3GPP TSG-RAN WG4 Meeting # 104-e R4-221xxxx

Electronic Meeting, 15– 26 August 2022

**Agenda item:** 11.2.4

**Source:** CATT

**Title:** WF on study on FS\_NR\_700800900

**Document for:** Approval

# Introduction

This WF is to capture the agreements for the SI FS\_NR\_700800900 discussion in RAN4#104e. The WF was drafted according the 1st round discussion summary [1] and was discussed in the 2nd round.

# Way Forward

## Topic #1: TP skeleton and work plan

### Work plan

The following work plan is approved.

RAN4#104-e:

1. Identify the critical issues for the band combinations.
2. Discuss the skeleton of the TR.

RAN4#104b-e:

1. Discuss the potential solutions for the identified issues for each band combination.
2. Approve the TR skeleton.

RAN4#105:

1. Further discuss the solutions.
2. Approve some TPs.

RAN4#106:

1. Approve the conclusions for each band combination of the SI.
   * Approve all of the TPs and the first version of TR.

### 2.1.2 TR skeleton

The TR skeleton in R4-2211714 can be used as the starting point to draft the TR skeleton in next meeting.

## CA\_n5-n8

### 2.2.1 Spectrum restriction assumption for the analysis

The following spectrum restriction can be used as the assumption for further CA\_n5-n8 UE RF analysis:

|  |  |  |
| --- | --- | --- |
|  | UL | DL |
| Frequency 1 (800MHz) | 824MHz - 835MHz | 869MHz - 880MHz |
| Frequency 2 (900MHz) | 904MHz - 915MHz | 949MHz - 960MHz |

*Comments from companies:*

*Company A:*

Apple: Despite the above frequency restriction may be applicable to a specific operator, it should not be used as a baseline for front-end filter implementation feasibility study as the filter design should cover the full band ranges in order to support the single-band operation in different regions.

ZTE: Dedicated filter may need to be studied.

OPPO: Our understanding on the above restriction means that RAN4 only support this frequency ranges in this band combination. And UE need to consider how to implement such band combination. But meanwhile, we share similar view as Apple, the RF component study should be common for future cases.

Samsung: Share similar view with Apple.

China Unicom: As there is frequency overlapping between n5 DL and n8 UL, spectrum restriction would be needed for the study of CA feasibility. This table is proposed as example bands as part of the study.

China Telecom: In our understanding, the feasibility study shall be based on the standard filter which cover the full band ranges, but can be better adapted for the CA\_n5-n8 with the frequency restriction, also to see if the requirements are acceptable or additional requirements need to be defined.

Qualcomm: In our view making spectrum restrictions give RAN4 still two alternatives for further studies in upcoming meetings; to assume full n5/n8 RF filters (baseline) or to assume restriction-specific RF filters. This was also captured in SI description notes 1 and 2. The implications of these two alternatives are of course completely different in magnitude.

Huawei: We can start to work based on the frequency restriction as listed above. In addition, we are open to hear other operators’ inputs about the frequency restriction to enlarge the eco-system as soon as possible. To Qualcomm, the baseline implementation has been specified in this SI, but I don’t think the frequency restriction-specific RF filters are excluded.

Skyworks: we are fine to assume that filters should cover the full band but then it implies for a 2 antenna case that there is non simultaneous Tx/Rx for n8UL with n5DL at least for one of the DL path (ie n5DL could operate as 1Rx while transmission in n5 with the related MSD for the proposed range. I suggest that both 2 and 3 antenna architecture are studied, in the case of a third antenna there may still be options for an optimized filter.

Vivo: What is the impact of this frequency restriction on RF architecture? Whether Full Range RF components or Partial Range RF components can be used as baseline?

### 2.2.2 UE RF architecture assumption

The following UE RF architectures can be assumed in the future meetings’ analysis for CA\_n5-n8.

2 antenna, 3 antenna

ZTE: Question for clairfication, does the ‘2 antenna, 3 antenna’ means the total antenna number which includes not only primary Tx/Rx antenna(s), but also diveristy Rx antenna(s)?

*Comments from companies:*

*Company A:*

OPPO: If only consider this n5+n8 band combination is ok, but if consider UE that supports also other band combinations like n8+n20+n28, then 4 antennas architecture (include main and diversity antennas) should also be considered here. This needs to be clarified.

Xiaomi: It is feasible to study 2 antenna and 3 antenna as a starting point. To ZTE, in our understanding 2 antenna and 3 antenna architecture here include both primary antenna and diversity antenna.

China Telecom: We support to use 2 antenna and 3 antenna as the starting point to study.

Qualcomm: OK to study 2 and 3 antennas. Let’s make it clear that the number of antennas here means total number of LB antennas including diversity.

Huawei: OK to assume 2 and 3 antennas architecture for further analysis for CA\_n5-n8.

Skyworks: The number of antennas should be understood as the total number of antennas to support Main UL/DL and diversity DL for all bands. Like for any combination it should be implementable with or without additional combinations. Since we are looking at minimum requirement this should be based on up to 3 antennas. If UE has a 4th antenna it will provide further freedom for the implementation to exceed the minimum requirement but 4 antenna cannot be mandated for CA\_n5-n8.

Vivo: 2-antenna, 3antenna is not that clear since RF architecture is still not clear. Maybe we can give an example block diagram for 2-antenna and 3-antenna.

### 2.2.3 CBW assumption

The following is the assumption of BCS0:

n5: {5,10}MHz, n8{5, 10}MHz

*Comments from companies:*

*Company A:*

OPPO: For clarification, there are 11 MHz in n5 and n8, is there restriction on the 10MHz location, for example in the middle?

China Telecom: For now, we are not quite sure the location for 10MHz, may be more general study is needed independent the location within the 11MHz. This can be further discussed.

Huawei: it should be based on operators’ input.

Skyworks: If the the location is not known we suggest that the 10MHZ is placed at the worst position for the study (ie n5DL at the top and n8UL at the bottom).

Vivo: We share the same view with Huawei.

### 2.2.4 RF parameters assumption

Continue the RF parameters discussion when the UE RF architecture and CBW are agreed.

*Comments from companies:*

*Company A:*

### 2.2.5 Feasibility issues need to be analysed

The following issues will be analyzed in the feasibility study.

* + The MSD due to IMD and cross band isolation.
  + The impact on n5 out-of-band blocking requirement.

*Comments from companies:*

*Company A:*

Apple: The impact on n5 out-of-band blocking requirement is based on the assumption of a triplexer implementation where the middle filter range covers both n5 DL and n8 UL.

OPPO: Can be further studied.

Xiaomi: OK with the recommended WF.

China Telecom: support the WF.

Qualcomm: OK with WF, but OBB study does not need to be restricted to triplexer assumption only

Skyworks: For the triplexer options with merged n5DL and n8UL, non-simultaneous n8UL and n5DL should be assumed. Can it be clarified what OOBB impact is expected in this case? If simultaneous n8UL and n5DL then the blocking impact could be added to the MSD aspect too.

### 2.2.6 Other observations and proposals

The following RF requirement framework applies to CA\_n5-n8, CA\_n5-n28 and CA\_n8-n20-28.

* + *Operating bands for CA*
  + *Channel bandwidths per operating band for CA*
  + *Co-existence studies*
  + *∆TIB and ∆RIB values*
  + *REFSENS requirements (MSD)*

*Comments from companies:*

*Company A:*

ZTE: The listed RF requirements are the classic RF requirements frameworks for inter-band NR CA including 1UL and 2UL. Except the listed ones, ‘UE maximum output power for Inter-band CA’ should be added.

BTW, the ‘*Co-existence studies*’ is not RF requirement, it should be replaced by ‘Spurious emissions for UE co-existence for Inter-band CA’.

Vivo: Co-existence studies here means harmonics and intermodulation interference study.

### 2.2.7 UL configuration

The CBW of UL configuration CA\_n5-n8 is the same as the DL.

*Comments from companies:*

*Company A:*

Skyworks, thank you for adding this but we also need to agree on exact number of RB of the UL. We suggest that the same RB allocation than single band REFSENS UL configuration is used and placed at the worst position

## CA\_n5-n28

### 2.3.1 UE RF architecture assumption

The following UE RF architectures can be assumed in the future meetings’ analysis for CA\_n5-n28

2 antenna, 3 antenna

*Comments from companies:*

*Company A:*

ZTE: Similar question as above, does the ‘2 antenna, 3 antenna’ means the total antenna number which includes not only primary Tx/Rx antenna(s), but also diveristy Rx antenna(s)?

OPPO: If only consider this n5+n28 band combination is ok, but if consider UE that supports also other band combinations like n8+n20+n28, then 4 antennas architecture (include main and diversity antennas) should also be considered here. This needs to be clarified.

Xiaomi: Ok with 2 antenna and 3 antenna that include primary antenna and diversity antenna.

Qualcomm: OK to study 2 and 3 antennas. Let’s make it clear that the number of antennas here means total number of LB antennas including diversity.

Huawei: OK to assume 2 and 3 antennas architecture for further analysis for CA\_n5-n28.

Skyworks, thank you for adding this but we also need to agree on exact number of RB of the UL. We suggest that the same RB allocation than single band REFSENS UL configuration is used and placed at the worst position

Vivo: One suggestion: give an example RF architecture block diagram to illustrate 2 antenna, 3 antenna solution.

### 2.3.2 CBW assumption

n5: 5, 10, 15, 20

n28: 5, 10, 15, 20, 25, 30

*Comments from companies:*

*Company A:*

OPPO: For clarification, is there CBW location restriction in this band combination?

Huawei: To OPPO, I don’t think we have CBW location restriction in this band combination**.**

Skyworks: If all n5 and n28 CBW are to be supported in the BCS:

* n5UL is 21MHz away from n28DL => ACLR2 interference for 15 and 20MHz UL ~ IMD5 issue
* n5DL is 121MHz away from n28UL => ACLR4 interference for 30MHz UL ~ IMD9 issue should be OK
* n28 dual duplexer should be studied.

**Vivo: No need to restrict CBW location.**

### 2.3.3 Feasibility issues need to be analysed

The following issues can be analyzed in the feasibility study.

* + The MSD due to cross band isolation

*Comments from companies:*

*Company A:*

ZTE: The supported CBW should be defined.

Skyworks: at least it needs to be confirmed if n5 UL includes 15 and 20MHz.=> worst case cross band MSD

### 2.3.4 Other observations and proposals

The following proposal is agreed: No IMD for 2UL CA n5-n28

*Comments from companies:*

*Company A:*

### 2.3.5 UL configuration

The CBW of UL configuration CA\_n5-n28 is the same as the DL.

*Comments from companies:*

*Company A:*

Skyworks, thank you for adding this but we also need to agree on exact number of RB of the UL. We suggest that the same RB allocation than single band REFSENS UL configuration is used and placed at the worst position

## CA\_n8-n20-n28

### 2.4.1 Spectrum restriction assumption for the analysis

The following spectrum restriction for n28 can be assumed in this study.

UL: 703MHz~733MHz

DL: 758MHz~788MHz

*Comments from companies:*

Nokia:The assumption should make sure that the restriction only applies to the status that a UE is configured with CA\_n8-n20-n28 while when the UE is in Non-CA state, the restriction doesn’t apply. FFS for which fallback configuration(s) requires the restriction.

Xiaomi: This assumption can be applied to CA case like DC specified in Rel-17.

Samsung: We think this restriction is for CA\_n8-n20-n28.QC: Ok with WF. As pointed out by Nokia, the n28 restriction is only for CA\_n20-n28 and it’s supersets e.g. CA\_n8-n20-n28.

Skyworks: the only n20 and n28 related already specified case is with proposed restriction and is critical for the architecture asumption. Non-CA state is unclear does it mean that this UE should support full n28 in single band? It it is the case we may need to duplicate/add other duplexers for n8 and n28. Note anyhow that 38.101-1 say this “For a higher order band combination of which CA\_n20-n28 is a subset, the frequency range in band n28 is restricted for the higher order band combination to 703-733 MHz for the UL and 758-788 MHz for the DL.”

Vivo: Whether to restrict band n28 depends on operator’s request.

### 2.4.2 UE RF architecture assumption

The following UE RF architectures can be assumed in the future meetings’ analysis for CA\_n8-n20-n28.

2 antenna, 3 antenna, 4 antenna.

*Comments from companies:*

*Company A:*

ZTE: Similar question as above: does the ‘2 antenna, 3 antenna, 4 antnna’ means the total antenna number which includes not only primary Tx/Rx antenna(s), but also diveristy Rx antenna(s)?

OPPO: For the three band combinations in this SI, do we need to consider a UE support all of them or studied separately but in the end UE in the market has to support all of them. This might need to be clarified in the SI. For 4 antennas architecture include main and diversity antennas.

Xiaomi: We are OK to study 4 antenna architecture for 3 low band BC. In our understanding the antenna number here means the sum of primary antenna and diversity antenna.

Qualcomm: OK to study at least 2 and 3 antennas. We are ok include 4 antenna studies as well, however practically thinking going in 3GPP from 2LB antenna to max 4 for smartphone form factor sounds a stretch. Let’s make it clear that the number of antennas here means total number of LB antennas including diversity.

Skyworks: The number of antennas should be understood as the total number of antennas to support Main UL/DL and diversity DL for all bands. In this case it is OK have up to 4 antennas.

Vivo: We need clearer picture than 2 antenna, 3 antenna, 4 antenna. Maybe an example diagram can be given for each solution.

### 2.4.3 CBW assumption

The following CBW assumption can be used in future study

n8: 5, 10, 15, 20

n20: 5, 10, 15, 20

n28: 5, 10, 15, 20, 25, 30

*Comments from companies:*

*Company A:*

Skyworks: is it really true that we need to consider all CBW and that an operator will max CBW in all 3 bands? then should we consider the simultaneous interference of 2 UL for the cross band cases?

Note that CA\_n20-n28 has a BCS0 with only up to 20MHz in n28.

### 2.4.4 Feasibility issues need to be analysed

The following issues will be analyzed in the feasibility study.

* + UL CA\_n8-n20 (IMD3 and IMD5), UL CA\_n20-n28 (IMD3).
  + The impact on n20 and n28 out-of-band blocking requirement

*Comments from companies:*

*Company A:*

Apple: The impact on n20 and n28 out-of-band blocking requirement is based on the assumption of a pentaplexer implementation where one of bandpass filter covers both n20 and n28 DL ranges.

ZTE: n20-n28 inter-band UL CA have already existed in the spec.

Samsung: Agree with ZTE, as we commented in first round, ULCA\_n20-n28 has already been specified with n28 limited to 703-733MHz (UL) and 758-788MHz (DL). If 2.4.1 confirm the frequency restriction, no need to redefine.

Qualcomm: OK with WF, but OBB study does not need to be restricted to pentaplexer assumption only

### 2.4.5 UL configuration

UL configuration of CA\_n8-n20, CA\_n8-n28, CA\_n20-n28 are supported for CA\_n8-n20-n28. The CBW assumption for UL and DL are the same.

*Comments from companies:*

*Company A:*

Skyworks, thank you for adding this but we also need to agree on exact number of RB of the UL. We suggest that the same RB allocation than single band REFSENS UL configuration is used and placed at the worst position

# Reference

[1] R4-2214108, Email discussion summary for [104-e] [130] FS\_NR\_700800900