-16 36.331 16.5.0 4717 - A NR\_newRAT-Core

In IE *UE-EUTRA-Capability*, UE only reports supported NR bands in NR-SA for handover and redirection. However, the UE may not 100% be able to work under the target gNB although the UE can support the NR band, it still relies on the supported bandwidth of this band. Thus, the target gNB checks UE NR capability and may find that the UE supported bandwidth cannot fulfil the condition, the target gNB will reject this handover procedure. It increases the failure probability for handover preparation and leads to handover delay and signalling overhead.

The proposed change is: to introduce the NR channel bandwidth capability per SCS in IE *UE-EUTRA-Capability*.

**Q1 Do companies agree with the intention of the CRs above?**

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| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| Qualcomm Incorporated | No | We propose to leave it to network implementation for the benefit that it can address legacy UEs. Future UEs will support more channel BWs and the problem itself will diminish.  Note that we still have very fundamental issue in NR standalone mode, i.e. the compatibility of channel BW capability between the UE and the network is not ensured before the UE access. We raised the issue back in August 2018 (R2-1811132). The feedback we got was “network can take care of it”. After some discussion, the only requirement is that the UE checks if it supports lower BW than the BW indicated in SIB1. |
| Docomo | Yes | We agree with the intention, although the solution might not work in UEs with non-downward-compatible channelBWs-UL/DL.  The eNB should not be required to comprehend UE-NR-Capability. |
| Nokia | No | Source eNB should not be expected to comprehend the NR capability. In that sense, if there is a mismatch the target should fail the HO. We don’t see any need for an enhancement and we fully agree with Qualcomm that this might be a solution with a diminishing return. |
| Apple | No | We see there is no need for an enhancement, and also agree with Qualcomm about this being already discussed. |
| SoftBank | No | Agree with the above companies, it was discussed before. |
| Ericsson | No | We agree that there may be cases where the UE supports the band of the intended target gNB but where it does not support a carrier bandwidth that the target gNB could use. But including those in the EUTRA capabilities would not help for several reasons.  Besides the carrier bandwidth bitmap (in BandNR) the supported bandwidth may be further limited by fields in the feature sets per CC. And signalling the entire NR supportedBandCombinationList in the EUTRA capabilities and validating it in the eNB is certainly not desirable.  Also, the lack of other features may prevent the gNB from admitting the UE. Hence, even if the UE reports the NR carrier bandwidths in the EUTRA capabilities, the connection may fail anyway (e.g. DSS not supported by the UE).  One should also bear in mind that the source node may not even know which features the target gNB requires (e.g. DSS). Hence, even if one would include all those capabilities into the EUTRA capabilities or if one would require the source eNB to peek into the NR capabilities, it could not do the validation anyway.  As QC said, those cases should vanish as more UEs support more bandwidths and the other vital features that may prevent a gNB from accepting a UE. If it happens anyway, the target gNB has now the possibility to indicate “insufficient UE capabilities” as cause value and thereby prevent the source eNB from trying again for the same UE shortly afterwards. |
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[R2-2107390](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_115-e\Docs\R2-2107390.zip) UE Capability filtering solution for EN-DC BC selection issue NTT DOCOMO, Inc. discussion Rel-17 TEI17

In realistic deployments, there is a possibility that EN-DC configuration fails due to the band combination selection process between eNB and gNB, if gNB supports only certain value of bandwidth (e.g. 100MHz). The proposals are listed below.

Proposal 1: RAN2 to support NR UE capability filtering by additional NR bandwidth parameters, e.g. list of channel bandwidths that should be supported for each band in the reported band combinations.

Proposal 2: RAN2 to support NR UE capability filtering by subcarrier spacing.

**Q2 Do companies agree with the intention of Proposal 1&2 above?**

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| **Company** | **Yes or No** | **Comments** |
| Qualcomm Incorporated | No | We propose to leave it to network implementation for the benefit that it can address legacy UEs. Future UEs will support more channel BWs and the problem itself will diminish.  Note that we still have very fundamental issue in NR standalone mode, i.e. the compatibility of channel BW capability between the UE and the network is not ensured before the UE access. We raised the issue back in August 2018 (R2-1811132). The feedback we got was “network can take care of it”. After some discussion, the only requirement is that the UE checks if it supports lower BW than the BW indicated in SIB1. |
| Docomo | Yes | As proponent.  If the CBWs supported by gNB and UE doesn’t match in any of the supported BCs, e.g. UE doesn’t support 100MHz CBW in any BCs in the network only supporting 100MHz CBW, this will be a problem. |
| Nokia | Maybe | To Docomo, how big is the problem at hand? Usually network is expected to support more channel bandwidths and be rather generic in such support so we don’t see why this is a problem. |
| Apple | No | While we sympathise with DCM, we also view that this additional filtering creates more effort at the UE with diminishing returns, while NWs usually support higher BWs anyway and are expected to configure the UE with UE supported BWs (as long as the UE can support initial BWP BW).  Moreover, we still have the issue with legacy and roaming UEs which do not support this change and the NW has to handle these anyway. |
| Ericsson | No | Same comments as for Q1. But an additional aspect is that adding such filtering possibility may imply that upon handover a target node may need to reacquire the UE capabilities, since it may be interested on different bandwidths. |
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[R2-2108578](file:///D:/Documents/3GPP/tsg_ran/WG2/RAN2/2108_R2_115-e/Docs/R2-2108578.zip) Support of newly introuduced 100M bandwidth for band n40 Huawei, HiSilicon discussion Rel-15 NR\_newRAT-Core

In RAN4#99e meeting, the new channel bandwidth 90M/100M were introduced for band n40, RAN2 need to consider how to differentiate the new UEs supporting 100MHz in n40 and the legacy n40 UEs which does not supporting 100MHz. The proposal is listed below.

Proposal 1: use spare bit in *channelBWs-DL/UL-v1590* to indicate the support of 100MHz channel bandwidth introduced later than 38101-1 v17.1.0 for FR1, and mandate the new UEs to set this bit to 1.

**Q3 Do companies agree with the intention of Proposal 1 above?**

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| **Company** | **Yes or No** | **Comments** |
| Qualcomm Incorporated | Yes, but | We understand the intention is to introduce IOT bit. Then the UE should not be mandated to set the bit to 1 (as written in the proposal 1).  And on the CR in R2-2108579, we think the following sentence is difficult to understand, and we do not think we should refer to a given version of the RAN4 specification.   * "The UE supports the 100M channel bandwidths for FR1 that were defined in clause 5.3.5 of TS 38.101-1 version 17.1.0 [2] for the given band.". |
| Nokia | Yes | There are two choices 1) Use the spare bit (as proposed by HW) OR 2) define specific capability for band n40. While 1) is more general, we think it may cause more problems (how does network know UE supports the spare value but doesn't support 100 MHz, or whether it's just a legacy UE). So perhaps 2) would be simpler in the end as this is a cleaner approach and probably avoids confusion in the future for implementations. |
| Apple | Yes with the intention | But we also think some discussion is needed on the use of spare bit. |
| SoftBank | See comments | Agree with the intention. We are open for the solution, but basically using spare bit should be carefully checked for avoiding side effects. |
| Ericsson | No | Specifying the conditions for setting this new bit tend to be very complex, as well as to use it for nw validation. We realize the network anyway needs to validate the intended carrier bandwidth against the supportedBandwidthDL/UL in FeatureSetPerDownlink/UplinkCC (i.e. we disagree with the statement in the paper that “*the network is only required to check the BandNR parameters to validate the supported SCS/bandwidth for of the UE*”). |
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[R2-2107980](file:///D:/Documents/3GPP/tsg_ran/WG2/RAN2/2108_R2_115-e/Docs/R2-2107980.zip) Allowed bandwidth in BWP configuration Ericsson discussion

In RAN2#114-e, this topic was addressed but no conclusion was taken, the contribution discusses this scenario and the impact to BWP configuration. The proposals are listed below.

Proposal 1 When configuring a UE with a dedicated BWP that is not within the channel bandwidth that the UE applied when acquiring SIB1, the network configures the downlinkChannelBW-PerSCS-List and/or uplinkChannelBW-PerSCS-List so that the channel bandwidth covers at least the active BWP.

Proposal 2 The network avoids DCI- and timer-based BWP switching to BWPs that are not within the RRC-configured channel bandwidth.

**Q4-1 Do companies agree with the intention of Proposal 1 above?**

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| **Company** | **Yes or No** | **Comments** |
| Qualcomm Incorporated | Yes | Thank you for giving us some time to check, from the last meeting. |
| Nokia | Partly | Firstly, we would like to confirm a common understanding that UE behaviour is not specified when CBW doesn't contain BWP size (that was always the R15 assumption).  Scenario in P1 seems a special (or corner) case and network should avoid going to that direction which may cause unpredictable UE behavior. Given this, we think only need to capture the understanding first and then see if anything specific needs to be added to the specification. |
| Apple | We agree with the intentions of both proposals. |  |
| SoftBank | Yes |  |
| Ericsson | Yes (proponent) | We agree to first try to reach common understanding. We understand the proposals above are already allowed in the specifications so no change may be required. |
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**Q4-2 Do companies agree with the intention of Proposal 2 above?**

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| **Company** | **Yes or No** | **Comments** |
| Qualcomm Incorporated | Yes |  |
| Nokia | No | See answer to Q4-1 |
| Apple | We agree with the intentions of both proposals. |  |
| SoftBank | Yes, but | We think no need to update any specifications. |
| Ericsson | Yes (proponent) | See comments to Q4-1. |
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### SimultaneousRxTx

[R2-2106958](file:///D:/Documents/3GPP/tsg_ran/WG2/RAN2/2108_R2_115-e/Docs/R2-2106958.zip) Reply LS on simultaneous Rx/Tx capability (R4-2108003; contact: Qualcomm) RAN4 LS in Rel-15 NR\_newRAT To:RAN2

[R2-2106963](file:///D:/Documents/3GPP/tsg_ran/WG2/RAN2/2108_R2_115-e/Docs/R2-2106963.zip) Reply LS on simultaneous Rx/Tx capability (R4-2111452; contact: Huawei) RAN4 LS in Rel-15 NR\_newRAT To:RAN2

[R2-2108572](file:///D:/Documents/3GPP/tsg_ran/WG2/RAN2/2108_R2_115-e/Docs/R2-2108572.zip) Clarification on the simultaneousRxTxInterBandCA capability in NR-DC Huawei, HiSilicon, Ericsson CR Rel-15 38.306 15.14.0 0561 2 F NR\_newRAT-Core R2-2106128

[R2-2108573](file:///D:/Documents/3GPP/tsg_ran/WG2/RAN2/2108_R2_115-e/Docs/R2-2108573.zip) Clarification on the simultaneousRxTxInterBandCA capability in NR-DC Huawei, HiSilicon, Ericsson CR Rel-16 38.306 16.5.0 0562 2 A NR\_newRAT-Core R2-2106129

[R2-2107130](file:///D:/Documents/3GPP/tsg_ran/WG2/RAN2/2108_R2_115-e/Docs/R2-2107130.zip) Simultaneous Rx/Tx UE capability Qualcomm Incorporated discussion Rel-15 NR\_newRAT-Core

[R2-2107389](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_115-e\Docs\R2-2107389.zip) Considerations on simultaneous Rx/Tx capability per band pair NTT DOCOMO, Inc. discussion Rel-15

In the LS R2-2106958, there are UEs that do not support simultaneous Rx/Tx capability for a band combination, but do support simultaneous Rx/Tx operation for some band pair(s) in the band combination. RAN4 asks to introduce per-band-pair signalling to the simultaneous Rx/Tx capability. Two possible solutions are provided in [10] and [11].

The proposals in [10] are listed below.

Proposal 1: Introduce UE capability signalling by which the UE indicates groups of bands where simultaneous Rx/Tx is NOT supported among bands in a group (FFS signalling details).

Proposal 2: The new UE capability signalling is introduced as an extension to the existing band combination list, i.e. no new band combination list is introduced.

Proposal 3: The UE using the new UE capability signalling shall not indicate the simultaneous Rx/Tx capability for the band combination, i.e. simultaneousRxTxInterBandCA and/or simultaneousRxTxInterBandENDC.

Proposal 4: The new UE capability signalling is introduced in release-16.

The proposals in [11] are listed below.

Proposal 1: RAN2 to specify per-band-pair signalling for simultaneous Rx/Tx capability as RAN4 suggested.

Proposal 2: Add a bitmap in MRDC-Parameters and CA-Parameters, where each bit represents whether simultaneous Rx/Tx is supported for a band pair in the BC.

**Q5-1 Do companies agree with the intention of introducing new capability signalling to support simultaneous Rx/Tx capability in a finer granularity for a band combination? If yes, which solution do companies prefer?**

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| --- | --- | --- | --- |
| **Company** | **Yes or No** | **Support of solution in [10] or [11] or other?** | **Comments** |
| Qualcomm Incorporated | Yes | [10] - Proponent | Per band pair signalling [11] may result in a large overhead. We think it is more useful for the network to know the configuration / scheduling restriction applicable to a group of bands than to know the UE capability of simultaneous capability per band pair. |
| Docomo | Yes | Fewer bits, Rel-15 | The lack of granularity is observed in UEs in the field. Solution should be available from Release 15.  As for signalling design, we understand both of [10] and [11] aim for fewer bits, and we would not stick to our solution in [11] if there is any other solution with fewer bits and the same granularity.  In this sense, whether to adopt exclude-list style (P1 of [10]) or not should be discussed jointly with the signalling design. Please note that a naïve solution of the exclude-list (2 x 5-bit “band index in the BC”) might consume 10 bits **per excluded band pair** per BC. |
| Nokia | See comments |  | For the R2-2107130/ R2-2107389, we are open to the final solution but the proposals from Docomo seemed cleaner and easy to understand. So we would like to go in that direction. |
| Apple | Yes | [11] | We think Docomo’s proposal is simpler and inline with the LS. |
| SoftBank | Yes | See comments | Both solutions can work but slightly prefer [11] as it is simpler solution. In addition, we also prefer to introduce this from Rel-15. |
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| Ericsson | Yes | Other: One new bit per BC for simultaneous Rx-Tx among TDD-FDD pairs only. | As QC says, we are concerned about the additional overhead and the complexity to validate it.  We think we can try to simplify the signaling by adding just one new bit per BC: simultaneousRxTxInterBandCA-TDD-FDD.  We understand that the typical problem today is that a UE cannot support simultaneous RxTx on two TDD carriers of a BC whereas it could support it between the FDD and TDD carriers of that BC. In such cases the UE may set the simultaneousRxTxInterBandCA-TDD-FDD. A gNB that comprehends that new field could transmit on the FDD UL and still expect the UE to receive on the TDD DL(s).  We think that the overhead and complexity of a more fine-grained signalling per BC is not justified by the use cases. |
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In the LS R2-2106963, RAN4 understands that the per BC capability is determined by UE implementation, therefore, there is no distinguishment for applicability of this UE capability for cases of same cell group or cross cell groups, i.e. the capability can apply across cell-groups for NR-DC.

The proposals in [10] are listed below.

Proposal 5: RAN2 to confirm the following interpretation of simultaneousRxTxInterBandCA does not cause any interoperability issue.

1. The UE indicating the support for simultaneousRxTxInterBandCA for an NR-DC band combination is considered to support simultaneous Rx/Tx for any pair of TDD-FDD / TDD-TDD bands, including intra-CG and inter-CG.

2. The UE not indicating the support for simultaneousRxTxInterBandCA for an NR-DC band combination is considered not to support simultaneous Rx/Tx for any pair of TDD-FDD / TDD-TDD bands, including intra-CG and inter-CG.

3. In case 2, the legacy network would not configure the UE with NR-DC due to the lack of inter-node resource coordination mechanism, or shall avoid simultaneous Rx/Tx across CGs (e.g. via an implementation specific solution).

Proposal 6: Inform RAN3 about RAN2 agreements and request RAN3 to make necessary changes to their specifications.

**Q5-2 Do companies agree with Proposal 5 above? If yes, do companies agree with Proposal 6 above?**

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| --- | --- | --- | --- |
| **Company** | **Yes or No**  **for Proposal 5** | **Yes or No**  **for Proposal 6** | **Comments** |
| Qualcomm Incorporated | Yes | Yes | Proponent |
| Docomo | Yes | No | P6: not clear what RAN3 impact is expected on top of the information of bands used in MN (see our answer in Q5-4) |
| Nokia | Yes | No | Agree with Docomo |
| Apple | Yes | No strong view |  |
| SoftBank | Yes | No | Agree with Docomo |
| Ericsson | Yes | No | On Proposal 6, we should first try to further understand whether currently this cannot be solved by other means. For instance, the Xn IE TDD UL-DL Configuration Common NR may be used so that MN and SN are aware of each other TDD UL/DL patterns. |
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The proposed change in [8][9] is: to clarify that *simultaneousRxTxInterBandCA* capability applies to any of the NR bands of the same CG and across MCG and SCG in NR-DC case.

**Q5-3 Do companies agree with the intention of the CRs above?**

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| **Company** | **Yes or No** | **Comments** |
| Qualcomm Incorporated | Yes |  |
| Docomo | Yes |  |
| Nokia | Yes but we think it could be simplified? | For R2-2108572/ R2-2108573, the CR does not say if the UE does not include the field for ca-ParametersNR-ForDC. What happens then? As per RAN4 LS it seems the inclusion in one place is enough to also cover for NR-DC. Then maybe the clarification should be like that that it is enough to also signal the DC field. |
| Apple | Yes, but we would like to discuss the issue raised by Nokia. |  |
| SoftBank | Yes |  |
| Ericsson | Yes (proponent) | We think what happens on the inclusion or not of the field in ca-ParametersNR-ForDC would be handled as any other field contained within ca-ParametersNR-ForDC as clarified 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 no version of this field (i.e., with and without suffix) is present for a band combination, the ca-ParametersNR field versions (with and without suffix) in BandCombination are applicable to the UE configured with NR-DC for the band combination. |
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In [11], it was observed that as *allowedBC-ListMRDC* omits the fallback band combinations, *allowedBC-ListMRDC* alone is not sufficient for the SN to determine which band pair to check the simultaneous Rx/Tx capability. The proposals in [11] are listed below.

Proposal 3: RAN2 to specify that the SN can use the selectedBandEntriesMNList field to check the per-band-pair simultaneous Rx/Tx capability in NR-DC, (NG)EN-DC, and NE-DC.

**Q5-4 Do companies agree with the intention of Proposal 3 above?**

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| **Company** | **Yes or No** | **Comments** |
| Qualcomm Incorporated | No | Can be clarified what is missing with the existing dynamic coordination mechanism that RAN3 had defined for MR-DC. |
| Docomo | Yes | As proponent.  If dynamic resource coordination is not used, the proposed solution is simpler. The network should not be mandated to support dynamic coordination mechanism. |
| Nokia | Yes | Think Docomo’s understanding is correct… @Qualcomm what is the dynamic coordination in RAN3 you are referring to? |
| SoftBank | Yes |  |
| Ericsson | No | If the SN could alternatively derive from the fields servFrequenciesMN-NR or servCellInfoListMCG-EUTRA-r16 which carriers the MN intends to configure and then validate the simultaneous RxTx capability only for those. However, we do not think this needs to be specified. |
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# Conclusions

*To be added…*

# References

BW handling

1. R2-2108574 Introduction of NR channel bandwidth capability for LTE-to-NR HO case Huawei, HiSilicon CR Rel-15 36.331 15.14.0 4716 - F NR\_newRAT-Core
2. R2-2108575 Introduction of NR channel bandwidth capability for LTE-to-NR HO case Huawei, HiSilicon CR Rel-16 36.331 16.5.0 4717 - A NR\_newRAT-Core
3. R2-2107390 UE Capability filtering solution for EN-DC BC selection issue NTT DOCOMO, Inc. discussion Rel-17 TEI17
4. R2-2108578 Support of newly introuduced 100M bandwidth for band n40 Huawei, HiSilicon discussion Rel-15 NR\_newRAT-Core
5. R2-2107980 Allowed bandwidth in BWP configuration Ericsson discussion

SimultaneousRxTx

1. R2-2106958 Reply LS on simultaneous Rx/Tx capability (R4-2108003; contact: Qualcomm) RAN4 LS in Rel-15 NR\_newRAT To:RAN2
2. R2-2106963 Reply LS on simultaneous Rx/Tx capability (R4-2111452; contact: Huawei) RAN4 LS in Rel-15 NR\_newRAT To:RAN2
3. R2-2108572 Clarification on the simultaneousRxTxInterBandCA capability in NR-DC Huawei, HiSilicon, Ericsson CR Rel-15 38.306 15.14.0 0561 2 F NR\_newRAT-Core R2-2106128
4. R2-2108573 Clarification on the simultaneousRxTxInterBandCA capability in NR-DC Huawei, HiSilicon, Ericsson CR Rel-16 38.306 16.5.0 0562 2 A NR\_newRAT-Core R2-2106129
5. R2-2107130 Simultaneous Rx/Tx UE capability Qualcomm Incorporated discussion Rel-15 NR\_newRAT-Core
6. R2-2107389 Considerations on simultaneous Rx/Tx capability per band pair NTT DOCOMO, Inc. discussion Rel-15