3GPP TSG-RAN WG2 Meeting #118 electronic ***R2-220xxxx***

Online, May 9-20, 2022

**Agenda item:** 6.24.1

**Source:** China Telecom

**Title:** [draft] Summary of [AT118-e][043][NR17] CRS interference mitigation (China Telecom)

**WID/SID:** NR\_demod\_enh2-Core

**Document for:** Discussion and Decision

# Introduction

This document is the report of the following email discussion:

* [AT118-e][043][NR17] CRS interference mitigation (China Telecom)

Scope: Treat R2-2204489, R2-2204980, R2-2204981, R2-2204982, R2-2205388, R2-2205389, R2-2205390, R2-2205391,

Ph1 Determine agreeable parts, Ph2 agree CRs

Intended outcome: Report, Agreed CRs

Deadline: Schedule 1

Discussions with Deadline **Schedule 1**:

A **first round** with **Deadline for comments W1 Thursday May 12th 1200 UTC** to settle scope what is agreeable etc

A Final round with **Final deadline W2 Wednesday May 18th 1200 UTC** to settle details / agree CRs etc.

**Contact from companies**

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# Phase 1 Discussion

In RAN4#102-e meeting, RAN4 discussed UE capability and network assistant signalling for CRS interference mitigation (CRS-IM) in scenarios with overlapping spectrum for LTE and NR. Based on that, RAN4 sent an LS (R2-2204489\_R4-2207238) and asked RAN2 to take the related agreements into account and design the corresponding UE capability and network assistance signalling.

## UE capability

According to the RAN4 LS, the following UE capabilities were discussed as summarized in R2-2205388.

* **Agreed capabilities**

1. Capability CRS-IM support in DSS scenario (also requires support of LTE-CRS rate-matching capability)
2. CRS-IM support for non-DSS case without NWA signalling, with SCS = 15 kHz
3. CRS-IM support for non-DSS case with NWA signalling, with SCS = 15 kHz

* **Capabilities with FFSs**

1. CRS-IM support for non-DSS case without NWA signalling, with SCS = 30 kHz
2. CRS-IM support for non-DSS case with NWA signalling, with SCS = 30 kHz

Regarding the detail design of UE capability structure, R2-2205388 gives the following three options and suggests RAN2 discuss which capability structure option to adopt for the Rel-17 CRS-IM capabilities.

**Option 1: Separate capability bits for Capability #2-#3 and Capability #4-#5:**

An example of TP for Option 1 is given in R2-2205388 as below:

FeatureSetDownlinkPerCC-v1710 ::= SEQUENCE {

crs-IM-LTE-r17 CRS-IM-LTE-r17 OPTIONAL

}

CRS-IM-LTE-r17 ::= SEQUENCE {

crs-IM-servingLTE-r17 ENUMERATED {supported} OPTIONAL,

crs-IM-neighbourLTE-noNWA-15kHz-r17 ENUMERATED {supported} OPTIONAL,

crs-IM-neighbourLTE-NWA-15kHz-r17 ENUMERATED {supported} OPTIONAL,

crs-IM-neighbourLTE-noNWA-30kHz-r17 ENUMERATED {supported} OPTIONAL,

crs-IM-neighbourLTE-NWA-30kHz-r17 ENUMERATED {supported} OPTIONAL

}

Another example of TP for Option 1 is given in R2-2204981 as below:

FeatureSetDownlinkPerCC-v17xx ::= SEQUENCE {

supportedCRS-InterfMitigation-r17 CRS-InterfMitigation-r17 OPTIONAL

}

CRS-InterfMitigation-r17 ::= SEQUENCE {

CRS-IM-DSS-15kHzSCS-r17 ENUMERATED {supported} OPTIONAL,

CRS-IM-nonDSS-15kHzSCS-r17 ENUMERATED {supported} OPTIONAL,

CRS-IM-nonDSSwithNWAssist-15kHzSCS-r17 ENUMERATED {supported} OPTIONAL,

...

}

**Option 2: Combined capability bits for Capability #2-#3 and Capability #4-#5:**

An example of TP for Option 2 is given in R2-2205388 as below:

FeatureSetDownlinkPerCC-v1710 ::= SEQUENCE {

crs-IM-LTE-r17 CRS-IM-LTE-r17 OPTIONAL

}

CRS-IM-LTE-r17 ::= SEQUENCE {

crs-IM-servingLTE-r17 ENUMERATED {supported} OPTIONAL,

crs-IM-neighbourLTE-noNWA-r17 SEQUENCE {

scs-15kHz ENUMERATED {supported} OPTIONAL,

scs-30kHz ENUMERATED {supported} OPTIONAL

} OPTIONAL,

crs-IM-neighbourLTE-NWA-r17 SEQUENCE {

scs-15kHz ENUMERATED {supported} OPTIONAL,

scs-30kHz ENUMERATED {supported} OPTIONAL

} OPTIONAL

}

**Option 3: CHOICE for NWA and non-NWA capabilities, combined capability bits for Capability #2-#3 and Capability #4-#5: (with the assumption that all UEs that support CRS-IM without NWA would also support CRS-IM with NWA.)**

An example of TP for Option 3 is given in R2-2205388 as below:

FeatureSetDownlinkPerCC-v1710 ::= SEQUENCE {

crs-IM-LTE-r17 CRS-IM-LTE-r17 OPTIONAL

}

CRS-IM-LTE-r17 ::= SEQUENCE {

crs-IM-servingLTE-r17 ENUMERATED {supported} OPTIONAL,

crs-IM-neighbourLTE-r17 CHOICE {

nwa-r17 SEQUENCE {

scs-15kHz ENUMERATED {supported} OPTIONAL,

scs-30kHz ENUMERATED {supported} OPTIONAL

},

noNWA-r17 SEQUENCE {

scs-15kHz ENUMERATED {supported} OPTIONAL,

scs-30kHz ENUMERATED {supported} OPTIONAL

}

} OPTIONAL

}

**Q1: Which capability structure option do companies prefer for Rel-17 CRS-IM capabilities?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1/2/3** | **Comments** |
| Apple | Option 2 | Option 2 and 3 are more readable and clear compared with Option 1. Between Option 2 and option 3, we prefer Option 2 because we don't think all UE that support CRS-IM without NWA are mandated to support CRS-IM with NWA. So, option 2 provides more flexibility. |
| China Telecom | Option 1 | Option 1 and 2 are both feasible. Option 1 is easier and more straightforward. So we prefer Option 1. And we are also fine with Option 2 if it is the majority view.  For Option 3, we are not sure whether the assumption can be accepted. For the case that a UE supports CRS-IM for non-DSS case **without NWA signalling, with SCS = 15 kHz**, and also supports CRS-IM for non-DSS case **with NWA signalling, with SCS = 30 kHz** (if Cap#5 is introduced in RAN4), Option 3 seems not feasible.  Regarding the detail wording of capabilities, the field names in R2-2205388 and CR R2-2205391 seem a little bit misleading. Those capabilities are introduced for CRS-IM in order to help the NR UE mitigate the interference from the LTE CRS of **neighbouring cells** in both DSS and non-DSS scenarios, so the wording of “crs-IM-servingLTE” is not quite clear. And we can have further discussion in Phase 2. |
| Huawei, HiSilicon | Option 1 | At this stage RAN4 has not yet concluded whether capability#4 and #5 need new capabilities, and therefore we think Option 1 is a safer approach. If RAN4 concludes to have these two capabilities, it can be extended in a straight forward way. We agree with China Telecom’s analysis on option 3, which is not preferred from our side.  In any case the introduction of capability#4 and #5 should wait for RAN4’s conclusion first. |
| ZTE | Option 1 | Agree with China Telecom and Huawei that option 1 is more straightforward. And it is also easy to be extended for capability#4 and #5, if needed. |
| Ericsson | Prefer Option 1 | It seems not very efficient to optimize the structure at this moment, with RAN4 still discussing FFS. |
| Samsung | Prefer Option 1 | From a pure ASN.1 perspective, we think that Option 2 seems better. But needs of capability#4 and #5 are FFS in RAN4 so Option 1 seems a safer way to take. |
| Qualcomm Incorporated | Option 1 | We agree to the point Apple made above. Isn’t it the case for instance that RAN4 requirements can be different between the cases without NWA and with NWA, and the UE may only support the requirements for the case without NWA? |
| CATT | Option 1 | Share the same view with China Telecom. |
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**Rapporteur summary of Q1:**

Regarding the capability structure option for Rel-17 CRS-IM capabilities, the majority of companies (7/8) support or prefer Option 1, i.e. “Separate capability bits for Capability #2-#3 and Capability #4-#5”. One company supports Option 2 and thinks it is more readable and clear.

Based on the majority view, the rapporteur suggests taking Option 1 for phase 2 CR drafting. Considering Capability#4 and 5 are still under discussion in RAN4, the rapporteur proposes that

**Proposal 1: Introduce separate capability bits for R17 CRS-IM related capabilities, including Capability#1, #2 and #3 defined in RAN4 LS, and can be extended for Capablility#4 and #5, if they are agreed to be introduced by RAN4.**

The rapporteur notices that the company CRs R2-2204980/R2-2204981 from CTC and HW, and R2-2205390/R2-2205391 from Nokia are both based on option 1, and the changes are quite similar except for the detailed wording. Since there is no technical difference between those company CRs, for the sake of simplicity, the rapporteur suggests that

**Proposal 2: Take R2-2204980/R2-2204981 as baseline CRs for Ph2 UE capability CR drafting discussion.**

## NWA signalling

The design of new RRC based network assistant (NWA) signalling for Rel-17 CRS-IM is needed to assist UE to perform CRS-IM based on the following RAN4 agreements.

|  |
| --- |
| RAN4 agreements:   * To perform CRS-IM, RAN4 has agreed that the UE should have the following default network configuration assumptions for each neighbour LTE cell: * For scenario 1, the CRS port number is same with that indicated in the existing IE *RateMatchPatternLTE-CRS* by the serving cell. For scenario 2, the CRS port number is 4. * Network-based CRS interference mitigation (i.e., CRS muting) is not enabled by *crs-IntfMitigConfig* in TS 36.331 for scenario 1 and 2. * For scenario 1, channel bandwidth and centre frequency is same with that indicated in the existing IE *RateMatchPatternLTE-CRS* by the serving cell. * For scenario 1, MBSFN configuration is same as that indicated in the existing IE *RateMatchPatternLTE-CRS* by the serving cell. For scenario 2, MBSFN is not configured. * With the above default network configuration assumptions, RAN4 has agreed that for UE supporting Capability #1, the UE can perform CRS-IM without Rel-17 new RRC network assistant signalling in scenario 1. For UE supporting Capability #2, the UE can perform CRS-IM without Rel-17 new RRC network assistant signalling in scenario 2 with 15 kHz SCS when *MeasObjectEUTRA IE* is configured and the configured measurement gaps overlap with neighbour LTE cell PBCH position. * Meanwhile, new RRC based network assistant signalling is agreed to be introduced to assist CRS-IM in Rel-17, and the Rel-17 new RRC signalling are optionally to be indicated to UE supporting Capability #1 and Capability #2. * Regarding the content of the Rel-17 new RRC network assistant signalling, for each neighbour LTE cell, RAN4 reach following agreements: * Downlink Centre frequency   + For scenario 1, the downlink centre frequency can be optionally signalled to the UE, if the above default centre frequency assumption is not valid.   + For scenario 2, the downlink centre frequency can be optionally signalled to UE. * Channel bandwidth   + For scenario 1, the channel bandwidth can be optionally signalled to the UE, if the above default channel bandwidth assumption is not valid.   + For scenario 2 with 15kHz SCS, the LTE channel bandwidth can be optionally signalled to UE supporting Capability #2, and should be signalled to UE supporting Capability #3 but not supporting Capability #2. * CRS port number   + For scenario 1 and scenario 2, the CRS port number can be optionally signalled to the UE, if the above default CRS port number configuration assumption is not valid * Cell ID   + For scenario 1 and scenario 2, the physical Cell ID can be optionally signalled to UE. * v-Shift   + For scenario 1 and scenario 2, the v-Shift information can be optionally signalled to UE.   + If Cell ID information is informed, then v-Shift information shall not be signalled to UE. * CRS muting   + For scenario 1 and scenario 2, the configuration of CRS muting can be optionally signalled to the UE if the above default CRS muting assumption is not valid. * MBSFN configuration   + For scenario 1 and scenario 2, the MBSFN subframe configuration can be optionally signalled to the UE if the above default MBSFN configuration assumption is not valid. * The above information is signalled under each serving cell with flexibility to support per UE level configuration with up to 8 interference cell information. |

Based on the company contributions (R2-2204982, R2-2205388 and R2-2205389), the following issues may need further discussion.

1. How network provides the Rel-17 new RRC NWA signalling to assist UE to perform CRS-IM.
2. How network provides the content of the Rel-17 new RRC NWA signalling of each neighbour LTE cell to the UE.

**Issue 1: How to provide NWA signalling for Rel-17 CRS-IM to the UE**

As indicated in R2-2205388, the CRS-IM configuration is only configured in CONNECTED mode, so a new Rel-17 IE can be added as part of *ServingCellConfig*, which is proposed in both of the following company CRs.

R2-2204982 suggests adding the Rel-17 CRS-IM related NWA signalling to *ServingCellConfig* as an optional field. An example of TP for TS 38.331 is given in R2-2204982 as below:

[[

lte-NeighCellsCRS-AssistInfoList-r17 SetupRelease { LTE-NeighCellsCRS-AssistInfoList-r17 } OPTIONAL, -- Need M

]]

R2-2205389 also suggests adding the Rel-17 CRS-IM related NWA signalling to *ServingCellConfig* as an optional field. An example of TP for TS 38.331 is given in R2-2205389 as below:

[[

lte-CRS-IM-r17 SetupRelease { CRS-IM-PatternLTE } OPTIONAL -- Need M

]]

**Q2: Do companies agree to introduce a new Rel-17 IE in *ServingCellConfig*** **as an optional field, which provides Rel-17 CRS-IM related configuration to assist the UE to perform CRS-IM?**

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| --- | --- | --- |
| **Company** | **Agree/ Not agree** | **Comments** |
| Apple | Agree |  |
| China Telecom | Agree |  |
| Huawei, HiSilicon | Agree |  |
| ZTE | Agree |  |
| Ericsson | Agree |  |
| Samsung | Agree |  |
| Qualcomm Incorporated | Agree |  |
| CATT | Agree |  |
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**Issue 2: How to provide the content of the CRS-IM related configuration of each neighbour LTE cell to the UE**

Regarding how to provide the detail content of the CRS-IM related configuration of each neighbour LTE cell to the UE, the CRs R2-2204982 and R2-2205389 give different proposals.

R2-2204982 proposes to provide a list of LTE neighbour cells configuration used by the UE for performing CRS-IM. An example of TP for TS 38.331 is given in R2-2204982 as below:

LTE-NeighCellsCRS-AssistInfoList-r17 ::= SEQUENCE (SIZE (1..maxNrofCRS-IM-InterfCell-r17)) OF LTE-NeighCellsCRS-AssistInfo-r17

LTE-NeighCellsCRS-AssistInfo-r17 ::= SEQUENCE {

neighCarrierBandwidthDL-r17 ENUMERATED {n6, n15, n25, n50, n75, n100,

spare2, spare1} OPTIONAL, -- Cond CRS-IM

neighCarrierFreqDL-r17 INTEGER (0..16383) OPTIONAL, -- Need S

neighCellId-17 EUTRA-PhysCellId OPTIONAL, -- Need M

neighCRS-muting-r17 ENUMERATED {enabled} OPTIONAL, -- Need R

neighMBSFN-SubframeConfigList-r17 EUTRA-MBSFN-SubframeConfigList OPTIONAL, -- Need S

neighNrofCRS-Ports–r17 ENUMERATED {n1, n2, n4} OPTIONAL, -- Need S

neighV-Shift-r17 ENUMERATED {n0, n1, n2, n3, n4, n5} OPTIONAL -- Cond NotCellID

}

R2-2205389 proposes to provide a common LTE neighbour cell configuration used by the UE for performing CRS-IM. An example of TP for TS 38.331 is given in R2-2204982 as below:

CRS-IM-PatternLTE-r17 ::= SEQUENCE {

carrierFreqDL-r17 INTEGER (0..16383) OPTIONAL, -- Need S

carrierBandwidthDL-r17 ENUMERATED {n6, n15, n25, n50,

n75, n100, spare2, spare1} OPTIONAL, -- Need S

mbsfn-SubframeConfigList-r17 EUTRA-MBSFN-SubframeConfigList OPTIONAL, -- Need S

crs-Muting-r17 ENUMERATED {true} OPTIONAL, -- Need R

maxCRS-Ports-r17 ENUMERATED {n1, n2, n4} OPTIONAL, -- Need S

candidateCells-r17 CHOICE {

v-ShiftList-r17 BIT STRING(6),

pciCandidateList-r17 SEQUENCE (SIZE (1..maxCRS-IM-cells-r17)) OF EUTRA-PhysCellId

} OPTIONAL -- Need R

}

For Option 1 proposed in R2-2204982, it enables the feasibility for the NW to provide different LTE neighbour cell configuration when needed, which is aligned with RAN4 agreements.

For Option 2 proposed in R2-2205389, it has less signalling overhead but can’t provide different LTE neighbour cell configuration. The rapporteur understands that whether different LTE neighbour cells can always have the same configuration used to assist the UE to perform CRS-IM may need further RAN4 discussion or clarification.

Based on the above, companies are welcome to give comments on the following two options.

* Option 1: Providing a list of LTE neighbour cells configuration for CRS-IM to the UE
* Option 2: Providing a common LTE neighbour cell configuration for CRS-IM to the UE

**Q3: Regarding how to provide the content of the CRS-IM related configuration of each neighbour LTE cell to the UE, which option do companies prefer?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1/2** | **Comments** |
| Apple | Option 1 | As mentioned by Rapporteur, option 2 has the assumption that NW will not provide different LTE neighbor cell configuration for CRS-IM, which is not clear and need RAN4 discussion. Considering the signaling overhead in dedicated RRC message is not a bottleneck issue, we prefer a more safe way, i.e. option 1. |
| China Telecom | Option 1 | Option 1 is aligned with RAN4 agreements. And we agree with Apple that the signalling overhead in dedicated RRC message is not a bottleneck issue. Besides, the LTE neighbour cells configurations are relatively stable, so we think the signalling overhead is acceptable. |
| Huawei, HiSilicon | Option 1 | We understand from RAN4 LS the configuration could be different for each cell, and thus we think option 1 is the right way forward to reflect RAN4’s intention. |
| ZTE | Option 1 | We understand that different LTE neighbour cell configuration for CRS-IM can be configured to the UE. |
| Ericsson | Option 1 |  |
| Samsung | Option 1 |  |
| Qualcomm Incorporated | Option 1, but questions | * The presence condition ‘NotCellID’ suggest it is possible that neither the EUTRA PCI nor the v-shift is provided. What is the UE behaviour in that case? E.g. which set of assistance info should the UE apply? * It may be a common scenario where multiple E-UTRA cells share the same CRS-IM assistance info. Should we also allow listing multiple PCIs for a given set of assistance parameters? |
| China Telecom |  | To reply the above questions from QC.  (1) Based on RAN4 LS, we understand that both the v-shift and PCI are optional, so it is possible that both of them are not provided. Regarding the UE behaviour in that case, I also check it with my RAN4 colleague, RAN4 understanding is that it can be left to UE implementation, and no further description is needed.  (2) Regarding whether it is a common scenario where multiple E-UTRA cells share the same CRS-IM assistance info, we think it may need further RAN4 discussion. Based on the current RAN4 LS, we don’t see the need or requirements to list multiple PCIs for a given set of assistance parameters. |
| CATT | Option 1 |  |

**Rapporteur summary of Q2 and Q3:**

Regarding how to provide NWA signalling for Rel-17 CRS-IM to the UE, all the companies agreed to introduce a new Rel-17 IE in *ServingCellConfig* as an optional field to provide Rel-17 CRS-IM related configuration to assist the UE to perform CRS-IM.

Regarding how to provide the content of the CRS-IM related configuration of each neighbour LTE cell to the UE, all the companies support Option 1, i.e. providing a list of LTE neighbour cells configuration set for CRS-IM to the UE, as proposed in R2-2204982. Qualcomm wonders what the UE behaviour is when both the EUTRA PCI and v-shift are not provided. The rapporteur clarifies that RAN4 understanding is that it can be left to UE implementation, thus no further description is needed. Qualcomm thinks it may be a common scenario where multiple EUTRA cells share the same CRS-IM assistance info and wonders whether to allow listing multiple PCIs for a given set of assistance parameters. The rapporteur clarifies that whether it is a common case is up to RAN4 discussion, and based on the current RAN4 LS, there seems no need to list multiple PCIs for a given set of assistance parameters.

Based on the above discussion, the rapporteur proposes that

**Proposal 3: Introduce a new Rel-17 IE in *ServingCellConfig* as an optional field to provide Rel-17 CRS-IM related configuration to assist the UE to perform CRS-IM.**

**Proposal 4: Provide a list of LTE neighbour cells configuration for CRS-IM to the UE. Take R2-2204982 as baseline CR for Ph2 NWA signalling CR drafting discussion.**

## Any others issues

If companies have any concerns on RAN4 LS or any other issues, please comment in below table.

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| **Company** | **Comments** |
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## Phase 1 Summary

A total of 8 companies provide views on 3 questions for Rel-17 CRS-IM, including UE capability reporting and NWA signalling related issues. During the offline discussion, most of the companies share similar views on these issues.

Based on the majority views, the rapporteur gives the following proposals.

**Proposal 1: Introduce separate capability bits for R17 CRS-IM related capabilities, including Capability#1, #2 and #3 defined in RAN4 LS, and can be extended for Capablility#4 and #5, if they are agreed to be introduced by RAN4.**

**Proposal 2: Take R2-2204980/R2-2204981 as baseline CRs for Ph2 UE capability CR drafting discussion.**

**Proposal 3: Introduce a new Rel-17 IE in ServingCellConfig as an optional field to provide Rel-17 CRS-IM related configuration to assist the UE to perform CRS-IM.**

**Proposal 4: Provide a list of LTE neighbour cells configuration for CRS-IM to the UE. Take R2-2204982 as baseline CR for Ph2 NWA signalling CR drafting discussion.**

# Phase 2 Discussion

TBD.

# Conclusion

TBD

# Reference

1. R2-2204489 LS on UE capability and network assistant signalling for CRS interference mitigation in scenarios with overlapping spectrum for LTE and NR (R4-2207238; contact: China Telecom) RAN4 LS in Rel-17 NR\_demod\_enh2-Perf To:RAN2
2. R2-2204980 CR to TS 38.306 on UE capability for Rel-17 CRS interference mitigation China Telecom, Huawei, HiSilicon CR Rel-17 38.306 17.0.0 0706 - B NR\_demod\_enh2-Core
3. R2-2204981 CR to TS 38.331 on UE capability for Rel-17 CRS interference mitigation China Telecom, Huawei, HiSilicon CR Rel-17 38.331 17.0.0 3020 - B NR\_demod\_enh2-Core
4. R2-2204982 CR to TS 38.331 on Network assistant signalling for Rel-17 CRS interference mitigation China Telecom, Huawei, HiSilicon CR Rel-17 38.331 17.0.0 3021 - B NR\_demod\_enh2-Core
5. R2-2205388 Introduction of network assistance signalling for CRS-IM Nokia, Nokia Shanghai Bell discussion Rel-17 NR\_demod\_enh2-Core
6. R2-2205389 Introduction of network assistance signalling for CRS-IM Nokia, Nokia Shanghai Bell CR Rel-17 38.331 17.0.0 3077 - B NR\_demod\_enh2-Core
7. R2-2205390 UE capabilities for network assistance signalling for CRS-IM Nokia, Nokia Shanghai Bell draftCR Rel-17 38.306 17.0.0 B NR\_demod\_enh2-Core
8. R2-2205391 UE capabilities for network assistance signalling for CRS-IM Nokia, Nokia Shanghai Bell draftCR Rel-17 38.331 17.0.0 B NR\_demod\_enh2-Core