3GPP TSG-RAN WG2 #116-e DRAFT R2-21xxxxx

Electronic Meeting, 1–12 Nov 2021

Source: NTT DOCOMO, INC.

Title: Report for [Post115-e][087][NR15] Simultaneous Rx/Tx cap finer granularity (NTT DOCOMO)

Agenda Item: x.y.z

Document for: Discussion and decision

# Introduction

This document is for the following email discussion planned during RAN2 #115-e.

* [Post115-e][087][NR15] Simultaneous Rx/Tx cap finer granularity (NTT DOCOMO)

 Scope: Aim to conclude in Q4. Progress based on R2-2107389. Consider also using the selectedBandEntriesMNList field to check the per-band-pair simultaneous Rx/Tx capability in NR-DC, (NG)EN-DC, and NE-DC. Consider also Inter-Node Coordination. If needed, can also disucss the scope in the beginning of the email discussion.

 Intended outcome: Report, CRs Agreeable to the extent possible / reasonable.

 Deadline: Long

Moderator would like to organize this email discussion in two phases:

**Phase 1**: Companies are invited to provide comments to the questions by Sep 30th.

**Phase 2**: Moderator provides the Phase 1 summary and updated draft CRs by Oct 11th and companies ~~can further comment~~ are invited to provide Phase 2 comments by Oct 19th, 0900 UTC; Moderator finalizes the summary and the draft CRs to submit on Oct 22nd.

# Contact points

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# Phase 1 Discussion

In the LS R2-2106958 [1], RAN4 asked to introduce per-band-pair signalling to the simultaneous Rx/Tx capability. In the last RAN2 meeting, it is discussed how to reflect the signalling into RAN2 specifications. Main open issues are as follows:

* UE capability signalling design for finer granularity
* Inter-node signalling to help validate per-band-pair capability
* Dynamic resource coordination

As a baseline, draft CRs that were discussed during RAN2 #115-e can be found in [5][6][7][8].

## UE capability signalling design

In this section, UE capability signalling design is discussed.

In RAN2 #115-e, there seems to be consensus on the intention of introducing new capability signalling to support simultaneous Rx/Tx capability in a finer granularity for a band combination. As for the detailed signalling design, a bitmap-based solution (Solution 1 below) gained substantial support as a baseline, but the discussion was postponed as some companies needed more time for checking and detailed discussion.

To aid the discussion, moderator tries to list the optimisation options that were proposed during RAN2 #115-e as follows, with some observations on pros/cons:

**Solution 1**: Baseline bitmap solution in the draft CRs [5-8]. Bitmap with length L(L-1)/2 for each band combination, where L is the number of band entries in the BC. Each bit represents whether simultaneous Rx/Tx is supported for each band pair in the BC. This seems to be a straightforward solution, with moderate signalling overhead in practical conditions (e.g. 10 band pairs for a 5-band BC) while large overhead in very large BCs (496 band pairs for a 32-band BC).

**Solution 2**: Exclude-list style solution as proposed in [3]. For each BC, list of band pairs for which simultaneous Rx/Tx is NOT supported is signalled. Justification from the proponent is that the solution enables network to know the configuration / scheduling restriction applicable to a group of bands. As compared to the baseline solution, depending on the scenario, this solution could reduce the signalling overhead if the exclude-list has small number of entries and otherwise could increase the overhead.

**Solution 3**: One new bit per BC indicating the support for simultaneous Rx/Tx for any TDD-FDD band pairs, as suggested by Ericsson during the email discussion [4]. Justification from the proponent is that it reduces overhead and complexity as compared to per-band-pair granularity. Moderator wonders if this solution aligns with RAN4 request/discussion, which moderator thinks should be clarified if companies would like to proceed with this solution.

**Solution 4**: Filtered bitmap solution only taking the band pair that includes at least one UL band into consideration, as proposed by ZTE during the email discussion [4]. As compared to the baseline solution, this solution could reduce the signalling overhead in many cases, at the potential cost of complexity.

Companies are invited to further discuss the solutions for convergence.

**Q1-1: Which solution do companies prefer and why? Analysis on signalling overhead, complexity, etc, is encouraged.**

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| --- | --- | --- |
| **Company** | **Preferred solution** | **Comments** |
| Docomo | 1 (See comments for other solutions) | We basically prefer Solution 1 as it is simple. Solution 4 would also be ok (or even better) if its complexity is acceptable to vendors.We do not prefer Solution 2 as its overhead could be larger than other solutions. However, if UE vendors can ensure that overhead is comparable to other solutions, i.e. number of list entries is sufficiently small, for now and future, then we could accept Solution 2. |
| CATT | Solution 1 | Solution1 is simple and able to cover all the use cases, the overhead of solution.1 is not so large since usually the band number of BC is 5.For solution 3, we have the same consideration as Moderator, it may be not aligned to the LS from R4 that discussed the information for each band pair other than a new bit to indicate the support for simultaneous Rx/Tx for any TDD-FDD band pairs.Soluton.2 and 4 are kind of variations of solution.1, may be less overhead is generated in some dedicated cases, but not sure it is beneficial for all the cases.  |
| Huawei, HiSilicon | Solution 1 | We have some concerns on the signaling overhead for per-band pair signaling, simpler signaling design is preferred, Solution 1 provides less signaling overhead. |
| SoftBank | Solution 1 | Solution 1 is simpler than others and overhead can be acceptable as it is not so large in practical BC. |
| Intel | Solution 1 and maybe consider Solution 4 | We prefer a solution which provides the least overhead.  For Solution 2, it is unclear to us how the overhead will reduce with using the exclude-list style. Isn’t it just an inverse of the bitmap of Solution 1? It will be good if the proponent can provide ASN.1 for Solution 2 to show how the overhead can be reduced.  For Solution 3, our understanding of the solution is that the simultaneous TX/RX restriction on band pair is more on between the TDD band pairs rather than the FDD and TDD band pairs and hence only 1 new capability bit is needed for simultaneous TX/RX over FDD and TDD band pairs are supported. Like the moderator, it is not clear to us whether it is sufficient to meet the requirement below from RAN4 LS:  For example, if the UE supports a combination of Band 1 + Band 2 + Band 3 + Band 4, the UE should be able to indicate that it supports simultaneous Rx/Tx between Band 1 and Band 2 but it does not support simultaneous Rx/Tx between Band 3 and Band 4. If RAN2 are going with this approach, it needs to further check with RAN4.  Solution 4 may further reduce the overhead of Solution 1. Hence we think it is good to introduce it, if possible.  |
| Qualcomm Incorporated | Solution 1 |  |
| Ericsson | Solution 3.(Solution 1 if 3 is not considered sufficient) | Solution 1: This is certainly possible but it does add quite considerable overhead to each BC. Regarding Solution 2: Validating an intended configuration against incapability signaling is typically more difficult in the gNB. Since it is not obvious that this variant will reduce the overhead significantly, we do not support this solution. We understand it may be more particular band pairs where the UE may not support simultaneous Rx/Tx. Solution 2 seems to be in line with this interpretation, but signals what the UE does not support. Hence, for simplicity we think it would be sufficient to use solution 3. However, if a finer granularity is really needed, we could accept Solution 1.  |
| MediaTek | Solution 1 | Solution 1 seems straightforward with acceptable overhead. However, we are wondering do we really need to have R15 CRs. R15 SPEC is frozen for long time and it seems okay to leave it as it. We suggest to have better granularity from R16.  |
| OPPO | Solution 1 | It is not clear whether solution2 can reduce signaling overhead. It depends on whether the detail number of band pair within one band combination. Solution 3 seems not align with RAN4 LS.As for solution4 we wonder whether technically it is correct. Assuming there is one band with DL only and another band with both UL and DL, then still it is necessary to indicate whether UE support Simultaneous Rx/Tx for such band pair. |

(Q1-1 summary)

9 companies provided their views. 8 companies support Solution 1 mainly for its simplicity. 1 company (Ericsson) supports solution 3 for smaller overhead but could accept Solution 1 if the finer granularity is really needed.

For the need of finer granularity, the wording of RAN4 LS (as in Intel’s comment) explains the need for per-band-pair signalling, as it mentions individual bands rather than band groups like duplex modes.

Hence the moderator thinks the following proposal is agreeable and we can proceed with brushing-up the draft CRs, which is based on Solution 1.

**Proposal 1**: Adopt Solution 1 in section 3.1 (bitmap-based solution in [2]) for UE capability signalling design.

One company suggests the signalling should be added in Rel-16. As it has not been discussed explicitly, Moderator would like to discuss in Phase 2 in which release we should introduce the UE capability signalling.

## Inter-node signalling to help validate per-band-pair capability

During the RAN2 115-e email discussion ([4] and reflector) there seems to be a consensus on the necessity of the information at the SN on the frequency bands used by the MN, which enables the SN to determine for which band pair it should check the simultaneous Rx/Tx UE capability.

Regarding how to signal the band information, it is proposed in [2] 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. However, companies could not converge on detailed choice or usage of the signalling during RAN2 115-e, including whether we need any clarification in the spec.

To move forward, moderator would first like to discuss the potential choice(s) of INM field incl. additional candidates pointed out by Ericsson, along with their feasibility and specification impact. Baseline analysis from moderator perspective is provided as follows:

***selectedBandEntriesMNList***: List of (indices to) bands used by MN in a non-RAT-dependent manner. Already assumed to be signalled in NR-DC, but the usage is explicitly limited to NR-DC. If adopted, field description seems to need clarification to allow the usage for other DC options. As a baseline, an example of the clarification is incorporated in the draft CRs [5][6].

***servFrequenciesMN-NR***: List of NR ARFCNs of all serving cells that include PCell and SCell(s) with SSB configured in MCG. The usage is explicitly limited to NR-DC. If adopted, field description seems to need clarification to allow the usage in NE-DC. In addition, moderator wonders whether the frequency band indicator can always be determined uniquely from NR ARFCN.

***servCellInfoListMCG-EUTRA-r16***: List which optionally contains one or more of DL EARFCN, UL EARFCN, and transmission bandwidth of the serving cell(s) in the MCG in intra-band (NG)EN-DC. If adopted, field description seems to need clarification to include the usage in inter-band EN-DC.

The above analysis is summarised in the table below.

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| --- | --- | --- | --- |
| **Field** | **Can we use the field in NR-DC?** | **Can we use the field in (NG)EN-DC?** | **Can we use the field in NE-DC?** |
| selectedBandEntriesMNList | Yes | Yes, with clarification of field desc | Yes, with clarification of field desc |
| servFrequenciesMN-NR | (comments needed) | No | (comments needed)(needs clarification of field desc) |
| servCellInfoListMCG-EUTRA-r16 | No | Yes, with clarification of field desc | No |

**Q2-1: Any comments on the above analysis?**

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| **Company** | **Comments** |
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(Q2-1 summary)

No comments were received. The above analysis seems to be in line with the companies’ understanding.

Based on the above analysis and discussion, companies are invited to provide their view on whether/how to clarify the specifications. To help convergence, options that are pointed out during RAN2 115-e are listed below.

**Option 1**: Clarify the field description of *selectedBandEntriesMNList* to allow simultaneous Rx/Tx capability checking in all DC options.

**Option 2**: Clarify nothing and leave the choice up to implementation, as suggested by Ericsson in [4].

Moderator wonders if adopting Option 2 might lead to an IOT problem or not. If companies prefer Option 2, comment on how to prevent potential IOT problems between MN and SN is encouraged.

**Q2-2: Which option do companies prefer?**

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| --- | --- | --- |
| **Company** | **Option** | **Comments** |
| Docomo | 1 | As current field descriptions for the fields in Q2-1 does not seem to assume usage in all MR-DC scenarios, we prefer to discuss how to clarify the field description of *selectedBandEntriesMNList* based on the draft CRs [5][6]. |
| CATT | Option 1  | If option 1 is not adopted, SN does not know the frequency bands used by the MN, which cannot enable the SN to determine which band pair it should check the simultaneous Rx/Tx UE capability for. |
| Huawei, HiSilicon | Option 1 | For the issue indicated in R2-2107389, it can be addressed by extending the *selectedBandEntriesMNList* field to (NG)EN-DC and NE-DC case, e.g.by removing the restriction on “This field is only used in NR-DC”. |
| SoftBank | Option 1 | Option 1 seems less impact and we prefer to remove the restriction and apply it to other DC options. |
| Qualcomm Incorporated | Option 1 |  |
| Ericsson | Option 2 or address it in RAN3 | The network nodes may also need the information on whether the resource is used for UL or DL, hence *selectedBandEntriesMNList* is not sufficient for this purpose.  |
| MediaTek | No strong view |  |
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(Q2-2 summary)

7 companies provided their views. 5 companies preferred Option 1, 1 company (Ericsson) preferred Option 2 or addressing the issue in RAN3, and 1 company had no strong view.

Ericsson commented about the information on whether the resource is used for UL or DL. Moderator’s understanding is that the network does not need to validate the simultaneous Rx/Tx capability between DL-only bands, and we could further optimize the network behaviour with the aid of the UL/DL information. Moderator would like to discuss further on the need/design for the UL/DL information at the network nodes, aiming to conclude the INM design in RAN2 116-e. As the existing RAN2 IE can convey the band information and the UL/DL information is an addition/complement to each band information, and asking RAN3 first will just prolong the discussion and delay the introduction of the solution, moderator thinks that it should be the baseline for this issue to be addressed in RAN2 and then notified to RAN3.

## Dynamic resource coordination

During the email discussion in RAN2 115-e [4], the usage of dynamic resource coordination mechanism for the UEs not capable of simultaneous Rx/Tx is discussed. As a result of discussion, there seems to be consensus on that dynamic resource coordination specified in RAN3 (MR-DC Resource Coordination Information > NR Resource Coordination Information in 38.423) does not currently support NR-DC.

To facilitate the discussion, several ways for the network to consider the simultaneous Rx/Tx capability were discussed during RAN2 115-e. Here moderator tries to summarize the discussed solutions, assuming a single band pair of interest for simplicity:

1. (Referred to as **1.** in [4]) If TDD config of the band pair is synchronized, neither of MN/SN has to check simultaneous Rx/Tx UE capability.
2. If TDD config of the band pair is not synchronized:

2.1) If the UE supports simultaneous Rx/Tx for the band pair, the gNBs can setup NR-DC without any scheduling restriction.

2.2) If the UE does not support simultaneous Rx/Tx for the band pair:

 2.2.1) (Referred to as **2.** in [4]) The gNBs may choose not to setup NR-DC for e.g. simplicity, sacrificing the throughput etc.

 2.2.2) (Referred to as **3.** in [4]) The gNBs may choose to setup NR-DC, possibly with scheduling coordination.

Based on the companies’ feedback in [4], moderator understands that the dynamic resource coordination mechanism would help 2.2.2 above. Most companies support or are ok to have the mechanism also for NR-DC, but no agreement was reached.

Now with more time checking, companies are invited again to provide comments on their interest on the mechanism and what we should let RAN3 know or request.

**Q3-1: Do companies support to introduce RAN3 resource coordination in NR-DC? If yes, do you agree to send an LS to RAN3 explaining the identified issue (i.e. dynamic resource coordination is not supported in NR-DC)?**

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| --- | --- | --- | --- |
| **Company** | **Support dynamic resource coordination?** | **Agree to send LS to RAN3?** | **Comments (e.g. suggestion on LS direction)** |
| Docomo | Maybe yes | Yes | From our perspective it is nice to have the dynamic coordination feature.We are fine to send an LS at least indicating that dynamic resource coordination is not supported in NR-DC. |
| Huawei, HiSilicon | Maybe yes | Yes | Based on the feedback in [4], it was the common understanding that NR Resource Coordination Information cannot be used for resource coordination in NR-DC and one company pointed out that IE “TDD UL-DL Configuration Common” can be used in this case. We understand the inter-node resource coordination in NR-DC is needed, and this can be informed to RAN3. Then RAN3 can further check whether this requirement is supported by their current spec or not, and if not, decide how to modify. |
| SoftBank | Not sure | Yes | Send LS to RAN3 and wait for their decision. |
| Qualcomm Incorporated | No strong view | Yes | Agree with the limitation of the current standard as outlined by the email discussion moderator. |
| Ericsson | No | Yes | We still do not think that the complexity of a finer granularity coordination is beneficial for the sake of non support of simultaneous Rx/Tx. But we would be fine to send an LS to RAN3 so that MN and SN can exchange which node configured which carrier with UL/DL. |
| MediaTek | No strong view | Yes | We are fine to check with RAN3 |
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(Q3-1 summary)

While there was not immediate interest to the dynamic resource coordination mechanism in RAN2, the companies were ok to send an LS to RAN3 and let them decide whether and how to change their specifications.

**Proposal 2**: Send LS to RAN3 indicating that the MR-DC Resource Coordination Information does not appear to be supported in NR-DC.

## General

This section is to discuss any issues not covered by previous sections, e.g. details on the draft CRs [5][6][7][8], aiming to agree the CRs in RAN2 116-e with potential modification.

**Q4-1:** **Any comments not covered by the previous sections?**

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| **Company** | **Comments** |
| Docomo (as moderator) | Draft CRs should be updated according to R2-2109063 and R2-2109064 that were agreed in RAN2 #115-e. Moderator would like to work on this once 38.331 is updated.As compared to the wording in R2-2109063/4 below, we would need some rewording an the original text refers to band combinations rather than band pairs.===*This capability applies to:** *TDD-TDD and TDD-FDD Intra-band (NG)EN-DC/NE-DC combination supporting both UL and DL intra-band (NG)EN-DC/NE-DC parts with additional inter-band NR/LTE CA component;*
* *TDD-TDD and TDD-FDD Intra-band (NG)EN-DC/NE-DC combination without supporting UL in both the bands of the intra-band (NG)EN-DC/NE-DC UL part;*
* *TDD-TDD and TDD-FDD Inter-band (NG)EN-DC/NE-DC combination without Intra-band component.*

*This capability is not applicable to the inter-band (NG)EN-DC/NE-DC combination, where the frequency range of the E-UTRA band is a subset of the frequency range of the NR band (as specified in Table 5.5B.4.1-1 of TS 38.101-3 [4]).* |
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# Phase 2 Discussion

## Release 15 or 16

Simultaneous Rx/Tx is a Rel-15 feature, and in RAN2 115-e draft CRs are produced for both Rel-15 and 16. However in Phase 1, one company (MediaTek) wondered the need for the R15 CR as the release is frozen and suggested to address it in only Rel-16. Also during RAN2 115-e [4], MediaTek commented that they are wondering whether we need R15 CRs, while two operators (Docomo, SoftBank) preferred R15 as e.g. the lack of granularity is observed in UEs in the field.

Companies are invited to provide their feedback on in which release we should introduce the UE capability signalling.

**Q5: In which release do companies think we should introduce the UE capability signalling?**

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| **Company** | **Release** | **Comments** |
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## New inter-node signalling

During Phase 1, Ericsson pointed out that the network nodes may also need the information on whether the resource is used for UL or DL, hence they thought *selectedBandEntriesMNList* is not sufficient for this purpose. Moderator’s understanding is that the network does not need to validate the simultaneous Rx/Tx capability between DL-only bands, and we could further optimize the network behaviour with the aid of the UL/DL information. Moderator would like to discuss the suggestion, aiming to conclude the INM design in RAN2 116-e.

As the existing RAN2 IE can convey the band information and the UL/DL information is an addition or complement to each band information, and asking RAN3 first will just prolong the discussion and delay the introduction of the solution, moderator thinks that it should be the baseline for this issue to be addressed in RAN2 and then notified to RAN3.

To realize the suggestion, a straightforward baseline solution would be:

* (a) adding to *CG-ConfigInfo* message, two 1-bit fields that indicate whether UL and DL is configured or not, which is signalled per *selectedBandEntriesMNList* entry; and
* adding to *CG-Config* message:
	+ (b) a list of band entries selected by the SN (like *selectedBandEntriesMNList*); and
	+ (c) the UL/DL information similar to (a) above.

According to the suggestion, Moderator wonders it might be beneficial to exchange the UL/DL information to and from the MN/SN. This results in not only the UL/DL information but also the used band information at the SN (i.e. (b) above), which might be beneficial for the same reason as *selectedBandEntriesMNList*., i.e. in order for the MN to decide which band out of the whole *selectedBandCombination* (potentially before fallback) it should validate the simultaneous Rx/Tx capability.

An example of the ASN.1 change would be:

-- ===== CG-ConfigInfo =====

ConfigRestrictInfoSCG ::= SEQUENCE {

 -- snip

 ...,

 [[

 selectedBandEntriesMNList SEQUENCE (SIZE (1..maxBandComb)) OF SelectedBandEntriesMN OPTIONAL,

 pdcch-BlindDetectionSCG INTEGER (1..15) OPTIONAL,

 maxNumberROHC-ContextSessionsSN INTEGER(0.. 16384) OPTIONAL

 ]],

 -- snip

 [[

 dl-UL-UsageMNList SEQUENCE (SIZE (1..maxBandComb)) OF DL-UL-UsageEntriesMN OPTIONAL -- (a)

 ]]

}

SelectedBandEntriesMN ::= SEQUENCE (SIZE (1..maxSimultaneousBands)) OF BandEntryIndex

BandEntryIndex ::= INTEGER (0.. maxNrofServingCells)

DL-UL-UsageEntriesMN ::= SEQUENCE (SIZE (1..maxSimultaneousBands)) OF DL-UL-Usage

DL-UL-Usage ::= SEQUENCE {

 dl-Configured ENUMERATED {true} OPTIONAL,

 ul-Configured ENUMERATED {true} OPTIONAL

}

-- ===== CG-Config =====

CG-Config-v16xy-IEs ::= SEQUENCE {

 selectedBandEntriesSN SEQUENCE (SIZE (1..maxSimultaneousBands)) OF SelectedBandEntrySN OPTIONAL,

 nonCriticalExtension SEQUENCE {} OPTIONAL

}

SelectedBandEntrySN ::= SEQUENCE {

 bandEntryIndex BandEntryIndex, -- (b)

 dl-UL-Usage DL-UL-Usage -- (c)

}

**Q6: Do companies agree to the addition of the information above? Any comments to the baseline design above?**

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| **Company** | **Agree to the need for the additional info?** | **Comments** |
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# Summary and Proposal

## Phase 1

UE capability signalling

All 7 companies out of 8 preferred Solution 1, mainly for simplicity. One company prefers coarser granularity (Option 3) but can compromise if the finer granularity is needed. As the need is already explained by the RAN4 LS, the moderator has the following proposal.

**Proposal 1**: Adopt Solution 1 in section 3.1 (bitmap-based solution in [2]) for UE capability signalling design.

One company suggested the signalling should be added in Rel-16. It is discussed in Phase 2 in which release we should introduce the UE capability signalling.

Inter-node signalling

7 companies provided their view. 5 companies preferred Option 1 (*selectedBandEntriesMNList*), 1 company (Ericsson) preferred Option 2 (clarify nothing) or addressing the issue in RAN3, and 1 company had no strong view.

Ericsson thought that Option 1 is not sufficient and the information on whether the resource is used for UL or DL may be needed, which is discussed in Phase 2, aiming to conclude the INM aspect in RAN2 116-e.

Dynamic Resource Coordination

While there was not immediate interest to the dynamic resource coordination mechanism in RAN2, all 6 companies were ok to send an LS to RAN3 and let them decide whether and how to change their specifications. The proposal below looks agreeable from Moderator’s perspective.

**Proposal 2**: Send LS to RAN3 indicating that the MR-DC Resource Coordination Information does not appear to be supported in NR-DC.

## Phase 2

TBA

# References

[1] R2-2106958, Reply LS on simultaneous Rx/Tx capability, RAN4.

[2] R2-2107389, Considerations on simultaneous Rx/Tx capability per band pair, NTT Docomo.

[3] R2-2107130, Simultaneous Rx/Tx UE capability, Qualcomm.

[4] R2-2109162, Summary of [AT115-e][016][NR15] UE Capabilities II, Huawei, HiSilicon.

[5] R2-2109188, CR for 38.331, Rel-15

[6] R2-2109189, CR for 38.331, Rel-16

[7] R2-2109190, CR for 38.306, Rel-15

[8] R2-2109191, CR for 38.306, Rel-16