**3GPP TSG-RAN WG4 Meeting # 109 R4-2318129**

**Chicago, US, November 13 – 17, 2023**

**Agenda item:** 8.1.4

**Source:** Moderator (ZTE)

**Title:** Topic summary for [109][123] FS\_SimBC

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

*RAN4 extensively studied the feasibility of simplification of band combination specification for NR and LTE in previous RAN4 meetings [SID: FS\_SimBC]. Fifteen proposals are submitted in this meeting under the following three sub agenda items:*

* *8.1.1 General aspects*
	+ *R4-2319604, R4-2319618*
* *8.1.2 Simplification of working procedure*
	+ *R4-2320021, R4-2320022, R4-2320323, R4-2320324*
* *8.1.3 Simplification of specification and reduction of test burden*
	+ *R4-2318473, R4-2319556, R4-2320025, R4-2320026, R4-2320819, R4-2320868, R4-2320880, R4-2320998, R4-2320999*

The companies’ contributions are listed with the five topics as below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Reference** | **TDoc** | **Title** | **Source** | **Topic** |
| [1] | **R4-2318473** | CR to R18 TS38.101-1 to align frequency range restriction for MSD | Skyworks | #3-1 |
| [2] | **R4-2319556** | On restricted frequency range for MSD requirements | Skyworks | #3-1 |
| [3] | **R4-2319604** | TR 38.846 v1.4.0\_Study on simplification of band combination specification for NR and LTE | ZTE | #1-1 |
| [4] | **R4-2319618** | TP for TR 38.846: On bandwidth classes for NR band combinations | ZTE | #1-2 |
| [5] | **R4-2320021** | Addition of tripe beat rules for MSD analysis | Nokia, Nokia Shanghai Bell | #2-1 |
| [6] | **R4-2320022** | TP to TR 38.846 Addition of Guidelines on Co-existence analysis for triple beat | Nokia, Nokia Shanghai Bell | #2-1 |
| [7] | **R4-2320025** | Discussion on rules of Harmonic mixing MSD requirements | Nokia, Nokia Shanghai Bell | #3-2 |
| [8] | **R4-2320026** | TP to TR 38.846 Addition of Guidelines on Harmonic mixing MSD requirements | Nokia, Nokia Shanghai Bell | #3-2 |
| [9] | **R4-2320323** | TP for 38.846 about that same UL configurations need to apply for all BCS’s | Ericsson, T-Mobile US, Apple, Nokia | #2-2 |
| [10] | **R4-2320324** | TP for 38.846 TP for 38.846 with some clarifications about rules for missing fallbacks | Ericsson | #2-3 |
| [11] | **R4-2320819** | On UL1-DL4 harmonic mixing | Skyworks | #3-2 |
| [12] | **R4-2320868** | Improved table template for 1UL/CC and 2UL/CC MSD studies | Skyworks | #3-2 |
| [13] | **R4-2320880** | Considerations on spec structure for inter-band CA configuration tables | ZTE | #3-4 |
| [14] | **R4-2320998** | TP for TR38.846 Guidelines on Cross-band MSD test points for SUL | Skyworks | #3-3 |
| [15] | **R4-2320999** | TP for TR38.846 Guidelines on Cross-band MSD with FDD UL-CA | Skyworks | #3-3 |

# Topic #1: Update TR for FS\_SimBC

*In this topic, the TR to collect the newly agreed TP in this meeting will be discussed. Furthermore, the lean-ups for the TR will also be handled.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2319604 | ZTE | TR 38.846 v1.4.0\_Study on simplification of band combination specification for NR and LTEThis contribution is to collect the agreed TP in RAN4#109 meeting with TR updated version v1.4.0.**[Moderator suggestion]** *This contribution will be submitted post RAN4 meeting for email approval. No online discussion is expected in the meeting.* |
| R4-2319618 | ZTE | This TP is to update the related definition of CA/DC bandwidth classes for NR. |

## Open issues summary

*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1 Post meeting TR handling

*No online discussion is expected.*

*Sub-topic description: This sub-topic is for post-meeting email approval. Tdoc R4-2319604 is reserved for the updated TR to collect the agreed TP for FS\_SimBC in this meeting.*

### Sub-topic 1-2 Clean-ups for TR 38.846

*Tdoc R4-2319618 is suggested to be presented.*

*Sub-topic description: This sub-topic is about the clean-ups for TR 38.846.*

**Issue 1-2A: Clean-ups for TR 38.846**

* Proposals
	+ *It is suggested to approve the clean-ups for TR 38.846 captured in R4-2319618.*
* Recommended WF
	+ It is suggested to approve the clean-ups mentioned in R4-2319618.

# Topic #2: Simplification of working procedure

*In this topic, the simplification of working procedure for band combination will be handled. Three sub-topics will be included in this topic. The first sub-topic is to discuss the addition of triple beat rules for MSD analysis. The second sub-topic is about the guidelines that same UL configurations need to apply for all BCS’s. The third sub-topics is to handle the rules for missing fallbacks.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2320021 | Nokia, Nokia Shanghai Bell | **Proposal 1.** We capture the band group rules in the TR guidelines with the proposed frequency ranges of [1] so that triple beat analysis is not conducted when the two uplink bands of the analysis are not in same or adjacent band groups according to table 1. |
| R4-2320022 | Nokia, Nokia Shanghai Bell | This is a TP to TR 38.846 to add the guidelines for analysis of triple beat that may cause self-interference. It is based on the discussion paper in R4-2320021. |
| R4-2320323 | Ericsson, T-Mobile US, Apple, Nokia | **Proposal 1.** Since there are no technical justification to have different UL configurations for different BCS’s, it is suggested to introduce a rule to have same UL configuration for all BCS’s for a DL configuration. |
| R4-2320324 | Ericsson | **Proposal 1.** It is suggested to agree the following guidelines related to missing fallbacks.* *There is no fixed limitation to number of fallbacks that are allowed to be corrected in parallel to their band combination request. But as a general guideline a consideration could focus on a rather flexible approach to encourage that known fallback issues are corrected as quickly as possible.*
 |

## Open issues summary

*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1 Rules on addition of triple beat rules for MSD analysis

*Tdoc R4-2320021 is suggested to be presented.*

*Sub-topic description: This sub-topic is to bring the discussion of the triple beat analysis for the changes in TR 38.718-02-01, TR 38.7183-03-01 and TR 38.846 to capture triple beat rules.*

**Issue 2-1A: Rules on addition of triple beat rules for MSD analysis**

* Proposals
	+ *It is suggested to capture the band group rules in the TR guidelines with the proposed frequency ranges so that triple beat analysis is not conducted when the two uplink bands of the analysis are not in same or adjacent band groups according to Table 1.*
* Table 5 : Band group definition for adjacent band-group criterion

|  |
| --- |
| **FR1 band group range** |
| **Name** | **FR1-1 (LB)** | **FR1-2 (MB)** | **FR1-3 (HB)** | **FR1-4 (VHB)** | **FR1-5 (UHB)** |
| **Range (MHz)** | **600-1000** | **1400-2200** | **2300-2700** | **3300-5000** | **5250-7125** |
| **Duplex mode** | **Mostly FDD** | **Mostly FDD** | **FDD and TDD** | **TDD only** | **TDD only** |

Table 1: Overview of analysis for any FDD and TDD combination outlining triple beat.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **FDD-FDD** | **FDD-TDD NC ULCA in FDD** | **FDD-TDD NC ULCA in TDD** | **TDD-TDD** |
| Simultaneous RX/TX | **MSD w. Triple beat analysis for both FDD RX bands** | 1) MSD w. NC ULCA analysis into TDD band**2) MSD w. triple beat analysis only for FDD RX band** | **MSD w. triple beat analysis only for FDD RX band** | MSD w. NC ULCA analysis into other TDD RX band |
| Non-simultaneous RX/TX |   | [1) MSD w. NC ULCA analysis into TDD band**2)** **MSD w. triple beat analysis only for FDD RX band]** | **[MSD w. triple beat analysis only for FDD RX band]** |   |

* Recommended WF
	+ It is suggested to collect companies’ view.

Skyworks: we need more offline discussions with Nokia. We have general guideline for triple beat. We definitely need the template.

CHTTL: question for table, if there is no simultaneous Tx-Rx, why is there impact on DL.

Nokia: we should discuss further whether we should revise TR. For non-simultaneous Tx-Rx, we cannot guarantee that there is always non-simultaneous Tx-Rx.

Samsung: If there is explicitly note for band combination that it is only non-simultaneous Tx-Rx. Then UE should guarantee this.

CHTTL: to Nokia, regarding non-simultaneous Tx-Rx, do you mean not mandatory one.

### Sub-topic 2-2 Same UL configurations applying for all BCS’s

*Tdoc R4-2320323 is suggested to be presented.*

*Sub-topic description: This sub-topic is to discuss the issues on same UL configurations applying for all BCS’s. Since there are no technical justification to have different UL configurations for different BCS’s. The aspects of HPUE also need to be considered. HPUE is affecting only UL and HPUE combinations is requested without BCS information. Therefore, HPUE requests are to be included for all DL BCS configurations (and not just a subset of them). It is suggested to set a rule to have same UL configuration for all BCS’s for a DL configuration, irrespective of whether it is specifically requested by the proponent.*

***Example:***

**

**

**Issue 2-2A: Rules on same UL configurations applying for all BCS’s**

* Proposals
	+ *It is suggested to introduce a rule to have same UL configuration for all BCS’s for a DL configuration.*
* Recommended WF
	+ It is suggested to collect companies’ view.

Qualcomm: we are OK with Rel-18. There would be NBC issue for early release.

CHTTL: for this proposal, it is better to find some way to request BSC in Rel-19 then we have no misalignment within Rel-18 spec.

Nokia: We support it. CHTTL has no concern on the procedure. It will make spec more simple.

ZTE: This is related to mechanism. We want to introduce the combo into the spec. We should first need request the combos and then after approving the combo we can put it in the spec.

Ericsson: The intention of Rel-18, there is too much focus on the procedure. BCS is for downlink. We cannot apply it for uplink.

Apple: support it. We do not think that BCS is really intended to distinguish uplink. It is mainly for DL. There is no technical reason why UL is sensitive to BCS.

ZTE: agree with CHTTL comment.

Agreement:

* It is suggested to introduce a rule to have same UL configuration for all BCS’s for a DL configuration.
	+ FSS from which release, the changes will be made.

### Sub-topic 2-3 Rules on handling of missing fallbacks

*Tdoc R4-2320324 is suggested to be presented.*

*Sub-topic description: This sub-topic is to clarify the rules and how to address missing fallbacks.*

*Open issues and candidate options before meeting:*

**Issue 2-3A: Rules on handling of missing fallbacks**

* Proposals
	+ It is suggested to agree the following guidelines related to missing fallbacks.
* *There is no fixed limitation to number of fallbacks that are allowed to be corrected in parallel to their band combination request. But as a general guideline a consideration could focus on a rather flexible approach to encourage that known fallback issues are corrected as quickly as possible.*
* Recommended WF
	+ It is suggested to collect companies’ view.

CHTTL: not OK with proposal. The proposal will make the existing rule meaningless and make companies not check fallback anymore.

Ericsson: When we do combinations, we have a lot of thing to be corrected in the future. We should not delay the correction.

ZTE: The main difference is one quarter. For the overhead of missing fallback, one quarter is reasonable.

# Topic #3: Simplification of specification and reduction of test burden

*In this topic, based on the previous agreements on cross-band isolation and harmonic mixing MSD, some further improvement and guidelines for SUL MSD test points and UL1-DL4 harmonic mixing will be discussed. In addition, some considerations on spec structure for inter-band CA configuration tables will also be discussed in this topic.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2319556 | Skyworks | **Titles: On restricted frequency range for MSD requirements****Observation 1.*** Most of the frequency range restrictions are justified at a region or country level
* Several cases are specific to an operator in Japan, but are justified by combining with a Japan-specific band and used by a single operator.
	+ It should be observed though that Japan-operator specific bands are often a sub-range of a harmonized band like 26/n26 for 18/n18 or 5/n5 or 74/n74 for 21/n21and is combined with a WW band (n41, n77, n1, n28)
* Where most cases with restricted spectrum only haves a Note saying that the MSD cannot be tested for the restricted spectrum. While some other cases have N/A for all parameters:
	+ If the frequency restriction is changed it is very difficult to assess what must to be re-evaluated.
* There are more detailed observations in Annex 5 and 6 about operator specific ranges.

**Proposals on rules for applying restricted frequency ranges:*** Operator specific frequency range restriction is not allowed for MSD studies:
	+ If the band combination contains a band that is solely deployed by one operator, then operator specific range can be considered on a case-by-case basis, only if:
		- The region or country restricted range is insufficient; or
		- If bandwidth class or separation bandwidth class is insufficient for intra-band ULCA cases
* Region or country specific frequency ranges can be used for MSD studies, if the combination can be clearly identified to be valid in a single region or country:
	+ In cases where multiple regions or countries apply, using different MSD points for different restricted ranges may be considered on a case-by-case basis and only if the overall valid frequency range is insufficient
* Whenever an MSD is not applicable, when applying a valid frequency range restriction, valid test point(s) parameters for the bands are provided with the MSD value and a note clarifying that the MSD cannot be measured within a valid frequency restriction range attached to the IMD order (last column).
 |
| R4-2318473 | Skyworks | **Title: CR to R18 TS38.101-1 to align frequency range restriction for MSD**There are many overlapping frequency range restriction and notes are not always attached to the specific MSD case. Also, there are operator specific Notes which are not preferable as impossible to maintain, and they can be replaced by region/country/BW class Notes without changes in requirement.**This CR is to implement the proposals in R4-2319556** |
| R4-2320025 | Nokia, Nokia Shanghai Bell | **Title: Discussion on rules of Harmonic mixing MSD requirements****Observation.** UL1/DL2 is to be treated with different conditions at 1GHz.**Proposal 1.** Agree that the conditions for UL1/DL2 is below 3GHz, because the above and below 1GHz seems irrelevant.**Proposal 2.** Add missed cases of UL1/DL2 in Table 1 and Table 2.**Proposal 3.** Add missed cases of UL3/DL2 in Table 3, once agreement has been made if the rule for UL3/DL2 of [1] is agreeable.**Proposal 4.** Agree when UL4/DL3 is to be included for harmonic mixing MSD specification.**Proposal 5.** RAN4 shall discuss and resolve the two TBDs in Table 4 and Table 5.**Proposal 6.** Agree to include Table 4 and Table 5 in TR38.846 |
| R4-2320026 | Nokia, Nokia Shanghai Bell | **Title: TP to TR 38.846 Addition of Guidelines on Harmonic mixing MSD requirements**This is a TP corresponding to R4-2320025 to add a common ruleset for band analysis for band combinations which needs this type of analysis to the TR. |
| R4-2320819 | Skyworks | **Title: On UL1-DL4 harmonic mixing****Observation 1.*** Even if the issue raised in RAN4#108, was about UL1/DL4, there are additional even harmonic mixing cases that are specified for PC3 and beyond:
	+ UL1/DL2 down to one DL band <1 GHz for PC3, others >1.5 GHz
	+ UL1/DL4 down to DL band <1 GHz for PC3
	+ UL3/DL2 for DL band >3 GHz for PC3
	+ UL3/DL4 down to DL band >1 GHz and <2 GHz
* When the same even-harmonic mixing case is specified for different power classes, the specified MSD values correspond to an interference level raising dB per dB, which is consistent with applicable theory, as harmonic mixing relates to a parasitic mixing gain/loss at harmonics. For example, the CA\_n2-n77 MSD value for n2 is 6.7, 9.1 and 11.8dB for PC3, PC2 and PC1.5, respectively.
* Note that some cases are defined for PC5 in the PC3 table as they pertain to NR-U bands
* As compared to LTE, sevaral aspects have changed:
	+ DL bands now support up to 5GHz for NR and 7.125 GHz for NR-U, while LTE was mostly limited to bands <2.7GHz
	+ UL1 now supports up to 7.125GHz (NR-U), while LTE was mostly limited to bands <2.7GHz
	+ PC2 and PC1.5 inter-band CA are introduced in NR. These did not exist in LTE.
	+ All of the above aspects contribute to additional issues with even-harmonic mixing for NR.

**Proposal 1.** Even-harmonic mixing MSD should be investigated and specified if necessary, for:* UL1/DL2 for a FR1 DL bands >1.5GHz for PC5/3/2 and for all FR1 DL bands for PC1.5
* UL1/DL4 for all FR1 DL bands for all power classes
* UL3/DL2 for all FR1 DL bands >3GHz for PC5/3 and >2GHz for PC2/1.5
* UL3/DL4 for all FR1 DL bands >1.5GHz for PC5/3 and >1GHz for PC2/1.5.

**Proposal on correction of current even-harmonic mixing cases in 38.101-1 in the last column of the table below:** |
| R4-2320868 | Skyworks | **Title: Improved table template for 1UL/CC and 2UL/CC MSD studies****Proposal 1.** * The two band and three band DL TP to TR templates for NRCA and ENDC are updated to add the 1UL harmonic, harmonic mixing, and cross-band isolation calculations tables with notes provided for guidance.
* An associated MSD analysis reporting table is also introduced in the TP to TR templates.
* Example tables provided in the contribution can be used as a starting point
* Harmonic mixing rules for investigation can be revised based on agreements.
* The cross band section can be reused for intra-band cases as up to IMD9 cases are evaluated.
* The objective is to introduce new templates for use in Release 19.
 |
| R4-2320998 | Skyworks | **Title: TP for TR38.846 Guidelines on Cross-band MSD test points for SUL****Proposal 1.** It is suggested to capture the guidelines proposed in R4-2320998 to ensure the MSD test points due to cross-band isolation for SUL which are clarified with regards to their NR-CA counterparts. |
| R4-2320999 | Skyworks | **Title: TP for TR38.846 Guidelines on Cross-band MSD with FDD UL-CA****Proposal 1.** It is suggested to capture the guidelines proposed in R4-2320999 to ensure the MSD test points due to cross-band isolation when the UL band is an FDD band configured for intra-band uplink CA operation. |
| R4-2320880 | ZTE | **Title: Considerations on spec structure for inter-band CA configuration tables****Observation 1.**  For inter-band CA configuration tables, the spec structure differs in different specifications. * In 38.101-1, the configurations for FR1 are categorized into different sub-clauses according to the number of constituent bands in the configuration, while in 38.101-3 all CA configurations between FR1 and FR2 are collected in one clause.
* In 38.101-1, some sub-clause further split the tables into different sub-tables, while in other sub-clauses all the configurations having the same number of constituent bands are in one big table.

**Proposal 1.**  For the clause of inter-band CA configuration tables, it is suggested to set several sub-clauses, each of which has the same number of constituent bands. If a sub-clause has large number of configurations, the configuration table can be further split into several sub-tables, a “group-tag” could be set for easier retrieval.  |

## Open issues summary

*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 3-1 Handling the restricted frequency range for MSD requirements

*Tdoc R4-2319556 is suggested to be presented.*

*Sub-topic description: The notes and requirements that have a frequency range restriction in 38.101-1 and 38.101-3 have been discussed in this sub-topic. The focus is on the band and band combination definitions and MSDs.*

*Open issues and candidate options before meeting:*

**Issue 3-1A: Rules for applying restricted frequency ranges**

* Proposals
	+ It is suggested to agree the following rules for applying restricted frequency ranges.
* Operator specific frequency range restriction is not allowed for MSD studies:
	+ If the band combination contains a band that is solely deployed by one operator, then operator specific range can be considered on a case-by-case basis, only if:
		- The region or country restricted range is insufficient; or
		- If bandwidth class or separation bandwidth class is insufficient for intra-band ULCA cases
* Region or country specific frequency ranges can be used for MSD studies, if the combination can be clearly identified to be valid in a single region or country:
	+ In cases where multiple regions or countries apply, using different MSD points for different restricted ranges may be considered on a case-by-case basis and only if the overall valid frequency range is insufficient
* Whenever an MSD is not applicable, when applying a valid frequency range restriction, valid test point(s) parameters for the bands are provided with the MSD value and a note clarifying that the MSD cannot be measured within a valid frequency restriction range attached to the IMD order (last column).
* Recommended WF
	+ It is suggested to collect companies’ view.

**Issue 3-1B: Applying restricted frequency ranges for CA\_n18-n77 and DC\_18\_n77**

* ***Proposal 1*** for CA\_n18-n77 and CA\_n18-n78 PC3 MSD test points.
* The relevant parts of the table below are used for the specification in 38.101-1 MSD due to IMDs of 2UL band tables. The IMD4 values are copied from similar band combination CA\_n5-n77 and IMD5 values from CA\_n14-n77.

|  | **NR or E-UTRA Band / Channel bandwidth / NRB / MSD** |
| --- | --- |
| **NR-CA or ENDC****Configuration** | **EUTRA or NR band** | **UL Fc (MHz)** | **UL/DL BW (MHz)** | **UL LCRB** | **DL Fc (MHz)** | **MSD (dB)** | **Duplex mode** | **IMD order** |
| CA\_n18-n77 | n18 | 827.5 | 5 | 25 | 872.5 | 8.3 | FDD | IMD48 |
|  | n77 | 3355 | 10 | 50 | 3355 | N/A | TDD | N/A |
|  | n18 | 817.5 | 5 | 25 | 862.5 | 5.5 | FDD | IMD58 |
|  | n77 | 4130 | 10 | 50 | 4130 | N/A | TDD | N/A |
| CA\_n18-n78 | n18 | 827.5 | 5 | 25 | 872.5 | 8.3 | FDD | IMD49 |
|  | n78 | 3355 | 10 | 50 | 3355 | N/A | TDD | N/A |
| NOTE8: For a UE which supports this band combination only when the Band n77 frequency range restriction of 3400 – 4100 MHz applies, the MSD test point(s) cannot be verified for the band combination and the test point(s) can be skipped.NOTE 9: For a UE which supports this band combination only when the Band n78 frequency range restriction of 3400 – 3800 MHz, the MSD test point(s) cannot be verified for the band combination and the test point(s) can be skipped. |

* ***Proposal 2*** for CA\_n18-n77 PC2 MSD test points.
* The relevant parts of the table below are used for the specification in 38.101-1 MSD due to IMDs of 2UL band tables. The IMD4 and IMD5 values are copied from similar band combination CA\_n5-n77.

|  | **NR or E-UTRA Band / Channel bandwidth / NRB / MSD** |
| --- | --- |
| **NR-CA or ENDC****Configuration** | **EUTRA or NR band** | **UL Fc (MHz)** | **UL/DL BW (MHz)** | **UL LCRB** | **DL Fc (MHz)** | **MSD (dB)** | **Duplex mode** | **IMD order** |
| CA\_n18-n77 | n18 | 827.5 | 5 | 25 | 872.5 | 8.3 | FDD | IMD48 |
|  | n77 | 3355 | 10 | 50 | 3355 | N/A | TDD | N/A |
|  | n18 | 817.5 | 5 | 25 | 862.5 | 5.5 | FDD | IMD58 |
|  | n77 | 4130 | 10 | 50 | 4130 | N/A | TDD | N/A |
| NOTE8: For a UE which supports this band combination only when the Band n77 frequency range restriction of 3400 – 4100 MHz applies, the MSD test point(s) cannot be verified for the band combination and the test point(s) can be skipped. |

* ***Proposal 3*** for DC\_18-n77 PC3 MSD test points.
* The relevant parts of the table below are used for the specification in 38.101-3 MSD due to IMDs of 2UL band tables. The IMD4 values are copied from similar band combination CA\_n5-n77 and IMD5 values from CA\_n14-n77. Not implemented as 38.101-3 CR needs too much rework.

| **NR or E-UTRA Band / Channel bandwidth / NRB / MSD** |
| --- |
| **NR-CA or ENDC****Configuration** | **EUTRA or NR band** | **UL Fc (MHz)** | **UL/DL BW (MHz)** | **UL LCRB** | **DL Fc (MHz)** | **MSD (dB)** | **IMD order** |
| DC\_18A\_n77A | 18 | 827.5 | 5 | 25 | 872.5 | 8.3 | IMD4 X |
|  | n77 | 3355 | 10 | 50 | 3355 | N/A | N/A |
|  | 18 | 817.5 | 5 | 25 | 862.5 | 5.5 | IMD5 X |
|  | n77 | 4130 | 10 | 50 | 4130 | N/A | N/A |
| NOTE X: For a UE which supports this band combination only when the Band n77 frequency range restriction of 3400 – 4100 MHz applies, the MSD test point(s) cannot be verified for the band combination and the test point(s) can be skipped. |

* ***Proposal 4*** for DC\_18-n77 PC2 MSD test points.
* The relevant parts of the table below are used for the specification in 38.101-3 MSD due to IMDs of 2UL band tables. The IMD4 values are copied from similar band combination CA\_n5-n77 and IMD5 values from CA\_n14-n77. Not implemented as 38.101-3 CR needs too much rework.

| **NR or E-UTRA Band / Channel bandwidth / NRB / MSD** |
| --- |
| **NR-CA or ENDC****Configuration** | **EUTRA or NR band** | **UL Fc (MHz)** | **UL/DL BW (MHz)** | **UL LCRB** | **DL Fc (MHz)** | **MSD (dB)** | **IMD order** |
| DC\_18A\_n77A | 18 | 827.5 | 5 | 25 | 872.5 | 18.4 | IMD4 X |
|  | n77 | 3355 | 10 | 50 | 3355 | N/A | N/A |
|  | 18 | 817.5 | 5 | 25 | 862.5 | 11.7 | IMD5 X |
|  | n77 | 4130 | 10 | 50 | 4130 | N/A | N/A |
| NOTE X: For a UE which supports this band combination only when the Band n77 frequency range restriction of 3400 – 4100 MHz applies, the MSD test point(s) cannot be verified for the band combination and the test point(s) can be skipped. |

* Recommended WF
	+ It is suggested to collect companies’ view on the above proposals.

### Sub-topic 3-2 Rules for harmonic mixing MSD requirements

*Tdoc R4-2320025 / R4-2320819 are suggested to be presented for Issue 3-2A.*

*Tdoc R4-2320868 is suggested to be presented for Issue 3-2B.*

*Sub-topic description: This sub-topic is to discuss the rules of harmonic mixing MSD requirements. The aspects of harmonic mixing implementations, considerations of dependency versus DL frequency, and UL power classes are to be considered. Furthermore, an improved table template for 1UL/CC and 2UL/CC MSD analysis is proposed for future studies.*

*Open issues and candidate options before meeting:*

**Issue 3-2A: Rules for harmonic mixing MSD requirements**

* **Proposal 1**
	+ PC3 harmonic mixing rules of analysis applicability.

|  |
| --- |
| **PC3 of UL band** |
|   | **UL1** | **UL2** | **UL3** | **UL4** |
| **DL2** | * Op1: All
* Op2: FR1 DL>1.5GHz
 | * Op1: N/A
 | * Op1: DL > 3GHz
 | * Op1: N/A
 |
| **DL3** | * Op1: All
 | * Op1: All
 | * Op1: N/A
 | * Op1: TBD2
 |
| **DL4** | * Op1: DL > 1GHz
* Op2: All
 | * Op1: N/A
 | * Op1: DL > 5GHz1
* Op2: FR1 DL>1.5GHz
 | * Op1: N/A
 |
| **DL5** | * Op1: All
 | * Op1: TBD3
 | * Op1: N/A
 | * Op1: N/A
 |
| Note 1: Also applicable for PC5Note 2: Depending on outcome of Proposal 4Note 3: Shown in R4-2316859, but no cases found in 38.101-1 |

* Recommended WF for **Proposal 1**

It is suggested to agree the harmonic mixing rules for the cells not in yellow in the above table. Further discussion will be focused on the yellow cells.

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* **Proposal 2**
	+ PC2 harmonic mixing rules of analysis applicability.

|  |
| --- |
| **PC2 of UL band** |
|   | **UL1** | **UL2** | **UL3** | **UL4** |
| **DL2** | * Op1: All
* Op2: FR1 DL>1.5GHz
 | * Op1: N/A
 | * Op1: All
* Op2: FR1 DL > 2GHz
 | * Op1: N/A
 |
| **DL3** | * Op1: All
 | * Op1: All
 | * Op1: N/A
 | * Op1: TBD2
 |
| **DL4** | * Op1: All
 | * Op1: N/A
 | * Op1: N/A
* Op2: FR1 DL>1GHz
 | * Op1: N/A
 |
| **DL5** | * Op1: All
 | * Op1: TBD3
 | * Op1: N/A
 | * Op1: N/A
 |
| Note 1: Also applicable for PC5Note 2: Depending on outcome of Proposal 4Note 3: Shown in R4-2316859, but no cases found in 38.101-1 |

* Recommended WF for **Proposal 2**

It is suggested to agree the harmonic mixing rules for the cells not in yellow in the above table. Further discussion will be focused on the yellow cells.

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* **Proposal 3**
	+ PC1.5 harmonic mixing rules of analysis applicability.

|  |
| --- |
| **PC1.5 of UL band** |
|   | **UL1** | **UL2** | **UL3** | **UL4** |
| **DL2** | * Op1: All
 | * Op1: N/A
 | * Op1: All
* Op2: FR1 DL > 2GHz
 | * Op1: N/A
 |
| **DL3** | * Op1: All
 | * Op1: All
 | * Op1: N/A
 | * Op1: TBD2
 |
| **DL4** | * Op1: All
 | * Op1: N/A
 | * Op1: N/A
* Op2: FR1 DL>1GHz
 | * Op1: N/A
 |
| **DL5** | * Op1: All
 | * Op1: TBD3
 | * Op1: N/A
 | * Op1: N/A
 |
| Note 1: Also applicable for PC5Note 2: Depending on outcome of Proposal 4Note 3: Shown in R4-2316859, but no cases found in 38.101-1 |

* Recommended WF for **Proposal 3**

It is suggested to agree the harmonic mixing rules for the cells not in yellow in the above table. Further discussion will be focused on the yellow cells.

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* **Proposal 4**
	+ PC5 harmonic mixing rules of analysis applicability.

|  |
| --- |
| **PC5 of UL band** |
|   | **UL1** | **UL2** | **UL3** | **UL4** |
| **DL2** | * Op1: All
* Op2: FR1 DL > 1.5GHz
 | * Op1: N/A
 | * Op1: FR1 DL > 3GHz
 | * Op1: N/A
 |
| **DL3** | * Op1: All
 | * Op1: All
 | * Op1: N/A
 | * Op1: TBD2
 |
| **DL4** | * Op1: DL > 1GHz
* Op2: All
 | * Op1: N/A
 | * Op1: FR1 DL>5GHz1
* Op2: FR1 DL>1.5GHz
 | * Op1: N/A
 |
| **DL5** | * Op1: All
 | * Op1: TBD3
 | * Op1: N/A
 | * Op1: N/A
 |
| Note 1: Also applicable for PC5Note 2: Depending on outcome of Proposal 4Note 3: Shown in R4-2316859, but no cases found in 38.101-1 |

* Recommended WF for **Proposal 4**

It is suggested to agree the harmonic mixing rules for the cells not in yellow in the above table. Further discussion will be focused on the yellow cells.

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Based on the outcomes of above discussion, the following Other proposals will be further decided.

* Other Proposals:
* **Proposal 5**: Add missed cases of UL1/DL2 in Table 1 and Table 2.
* Table 1: Low band combinations, previously following DL<2GHz

|  |  |  |
| --- | --- | --- |
| **Band combination** | **Case** | **Reason** |
| **CA\_n3-n5** | UL1/DL2 | n=2 of n∙DL+m∙UL, where n+m<6 was omitted when DL<2GHz |
| **CA\_n3-n18** | UL1/DL2 | n=2 of n∙DL+m∙UL, where n+m<6 was omitted when DL<2GHz |
| **CA\_n5-n66** | UL1/DL2 | n=2 of n∙DL+m∙UL, where n+m<6 was omitted when DL<2GHz |
| **CA\_n8-n391** | UL1/DL2 | n=2 of n∙DL+m∙UL, where n+m<6 was omitted when DL<2GHz |
| **CA\_n26-n66** | UL1/DL2 | n=2 of n∙DL+m∙UL, where n+m<6 was omitted when DL<2GHz |

* Table 2: Mid band combinations also applicable to DL<2GHz

|  |  |  |
| --- | --- | --- |
| **Band combination** | **Case** | **Reason** |
| **CA\_n3-n771** | UL1/DL2 | n=2 of n∙DL+m∙UL, where n+m<6 was omitted when DL<2GHz |
| **CA\_n3-n781** | UL1/DL2 | n=2 of n∙DL+m∙UL, where n+m<6 was omitted when DL<2GHz |

* **Proposal 6**: Add missed cases of UL3/DL2 in Table 3, once agreement has been made if the rule for UL3/DL2 of [1] is agreeable.
* Table 3: Cases of UL3/DL2 with DL >3GHz

|  |  |  |
| --- | --- | --- |
| **Band combination** | **Case** | **Reason** |
| **CA\_n7-n77 (n778,9)** | UL3/DL2 | Skipped. PC3 (n77 >3GHz). Applicable for PC3 |
| **CA\_n7-n78 (n788,9)** | UL3/DL2 | Removed in [3]. Applicable for PC3 |
| **CA\_n30-n77 (n778,9)** | UL3/DL2 | Skipped. Applicable for PC3 |
| **CA\_n46-n48** | UL3/DL2 | Skipped. Applicable for PC3 |
| **CA\_n46-n77** | UL3/DL2 | Skipped. Applicable for PC3 |
| **CA\_n46-n78** | UL3/DL2 | Skipped. Applicable for PC3 |

**Proposal 7: Correction of current even-harmonic mixing cases in 38.101-1 in the last column of the table below:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **UL band** | **Power Class** | **DL band** | **DL band range** | **UL/DL collision** | **outcome** |
| n46 | PC5 | n7 | >2 GHz and <3 GHz | UL1/DL2 | Specification kept |
| n3 | PC3 | n26 | <1 GHz | UL1/DL2 | **MSD can be removed for PC3** |
| n77 | PC3 | n70 | >1.5 GHz and <2 GHz | UL1/DL2 | Specification kept |
| n77 | PC3/2/1.5 | n2 | >1.5 GHz and <2 GHz | UL1/DL2 | Specification kept |
| n77 | PC3/2/1.5 | n25 | >1.5 GHz and <2 GHz | UL1/DL2 | Specification kept |
| n77 | PC2/PC1.5 | n3 | >1.5 GHz and <2 GHz | UL1/DL2 | Specification kept |
| n78 | PC2 | n3 | >1.5 GHz and <2 GHz | UL1/DL2 | Specification kept |
| n7 | PC3 | n71 | <1 GHz | UL1/ DL4 | Specification kept |
| n77 | PC3 | n8 | <1 GHz | UL1/DL4 | Specification kept |
| n78 | PC2 | n8 | <1 GHz | UL1/DL4 | Specification kept |
| n77 | PC2/PC1.5 | n5 | <1 GHz | UL1/DL4 | Specification kept |
| n40 | PC3 | n77/78 | >3 GHz | UL3/DL2 | Specification kept |
| n41 | PC3 | n77/78 | >3 GHz | UL3/DL2 | Specification kept |
| n41 | PC3 | n39 | >1.5 GHz and <2 GHz | UL3/DL4 | Specification kept |

* Recommended WF
	+ The decision of **Proposal 5** ~ **7** will be based on the discussion outcome of **Proposal 1** ~ **4**.

**Issue 3-2B: Improved table template for 1UL/CC and 2UL/CC MSD studies**

* Proposals
	+ Option 1: It is suggested to consider the following guidelines for future studies on 1UL/CC and 2UL/CC MSD evaluation:
		- The two band and three band DL TP to TR templates for NRCA and ENDC are updated to add the 1UL harmonic, harmonic mixing, and cross-band isolation calculations tables with notes provided for guidance.
		- An associated MSD analysis reporting table is also introduced in the TP to TR templates.
		- Example tables provided in the contribution can be used as a starting point.
		- Harmonic mixing rules for investigation can be revised based on agreements.
		- The cross band section can be reused for intra-band cases as up to IMD9 cases are evaluated.
		- The objective is to introduce new templates for use in Release 19.
* This table is populated with the CA\_n18-n77 case as an example.

**Table 2: Template for 1UL(1CC) and 2UL(1CC per band) frequency analysis**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE carriers** | **f1\_low** | **f1\_high** | **f2\_low** | **f2\_high** |
| **Band number / type** | **n18** | **FDD** | **n77** | **TDD** |
| **Inputfrequencies2** | **UL** | 815 | 830 | 3400 | 4200 |
| **DL** | 860 | 875 | 3400 | 4200 |
| **near miss** | 760 | 975 | 3385 | 4215 |
| **Duplex distance / Maximum UL CBW** | 45 | 15 | 0 | 100 |
| **UL harmonics frequencies**  | **H2** | 1630 | 1660 | 6800 | 8400 |
| **H3** | 2445 | 2490 | 10200 | 12600 |
| **H4** | 3260 | 3320 | 13600 | 16800 |
| **H5** | 4075 | 4150 | 17000 | 21000 |
| **DL harmonics frequencies**  | **H23** | 1720 | 1750 | 6800 | 8400 |
| **H34** | 2580 | 2625 | 10200 | 12600 |
| **H45** | 3440 | 3500 | 13600 | 16800 |
| **H56** | 4300 | 4375 | 17000 | 21000 |
| **Cross band ACLR range** | **ACLR1** | 845 | 890 | 3300 | 4300 |
| **ACLR2** | 830 | 905 | 3200 | 4400 |
| **ACLR3** | 815 | 920 | 3100 | 4500 |
| **ACLR47** | 800 | 935 | 3000 | 4600 |
| **2nd order IMD8** | **products** | |f2\_low – f1\_high| | |f2\_high – f1\_low| | |f2\_low + f1\_low| | |f2\_high + f1\_high| |
| **frequency**  | 2570 | 3385 | 4215 | 5030 |
| **3rd order IMD8** | **products** | |f2\_low – 2\*f1\_high| | |f2\_high – 2\*f1\_low| | |2\*f2\_low – f1\_high| | |2\*f2\_high – f1\_low| |
| **frequency**  | 1740 | 2570 | 5970 | 7585 |
| **products** | |2\*f1\_low + f2\_low| | |2\*f1\_high + f2\_high| | |2\*f2\_low + f1\_low| | |2\*f2\_high + f1\_high| |
| **frequency**  | 5030 | 5860 | 7615 | 9230 |
| **4th order IMD8** | **products** | |3\*f1\_low – f2\_high| | |3\*f1\_high – f2\_low| | |3\*f2\_low – f1\_high| | |3\*f2\_high –f1\_low| |
| **frequency**  | 910 | 1755 | 9370 | 11785 |
| **products** | |3\*f1\_low +f2\_low| | |3\*f1\_high + f2\_high| | |3\*f2\_low+f1\_low| | |3\*f2\_high +f1\_high| |
| **frequency**  | 5845 | 6690 | 11015 | 13430 |
| **products** | |2\*f1\_low –2\*f2\_high| | |2\*f1\_high –2\*f2\_low| | |2\*f1\_low +2\*f2\_low| | |2\*f1\_high +2\*f2\_high| |
| **frequency**  | 5140 | 6770 | 8430 | 10060 |
| **5th order IMD8** | **products** | |f1\_low –4\*f2\_high| | |f1\_high –4\*f2\_low| | |f2\_low –4\*f1\_high| | |f2\_high –4\*f1\_low| |
| **frequency**  | 12770 | 15985 | 80 | 940 |
| **products** | |f1\_low +4\*f2\_low| | |f1\_high +4\*f2\_high| | |f2\_low+4\*f1\_low| | |f2\_high +4\*f1\_high| |
| **frequency**  | 14415 | 17630 | 6660 | 7520 |
| **products** | |2\*f1\_low –3\*f2\_high| | |2\*f1\_high –3\*f2\_low| | |2\*f2\_low -3\*f1\_high| | |2\*f2\_high -3\*f1\_low| |
| **frequency**  | 8540 | 10970 | 4310 | 5955 |
| **products** | |2\*f1\_low +3\*f2\_low| | |2\*f1\_high +3\*f2\_high| | |2\*f2\_low+3\*f1\_low| | |2\*f2\_high +3\*f1\_high| |
| **frequency**  | 11830 | 14260 | 9245 | 10890 |
| Note 1: All frequencies are in MHz |
| Note 2: Region or country-based frequency restriction can be applied if the band combination is identifiable to a single region or country |
| Note 3: UL1/DL2 harmonic mixing collisions should be investigated for DL bands > 1.5GHz, UL3/DL2 may be considered for DL bands >3GHz |
| Note 4: UL1or2or3/DL3 harmonic mixing collisions should be investigated |
| Note 5: UL1/DL4 harmonic mixing collisions should be investigated for DL bands > 0.5GHz and UL2or3/DL4 for bands > 1.5GHz. |
| Note 6: UL1or2/DL5 harmonic mixing collisions should be investigated |
| Note 7: In cases where ACLR3 range does not overlap with the other band DL range, there may still be a residual MSD due to transmitter noise floor for low filter rejection |
| Note 8: The IMD section is needed for 2UL case only, only the lowest even and odd order overlapping a DL band should be specified |

**Table 3: Template for 1UL(1CC) and 2UL(1CC per band) MSD analysis**

|  |  |
| --- | --- |
| **1UL harmonics** | UL4 and UL5 of band n18 fall into DL1 of band n77 |
| **1UL Harmonic mixing** | DL4 of n18 overlaps with UL1 of n77, MSD should be investigated as it a DL4 of a band <1GHz |
| **1UL cross band** | no cross band range overlaps with the other DL band and the distance is large so no noise floor related MSD should be investigated  |
| **2UL IMDs** | IMD2 falls in band n77 DL but can be ignored as it is a TDD bandIMD4 falls in band n18 DL and should be specifiedIMD5 falls in band n18 DL and should be specified |
| Note 1: For MSD analysis, any harmonic or IMD product overlapping a DL band or DL harmonic overlapping an UL band or its harmonics should be investigated and commented in this Table. For cases where there is no overlap but the product falls within the maximum UL CBW distance of a DL band, near miss MSD should be considered for low order products. |

* Recommended WF
	+ Collect companies’ view.

### Sub-topic 3-3 Guidelines on cross-band MSD test points

*Tdocs R4-2320998 and R4-2320999 are suggested to be presented for Issue 3-3A and 3-3B respectively.*

*Sub-topic description: This topic discusses the guidelines on cross-band MSD test points for SUL and FDD UL-CA.*

*Open issues and candidate options before meeting:*

**Issue 3-3A: Guidelines on cross-band MSD test points for SUL**

* Proposals
	+ Option 1: It is suggested to adopt the following guidelines for the SUL configuration for cross-band isolation MSD test points:
		- For SUL band combinations, and for the first test point which evaluates the MSD for the lowest DL CBW, the SUL band should be configured with the highest supported CBW, as specified in Table 5.5C-1. This ensures that the SUL band lowest IMD order has a maximum reach towards the DL affected band.
		- For the second test point, the choice of the SUL CBW remains open to account for exceptions or regional concerns, or to address a proponent’s request.
		- The SUL SCS should be the lowest SCS that can be supported for the selected SUL CBW. For example, if the SUL CBW is 50 MHz, then SCS15 kHz should be specified.
		- For the UL configuration "Lcrb" for the SUL band: The UL Lcrb of the NR band counterpart as defined in Table 7.3.2-3 (UL configuration for UL Band REFSENS) for the corresponding SUL band CBW is specified. A SUL-NR counterpart look-up is provided in Table 7.3.2-1.

Table 7.3.2-1: SUL-NR counterpart lookup table.

| **SUL band** | **NR UL Band counterpart** | **FUL\_low – FUL\_high (MHz)** |
| --- | --- | --- |
| n80 | n3 | 1710 – 1785 |
| n81 | n8 | 880 – 915 |
| n82 | n20 | 832 – 862  |
| n83 | n28 | 703 – 748 |
| n84 | n1 | 1920 – 1980 |
| n86 | n66 | 1710 – 1780 |
| n89 | n5 | 824 – 849 |
| n95 | n34 | 2010 – 2025 |
| n97 | n40 | 2300 – 2400 |
| n98 | n39 | 1880 – 1920 |
| n99 | n24 | 1626.5 – 1660.5 |

* + - The SUL RBstart should ensure that the UL RBs are positioned closest to the DL affected band.
		- The SUL carrier center frequency should be configured closest to the affected DL band.
* Recommended WF
	+ Collect companies’ view.

**Issue 3-3B: Guidelines on cross-band MSD test points for FDD UL-CA**

* Proposals
	+ Option 1: It is suggested to adopt the following guidelines for cross-band isolation MSD test points due to the FDD band configured with dual uplink intra-band CA.
1. FDD band intra-band contiguous uplink CA configuration:
	1. PCC/SCC: the UL CBW, SCS, and UL RB allocation "Lcrb" should be configured to the specified PCC/SCC CBW/SCS/Lcrb of the band's MSD test point.

For example, for uplink CA\_n5B, the PCC/SCC CBW, SCS and Lcrb should be configured according to the TS38.101-1 Table 7.3A.2.1-1, i.e. CBW: 10MHz+10MHz, SCS:15/15 (kHz), Lcrb:10RB/10RB.

In case the FDD band UL-CA MSD test point is not specified:

* + 1. The PCC/SCC UL CBW shall be set equal,

If configuring equal CBW is not possible, then set the PCC CBW 5MHz smaller [1],

* + 1. The aggregated UL RB allocation (aka "RBtot") is set equal to the Lcrb specified for the single carrier REFSENS test point that corresponds to the UL-CA aggregated BW.

Example, for UL-CA 10MHz+10MHz, adopt the Lcrb specified for 20MHz CBW REFSENS [1],

* + 1. The PCC/SCC UL RB allocation "Lcrb" should be configured to ensure equal PSD between across the PCC and the SCC,
	1. The PCC/SCC UL RBstart shall be configured to create a direct hit collision of the affected DL SCC with the lowest 2UL IMD product. If conditions to create a direct hit collision cannot be met, then configure the PCC/SCC RBstart that results in a partial collision of the lowest 2UL IMD product,
	2. The highest IMD order to be considered is [13],
	3. Configure the UL carrier frequency closest to the affected DL SCC carrier frequency.
	4. Whenever possible, the UL band configuration should be configured to avoid self-desense.

In case self-desense cannot be avoided:

* + 1. the MSD test point shall not lead to a higher desense than the band's MSD test point (when specified),
		2. To prevent radio link failure during conformance test, RAN5 should be informed that self-desense may occur on the UL FDD band.
1. Affected DL band SCC configuration:
	1. DL SCC carrier frequency: configured closest to the FDD UL-CA carrier,
	2. DL SCC CBW: configured to its smallest supported CBW.
* Recommended WF
	+ Collect companies’ view.

### Sub-topic 3-4 Spec structure for inter-band CA configuration tables

*Tdoc R4-2320880 is suggested to be presented.*

*Sub-topic description: This sub-topic is to discuss the spec structure for inter-band CA configuration tables. Some solutions to improve the efficiency to retrieve the inter-band CA combinations are considered.*

*Open issues and candidate options before meeting:*

**Issue 3-4A: Issues on spec structure improvement for inter-band CA configuration talbes**

* Proposals
	+ Option 1: For the clause of inter-band CA configuration tables, it is suggested to set several sub-clauses, each of which has the same number of constituent bands. If a sub-clause has large number of configurations, the configuration table can be further split into several sub-tables, a “group-tag” could be set for easier retrieval.
		- For clause 5.5A.1 inter-band CA between FR1 and FR2 in TS 38.101-3, it is suggested to set new sub-clauses based on the number of constituent band, for example as below.



* + - For clause 5.5A.3.1 two-band inter-band CA configuration within FR1 in TS 38.101-1, some “group-tag” are suggested to be set for the purpose of easier retrieval, for example as below.



* + - For clause 5.5A.3.2 to 5.5A.3.5 with three-band to six-band inter-band CA configuration within FR1 in TS 38.101-1, the configuration table is suggested to be further split into several sub-tables, and some “group-tag” are suggested to be set for the purpose of easier retrieval.
* Recommended WF
	+ Collect companies’ view.

*Apple/Ericsson: we cannot agree to split the requirements into short tables.*

*ZTE: two band, we have already split the table.*