

[RAN95e-RAN4-R18Prep-06]
Variant of [RAN95e-RAN4-R18Prep-06] Version 0.0.7
RAN

3GPP TSG-RAN Meeting #95-e RP-220024

Electronic Meeting, March 17 – March 23, 2022

Agenda Item: X

Source: RAN4 chair (Huawei)

Title: Moderator's summary for discussion [RAN95e-RAN4-R18Prep-06] Other RAN4 Enhancements

Document for: report

1 General

According to RAN Chair guidance, RAN95e-RAN4-R18Prep-06 will cover (as in RP-212682) Topics #1/#2 (band combination related topics), Topics#8/#9 (ATG/HAPS), Topic#12 (support of intra-band non-collocated EN-DC/NR-CA deployment), topic#13 (FR2 HST enhancement), and possibly other topics.

In the following, the topic number in RP-212682 will be reused for each topic. This document will capture the summary of the initial round.

2 Topic #1: Simplification of band combination specification

2.1 Initial round

2.1.1 Objectives

Based on RP-212682, the potential stabilized objectives are as follows:

- Investigate and simplify the working procedure for approving documents for TS and TR for band combinations to improve the quality of specifications
- RAN4 reduces the redundant and unnecessary work for big CRs, draft CRs and TPs
- RAN4 improves the procedures for cross-checking to avoid conflict between big CR/CRs across basket WIs
- [RAN4 identifies the potential consolidation/re-alignment of basket WIs]
- Investigate the feasibility and optimize the specification structure and reduce the test burden
 - Study the methodology to simplify the test efforts for a UE supporting multiple features, e.g., NR-CA, EN-DC on the same band combination

- Study of similarity and dependency of RF requirements for different features on the same band combination
- Study the methodology to simplify RF requirements specifications for
 - MSD requirements in 38.101-1 and 38.101-3, e.g., reducing the test configurations with different bandwidth combinations.
 - [Leftover issues from Rel-17 SI including Delta_TIB, Delta_RIB, Delta_TC,c in P_{cmax} for low boundary formula.]

Please provide your comments below.

Feedback Form 1:

<p>1 – Spark NZ Ltd</p> <p>Spark NZ supports the objective of simplifying the band combination standardisation process. We expect there will be a huge backlog of new bands being introduced and the permutations being presented increases this problem to the point of not being sustainable.</p> <p>However we are mindful that the quality and overall oversight from 3GPP is still required to ensure quality of combinations.</p>
<p>2 – Guangdong OPPO Mobile Telecom.</p> <p>Support the contents.</p>
<p>3 – Huawei Technologies France</p> <p>Huawei supports to have study for simplification of band combinations in Rel-18. The listed objectives are based on previous rounds of discussions. We support the objectives.</p>
<p>4 – China Telecommunications</p> <p>We support the study.</p>
<p>5 – Nokia Japan</p> <p>We support the SI. Though we are not against inclusion of this objective to discuss potential consolidation/re-alignment of basket WIs toward Rel-19 during Rel-18 SI, it is essential to discuss the same aspects toward Rel-18 baskets WIs now before the Rel-18 basket WIs start. Otherwise, even if we discuss some improvement in the SI, the effect is very limited without suitable basket WI arrangements.</p>
<p>6 – Ericsson LM</p> <p>We support the study item. We are also fine with the objectives.</p>

7 – AT&T GNS Belgium SPRL

We support the study item. We think that the brackets should be removed from the following objective.

- RAN4 identifies the potential consolidation/re-alignment of basket WIs

The consolidation and re-alignment of basket WIs will reduce implementation errors due to overlapping updates and remove redundant efforts.

8 – QUALCOMM JAPAN LLC.

In general we are supportive of changing/reducing the workload for the CA band combo related procedures, however, we think that a major change is needed to make the whole process scalable and not have RAN4 drown in CA proposals. The discussion should involve MCC and the whole process should be changed, for example, an online tool could be used to propose a CA combination and the TP and CR could be automatically generated.

9 – KDDI Corporation

We support the study item.

10 – ZTE Corporation

Simplification of band combination specification:

Firstly, we have strong interest on this topic since band combination simplifications have been approved in Rel-17 and we think that this topic in Rel-18 could be treated as continuation of Rel-17.

We are fine with most parts of the existing objectives listed, however we would like to add more objectives as following:

- 1) **Further collect agreements on the rules and guidelines of specifying band combinations;**
- 2) how to identify the potential consolidation/re-alignment of basket WIs in RAN4 should also be considered especially before the start of the Rel-18. The final principle could also be captured in this SID for the reference of further release.

In addition, we also have the following suggestions on the existing objectives:

RAN4 reduces the redundant and unnecessary work for ~~big CRs, draft CRs and TPs~~

Currently, the big CRs aim to include/reflect all the approved TPs and endorsed draft CRs proposed by the proponents, which are based on the band configurations and the latest specification version. There are no redundant and unnecessary work in big CRs and draft CRs for all the basket WID works. Indeed, we think the redundant and unnecessary work should be focused on TPs.

~~RAN4 improves the procedures for cross-checking to avoid conflict between big CR/CRs across basket WIs.~~

Indeed some conflicts between big CRs are found between some Rel-17 basket WIDs, such as 1UL/3DL and 2UL/3DL NR CA basket WIDs, 1UL/4DL and 2UL/4DL NR CA basket WIDs, where the clauses for configuration table are overlapped. It will cause conflict and trouble for MCC to implement all the CRs [5]. However, we think this can be solved if these basket WIDs are re-arranged for Rel-18, such as merging

1UL and 2UL into one basket WID or something else, which is still under discussion. Therefore, we think there is no need for this objective.

More details could be found in R4-2200614 (Motivation paper) and R4-2200615 (Proposed SID).

11 – Beijing Xiaomi Mobile Software

We support the objectives

12 – China Unicom

We support the work, and fine with the objectives.

13 – SoftBank Corp.

We support this activity and are fine with the objectives.

14 – LG Electronics Deutschland

We support this study that can reduce UE testing efforts efficiently.

15 – Intel Corporation SAS

We support this work on Simplification of band combination specification. The current number of BCs and associated RF requirements become an issue for implementation and testing. Development of new approaches is important to improve RAN4 working efficiency and the current objectives are OK to us. The only comment is maybe could proponent clarify on the detailed scope for leftover issues from R17 SI.

16 – Skyworks Solutions Inc.

We support simplification but we should make sure that the quality is there. Today we still have many issues with TP for block approval, cases that are not for black approval. If we want to simplify further it should not result in a flood of errors in the spec. If this has to work then the community should agree on better defined rules that are embedded in a tool (not word) so that errors are reduced. this means that there are also less exceptions or optimization. We do not see how we can enable more and more combinations to be automatically approved including potential errors and at the same time having requests for improved MSD.

17 – Deutsche Telekom AG

Considering the high effort related to increasing number of combinations and to increase the efficiency, we support all the objectives related to the simplification of band combination specifications.

18 – Samsung Electronics Co.

We support this study

19 – MediaTek Inc.

In general, we are supportive as long as it does not put any additional requirements on the UE compared to existing requirements applicability, and does actually simplify processes and workload.

2.1.2 SI/WI and impacts to other WG

Based on RP-212682, an SI was proposed and there is no impact on other WG.

- An SI is supposed to be approved for Topic #1
- There is no impact on other WG, i.e., no need to involve other WG as secondary WG.

Please provide your comments below.

Feedback Form 2:

1 – Nokia Japan We don't see the impact of the SI on other WG while as mentioned in Form 1, it is essential to discuss basket WI arrangement for Rel-18 in TSG RAN before the Rel-18 basket WIs start.
2 – Ericsson LM We also do not see any impact on other WG.
3 – AT&T GNS Belgium SPRL We do not see any impact to any other WG.
4 – ZTE Corporation From our understanding, it's better to add the RAN5 as secondary working group since it's clear indicated to study the methodology to simplify the test efforts for a UE supporting multiple features, e.g., NR-CA, EN-DC on the same band combination. The basic framework of RAN4 to simplify the test efforts should also have impacts of RAN5 work.
5 – Intel Corporation SAS We support this SI. Just to clarify if RAN5 is also involved or not.

2.1.3 Summary of initial round

Almost all the companies support this project. There are some comments on objectives raised by companies.

For Nokia comment on the potential consolidation/realignment of basket WIs towards Rel-18, RAN4 has already discussed this for Rel-18 and there was outcome captured in the documents in the previous RAN4 meeting. And the more discussion will be held before approving Rel-18 basket WIs. The concerned objective aims at further improvement towards Rel-19 and further release. And AT&T commented to remove the [] on this objective. So the moderator propose to remove [] and add clarification that this objective is for further improvement towards the future release.

- {RAN4 identifies the potential consolidation/re-alignment of basket WIs for the future release(s)}

Qualcomm commented that the MCC should be involved and a automatic tool would be needed. Skyworks commented that the quality of specifications need be ensured by better defined rules. In the moderator's

understanding, The main purpose of those bullets is to improve the efficiency of specify band combinations. But at the same time the proper rules and/or guidance are needed to ensure the quality of specifications. Some improvements after the first bullet target at efficiency, while others target at ensuring the quality.

ZTE commented that RAN4 needs collect and capture agreements on the rules and guidelines in the TR of this project. ZTE also proposed to removed big CRs and draft CRs from the objective of reduction of redundant and unnecessary work, and to remove the objective about cross-checking. In the moderator's view, there might be some case where there is some redundant or unnecessary work for big CRs or draft CRs, although the redundancy and unnecessary work would exist mainly for TPs. And the reason to remove the bullet of cross-checking is based on the assumption that some work of consolidation of basket WIs has been done. So the moderators would like to suggest to keep those bullets but add if any to leave some room for further checking.

To capture those comments, the moderator proposes to re-structure the bullets for simplification of specifications.

- Investigate and simplify the working procedure for approving documents for TS and TR ~~for band combinations~~ to improve the efficiency to specify band combinations and the quality of specifications
 - Improve the efficiency considering
 - RAN4 reduces the redundant and unnecessary work for big CRs, draft CRs and/or TPs, if any
 - Define rules, or develop tools to help generating documents, if feasible
 - Improve the quality considering
 - RAN4 identifies the potential consolidation/re-alignment of basket WIs for future release(s)
 - RAN4 improves the procedures for cross-checking to avoid conflict between big CR/CRs across basket WIs, if any
 - RAN4 captures the agreements about the rules and guidelines including the outcome of the above sub-bullets in the corresponding TR

Intel would like the proponents to clarify the detailed scope for leftover issues from R17 SI. In the moderator's understanding, the leftover issues include Delta_TIB, Delta_RIB and Delta_TC,c in P_{max} for low boundary formula. There seemed some room to simplify those three requirements. Thus the moderator suggests to make that bullet more clear.

- Study the methodology to simplify RF requirement specifications for
 - MSD requirements in 38.101-1 and 38.101-3, e.g., reducing the test configurations with different bandwidth combinations.
 - ~~{Leftover issues from Rel-17 SI including Delta_TIB, Delta_RIB, Delta_TC,c in P_{max} for low boundary formula.}~~

Mediatek commented that there will be no additional RF requirements specified. The moderator would like to propose adding a note to clarify that.

In the intermediate round, moderator encourages companies to further check and comment on the above modified objectives to converge on them.

According to feedback, it seems that SI is acceptable. Two companies suggested to involve RAN5 as the secondary WG. So in the intermediate round, companies are suggested to further comment on whether RAN5 should be involved as the secondary WG for this item.

2.2 Intermediate round

The target of the intermediate round is to converge on the objectives.

2.2.1 Objectives

Based on the summary of the initial round, the moderator modifies the objectives as below to capture companies' comment. The reasoning is provided in section 2.1.3.

The proposed objectives:

- Investigate and simplify the working procedure for approving documents for TS and TR to improve the efficiency to specify band combinations and the quality of specifications
 - Improve the efficiency considering
 - RAN4 reduces the redundant and unnecessary work for big CRs, draft CRs and/or TPs, if any
 - Define rules, or develop tools to help generating documents, if feasible
 - Improve the quality considering
 - RAN4 identifies the potential consolidation/re-alignment of basket WIs for future release(s)
 - RAN4 improves the procedures for cross-checking to avoid conflict between big CR/CRs across basket WIs
 - RAN4 captures the agreements about the rules and guidelines including the outcome of the above sub-bullets in the corresponding TR
- Investigate the feasibility and optimize the specification structure and reduce the test burden
 - Study the methodology to simplify the test efforts for a UE supporting multiple features, e.g., NR-CA, EN-DC on the same band combination
 - Study of similarity and dependency of RF requirements for different features on the same band combination
 - Study the methodology to simplify RF requirement specifications for

- MSD requirements in 38.101-1 and 38.101-3, e.g., reducing the test configurations with different bandwidth combinations.
- Delta_TIB, Delta_RIB, Delta_TC,c in P_{max} for low boundary formula.

- NOTE: no additional UE RF requirement is expected as the outcome of this SI.

Please provide your comment below.

Feedback Form 3:

<p>1 – Verizon UK Ltd</p> <p>We support this work! One comment is for the objective. We should state clearly this work shall be applied to all of the power-class band combustions.</p>
<p>2 – AT&T GNS Belgium SPRL</p> <p>We are OK with the moderator proposed objectives.</p> <p>Concerning our comment in the first round on removing the brackets on "RAN4 identifies the potential consolidation/re-alignment of basket WIs", we were more concerned with being able to have more discussion on the consolidation/re-alignment of Rel-18 basket WIs as we think that the LTE baskets should follow a similar approach as decided for NR baskets. If there is an understanding that more discussion will be held on this topic before approving Rel-18 basket WIs, we are OK with or without the "RAN4 identifies the potential consolidation/re-alignment of basket WIs for future release(s)" bullet item.</p>
<p>3 – SoftBank Corp.</p> <p>We support the proposed objectives.</p>
<p>4 – Apple AB</p> <p>we continue supporting this work.</p>
<p>5 – Nokia Japan</p> <p>Thanks the moderator for initiating the discussion. We'd like to ask the moderator to clearly capture in the summary of the e-mail discussion that Rel-18 basket WI re-arrangement will be discussed before the Rel-18 basket WIs are approved.</p>
<p>6 – vivo Communication Technology</p> <p>We support this work.</p>
<p>7 – China Unicom</p> <p>We support this work.</p>
<p>8 – Skyworks Solutions Inc.</p> <p>We support this work and it shall also cover the current "not for block approval" cases where a developed specification framework, rules and guidelines would allow to return to a block approval mode.</p>

9 – ZTE Corporation

Basically we are fine with moderator proposed objectives with moderators' further clarifications.

Regarding the consolidation/re-alignment for Rel-18 basket WID, the general principle should be determined at the RAN#96e June meeting, however this basic principle should be captured in this SID and TR for the reference of future release.

10 – ZTE Corporation

Our original intentions is to involve RAN5 since there are lots of test burden reduction, if these agreed framework or information could be circulated with RAN5 in time, this would also speed up the corresponding work in RAN5.

11 – LG Electronics Deutschland

We support objectives proposed by moderator

12 – Ericsson LM

We support the objectives

13 – Intel Corporation SAS

We are fine with the objectives.

14 – Huawei Technologies France

1) For the bullet, "Define rules, or develop tools to help generating documents, if feasible". Rules and tools are too general. It's better to clarify the specific aspect for the rules and tools. Otherwise, the scope can't be controlled. Since this objective is for improving the efficiency, it's proposed to set the following specific objectives.

The following rules will be investigated and defined if necessary

NOTE: SID should be further revised before other new aspects need to be defined.

- investigate whether the workflow can be improved under the condition that quality can be guaranteed.

Develop the following tools to reduce RAN4's workloads, if feasible

2) For the bullet, "RAN4 improves the procedures for cross-checking to avoid conflict between big CR/CRs across basket WIs **and other WIs**"

3) For the bullet, "Delta*TIB*, *DeltaRIB*, Delta_TC,c in P_{max} for low boundary formula." It can be replaced by the following specific objectives.

For Delta*TIB*, *DeltaRIB*, to investigate and define the framework of the general principle or requirements with band-combination specific exceptions.

For Delta_TC,c, to investigate whether it can be removed in low boundary formula for p_{max}.

4) The outcome of bullet “Investigate the feasibility and optimize the specification structure and reduce the test burden” may have an impact on the specification. For example, specification structure may be improved and the test burden can be clarified. In order to avoid the ambiguity, it’s better to clarify that **“CR is not expected in this SI, but specifications works based on the outcome of this SI can be done under TEI or following WI”** and remove the note ”NOTE: no additional UE RF requirement is expected as the outcome of this SI.”.

15 – Huawei Technologies France

We’d like to propose the following justification for this SI.

The huge number of band combinations and configurations with different downlink CC numbers and uplink CC numbers configured are specified since Rel-15. RAN4 spent lots of time introducing band combinations by current working procedure. It can be observed to further optimize and improve working procedure in order to improve the efficiency to specify band combinations and the quality of specifications.

In the current specifications, the UE RF requirements are specified per feature (e.g., CA, DC, EN-DC, SUL) for a band combination (e.g., band A+B+C). But most of RF requirements depend on which spectrum are combined and how many UL and on which spectrum UL will be transmitted, and are independent of those features. As a result, there are redundancy during the verification of RF requirements for a combination of bands. Particularly, UE needs to pass some similar CA and EN-DC RF requirements on the same combination of bands, e.g., *CAnA-nB*, *EN-DCAnB*, *EN-DCB_nA*, where A and nA correspond to the same spectrum for LTE and NR separately. But the RF implementation under the verification for CA and EN-DC would be the same. It’s better to investigate the dependency and applicability for RF requirements among different feature of same spectrum combination to reduce the redundant tests.

In current specification, most of RF requirements are related to band combination specific except for MSD. It’s better to study methodology to simplify RF requirements specifications for MSD requirement to reduce the test configurations with different bandwidth combinations. For the other band combination specific RF requirements, it’s better to further optimize the specification structure.

- Working procedure needs be improved and simplified. There are more and more band combinations introduced, which makes current working procedure not sustainable and less efficient
 - o Improve the efficiency of specifying band combinations by reducing redundant work, defining rules and developing tools.
 - o Improve the quality of specifications by avoiding the conflict between big CRs and incomplete CRs.
 - o Reduce the redundancy and unnecessary work.
- Address the issues caused by big number of band combinations for UE implementation and testing. Some tests for a band combination seems redundant. To further optimize the specification structure.

16 – KDDI Corporation

We support the proposed objectives.

2.2.2 SI/WI and impacts to other WG

The moderator proposes

- Approve an SI for Topic #1.

More discussion on whether RAN5 should be involved as the secondary WG for reduction of test burden is needed. Please companies provide comment on that.

Feedback Form 4:

<p>1 – Spark NZ Ltd</p> <p>Ok to involve RAN5 as a secondary WG, but we must be clear objectives we require from them. Are we also confident that by involving them we still achieve the objective of faster turn around on new combinations, etc.</p>
<p>2 – Skyworks Solutions Inc.</p> <p>regarding RAN5, one aspect is whether additional test points are added compared to RAN4 REFSENS exceptions: in our view only the exceptions should be tested as the generic REFSENS is already tested low,mid,high per band.</p>
<p>3 – ZTE Corporation</p> <p>Our original intentions is to involve RAN5 since there are lots of test burden reduction, if these agreed framework or information could be circulated with RAN5 in time, this would also speed up the corresponding work in RAN5.</p>
<p>4 – Intel Corporation SAS</p> <p>We are fine to leave RAN5 as not included or impacted.</p>
<p>5 – Ericsson LM</p> <p>We suggest NOT to include RAN4 as secondary WG. However, RAN5 should be consulted and also informed during the SI.</p> <p>One suggestion is to send LS to RAN5 after every RAN4 meeting or at least once per quarter to inform them about RAN4 agreements and seek their input. More detailed RAN5 input can also be sought before RAN4 takes the final decisions especially on specific objectives which have more impact on RAN5 e.g.</p> <ul style="list-style-type: none">- Improve the efficiency considering- Study the methodology to simplify RF requirement specifications for

2.2.3 Summary of intermediate round

Companies provided the constructive comments to improve the objectives.

Verizon commented that the work shall be applied to all the power class. To capture this comment, the moderator proposes to add a NOTE to clarify that the work should be applied to all the power classes.

AT&T, Nokia expressed the desire for having more discussions on the consolidation/re-alignment of Rel-18 basket WIs. It seemed OK to remove the corresponding sub-bullet in objectives, but have an additional agreement to capture that action point for Rel-18. The moderators are OK to remove the bullet for consolidation/re-alignment of basket WIs and list the action point, considering such action should be taken recently.

Skyworks proposed capture the rules for “not for block approval” cases. The moderator adds a sub-bullet to capture it under the bullet for improving the efficiency. Huawei proposed to improve the objectives for improving the efficiency. The moderator provides some modifications accordingly. Regarding the proposed “NOTE: SID should be further revised before other new aspects need to defined.” The moderator understands the concern, i.e., some discussion out of scope may be proposed in WG. But as the usual business, in principle only the contributions falling within the scope of WI/SI will be treated and if not the revision of WI/SI is needed. So in the moderator’s view, there is no need to capture the proposed NOTE.

ZTE commented that the general principle for consolidation/re-alignment for Rel-18 basket WID need be captured in TR. Moderator thinks that the existing objective “RAN4 captures the agreements about the rules and guidelines including the outcome of the above sub-bullets in the corresponding TR” can cover it. To make it more clear, the moderator would like to change it to “RAN4 captures the agreements about the rules and guidelines including but not being limited to the outcome of the above sub-bullets in the corresponding TR.”

Huawei responded to Intel questions and clarified the bullet for Delta_TIB, Delta_RIB, Delta_TC,c. The moderator takes those proposed modification.

Huawei proposed to remove the NOTE of no additional UE RF requirement is expected. The moderator understands the concern. After the study, some requirements may need to be modified, e.g., in the way to formulate the requirements, to reduce the test burden. Although there will be no tightening or relaxation of requirements for UE, companies may refuse the proposal just based on the NOTE of no additional UE RF requirement is expected. So the moderator changes the note to clarify that the requirements applicable to UE won’t be increased.

Huawei provided the draft justification. The moderator uses it as the baseline and has the necessary modifications.

Regarding whether RAN5 should be involved or not, there was no consensus. In the moderator’s view, RAN4 can send LS to RAN5 if needed, which is a usual business. Thus moderator suggests not to have any secondary working group for this SI.

Based on the above comments, the modified objectives, draft justification, suggestion on WI or SI, secondary working group and additional agreement are provided in the following section of final round for further checking.

2.3 Final round

2.3.1 Objectives

- Investigate and simplify the working procedure for approving documents for TS and TR to improve the efficiency to specify band combinations and the quality of specifications

- Improve the efficiency considering
 - RAN4 reduces the redundant and unnecessary work for big CRs, draft CRs and/or TPs, if any
 - ~~Define rules, or develop tools to help generating documents, if feasible~~
 - The following rules will be investigated and defined if necessary
 - Investigate whether the workflow can be improved under the condition that quality can be guaranteed.
 - Develop rules or guidelines covering the process of not for block approval.
 - Develop the necessary tools to reduce RAN4's workloads if feasible
- Improve the quality considering
 - ~~RAN4 identifies the potential consolidation/re-alignment of basket WIs for future release(s)~~
 - RAN4 improves the procedures for cross-checking to avoid conflict between big CR/CRs across basket WIs and other WIs
- RAN4 captures the agreements about the rules and guidelines including but not being limited to the outcome of the above sub-bullets in the corresponding TR
- Investigate the feasibility and optimize the specification structure and reduce the test burden
 - Study the methodology to simplify the test efforts for a UE supporting multiple features, e.g., NR-CA, EN-DC on the same band combination
 - Study of similarity and dependency of RF requirements for different features on the same band combination
 - Study the methodology to simplify RF requirement specifications for
 - MSD requirements in 38.101-1 and 38.101-3, e.g., reducing the test configurations with different bandwidth combinations
 - ~~Delta_TIB, Delta_RIB, Delta_TC,c in P_{max} for low boundary formula~~
 - For Delta_TIB and Delta_RIB requirements, investigate and define the framework of the general principle or requirements with band-combination specific exceptions
 - For Delta_TC,c, investigate whether it can be removed in low boundary formula for P_{max}
- NOTE 1: no additional UE RF requirement is expected as the outcome of this SI. The requirements applicable to UE won't be increased.
- NOTE 2: The work should be applied to all the power classes

Please further check and provide comments if needed.

Feedback Form 5:

<p>1 – SoftBank Corp.</p> <p>We support the proposed objectives.</p>
<p>2 – ZTE Corporation</p> <p>we support the proposed objectives.</p>
<p>3 – Huawei Technologies France</p> <p>We support the moderator proposals.</p>
<p>4 – KDDI Corporation</p> <p>We support the proposed objectives.</p>
<p>5 – LG Electronics Deutschland</p> <p>We support the moderator’s proposal</p>
<p>6 – Skyworks Solutions Inc.</p> <p>the proposal from moderator captures all the key ingredients. we support</p>
<p>7 – China Unicom</p> <p>We support the proposed objectives.</p>
<p>8 – Intel Corporation SAS</p> <p>We support the objectives. It is clear thanks.</p>
<p>9 – Ericsson LM</p> <p>We support the objectives.</p>
<p>10 – QUALCOMM JAPAN LLC.</p> <p>We support the proposals</p>
<p>11 – AT&T GNS Belgium SPRL</p> <p>We support the moderator proposal.</p>

2.3.2 Justifications, SI/WI and other aspects

Justifications:

————— Justification —————

Firstly, the huge number of band combinations and configurations with different downlink CC numbers and uplink CC numbers configured are specified since Rel-15. RAN4 spent lots of time to introduce band combinations following the current working procedure. It can be observed that the further optimization and improvement of the working procedure would be useful in order to improve the efficiency to specify band

combinations and the quality of specifications.

Secondly, in the current specifications, the UE RF requirements are specified per feature (e.g., CA, DC, EN-DC, SUL) for a band combination (e.g., band A+B+C). But most of RF requirements depend on which spectrum are combined, how many Tx antennas are used, and on which spectrum UL will be transmitted, and are independent of those above features. As a result, there would be redundancy during the verification of RF requirements for a combination of bands. Currently, the UE needs to pass the similar CA and EN-DC RF requirements on the same combination of bands, e.g., CA_nA-nB, EN-DC_A_nB, EN-DC_B_nA, where A and nA correspond to the same spectrum for LTE and NR separately. But the RF implementation under the verification for CA and EN-DC would be the same. It's better to investigate the dependency and applicability for RF requirements among different features for the same spectrum combination to reduce the redundant tests.

Thirdly, in the current specification, most of RF requirements are band combination specific except for MSD. It's better to study methodology to simplify RF requirements specifications for MSD requirement to reduce the test configurations with different bandwidth combinations. For the other band combination specific RF requirements including Delta_TIB, Delta_RIB and Delta_TC,c, it's better to further optimize the specification structure.

————— Justification —————

Please check and provide your comments.

Feedback Form 6:

1 – ZTE Corporation

most of RF requirements are band combination specific except for MSD;

The above sentence is not correct since MSD is also band combination specific requirements, the following updates seems more reasonable.

most of RF requirements are band ~~combination~~ specific except for MSD;

2 – Skyworks Solutions Inc.

I think it is important to capture in the justification that the current procedure also results in a lot of errors and flags and that the process can only be simplified if we develop guideline, rules and tools to ensure good quality of the submitted contributions.

3 – AT&T GNS Belgium SPRL

We support the moderator proposal with the suggested updates from ZTE and Skyworks.

WI or SI

- SI

Secondary working group:

- Not include any WG as the secondary work group.

Additional tentative agreement:

- The consolidation/re-alignment for Rel-18 basket WI will be discussed before the Rel-18 basket WIs are approved.

Please provide your comments if any for WI or SI, secondary working group and other agreement.

Feedback Form 7:

<p>1 – T-Mobile USA Inc.</p> <p>We’d prefer this to be a Work Item so that decisions to improve the process can be implemented without waiting for the a full Study Item to complete and a Work Item to begin.</p>
<p>2 – ZTE Corporation</p> <p>since no additional requirements are expected for this work, SI is more preferred.</p>
<p>3 – Skyworks Solutions Inc.</p> <p>In any case, if some tools/rules and guidelines are put in place it will take some time to be adopted in the procedures. It might be better to do the changes once we have agreements which may not happen in the SI Phase. May be we need to develop a plan on how the the simplification/guidelines/rules/tools are deployed within the study phase with clear target dates for implementation.</p>
<p>4 – QUALCOMM JAPAN LLC.</p> <p>In our understanding this has to be a SI because it is not clear what a normative phase would look like.</p>
<p>5 – AT&T GNS Belgium SPRL</p> <p>We support the moderator proposal.</p>

2.3.3 Summary of final round

It seems the proposed objectives in the final are acceptable to the group. We re-write the objectives, justifications below without change marks. The comments from ZTE, Skyworks on justifications were captured by the moderator.

Regarding SI or WI, T-Mobile preferred WI, and Skyworks proposed to develop a plan to implement those simplification/guidelines/rules/tools. Qualcomm shared the view that that it is not clear what a normative phase would be with the study. In the moderator’s view, we may need a follow-up WI if the implementation work is big and for some smaller work maybe it can be done via TEI if agreeable to the group. But at the current stage, the study is needed first. It would be better to keep SI for the time being. In March RAN plenary, we can discuss the timeline for this SI or if experts had strong view we can re-open the discussion whether this project should be SI or WI.

For Topic #1, the recommended conclusions are as follows. Based on the conclusions, the moderator will prepare the draft SID.

Objectives:

- Investigate and simplify the working procedure for approving documents for TS and TR to improve the

efficiency to specify band combinations and the quality of specifications

- Improve the efficiency considering
 - RAN4 reduces the redundant and unnecessary work for big CRs, draft CRs and/or TPs, if any
 - The following rules will be investigated and defined if necessary
 - Investigate whether the workflow can be improved under the condition that quality can be guaranteed.
 - Develop rules or guidelines covering the process of not for block approval.
 - Develop the necessary tools to reduce RAN4's workloads if feasible
- Improve the quality considering
 - RAN4 improves the procedures for cross-checking to avoid conflict between big CR/CRs across basket WIs and other WIs
- RAN4 captures the agreements about the rules and guidelines including but not being limited to the outcome of the above sub-bullets in the corresponding TR
- Investigate the feasibility and optimize the specification structure and reduce the test burden
 - Study the methodology to simplify the test efforts for a UE supporting multiple features, e.g., NR-CA, EN-DC on the same band combination
 - Study of similarity and dependency of RF requirements for different features on the same band combination
 - Study the methodology to simplify RF requirement specifications for
 - MSD requirements in 38.101-1 and 38.101-3, e.g., reducing the test configurations with different bandwidth combinations
 - For Delta_TIB and Delta_RIB requirements, investigate and define the framework of the general principle or requirements with band-combination specific exceptions
 - For Delta_TC,c, investigate whether it can be removed in low boundary formula for P_{max}
- NOTE 1: The requirements applicable to UE won't be increased.
- NOTE 2: The work should be applied to all the power classes

Justifications:

Firstly, the huge number of band combinations and configurations with different downlink CC numbers and uplink CC numbers configured are specified since Rel-15. RAN4 spent lots of time to introduce band combinations following the current working procedure. It can be observed that the further optimization and improvement of the working procedure would be useful in order to improve the efficiency to specify band combinations and the quality of specifications.

And the current procedure also results in a lot of errors and workload like reviewing and flagging the documents with errors. The process can only be simplified to improve the efficiency if we develop guideline, rules and tools to ensure good quality of the submitted contributions.

Secondly, in the current specifications, the UE RF requirements are specified per feature (e.g., CA, DC, EN-DC, SUL) for a band combination (e.g., band A+B+C). But most of RF requirements depend on which spectrum are combined, how many Tx antennas are used, and on which spectrum UL will be transmitted, and are independent of those above features. As a result, there would be redundancy during the verification of RF requirements for a combination of bands. Currently, the UE needs to pass the similar CA and EN-DC RF requirements on the same combination of bands, e.g., CA_nA-nB, EN-DC_A_nB, EN-DC_B_nA, where A and nA correspond to the same spectrum for LTE and NR separately. But the RF implementation under the verification for CA and EN-DC would be the same. It's better to investigate the dependency and applicability for RF requirements among different features for the same spectrum combination to reduce the redundant tests.

Thirdly, in the current specification, most of RF requirements are band combination specific except for MSD. It's better to study methodology to simplify RF requirements specifications for MSD requirement to reduce the test configurations with different bandwidth combinations. For the other band combination-specific RF requirements including Delta_TIB, Delta_RIB and Delta_TC,c, it's better to further optimize the specification structure.

WI or SI

- SI

Secondary working group:

- Not include any WG as the secondary work group.

Other tentative agreement:

The consolidation/re-alignment for Rel-18 basket WI will be discussed before the Rel-18 basket WIs are approved.

3 Topic #2: Enhancement for 700+800+900MHz band combination

3.1 Initial round

3.1.1 Objectives

Based on RP-212682, the potential stabilized objectives are as follows:

- Investigate the feasibility to enable simultaneous transmission on two UL bands and simultaneous reception on three bands for the band combination of 700, 800 and 900MHz spectrum for smart phone with small form factor (RAN4)

- The following band combinations will be considered:
 - CA_n8-n20-n28 with uplink configurations of CA_n8-n20, CA_n8-n28, CA_n20-n28
 - CA_n5-n8-n28 with uplink configurations of CA_n5-n8, CA_n5-n28, CA_n8-n28
 - The following aspects need be studied
 - UE architecture including n-plexing, PA
 - Wideband antenna
 - Performance due to impacts including inter-modulation products
 - Method to manage the inter-modulation product impacts
 - Power class 3 (PC3) is considered in this study.
- Identify and specify necessary RAN4 requirements including Tx and Rx RF requirements (RAN4)

Please provide your comments below.

Feedback Form 8:

<p>1 – Spark NZ Ltd</p> <p>Spark NZ fully supports this WI and it’s objectives. However we note of particular interest (as per the proposed study aspects) will be the sub-1GHz bands intermodulations impacts, when multiplexed onto the same antenna. Previous studies had shown seperate antennas where required to provide the required isolation, which are at odds with the requirement of a small form factor UE. Alternative technologies including signalling processing techniques could be investigated.</p>
<p>2 – Spark NZ Ltd</p> <p>Spark NZ also notes that through the use of a Wideband antenna care should be taken not to compromise the efficiency over operating bandwidth of the antenna.</p>
<p>3 – Guangdong OPPO Mobile Telecom.</p> <p>It is challenging for smartphone to support this three low band combination even it is 2T/3R, since shared antenna for these bands will cause efficiency degradation and it makes UE has to implement three big separate antennas. It might be better to start this WI with a study phase for companies to check the implementation feasibility and solutions.</p>
<p>4 – Huawei Technologies France</p> <p>Huawei supports this WI and it’s objectives.</p> <p>Many operators own 700, 800 and 900MHz spectrum or other low bands. The coverage on those bands are very good. But the available spectrum on those bands is quite small, which causes difficulty to meet 5G high data rate requirements on those bands. So they should be aggregated to achieve the larger throughput on both downlink and uplink. The study in Rel-17 is focused on FWA/CPE. Though it is challenging, it would be worth to investigate and enable smartphone on low frequency band combinations.</p>

5 – China Telecommunications

We support this work, which is very important for utilizing the spectrum with narrow bandwidths in low frequency bands.

The objectives are generally stable after several rounds of discussion in the last year, and we have some wording updates:

1) Suggest to change the title of the work from “Enhancement for 700+800+900 band combinations” to “Support of UL CA on two bands in sub-1GHz”, to better reflects the content of the work.

2) Also include 2DL and 2UL band combinations, i.e.,

- Investigate the feasibility to enable simultaneous transmission on two UL bands and simultaneous reception on **two or** three bands for the band combination of **sub-1GHz 700, 800 and 900MHz** spectrum for smart phone with small form factor (RAN4)

○ The following band combinations will be considered:

■ *CAn8-n20-n28 with uplink configurations of CAn8-n20, CAn8-n28, CAn20-n28*

■ *CA_n5-n8-n28 with uplink configurations of CA_n5-n8, ~~CAn5-n28~~, CAn8-n28*

6 – VODAFONE Group Plc

Vodafone fully supports this work. We appreciate it is challenging for the smaller smartphone formfactor, but we would like to see it investigated nonetheless.

7 – TELECOM ITALIA S.p.A.

We fully support. For example, it is a key enabler to bridge the digital divide in rural areas

8 – Nokia Japan

We understand the motivation of this work. We, however, believe completion of the fallback combinations for these 700MHz+800MHz+900MHz band combinations must be the precondition to discuss the necessity of this WI or SI. Since some of the fallback combinations have not been even proposed, we don't see the urgency of approving this work at this moment.

9 – TELEFONICA S.A.

We support this WI. It would benefit the 5G deployment by improving the performance in low-frequency bands scenarios.

10 – QUALCOMM JAPAN LLC.

We do not think this work will be useful in any way. The technical challenges are known and documenting them will not help solve the problems. Also, the practical use case is limited since there are just very few operators who own all 3 low bands. Whenever the technology will be available, such combinations will be implemented irrespective of what is documented in the SI.

11 – ZTE Corporation

700+800+900MHz:

We are fine with the existing objectives to have feasibility study to support 2T3R for Low-low band combinations.

12 – Beijing Xiaomi Mobile Software

Considering the implementation of these band combination is not easy , starting with a study phase is preferred.

13 – CATT

We support to start the work for 700MHz+800MHz+900MHz band combinations. A study phase can be added to evaluate implementation aspects.

14 – Apple AB

Implementing 2T/3R for this band combination is expected to be challenging as the bands are close to each other and cross-band interference and IMD products falling into RX bands would cause large MSDs. Considering the technical challenges, this work should start as SI if it is agreed to move forward.

15 – Intel Corporation SAS

We recognize the significance of this item. The objectives are fine to us.

For feasibility stage, we suggest refining the wording as “for smart phone form factor” (we assume no differentiation of smartphones with large/small form factors).

16 – China Telecommunications

China Telecom 2:

Response to Nokia’s comments:

We can explicitly state that the feedbacks need also to be considered:

- Investigate the feasibility to enable simultaneous transmission on two UL bands and simultaneous reception on **two or** three bands for the band combination of 700, 800 and 900MHz spectrum for smart phone with small form factor (RAN4)

○ The following band combinations will be considered:

■ *CA_{n8-n20-n28} with uplink configurations of CA_{n8-n20}, CA_{n8-n28}, CA_{n20-n28}, **and the fallbacks***

■ *CA_{n5-n8-n28} with uplink configurations of CA_{n5-n8}, ~~CA_{n5-n28}~~, **CA_{n8-n28}**, **and the fallbacks***

Considering that the fallbacks also include 2DL with 1UL, our previous suggestion on the title of work seems not appropriate, and we can refine it as “**Enhancements for sub-1GHz band combination**”. To clarify, the updated title does not enlarge the scope, since there are only 700/800/900 bands in 38.101-1 for sub-1GHz.

Response to Qualcomm’s comments:

Not only 3 bands CA but also 2 bands CA are considered.

We understand there is technical difficulty to support the CA with adjacent bands, but we could not say it is infeasible. In addition, we agree that a pure SI resulting in a TR only is not meaningful, and we need to define the corresponding requirements in Rel-18.

17 – Ericsson LM

We are fine to start this work but as study item and not a work item. It is not clear the outcome of the study therefore we do not support the idea to start the WI with study phase.

<p>18 – Deutsche Telekom AG</p> <p>This item is important for Deutsche Telekom to meet 5G high data rate requirements using the deployed low bands which already have a good coverage. We support the work with 700MHz+800Mhz+900Mz bands.</p>
<p>19 – BT plc</p> <p>We believe the scope of this work should be expanded to include the 700MHz supplementary downlink, NR band n67. In particular the CA_n20A-n67A band combination should be included in the scope of the work.</p>
<p>20 – Skyworks Solutions Inc.</p> <p>We have covered some LB-LB and LB-LB-LB combinations in R17 and even with 1UL it often results in large MSDs. 2UL will only make it worse other than some cases where the 2DL are in the middle of the 2 UL. theses cases are already covered within the "not for bloc approval" thread and should be treated case by case so we do not see the benefit of a dedicated SI/WI. Finally there is no such thing as a wideband antenna for LB in a smartphone and especially not two good LB antennas. the best LB antenna is usualy physically too small for the lower part of LB thus tuning is necessary. Only FWA may provide enough room for two good LB antennas that are physically large enough to be wideband.</p>
<p>21 – Telia Company AB</p> <p>We fully support this work for 700/800/900 MHz bands.</p>
<p>22 – MediaTek Inc.</p> <p>This leads to quite challenging RF design in the UE, which may impact radio performance even when less than 3 carriers are configured, so not supportive of this. We also question the need to go to the complexity of 3DL/2UL when even 3DL/1UL for this band combination has not yet been included yet in current specs.</p>
<p>23 – Huawei Technologies France</p> <p>One more comment, we prefer to focus on 700/800/900 MHz bands for the work, in that case, we see no need to make changes of following band combinations.</p> <p>CAn8-n20-n28 with uplink configurations of CAn8-n20, CAn8-n28, CAn20-n28</p> <p>CAn5-n8-n28 with uplink configurations of CAn5-n8, CAn5-n28, CAn8-n28</p>

3.1.2 SI/WI and impacts to other WG

Based on RP-212682, an SI was proposed and there is no impact on other WG.

- An SI is supposed to be approved for Topic #2
- There is no impact on other WG, i.e., no need to involve other WG as secondary WG

Please provide your comments below.

Feedback Form 9:

1 – China Telecommunications

We support a WI with a study phase, but not a SI.

2 – TELECOM ITALIA S.p.A.

Same view as China Telecom.

3.1.3 Summary of initial round

16 companies can accept this project, including 8 operators who supported the work and 8 infra or UE vendors who are OK with SI or WI with study phase. 4 companies still had concern.

The first issue is related to fall back mode. Nokia and Skyworks commented that the fallback combinations need be finalized first. As responded by China Telecom, the fallback mode can be also included in the project.

The second issue is that there will challenge for RF design, especially considering the separate antennas which provide the good isolation to address MSD issue does not fit the form factor of smart phone. As responded by Spark, some solution including signalling processing techniques could be investigated. And all the companies were aware of challenging and at the same time operators showed the big interest for this use case.

The third issue is related to the organization of the work. Company did not support a dedicated item. But in the moderator view, the dedicated item would be more proper to address this challenging work with a clear target completion date and objectives. The basket WI is more suitable for the introduction of band combinations which need less technique discussion, but would not be suitable to include the study of the feasibility and solutions to support those band combinations in the smart phone.

Besides, Intel commented on the wording and proposed to refine it as "for smart phone form factor". And China Telecom proposed to change the title of the work in a more general way and proposed the change of one band combination. BT added more band combination.

Although some companies proposed the WI with study phase, the SI to identify the issue and investigate the potential solution would be a middle ground in the moderator's view by removing "specify" in the last main bullet. To address the first issue, the moderator would like to follow China Telecom responses to companies, i.e., adding the fallback modes. To address the second issue, the moderator would like to modify the first main bullet by adding investigation of the solutions to enable LB+LB+LB for smart phone form factor. Regarding China Telecom comments to change the title, the moderator would like to postpone the discussion on it, since the group did not converge on the objectives yet. Regarding the change or addition of band combinations, the moderator simply listed them and put [] for further checking respecting to operators' input.

Based on the above, the moderator would like to propose a SI with the following modified objectives.

- Investigate the feasibility and solutions to enable simultaneous transmission on two UL bands and simultaneous reception on two or three bands for the band combination of 700, 800 and 900MHz spectrum for smart phone with small form factor (RAN4)
 - The following band combinations will be considered:
 - CA_n8-n20-n28 with uplink configurations of CA_n8-n20, CA_n8-n28, CA_n20-n28, and the fallback modes

- [CA_n5-n8-n28 with uplink configurations of CA_n5-n8, CA_n5-n28, CA_n8-n28, and the fall back modes]
 - CA_n5-n8 with uplink configurations of CA_n5-n8, and the fallback modes
 - CA_n20-n67 with uplink on band n20
 - The following aspects need be studied
 - UE architecture including n-plexing, PA
 - Wideband antenna
 - Performance due to impacts including inter-modulation products
 - Method to manage the inter-modulation product impacts
 - Power class 3 (PC3) is considered in this study.
- Identify and specify necessary RAN4 requirements including Tx and Rx RF requirements (RAN4)

In the intermediate round, the moderator encourages companies to further check those objectives.

Regarding whether it should be an SI or WI with study phase, 2 operators proposed WI with study phase. The moderator fully understand the reason. But to move forward, SI would be a middle ground. So the moderator proposes SI with no other WG involved. In the intermediate round, the further checking on that proposal would be needed.

3.2 Intermediate round

3.2.1 Objectives

Based on the initial round summary, the moderator would like to propose the following modified objectives.

- Investigate the feasibility and solutions to enable simultaneous transmission on two UL bands and simultaneous reception on two or three bands for the band combination of 700, 800 and 900MHz spectrum for smart phone form factor
 - The following band combinations will be considered:
 - CA_n8-n20-n28 with uplink configurations of CA_n8-n20, CA_n8-n28, CA_n20-n28, and the fallback modes
 - [CA_n5-n8-n28 with uplink configurations of CA_n5-n8, CA_n5-n28, CA_n8-n28, and the fall back modes]
 - CA_n5-n8 with uplink configurations of CA_n5-n8, and the fallback modes
 - CA_n20-n67 with uplink on band n20
 - The following aspects need be studied

- UE architecture including n-plexing, PA
 - Wideband antenna
 - Performance due to impacts including inter-modulation products
 - Method to manage the inter-modulation product impacts
- Power class 3 (PC3) is considered in this study.
- Identify necessary RAN4 requirements including Tx and Rx RF requirements

Please provide further comments below.

Feedback Form 10:

<p>1 – Spark NZ Ltd</p> <p>We're ok with the newly worded objectives, however we note the second bullet:</p> <p>the fall back modes</p> <p>should be included and part of the objectives.</p>
<p>2 – China Telecommunications</p> <p>We support the objective.</p>
<p>3 – Guangdong OPPO Mobile Telecom.</p> <p>For clarification of 2UL in this 3 LB, is Tx swiching among these bands targeted or fixed 2UL bands transmission?</p>
<p>4 – Orange</p> <p>Orange supports the work and the current objectives.</p>
<p>5 – Nokia Japan</p> <p>Thanks for the consideration of our comments on fallback band combinations. We, however, would like to make sure in the objective that technical discussion on 3 bands combination is allowed to start after the completion of all the fallback band combination requirements. Since it is not reasonable to start 3 bands combination if we see challenges in even 2 bands combination.</p>
<p>6 – TELECOM ITALIA S.p.A.</p> <p>We can accept to have a Study Item as a compromise. However, it should be clear that the target is to have a follow up Work Item in Rel 18 if the outcome of the study is positive.</p> <p>Therefore a [x] months duration for the SI should be agreed followed by a Rel 18 WI (of course if the outcome of the study demonstrates the feasibility).</p> <p>ok with the proposed objectives.</p>

7 – China Telecommunications

Response to OPPO:

To our understanding, this topic only touches the BC specific requirements, and other generic enhancement like Tx switching is up to the discussion in other WI.

Response to Nokia:

OK to prioritize 2 bands combination. Meanwhile, given it is going to be a SI as suggested by moderator, we update the wording below:

technical discussion on 3 bands combination is allowed to start after the completion of feasibility study of all the fallback band combinations requirements.

8 – Skyworks Solutions Inc.

Our comment on the feasibility of LB wideband antenna for smartphone has not been captured. the bullet: wideband antenna should be changed to: study feasibility of LB wideband antennas (main and diversity) depending on form factor (FWA/smartphone). Without this we will define new requirements for combinations that cannot be implemented with good OTA performance for smartphones. Especially for 2UL case, each UL is already reduced by 3dB but will still result in very large MSD.

9 – ZTE Corporation

We support the proposed objective with study phase firstly.

10 – Ericsson LM

As commented in the initial round, this should start as SI not WI. There are many technical issues and the outcome is unclear. Therefore, objectives for the WI cannot be agreed at this stage.

11 – LG Uplus

We support the proposed objectives.

12 – Intel Corporation SAS

We are fine with the objectives.

13 – Huawei Technologies France

We support the objective.

14 – Huawei Technologies France

The following justification is proposed.

Sub-1GHz plays the important role in wireless communication due to outstanding coverage performance. However, sub-1GHz spectrum were rare and allocated fragmentally in such as 700/800/900 MHz for IMT. Combination of 700MHz+800Mhz+900Mz bands can achieve 5G high data rate and with good coverage. In future, possibly more sub-1GHz spectrum bands such as 700/800/900 MHz can be operated under the co-construction and sharing business mode. Thus, there is potential commercial deployment request for 700/800/900 MHz combinations from operators. Currently, RAN4 has studied the combinations of

700MHz+800Mhz+900Mz for FWA. However, combining 700/800/900MHz for smart phone seems a little challenging due to limit of terminal components based on the preliminary analysis. The dedicated item would be more proper to address this challenging work with a clear target completion date and objectives. The basket WI is more suitable for the introduction of band combinations which need less technique discussion. That is why this controversial combo was taken out from basket WI and intended to be worked as an independent item.

- *The available spectrum on bands of 700, 800 and 900 MHz is small. Although the coverage on those bands is excellent, the small available channel bandwidth cannot fulfill high data rate NR service.*
- *Band combination of 700+800+900 can only be supported by FWA devices with larger form factor.*
- *Extend the support of features, e.g., NR-CA, EN-DC, on 700+800+900 band combinations to smart-phone*

15 – MediaTek Inc.

We agree that at best this should be a study item, as the gains are unclear to us. Also any resulting feasible band combinations should be an output of the study not an input.

3.2.2 SI/WI and impacts to other WG

The moderator would like to propose

- SI with no other WG involved for Topic #2.

Please provide comments if any.

Feedback Form 11:

1 – China Telecommunications

Given the situation in round 1, we can accept a SI, and suggest a 9-month SI.

2 – QUALCOMM JAPAN LLC.

This should clearly be an SI as the technical issues are unlikely to be easily solved

3 – Skyworks Solutions Inc.

This should be an SI

4 – Intel Corporation SAS

We support this proposal.

5 – Huawei Technologies France

We are ok to start with a SI .

3.2.3 Summary of intermediate round

Almost all the companies can accept to have a study item first. There were some comments on the objectives.

Spark commented that the band combination of CA_n5-n8-n28 should be included. So the moderators remove the [].

OPPO questioned if Tx switching or fixed 2UL bands are assumed. China Telecom responded that the generic enhancement like Tx switching is up to the discussion in other WI. In the moderator view, the study is conducted on the UE which is capable of supporting CA and whether such UE with smart phone form factor is able to support those listed CA band combinations. As China Telecom commented, there seems no need to mention the capability based on Tx switching in this SI.

Nokia commented that the fallback mode needs be studied first before looking into three band combination. China Telecom proposed the change with some modifications, accordingly. The moderator can take those comments.

Telecom Italia proposed to have the WI if the study is positive. The moderator would like to capture it as an additional agreement to see if it is agreeable.

Skyworks proposed the change for the objectives related to wideband antennas. The moderator is fine with the proposal. But since the motivation of this work is to enable the support of LB combinations, the FWA does not need be mentioned here.

Ericsson commented that objectives for the WI cannot be agreed at this stage. In the moderator view, there is no objective for WIs in the draft objectives.

Huawei provided the justification. The moderator will prepare the draft justification based on Huawei's input.

The proposal of SI with no other WG involved was acceptable. And China Telecom proposed 9 month duration for the SI. The moderator would like to draft an additional agreement based on Telecom Italia and China Telecom inputs.

Based on the comments and responses, the modified objectives, draft justification, suggestion on WI or SI, secondary working group and additional agreement are provided in the following section of final round for further checking.

3.3 Final round

3.3.1 Objectives

Objectives:

- Investigate the feasibility and solutions to enable simultaneous transmission on two UL bands and simultaneous reception on two or three bands for the band combination of 700, 800 and 900MHz spectrum for smart phone form factor

- The following band combinations will be considered. And the technical discussion on three band combination will start after the completion of feasibility study of all the fallback band combinations.
 - CA_n8-n20-n28 with uplink configurations of CA_n8-n20, CA_n8-n28, CA_n20-n28, and the fallback modes
 - {CA_n5-n8-n28 with uplink configurations of CA_n5-n8, CA_n5-n28, CA_n8-n28, and the fall back modes}
 - CA_n5-n8 with uplink configurations of CA_n5-n8, and the fallback modes
 - CA_n20-n67 with uplink on band n20
 - The following aspects need be studied
 - UE architecture including n-plexing, PA
 - Study feasibility of low bandW-wideband antenna
 - Performance due to impacts including inter-modulation products
 - Method to manage the inter-modulation product impacts
 - Power class 3 (PC3) is considered in this study
- Identify necessary RAN4 requirements including Tx and Rx RF requirements

Please check and provide comment if needed.

Feedback Form 12:

<p>1 – Spark NZ Ltd</p> <p>Spark NZ supports the wayforward suggested by the moderator.</p>
<p>2 – China Telecommunications</p> <p>Thanks for the updated objective. We are ok with it.</p>
<p>3 – T-Mobile USA Inc.</p> <p>We have serious concerns about including CA_{n5-n8-n28}. The downlink of n5 overlaps with the uplink of n8. These bands were not intended to be deployed in the same region much less the same device. While we understand n5 and n8 have been deployed in some countries together, we think it would set a bad precedent for RAN4 to support CA of bands where the uplink of one band overlaps with the downlink of the other band. Also, CA_n5A-n8A would be a mandatory fallback for CA_n5-n8-n28, yet CA_n5-n8 is not standardized. Therefore, CA_n5-n8-n28 needs to be removed from the objectives. CA_n5-n8 should also not be included in the objectives either, as the uplink of n8 overlaps with the downlink of n5.</p>
<p>4 – Huawei Technologies France</p> <p>We are ok with moderator’s proposals. Regarding the issue for CA_n5-n8-n28 raised by T-Mobile USA, as the objective is to investigate the feasibility and solutions, the implementation feasibility as well as standard issues should be studied anyway. So we are ok to keep it in the objective.</p>

<p>5 – ZTE Corporation</p> <p>we are also fine with the current objectives. Regarding the issues raised by T-Mobile USA, we tend to agree with Huawei that the feasibility study for CA_n5-n8 is still necessary.</p>
<p>6 – Orange</p> <p>we support this proposal</p>
<p>7 – Skyworks Solutions Inc.</p> <p>CA_n5-n8-n28 is not feasible and shall not be used as example as there is overlap of n8 UL with n5 DL. this is certainly not an option for any LB-LB-LB implementation. This gives an idea of how serious this LB-LB-LB with dual UL target is in terms of implementation. we will not agree to this SI with such example band combination. Rather than removing brackets we should remove this bullet.</p>
<p>8 – TELECOM ITALIA S.p.A.</p> <p>We support this proposal.</p> <p>Concerning the issue raised by T-Mobile, we are not interested in this combination. The main concern is if including this combination further complicates the study. Therefore we would prefer to remove it from the objectives.</p>
<p>9 – MediaTek Inc.</p> <p>If operators are not requesting inclusion of n5 in the study, then it should be removed.</p>
<p>10 – Nokia Japan</p> <p>It would be great if UE vendors/chipset vendors could share their views on how to obtain isolation between n5 and n8 during CA.</p>
<p>11 – China Telecommunications</p> <p>We requested n5+n8, and Spark NZ requested n5+n8+n28. Based on operator requests, the two combinations cannot be removed.</p> <p>Regarding the overlapping of n5 downlink and n8 uplink, it can be handled by, e.g., 1 active UL in n5 while DL is in two or three bands, or add restriction on the frequency range of operation bandwidth. The details can be discussed in the SI.</p>
<p>12 – Intel Corporation SAS</p> <p>We support the objectives.</p>
<p>13 – QUALCOMM JAPAN LLC.</p> <p>We agree with the comments from T-Mobile, there is no point in studying such band combination. Does any operator even own this combination? what is the point of using it as an example?</p>

3.3.2 Justifications, SI/WI and other aspects

Justifications:

- Justifications -

Sub-1GHz bands play the important role in wireless communication due to the outstanding coverage performance. However, sub-1GHz spectrum were rare and the spectrum allocation is fragmental. For the individual operator, only a small portion is allocated on 700/800/900MHz IMT bands, which is difficult to meet the NR wideband service requirements.

A straightforward but promising approach to promote those low bands is to combine them by using CA or DC to achieve the high data rate and the good coverage at the same time. Such approach would be a key enabler to bridge the digital divide in rural areas, as the operators commented. A lot of operators showed the interests on this enhancement.

However, according to the existing RAN4 study of the band combination of 700+800+900MHz, only FWA can support it because the separate antennas are needed to achieve the good isolation. A number of challenges were identified for a device with a smart phone form factor to support the combinations of those low bands.

So a dedicated study item with a clear target date and objectives is proposed to identify the issues and investigate the solution to enable the support of band combinations made up of 700/800/900MHz for a smart phone, which would be critical to promote NR on those low bands.

- Justifications -

Please provide your comment on the justifications below.

Feedback Form 13:

1 – China Telecommunications OK with the justification.
2 – Huawei Technologies France We are ok with the justification part.
3 – ZTE Corporation we are okay with the justification.
4 – Skyworks Solutions Inc. To be balanced the justification should also cover the UE implementation challenges in terms of MSD level and LB antenna performance
5 – TELECOM ITALIA S.p.A. support
6 – QUALCOMM JAPAN LLC. The justification says "a lot of operators" but only a few (4 ?) have actually shown real interest, the sentence should be corrected. It is still not clear how many operators actually own these 3 bands.

7 – China Telecommunications

To Qualcomm: 10 operators have supported this topic in the 3GPP discussion this week, could be fine to say "a lot of"...

WI or SI

- Dedicated SI

Secondary working group:

- Not include any WG as the secondary work group.

Additional tentative agreement:

- A nine months duration for the SI should be agreed followed by a Rel-18 WI, if the outcome of the study demonstrates the feasibility.

Please provide your comments on WI or SI, secondary working group and additional tentative agreement below.

Feedback Form 14:

<p>1 – China Telecommunications</p> <p>We agree there is no other WG impact, and support the above additional tentative agreement.</p>
<p>2 – Huawei Technologies France</p> <p>We are ok with the moderator proposal and the tentative agreement.</p>
<p>3 – TELECOM ITALIA S.p.A.</p> <p>of course, being a proponent, we support the tentative agreement</p>
<p>4 – Ericsson LM</p> <p>We are Ok with the SI. Whether there will be a potential follow up WI depends on the outcome of the SI.</p>

3.3.3 Summary of final round

T-Mobile commented that the downlink of n5 overlaps with the uplink of n8 and thus proposed to remove CA_n5-n8-n28 and CA_n5-n8. Skyworks and Qualcomm agreed with T-Mobile that those band combinations are not feasible. But China Telecom expressed that those band combinations were requested by China Telecom and Spark separately. Huawei and ZTE thought that anyway there needs a feasibility study and it would be OK to include those band combinations. In the moderator’s view, this is controversial, for which the technique issue needs be addressed. Thus the moderator proposes to put [] on those band combinations and

clarify there are controversial issues on them, which need more discussions, and in the draft SID, those band combinations will be included for the time being but within [].

For the justification part, Skyworks proposed to capture the challenges about MSD level and LB antenna performance. Qualcomm commented on “a lot of operators”. The moderator makes the modifications to capture those comments.

Based on the comments, the following conclusions are recommended:

Objectives:

- Investigate the feasibility and solutions to enable simultaneous transmission on two UL bands and simultaneous reception on two or three bands for the band combination of 700, 800 and 900MHz spectrum for smart phone form factor
 - The following band combinations will be considered. And the technical discussion on three band combination will start after the completion of feasibility study of all the fallback band combinations.
 - CA_n8-n20-n28 with uplink configurations of CA_n8-n20, CA_n8-n28, CA_n20-n28, and the fallback modes
 - [CA_n5-n8-n28 with uplink configurations of CA_n5-n8, CA_n5-n28, CA_n8-n28, and the fall back modes]
 - [CA_n5-n8 with uplink configurations of CA_n5-n8, and the fallback modes]
 - CA_n20-n67 with uplink on band n20
 - The following aspects need be studied
 - UE architecture including n-plexing, PA
 - Study feasibility of low band wideband antenna
 - Performance due to impacts including inter-modulation products
 - Method to manage the inter-modulation product impacts
 - Power class 3 (PC3) is considered in this study
- Identify necessary RAN4 requirements including Tx and Rx RF requirements

Issues which need further discussions in the objectives

- Should CA_n5-n8-n28 with uplink configurations and CA_n5-n8 be included as the example band combinations given that the downlink of band n5 overlaps with uplink of band n8?

Justifications:

Sub-1GHz bands play the important role in wireless communication due to the outstanding coverage performance. However, sub-1GHz spectrum were rare and the spectrum allocation is fragmental. For the individual operator, only a small portion is allocated on 700/800/900MHz IMT bands, which is difficult to meet the NR wideband service requirements.

A straightforward but promising approach to promote those low bands is to combine them by using CA or DC to achieve the high data rate and the good coverage at the same time. Such approach would be a key enabler to bridge the digital divide in rural areas, as the operators commented. ~~A lot of~~ The operators showed the interests on this enhancement.

However, according to the existing RAN4 study of the band combination of 700+800+900MHz, only FWA can support it because the separate antennas are needed to achieve the good isolation. A number of challenges were identified for a device with a smart phone form factor to support the combinations of those low bands. Those challenges include the maximum sensitivity degradation (MSD) and poor low band antenna performance.

So a dedicated study item with a clear target date and objectives is proposed to identify the issues and investigate the solution to enable the support of band combinations made up of 700/800/900MHz for a smart phone, which would be critical to promote NR on those low bands.

WI or SI

- Dedicated SI

Secondary working group:

- Not include any WG as the secondary work group.

Additional tentative agreement:

A nine months duration for the SI should be agreed followed by a Rel-18 WI, if the outcome of the study demonstrates the feasibility.

4 Topic #5: BS RF requirement evolution

4.1 Initial round

4.1.1 Working area/Objective #5-1: HBS

Based on RP-212682, the following objectives seem stabilized:

- Home base station (HBS) (RAN4)
 - o Example band is n41

- Specify RF requirements for BS
 - Identify the scenario and conduct co-existence study for defining the BS requirements
- Specify conformance testing requirements
- No new demodulation performance requirement is needed

NOTE: Further discuss on what kind of simulation campaigns are needed and what the scenarios are in the future meetings before Rel-18 RAN4 package approval.

Please provide your comments below.

Feedback Form 15:

<p>1 – Spark NZ Ltd</p> <p>Spark NZ supports the initiative to define RF requirements for a HBS. However we note of importance regulatory obligations including geographic areas for TX, adjacent operator and adjacent band co-existence must be respected.</p>
<p>2 – TELECOM ITALIA S.p.A.</p> <p>Due to the low uptake of HBS in previous technologies, we see this proposal as low priority</p>
<p>3 – Nokia Germany</p> <p>Not high priority unless clear justification provided why not to reuse Local Area BS requirements since lower output power levels are allowed for other BS classes</p>
<p>4 – Ericsson France S.A.S</p> <p>In E-UTRA, compared to a LA BS, the differences are (i) Power control (ii) More relaxed frequency error requirement (iii) More stringent absolute ACLR and OBUE (iv) Raised signal levels for dynamic range, ACS RX requirements.</p> <p>The E-UTRA home class is developed for CSG. Without CSG, the co-channel power setting requirement is not relevant as co-channel UEs will all connect to the BS. Also, the reason for increasing the signal levels for RX dynamic range, ACS is the possible presence of co-channel UEs connected to an outdoor BS for CSG, but this will not be the case here so there will be no need to change RX requirements. This leaves a more stringent ACLR and less stringent frequency error. It is not obvious why absolute ACLR should be tightened to -50dBm / MHz in a home (the UE ACS will dominate the DL adjacent channel anyhow) and what the benefits are of further relaxing the frequency error, since it is already relaxed for local area.</p> <p>Thus we would like to clarify the benefit compared to LA. If as we suggest the benefit is not obvious then we prefer not to invest RAN4 time into creating another BS class (but it could be clarified that the LA deployment scenario also includes home deployments).</p> <p>Regarding co-existence simulations, it is important to prioritize ATG, Full Duplex, NTN etc. co-existence studies and we believe that, without there being CSG, there is no need for a co-existence study for home BS as existing indoor co-existence is sufficient.</p>

5 – ZTE Corporation

Per our understanding that , Home eNB introduced in LTE phase is assumed with CSG functionality, however for NR, we don't have the CSG specified yet, maybe NPN with CAG could serve as similar usage. From our understandings, the main purpose here is to allow another BS type in RAN4 spec which could have certain RF requirement relaxations compared with Local area BS types.

If LTE Home eNB requirement could be used as baseline and additional work for NR should be limited.

6 – CATT

The specification work could be limited if NR HBS can be used as starting point. To reduce work load, co-existence simulations should be conducted only for the requirements that is identified as necessary.

7 – China Mobile Group Device Co.

HBS can be utilized to enhance indoor coverage without requiring high output power. The application of NR HBS is a cost-effective solution and certain RF requirements maybe relaxed compared with LA.

Thank Ericsson for detailed analysis of requirements difference between HBS and LA.

- we also think absolute ACLR requirement is quite stringent for home class and this requirement should be carefully reanalyzed for NR rather than blindly reusing the same value as E-UTRA.
- About clarifying LA deployment also include home deployment, we are concerned that can we just capture such clarification into the TS without a new WID?

8 – Intel Corporation SAS

We support HBS and the current objectives are OK to us. It is a viable deployment scenario which assembles to LTE Femto cells and 3GPP may need to open the door for such implementations. The work shall strive to reuse the existing BS requirements and focus on identifying if any changes in requirements are required.

4.1.2 Working area/Objective #5-2: mmWave multi-band BS

Based on RP-212682, the following objectives were proposed

- mmWave multi-band BS
 - o mmWave multi-band BS (RAN4)
 - Specify RF requirements for mmWave BS capable of multi-band operation

Please provide your comments below.

Feedback Form 16:

1 – Spark NZ Ltd

Spark NZ supports this objective as we see overlapping bands in some jurisdictions (eg. n257 and n258), which may open all, or part of each band, therefore a single BS supporting this would be desirable, providing

RF performance over the wide frequency range is not compromised (vs. single band BS).

2 – Huawei Technologies France

We support to have RAN4 work on mmWave MB-BS in Rel-18.

Performance enhancement

According to operators' deployment demand, requirements for both inter-band DL CA and inter-band UL CA are studied in UE RF FR2 WI. A multi-band RF module can easily fulfill the requested TAE requirement for co-location scenario, which is helpful to guarantee the performance with smaller MRTD.

Deployment scenarios and Band combinations

Similar to FR1, the spectrum for the operator may not be acquired at the same time for different bands, or CA may not be needed for the initial deployment but the capacity enhancement needs to be considered later via CA. A multi-band BS would be helpful for operator to reduce the cost as well as the site engineering issue.

The evolvement of BS type is quite slow. When RAN4 had AAS study from Rel-11, there is no commercial deployment of such BS type at all, but after completion of all the OTA requirements finally in Rel-14 for LTE and Rel-15 for NR, Massive MIMO is a very popular deployment scenario nowadays around the world. As inter-band CA for FR2 was already introduced from Rel-16, it's the right time to consider mmWave MB-BS for 5G-advanced in Rel-18.

For mmWave MB-BS, the example band combination could be 26+28GHz, 28+39GHz, 26+40, 28+40 GHz.

Proposed objectives for mmWave MB-BS

Core part:

Specify RF requirements core requires for FR2 multi-band BS:

- Check FR1 multi-band methods are applicable for FR2, agree appropriate inter RF BW gaps
- Check FR1 exceptions are acceptable for FR2
- Modify appropriate sub-clauses for core RF specification to include FR2 multi-band
- Modify appropriate sub-clauses in EMC specification

Note: although NR is included in the MSR AAS BS specification FR2 is not included as such no changes are need to the 37 series specifications.

Perf part:

Appropriate sub-clauses in the BS conformance specifications to be modified.

3 – Ericsson France S.A.S

We do not support this WI at this time.

We note that the specification already supports building a single BS that supports multiple bands within the same BS housing. Such a BS can support carrier aggregation. What is proposed here is considering requirements for an implementation where an extremely wide bandwidth signal is generated using the same RF components.

It is not obvious that such a wide bandwidth would be beneficial; in fact considering close integration of radio and antennas etc. it is quite likely that RF and beamforming performance could be compromised in such an implementation.

In any case, we believe that it premature to start writing a specification for such wideband radios in Rel-18 considering the maturity levels of the associated technologies, and that operator needs relating to site solutions, CA etc. can be supported with the existing standard. Attempting to simply copy/re-use FR1 multi-band approaches could lead to a specification that is not actually carefully enough designed for wideband technologies when they become mature.

4 – Nokia Germany

We are supportive of this work. With regards to proposed objectives, we should also include objective on multi-band definition for FR2 (if the same or different than for FR1 shall be used). For applicable scenarios, we are fine to include example scenarios but we shall also clarify the intention is to define generic requirements for any future scenarios. Finally, do we need to also include information if bands used for multi-band scenario are synchronized?

5 – ZTE Corporation

As commented in the previous e-mail discussions, it should be very challenging to support 28+39GHz with common active RF components, if other vendors and operators have strong interest on this type of BS, we are also open to have study item firstly to check its feasibility firstly. Similar as other multi-band operation within 28GHz or 39GHz, operators request would be appreciated.

6 – Huawei Technologies France

Inter-band CA has been discussed a lot from Rel-16 for UE RF including both CBM an IBM. For both UE and BS, supporting multi-band operation is challenging, but it is worth to do the study. For BS side, from deployment perspective, a MB-BS is beneficial for operators from both cost and engineering aspects. Regarding the request, we already saw inputs from operator in RAN#94e. We are ok with Nokia's proposal to include objective on multi-band definition for FR2. In our understanding, as it is a MB-BS for co-location scenario, the TDDs bands are synchronized in such scenario.

7 – CKH IOD UK LIMITED

3UK would like to support this work item.

8 – CATT

If this work is to be included in Rel-18 from technique evolution point of view, it is preferred to start with a SI. The scenarios, typical implementation and challenges should be well evaluated.

4.1.3 Working area/Objective #5-3: NTN BS Type 1-O

Based on RP-212682, the following objectives were proposed

- NTN BS Type 1-O
 - o Requirements for NTN BS Type 1-O

- Investigate reference architecture
- Specify RF requirements
- Specify conformance testing requirements

Please provide your comments below.

Feedback Form 17:

<p>1 – Ericsson France S.A.S</p> <p>This is covered in Rel-17 NTN</p>
<p>2 – ZTE Corporation</p> <p>This NTN BS type 1-O has been agreed in Rel-17, therefore we don't see its necessity to further discuss it in REL-18.</p>
<p>3 – CATT</p> <p>Yes, this work is already started in RAN4#101-bis-e.</p>
<p>4 – Huawei Technologies France</p> <p>Agree with other companies that the work has been started in Rel-17 NTN already.</p>

4.1.4 Working area/Objective #5-4: Others

Based on RP-212682, the other objectives were proposed

- Others
 - Investigate and if possible simplify declaration.
 - Rel-17 leftover

Please provide your comments below.

Feedback Form 18:

<p>1 – Intel Corporation SAS</p> <p>We would like to understand more about the details on how it is possible to simplify the existing declaration. And what are the exact Rel-17 leftovers in this scope.</p>
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4.1.5 SI/WI and impacts to other WG

Please provide your comments on whether an WI, WI with study phase, or SI will be approved for Topic #5.

Feedback Form 19:

Please provide your comments on whether there is need to involve other WG as secondary working group.

Feedback Form 20:

4.1.6 Summary of initial round

HBS

For HBS, 3 companies thought the potential project should be with lower priority, 1 companies would like to limit the scope, 4 companies supported the work.

The main issue is whether the existing LA BS requirements can cover the proposed HBS or not. Considering there is no CSG specified in NR, the HBS would not be beneficial compared to LA BS. But as responded by ZTE, NPN with CAG might serve the similar usage.

In moderator's view, to move forward, a study phase to investigate whether LA BS requirement can cover HBS could be done before the normative work. And thus the moderator proposes the following modified objectives.

- Home base station (HBS)
 - Example band is n41
 - Phase I: Study phase
 - Study if NR local area BS requirements can be applied to HBS or LTE home eNB requirement could be used as baseline to define the requirement for HBS.
 - Phase II: Normative work
 - Specify RF requirements for BS
 - Specify conformance testing requirements
 - No new demodulation performance requirement is needed.

mmWave multi-band BS

4 companies supported this work. Among them there were two operators. 2 companies were OK with study first. 1 companies were against it.

In the moderator understanding, the main concern is that the same RF component cannot provide the wide bandwidth signal covering multiple mmWave bands, and even if it can be done, the performance would be compromised.

Besides, Nokia commented that the objective on multi-band definition for FR2 should be included, the example band can be added with the understanding that the generic requirements will be specified, and the multi-band should be assumed synchronized. Huawei provided more detailed objective.

Based on the feedback, the moderator would like to suggest a study phase before the normative work.

- mmWave multi-band BS

- Example bands: 26+28GHz, 28+39GHz, 26+40GHz, 28+40GHz
 - Target at studying and defining the generic requirements
 - NOTE some down-selection would be needed
- Phase I: Study phase
 - Investigate if the common RF component can cover the wide bandwidth for the example bands
- Phase II: normative work depending on the conclusion of phase I
 - Core part:
 - Specify the definition of multi-band for FR2
 - Specify RF core requirements for FR2 multi-band BS:
 - Investigate if FR1 multi-band methods are applicable for FR2, and agree on the appropriate inter-RF BW gaps
 - Investigate if FR1 exceptions are acceptable for FR2
 - Define RF core requirements to include FR2 multi-band BS
 - Define EMC requirements
 - Perf part:
 - Specify the BS conformance test requirements
 - NOTE 1: The multi-bands are synchronized
 - NOTE 2: No change is needed for 37 series specification since FR2 is not included in MSR AAS BS specifications.

NTN BS Type 1-O

Companies commented that it was covered in Rel-17. Thus the moderator proposes to drop this working area.

Others

There seemed no proponent for them and thus the moderator proposes to drop this working area.

4.2 Intermediate round

4.2.1 Objectives

Based on the summary of initial round, the moderator merges working area #5-1 and #5-2 in this section and provide the following objectives for the discussions in the intermediate round.

- Home base station (HBS)
 - Example band is n41
 - Phase I: Study phase
 - Study if NR local area BS requirements can be applied to HBS or LTE home eNB requirement could be used as baseline to define the requirement for HBS.
 - Phase II: Normative work
 - Specify RF requirements for BS
 - Specify conformance testing requirements
 - No new demodulation performance requirement is needed.

Please provide your comments below.

Feedback Form 21:

1 – Nokia Germany

HBS: short study to discuss potential requirements is fine but our preference is to consider SI for this work rather than conclude already now WI is needed

mmWave multi-band BS: we believe the definition of the mmWave multi-band BS shall be discussed and confirmed during the study phase. It is not clear what is meant by down-selection in NOTE for example bands? The intention should be to define generic requirements to address also future scenarios. We propose to change NOTE 1 to "requirements for mmWave multi-band BS to be defined for synchronized operating bands"

2 – Spark NZ Ltd

We support the proposed way forward.

3 – TELECOM ITALIA S.p.A.

We are concerned with the work load and consider the full topic#5 as low priority

4 – ZTE Corporation

We support the proposed objectives from moderators.

5 – Intel Corporation SAS

We support the proposed WF for HBS.

6 – Ericsson France S.A.S

As discussed in the 1st round, examining the E-UTRA HBS specification, in the absence of CSG (and hence the lack of need to consider interference to/from UEs on the same channel that are not connected to the HNB), the only requirements that are different are frequency error (due to lower mobility assumption) and tighter absolute ACLR/OBUE (not really obvious why there requirements need to be so tight).

In our view, the frequency error change would not make much difference in implementation and the HNB scenario can be covered by LA. A Note could be inserted into the specification; it could be checked with MCC before RAN if this can be done with a TEI CR or would need a WI.

However if there is a preference to confirm in RAN4, a limited study item with small TU allocation could be OK. In that case, we would propose to change the “Specify RF requirements for BS” to “If necessary, specify RF requirements for the BS” and “If necessary, specify conformance requirements...”

7 – China Mobile Group Device Co.

we support moderator’s proposals.

At least a study phase is needed for NR HBS. Regarding TEI CR or a followed WI, it depends on further decision of RAN plenary.

- mmWave multi-band BS

- Example bands: 26+28GHz, 28+39GHz, 26+40GHz, 28+40GHz
 - Target at studying and defining the generic requirements
 - NOTE some down-selection would be needed
- Phase I: Study phase
 - Investigate if the common RF component can cover the wide bandwidth for the example bands
- Phase II: normative work depending on the conclusion of phase I
 - Core part:
 - Specify the definition of multi-band for FR2
 - Specify RF core requirements for FR2 multi-band BS:
 - Investigate if FR1 multi-band methods are applicable for FR2, and agree on the appropriate inter-RF BW gaps
 - Investigate if FR1 exceptions are acceptable for FR2

- Define RF core requirements to include FR2 multi-band BS
- Define EMC requirements
- Perf part:
 - Specify the BS conformance test requirements
- NOTE 1: The multi-bands are synchronized
- NOTE 2: No change is needed for 37 series specification since FR2 is not included in MSR AAS BS specifications.

Please provide your comments below.

Feedback Form 22:

1 – Spark NZ Ltd

We support the proposed way forward, and specifically acknowledge the comment on studying the wide-band aspects, as highlighted by Ericsson;

- Investigate if the common RF component can cover the wide bandwidth for the example bands

2 – ZTE Corporation

Similar comments as Nokia, the definition of the mmWave multi-band BS shall be discussed and confirmed during the study phase

3 – Ericsson France S.A.S

In our understanding, covering the 24-40GHz range with a wideband radio and antennas in a way that does not degrade output power and beamforming performance compared to separate radio/antennas is not likely within the Rel-18 timescale.

Copy/pasting the FR1 multi-band approach in the RAN4 specification is of course straightforward; the question is whether when done so far in advance of the technology maturity it is obvious that the FR1 approach is directly re-usable. There is the risk that a “multi-band” specification is made that is in the end not sufficient.

Of course, covering 24-29GHz (or especially some smaller range covering carriers in the overlapping parts of n257/n258) is quite different to attempting to cover the whole of FR2-1 and may be more feasible and of less concern.

Apart from the wideband radio, FR2 implementations need to tightly integrate antenna and radio and so the feasibility and performance of wideband antenna solutions needs to be considered. So we would propose the following for a study phase:

Phase I: Study phase

- Investigate the feasibility and performance of wideband RF and antenna architectures covering multiple FR2 bands
- Investigate if FR1 multi-band methods are re-usable for FR2, and (if so) agree on the appropriate inter-RF BW gaps
- Investigate if FR1 exceptions are acceptable for FR2
- Investigate whether a generic solution for all combinations within FR2-1 is feasible or whether a solution for all or a part of the 24-29GHz frequency range in which n257/n258 overlap should be targeted

Phase II: normative work depending on the conclusion of phase I

■ Core part:

- If needed, specify the definition of multi-band for FR2
- If deemed feasible and useful, specify RF core requirements for FR2 multi-band BS:
 - Dependent on the Study phase outcome, this may be all or a part of FR2

■ Perf part:

- If needed, specify the BS conformance test requirements

■ NOTE 1: The multi-bands are synchronized

■ NOTE 2: No change is needed for 37 series specification since FR2 is not included in MSR AAS BS specifications.

As stated, we do not really see a benefit from this work in Rel-18, although it may be that a solution for at least a part of the frequency range where n257/n258 (as feasible) could be useful. Overall RAN4 workload should be considered when making a decision.

One question to Nokia: What needs clarifying about the definition of multi-band ? Below is the FR1 definition. A BS that transmits multiple bands from different radios is perfectly feasible for FR1 (and FR2) and can comply to existing requirements, but is not called multi-band. Can't the definition and approach (i.e. multi-bands from separate radios already feasible) just be directly re-used for FR2 ?

multi-band RIB: *operating band* specific RIB associated with a transmitter or receiver that is characterized by the ability to process two or more carriers in common active RF components simultaneously, where at least one carrier is configured at a different *operating band* than the other carrier(s) and where this different *operating band* is not a *sub-band* or *superseding-band* of another supported *operating band*

4 – Huawei Technologies France

Based on the comments above, we provide a revised version as below:

- Example bands: 26+28GHz, 28+39GHz, 26+40GHz, 28+40GHz
- o Target at studying and defining the generic requirements
- o ~~NOTE some down-selection would be needed~~
- Phase I: Study phase
 - o Investigate if the common RF component can cover the wide bandwidth for the example bands
 - o Investigate whether generic solution for all combinations within FR2-1 is possible and/or a solution for all or a part of the 24-29GHz frequency range in which n257/n258 overlap should be targeted
 - o Study the definition of FR2 multi-band BS
- Phase II: normative work depending on the conclusion of phase I
 - o Core part:
 - § ~~Specify the definition of multi-band for FR2~~
 - § Specify RF core requirements for FR2 multi-band BS:
 - Investigate if FR1 multi-band methods are applicable for FR2, and (if so) agree on the appropriate inter-RF BW gaps
 - Investigate if FR1 exceptions are acceptable for FR2
 - Define RF core requirements to include FR2 multi-band BS
 - Define EMC requirements
 - o Perf part:
 - o Specify the BS conformance test requirements
 - NOTE 1: ~~The multi-bands are synchronized~~ requirements for mmWave multi-band BS to be defined for synchronized operating bands
 - NOTE 2: No change is needed for 37 series specification since FR2 is not included in MSR AAS BS specifications.

4.2.2 SI/WI and impacts to other WG

The moderator proposes

- Approve a WI with study phases for Topic #5.
- No other WG should be involved as the secondary WG

Please provide your comments below.

Feedback Form 23:

1 – Intel Corporation SAS

We support this proposal.

2 – Ericsson France S.A.S

Agree no other WG needs to be involved.

For the HBS, we propose companies check before RAN whether there is really any need to not just use LA BS requirements and whether a note can be inserted using a TEI CR.

For multi-band BS, we have proposed some revised objectives, but overall we do not think this should have high priority if other RAN4 workload is high. A view should be taken on overall workload.

4.2.3 Summary of intermediate round

Companies made comment on the objectives, how to manage the project either SI or SI following by TEI or WI, and the priority.

Home base station (HBS)

For HBS, Nokia preferred a short SI and not to conclude that WI is needed. Ericsson also commented that only relaxed frequency error and tighter absolute ACLR/OBUE requirements would need be investigated and thus a SI with limited TU would be OK. The normative work could be done in TEI. The moderator proposes to add the clarification on objectives of Phase II, i.e., start normative work if the outcome of study phase is positive, and add the note to check with MCC if the normative work can be done with TEI CR.

Telecom Italia de-prioritized this work considering the RAN4 workload. The moderator plans to stabilize the objectives as much as possible. In the upcoming RAN plenary, the prioritization across items will be discussed and done.

mmWave multi-band BS

For multi-band mmWave BS, Nokia questioned the meaning of Note under the example band bullet and proposed the change for NOTE1. Huawei made the corresponding changes. The moderator can take those changes.

ZTE and Nokia commented that the definition of mmWave multi-band BS shall be discussed and confirmed during the study phase. Ericsson thought the existing multi-bands definition can be reused. More clarification would be needed. Huawei provided the modifications accordingly. The moderator will take those modifications.

Ericsson did not see the urgency of this work in Rel-18. The moderator plans to stabilize the objectives as much as possible. In the upcoming RAN plenary, the prioritization across items will be discussed and done.

The moderator's proposals for SI/WI and impacts to other WG seemed acceptable.

Based on the comments and responses, the modified objectives, draft justification, suggestion on WI or SI, secondary working group and additional agreement are provided in the following section of final round for further checking.

4.3 Final round

4.3.1 Objectives

Objectives:

- Home base station (HBS)
 - Example band is n41
 - Phase I: Study phase
 - Study if NR local area BS requirements can be applied to HBS or LTE home eNB requirement could be used as baseline to define the requirement for HBS.
 - Phase II: Normative work, which starts if the outcome of study phase is positive
 - Specify RF requirements for BS
 - Specify conformance testing requirements
 - No new demodulation performance requirement is needed.
 - NOTE: check with MCC if the normative work can be done with TEI CR
- mmWave multi-band BS
 - Example bands: 26+28GHz, 28+39GHz, 26+40GHz, 28+40GHz
 - Target at studying and defining the generic requirements
 - ~~NOTE some down-selection would be needed~~
 - Phase I: Study phase
 - Investigate if the common RF component can cover the wide bandwidth for the example bands
 - Investigate the feasibility and performance of wideband RF and antenna architectures covering multiple FR2 bands
 - Investigate if FR1 multi-band methods are re-usable for FR2, and (if so) agree on the appropriate inter-RF BW gaps
 - Investigate if FR1 exceptions are acceptable for FR2
 - Investigate whether a generic solution for all combinations within FR2-1 is feasible possible and/or whether a solution for all or a part of the 24-29GHz frequency range in which n257/n258 overlap should be targeted
 - Study the definition of FR2 multi-band BS
 - Phase II: normative work depending on the conclusion of phase I
 - Core part:

- Specify the definition of multi-band for FR2, if needed
- Specify RF core requirements for FR2 multi-band BS, if deemed feasible
 - Investigate if FR1 multi-band methods are applicable for FR2, and agree on the appropriate inter-RF BW gaps
 - Investigate if FR1 exceptions are applicable for FR2
 - Define RF core requirements to include FR2 multi-band BS
 - Dependent on the study phase outcome, this may be all or part of FR2 bands
 - Define EMC requirements
- Perf part:
 - Specify the BS conformance test requirements, if needed
- NOTE 1: ~~the multi-bands are synchronized~~ The requirements for mmWave multi-band BS are to be defined for the synchronized operation bands.
- NOTE 2: No change is needed for 37 series specification since FR2 is not included in MSR AAS BS specifications.

Please check them and provide comments if any.

Feedback Form 24:

1 – Nokia Germany

HBS: the objectives have still normative phase but this depends on the study phase outcome. Perhaps the following: ”which starts if the outcome of study phase is positive” can be changed to ”which starts only if the study conclude new requirements are necessary”

mmWave multi-band BS: ”a solution for all or a part of the 24-29GHz frequency range in which n257/n258 overlap should be targeted” -> ”a solution for all or a part of the 24-29GHz frequency range in which n257/n258/n261 overlap should be targeted”

typo: The requirements for mmWave multi-band BS are to be defined for the synchronized operation bands -> The requirements for mmWave multi-band BS are to be defined for the synchronized operating bands

2 – Spark NZ Ltd

Spark supports the moderator’s proposed way-forward for the mmWave multi-band BS.

3 – Huawei Technologies France

For mmWave multi-band BS , we are ok with the moderator’s proposal and also fine with the update and correction suggestions by Nokia.

4 – Ericsson France S.A.S

Home BS: Actually the note ” NOTE: check with MCC if the normative work can be done with TEI CR” is not needed if this is anyhow a WI; adding the note would be the ”normative” work. What we mean is

that it might be good if companies would check prior to RAN the home eNB requirements and in case the LA can be used then the note could be added using TEI instead of the WI. If companies prefer to formulate as a WI with a study phase it is OK as long as the TU are small.

multi-band BS: The moderator proposal and the Nokia proposed updates are OK. We continue to be rather skeptical to the benefits at this stage, but if RAN4 workload allows and other companies support we can accept these objectives.

5 – China Mobile Group Device Co.

Home BS: we support moderator’s proposal with following update as proposed by Ericsson

~~”NOTE: check with MCC if the normative work can be done with TEI CR”~~

6 – Intel Corporation SAS

We are OK with the objectives.

4.3.2 Justifications, SI/WI and other aspects

Justifications:

Justifications

Home base station (HBS)

Considering that Wide Area BS and indoor power distribution system in some scenarios cannot meet the coverage of 5G network deployment, the home base station (HBS) can be utilized to enhance indoor coverage without requiring high base station output power. The application of Home Base Station for NR is a cost-effective solution in some scenarios.

However, the existing NR BS class does not specify the RF requirements of HBS. In order to meet the increasing popularity of large capacity and high reliability of data services and indoor deep coverage deployment applications, the intention of this Work Item is to introduce HBS and specify related RF specifications in Rel-18.

It is proposed to specify RF requirements for NR FR1 supporting Home Base Station. This Work Item is to develop a new feature to enable HBS application in home scenarios for NR FR1.

mmWave multi-band BS

BS requirements for mmWave frequency range were introduced initially from Rel-15 [1]. With the release evolution, more FR2 bands are specified after Rel-15. Now the FR2 frequency range covers 26 GHz, 28 GHz, 39 GHz, 40 GHz, 47 GHz bands and also extends to 52.6-71GHz.

Requirements for FR2 BS are full OTA based, but so far the mmWave BS requirements are only applicable for single FR2 operating band. However, inter-band CA band combinations are already supported for FR2, the TAE requirements for intra-band CA for the BS may limit the performance of common beam management under these conditions. A multi-band BS implementation would easily meet any tighter TAE requirements and enable better common beam management for inter-band CA cases. Beyond the inter band CA beam management multi-band BS can have advantages for efficient radio design and power sharing between bands

which have been seen in the implementation of FR1 dual band systems. At the same time technical solutions for wide band FR2 components is progressing so it will be more feasible in the future to consider wide band RF solutions.

Potential mmWave MB-BS band combinations with the existing FR2 bands are: 26+28GHz, 28+39GHz, 26+40, 28+40 GHz.

This work item will specify the modifications need to the BS RF core and performance specification to specify an FR2 multi-band BS.

Whilst the design of a multi-band BS is far from trivial the modifications to the requirements are quite small effecting only 12 sub-clauses for FR1 with most changes dealing with exclusion of operating bands and requirements inside inter RF BW gaps. Applying this to FR2 is not a very large task.

Justifications

Please provide your comments below.

Feedback Form 25:

1 – Ericsson France S.A.S

Home BS:

Since the outcome is likely to be that LA BS class covers home scenario, we suggest some wording change:

Considering that Wide Area BS and indoor power distribution system in some scenarios cannot meet the coverage of 5G network deployment, the home base station (HBS) can be utilized to enhance indoor coverage without requiring high base station output power. The application of Home Base Station for NR is a cost-effective solution in some scenarios.

However, the existing NR BS class does not ~~specify the RF requirements of~~ clearly indicate whether HBS scenarios are covered. In order to meet the increasing popularity of large capacity and high reliability of data services and indoor deep coverage deployment applications, the intention of this Work Item is to ~~introduce~~ ensure HBS and ~~specify related RF specification~~ scenarios are clearly covered in Rel-18 by means of either clarifying the scope of the LA BS or adding a new BS class for HBS.

~~It is proposed to specify RF requirements for NR FR1 supporting Home Base Station. This Work Item is to develop a new feature to enable HBS application in home scenarios for NR FR1.~~

Multi-band BS:

We are not convinced that wideband radio is needed for supporting CA combinations and it is not clear whether a multi-band BS (at least, one covering 24-40GHz) would be more power efficient. Also the justification presumes the FR1 solution; this should be checked. Also, it is possible for a BS to transmit multiple bands today, but it would need multiple radio units inside the BS. We propose some simplification of the justification to avoid these assumptions:

BS requirements for mmWave frequency range were introduced initially from Rel-15 [1]. With the release evolution, more FR2 bands are specified after Rel-15. Now the FR2 frequency range covers 26 GHz, 28 GHz, 39 GHz, 40 GHz, 47 GHz bands and also extends to 52.6-71GHz.

Requirements for FR2 BS are full OTA based, but so far the mmWave BS requirements are only applicable for single FR2 operating band, meaning that a BS transmitting multiple bands needs to do so from separate radio units within the BS. Development of multi-band requirements would enable a wideband radio/antenna solution that could operate over multiple bands. However, inter-band CA band combinations are already supported for FR2, the TAE requirements for intra-band CA for the BS may limit the performance of common beam management under these conditions. A multi-band BS implementation would easily meet any tighter TAE requirements and enable better common beam management for inter-band CA cases. Beyond the inter-band CA beam management multi-band BS can have advantages for efficient radio design and power sharing between bands which have been seen in the implementation of FR1 dual band systems. At the same time technical solutions for wide band FR2 components is progressing so it will be more feasible in the future to consider wide band RF solutions.

Potential mmWave MB-BS band combinations with the existing FR2 bands are: 26+28GHz, 28+39GHz, 26+40, 28+40 GHz.

This work item will study the feasibility and specification needs for multiband and if feasible specify the modifications need to the BS RF core and performance specification to specify an FR2 multi-band BS.

Whilst the design of a multi-band BS is far from trivial the modifications to the requirements are quite small effecting only 12 sub-clauses for FR1 with most changes dealing with exclusion of operating bands and requirements inside inter RF BW gaps. Applying this to FR2 is not a very large task.

2 – China Mobile Group Device Co.

for HBS: the justification proposed by Ericsson is OK for us.

WI or SI

- A dedicated WI with study phase

Secondary working group:

- Not include any WG as the secondary work group.

Please provide your comments on WI/SI and secondary working group.

Feedback Form 26:

1 – Nokia Germany

We prefer SI for HBS since the outcome of the study phase is not known and normative work may be not needed

2 – Ericsson France S.A.S

To Nokia: One of the outcomes from the study may be that the LA BS class is suitable, but a note is added to clarify that HBS deployment scenario is covered by LA BS (or similar). In case it is not possible to add such a note as TEI, it may be preferable to make this a WI. Otherwise to start a follow-on WI just to add a note would be rather strange. It could maybe be captured that the outcome may be no normative work if you prefer.

Of course, if a note can be added as TEI then this consideration is not needed.

3 – China Mobile Group Device Co.

we support moderator's proposal.

4 – China Mobile Group Device Co.

We share the same view with Ericsson, the work load of the Normative work could be much less. Besides, current objective also includes "Normative work, which starts if the outcome of study phase is positive". Therefore, a WI with study phase is more preferred.

4.3.3 Summary of final round

Nokia made comments to suggest the modifications on the objectives. The moderator is fine with them. Ericsson clarified the intention to check with MCC. CMCC proposed to remove the NOTE for checking with MCC. The moderator is fine to remove it with the understanding that companies can live with the current scope with smaller TU allocation. The TU budget can be discussed later in March RAN.

For the justification, Ericsson proposed the modifications, which seemed OK to proponents. The moderators would like to take that modified version as the justifications in the draft WID.

Nokia preferred SI. Ericsson thought depending on the outcome of SI the normative work with smaller TU would be needed and thus is OK with WI with study phase. CMCC shared the same view as Ericsson. The moderator prefers to have a WI with the study phase.

Based on the comments, the following conclusions are recommended.

Objectives:

- Home base station (HBS)
 - Example band is n41
 - Phase I: Study phase
 - Study if NR local area BS requirements can be applied to HBS or LTE home eNB requirement could be used as baseline to define the requirement for HBS.
 - Phase II: Normative work, which starts only if the study concludes that the new requirements are necessary~~outcome of study phase is positive~~
 - Specify RF requirements for BS
 - Specify conformance testing requirements
 - No new demodulation performance requirement is needed.
 - ~~NOTE: check with MCC if the normative work can be done with TEI CR~~
- mmWave multi-band BS
 - Example bands: 26+28GHz, 28+39GHz, 26+40GHz, 28+40GHz

- Target at studying and defining the generic requirements
- Phase I: Study phase
 - Investigate the feasibility and performance of wideband RF and antenna architectures covering multiple FR2 bands
 - Investigate if FR1 multi-band methods are re-usable for FR2, and (if so) agree on the appropriate inter-RF BW gaps
 - Investigate if FR1 exceptions are acceptable for FR2
 - Investigate whether a generic solution for all combinations within FR2-1 is ~~feasible~~ possible and/or ~~whether~~ a solution for all or a part of the 24-29GHz frequency range in which n257/n258/n261 overlap should be targeted
 - Study the definition of FR2 multi-band BS
- Phase II: normative work depending on the conclusion of phase I
 - Core part:
 - Specify the definition of multi-band for FR2, if needed
 - Specify RF core requirements for FR2 multi-band BS, if deemed feasible
 - Define RF core requirements to include FR2 multi-band BS
 - Dependent on the study phase outcome, this may be all or part of FR2 bands
 - Define EMC requirements
 - Perf part:
 - Specify the BS conformance test requirements, if needed
 - NOTE 1: The requirements for mmWave multi-band BS are to be defined for the synchronized operating bands.
 - NOTE 2: No change is needed for 37 series specification since FR2 is not included in MSR AAS BS specifications.

Justifications:

Home base station (HBS)

Considering that Wide Area BS and indoor power distribution system in some scenarios cannot meet the coverage of 5G network deployment, the home base station (HBS) can be utilized to enhance indoor coverage without requiring high base station output power. The application of Home Base Station for NR is a cost-effective solution in some scenarios.

However, the existing NR BS class does not ~~specify the RF requirements of~~ clearly indicate whether HBS scenarios are covered. In order to meet the increasing popularity of large capacity and high reliability of data

services and indoor deep coverage deployment applications, the intention of this Work Item is to introduce/ensure HBS and specify related RF specifications/scenarios are clearly covered in Rel-18 by means of either clarifying the scope of the LA BS or adding a new BS class for HBS.

~~It is proposed to specify RF requirements for NR FR1 supporting Home Base Station. This Work Item is to develop a new feature to enable HBS application in home scenarios for NR FR1.~~

mmWave multi-band BS

BS requirements for mmWave frequency range were introduced initially from Rel-15 [1]. With the release evolution, more FR2 bands are specified after Rel-15. Now the FR2 frequency range covers 26 GHz, 28 GHz, 39 GHz, 40 GHz, 47 GHz bands and also extends to 52.6-71GHz.

Requirements for FR2 BS are full OTA based, but so far the mmWave BS requirements are only applicable for single FR2 operating band, meaning that a BS transmitting multiple bands needs to do so from separate radio units within the BS. Development of multi-band requirements would enable a wideband radio/antenna solution that could operate over multiple bands. However, inter-band CA band combinations are already supported for FR2, the TAE requirements for intra-band CA for the BS may limit the performance of common beam management under these conditions. A multi-band BS implementation would easily meet any tighter TAE requirements and enable better common beam management for inter-band CA cases. Beyond the inter-band CA beam management multi-band BS can have advantages for efficient radio design and power sharing between bands which have been seen in the implementation of FR1 dual band systems. At the same time technical solutions for wide band FR2 components is progressing so it will be more feasible in the future to consider wide band RF solutions.

Potential mmWave MB-BS band combinations with the existing FR2 bands are: 26+28GHz, 28+39GHz, 26+40, 28+40 GHz.

This work item will study the feasibility and specification needs for multiband and if feasible specify the modifications need to the BS RF core and performance specification to specify an FR2 multi-band BS.

~~Whilst the design of a multi-band BS is far from trivial the modifications to the requirements are quite small effecting only 12 sub-clauses for FR1 with most changes dealing with exclusion of operating bands and requirements inside inter RF BW gaps. Applying this to FR2 is not a very large task.~~

WI or SI

- A dedicated WI with study phase

Secondary working group:

- Not include any WG as the secondary work group.

5 Topic #8: ATG

5.1 Initial round

5.1.1 Objectives

Based on RP-212682, the following objectives seem stabilized:

- Specify features to core specifications of RF requirements for coexistence between ATG and IMT terrestrial network [RAN4]
 - Core part: Specify core requirements for coexistence between ATG and IMT terrestrial network [RAN4]
 - Example bands include n1, n78 and n79.
 - Perform FR1 co-existence evaluation for ATG network (e.g. ACLR, ACS)
 - Identify key characteristics where it is necessary to differentiate ATG BS and UEs from ground based BS and UEs
 - Aim to reuse existing requirements for BS and UE where possible.
 - Specify RF requirements for ATG UE/BS
 - Considering the results of co-existence simulations in terms of impact on emissions and RX requirements, cell sizes and link budgets, technology capabilities, likely BS and UE architectures and other relevant aspects.
 - Taking into account identified differences between ATG and ground based systems
 - Consider BS type 1-C/1-H/1-O and specify the requirements
 - Consider conductive requirements for UE
 - Specify RRM core requirements for ATG UE
 - Taking into account identified differences between ATG and ground based systems
 - Considering the different nature of ATG UEs and their view of the network, increased cell sizes and other relevant aspects
 - Specify new UE/BS type(s) for ATG network if necessary
 - Perf part: Identify and specify RRM/demodulation performance requirements for ATG, taking into account the decisions/outcome of Rel-17 NTN work item. [RAN4]
 - Specify test procedures for ATG BS conformance testing
 - RRM performance requirements and test cases for ATG UE type. [RAN4]
 - Demodulation performance requirements and test cases for ATG UE/BS. [RAN4]

Please provide your comments below.

Feedback Form 27:

<p>1 – Guangdong OPPO Mobile Telecom.</p> <p>Ok with content.</p>
<p>2 – China Telecommunications</p> <p>Support to include ATG WI in R18.</p>
<p>3 – Ericsson France S.A.S</p> <p>We support to include this in Rel-18. It has been under discussion since Rel-17 already. Other NTN components such as satellite and HAPS were already covered.</p>
<p>4 – Apple AB</p> <p>We support the work in general.</p>
<p>5 – QUALCOMM JAPAN LLC.</p> <p>As we commented before, it should be clarified what can be reused from NTN and what has to be newly specified. This work will require a lot of time in RAN4 based on the NTN experience(NTN has asked for around 1 TU but now there are 2-3 email threads in 2 sessions and progress is slow). A complete system design is required so it is very difficult to do any downscoping.</p>
<p>6 – vivo Communication Technology</p> <p>We support this work in Rel-18.</p>
<p>7 – ZTE Corporation</p> <p>The existing scope and objectives have already been very stable, based on the RAN-P guidance of tangible commercial interest, this ATG definitely has its commercial trial and market demand, therefore it's very important to approve it in Rel-18. In addition, in Rel-17, both NTN and HAPS has already been considered and specified, we need to address ATG in Rel-18 without any further delay.</p>
<p>8 – China Unicom</p> <p>We support to have Rel-18 ATG Work Item, and fine with the objectives.</p>
<p>9 – China Mobile Group Device Co.</p> <p>ATG was proposed as a Rel-17 RAN4 WI from 2019. After several round detailed discussion, now the scope and objectives are quite stable. Considering the urgency of commercialization, we propose to treat ATG as high priority topic in Rel-18 RAN4.</p> <p>To Qualcomm: Some clarification about which requirements are reused and which requirements are new . RAN4's experience shows RAN4 will discuss these issues in the formal WG discussion after approval of WID. so RAN4 could discuss this issue after approval of the WID. Besides, current objectives list some guidance for such issue that "Aim to reuse existing requirements for BS and UE where possible." to help reduce workload.</p>

10 – Intel Corporation SAS

We support this item. It can be considered as separate item. The detailed objectives listed above are fine for us.

11 – Nokia France

This topic has been extensively discussed, and the operator interest is clear.

In order to ensure that the work can now move forward in Rel-18, some phasing could be considered: specifically, the RF objectives seem clear, while the RRM and demod work would benefit from further clarification to take into account the NTN situation. Note that the NTN Rel-18 WID states that it has “implicit compatibility to support ... ATG (air to ground) scenarios”, and at least this would need to be updated to avoid overlap between the NTN and ATG topics. Therefore maybe the RF work for ATG could start first.

12 – Deutsche Telekom AG

As operator of ATG network with high commercial interests, we support the specification of requirements related to coexistence between ATG and IMT terrestrial network.

13 – Samsung Electronics Co.

We support ATG work

14 – MediaTek Inc.

For such work, it is important to clarify exactly what is the operating scenario.

Is the BS on the ground, and the UE in the aircraft? If this is the case:

- Is it assumed that the UE is communicating with the ground via a Satellite Access Node? Or some other topology?
- Is the UE assumed to be a CPE type of node?

All of this scenario information is critical to identify the scope of any work or study that is being taken on by RAN4, and needs to be clarified before the work starts.

15 – China Mobile Group Device Co.

Some clarification to Nokia: RRM and demod work are only based on the outcome of R17 NTN work item and not consider any R18 evolution. We update the wordings as below to make the objectives more clearly.

- Specify RRM core requirements for ATG UE **based on the outcome of Rel-17 NTN work item**
- Perf part: Identify and specify RRM/demodulation performance requirements for ATG, **taking into account based on the decisions**/outcome of Rel-17 NTN work item. [RAN4]

16 – China Mobile Group Device Co.

to MTK: yes, BS on the ground, and the UE in the aircraft.

for the first question: our preference is that UE aircraft directly communicate with ground gNB without any satellite access node.

for the second question: CPE is one kind of candidate types and the objectives also include "Specify new UE/BS type(s) for ATG network if necessary" so we could further discuss types related issues after the approval of this WID.

5.1.2 SI/WI and impacts to other WG

Based on RP-212682, an WI was proposed.

- An WI is supposed to be approved for Topic #8.
- No RAN1/RAN2 impact is expected

Please provide your comments below on whether it should be WI, WI with study phase or SI and whether there is need to involve other WG.

Feedback Form 28:

<p>1 – China Telecommunications</p> <p>Prefer a WI.</p>
<p>2 – Ericsson France S.A.S</p> <p>A WI is fine; there is no need for study</p>
<p>3 – Nokia France</p> <p>A WI is OK, but some objectives within that seem to be more like studies, e.g.:</p> <ul style="list-style-type: none"> - Perform FR1 co-existence evaluation for ATG network (e.g. ACLR, ACS) - Identify key characteristics where it is necessary to differentiate ATG BS and UEs from ground based BS and UEs <p>and the identification of RRM core requirements and distinguishing from NTN work.</p>
<p>4 – CATT</p> <p>WI is ok.</p>

5.1.3 Summary of initial round

13 companies supported this work. 1 companies had concern on the workload. Some comments were made. Nokia proposed to do RF requirement first and then RRM taking into account the NTN situation. CMCC

responded that all the ATG RRM work is based on Rel-17. Mediatek commented on the scenario. CMCC clarified that BS on the ground and UE on the aircraft, and the new device will be developed.

Based on the comment and response, the moderator proposed the follow modified objectives.

- Specify features to core specifications of RF requirements for coexistence between ATG and IMT terrestrial network [RAN4]
 - Scenario: BS on the ground, and the UE in the aircraft
 - Core part: Specify core requirements for coexistence between ATG and IMT terrestrial network [RAN4]
 - Example bands include n1, n78 and n79.
 - Perform FR1 co-existence evaluation for ATG network (e.g. ACLR, ACS)
 - Identify key characteristics where it is necessary to differentiate ATG BS and UEs from ground based BS and UEs
 - Aim to reuse existing requirements for BS and UE where possible.
 - Specify RF requirements for ATG UE/BS
 - Considering the results of co-existence simulations in terms of impact on emissions and RX requirements, cell sizes and link budgets, technology capabilities, likely BS and UE architectures and other relevant aspects.
 - Taking into account identified differences between ATG and ground based systems
 - Consider BS type 1-C/1-H/1-O and specify the requirements
 - Consider conductive requirements for UE
 - Specify RRM core requirements for ATG UE based on the outcome of Rel-17 NTN WI
 - Taking into account identified differences between ATG and ground based systems
 - Considering the different nature of ATG UEs and their view of the network, increased cell sizes and other relevant aspects
 - Specify new UE/BS type(s) for ATG network if necessary
 - Perf part: Identify and specify RRM/demodulation performance requirements for ATG, ~~taking into account~~ based on the ~~decisions~~/outcome of Rel-17 NTN work item. [RAN4]
 - Specify test procedures for ATG BS conformance testing
 - RRM performance requirements and test cases for ATG UE type. [RAN4]
 - Demodulation performance requirements and test cases for ATG UE/BS. [RAN4]
- NOTE: further refinement of objectives would be needed in the future meeting.

In the intermediate round, the moderator encourages companies to further check the objectives.

Based on the feedback, the moderator think the following is agreeable.

- Approve an WI for Topic #8.
- No RAN1/RAN2 impact is expected

5.2 Intermediate round

5.2.1 Objectives

Based on the summary of the initial round, the moderator proposes the following objectives.

- Specify features to core specifications of RF requirements for coexistence between ATG and IMT terrestrial network [RAN4]
 - Scenario: BS on the ground, and the UE in the aircraft
 - Core part: Specify core requirements for coexistence between ATG and IMT terrestrial network [RAN4]
 - Example bands include n1, n78 and n79.
 - Perform FR1 co-existence evaluation for ATG network (e.g. ACLR, ACS)
 - Identify key characteristics where it is necessary to differentiate ATG BS and UEs from ground based BS and UEs
 - Aim to reuse existing requirements for BS and UE where possible.
 - Specify RF requirements for ATG UE/BS
 - Considering the results of co-existence simulations in terms of impact on emissions and RX requirements, cell sizes and link budgets, technology capabilities, likely BS and UE architectures and other relevant aspects.
 - Taking into account identified differences between ATG and ground based systems
 - Consider BS type 1-C/1-H/1-O and specify the requirements
 - Consider conductive requirements for UE
 - Specify RRM core requirements for ATG UE based on the outcome of Rel-17 NTN WI
 - Taking into account identified differences between ATG and ground based systems
 - Considering the different nature of ATG UEs and their view of the network, increased cell sizes and other relevant aspects
 - Specify new UE/BS type(s) for ATG network if necessary

- Perf part: Identify and specify RRM/demodulation performance requirements for ATG based on the outcome of Rel-17 NTN work item. [RAN4]
 - Specify test procedures for ATG BS conformance testing
 - RRM performance requirements and test cases for ATG UE type. [RAN4]
 - Demodulation performance requirements and test cases for ATG UE/BS. [RAN4]
- NOTE: further refinement of objectives would be needed in the future meeting.

Please provide your comments.

Feedback Form 29:

<p>1 – China Telecommunications</p> <p>Support the objective.</p>
<p>2 – Apple AB</p> <p>It is proposed to include the following clarification on UE type <u>Scenario: BS on the ground, and the CPE type of UE is mounted in the aircraft.</u></p>
<p>3 – Guangdong OPPO Mobile Telecom.</p> <p>For clarification, is same channel or different channel used in the ATG communication comparing with ground IMT network?</p>
<p>4 – MediaTek Inc.</p> <p>My 1st round questions were half answered, but not fully. To simplify, is it (1) or (2) below that is being proposed?</p> <p>1) A "direct radio link" between the BS on the ground and the CPE type of UE in the aircraft?</p> <p>2) A BS on the ground is communicating via a NTN feeder radio link to a Satellite Access Node in space, which is then relaying to the CPE on the plane via a NTN service radio link? (same approach as for NTN architecture)</p>
<p>5 – China Mobile Group Device Co.</p> <p>Some clarifications:</p> <p>to OPPO: the adjacent-channel scenario</p> <p>to MTK: 1) is the correct understanding. ATG system architecture will only include two components, the ground gNB and UE aircraft. There is no "relay/repeater" component between ground gNB and UE aircraft. gNB directly communicate with UE . The main differences between TN system and ATG system include:</p>

1. the UE is mounted on the aircraft rather than on the ground
2. gNB pointing toward to the aircraft rather than to the ground

6 – QUALCOMM JAPAN LLC.

Our questions on what is to be reused from NTN were not really answered, we would rather avoid this discussion in RAN4. Discussing what can be reused or not does not reduce the workload much. We still have concerns that this item will require a lot of time this is why it would be good to identify as early as possible what can be reused.

7 – vivo Communication Technology

We are OK with the objectives.

8 – Nokia France

Thank you for the clarification that the scenario of interest here is BS on the ground communicating directly with a CPE UE in the aircraft.

However, this makes it a different scenario from NTN, unlike the previous understanding. We would therefore suggest to:

- remove the references to NTN,
- rename the item "Support for airborne CPE" in order to distinguish from the ATG scenario covered by the NTN work item, and
- then it should be discussed how this new airborne CPE scenario relates to the HST and UAV work (what are the differences and what can be reused), before we can get a clear view on what the objectives should be.

9 – China Unicom

We are fine with the objectives, and support the work.

10 – ZTE Corporation

To QC, regarding what requirement could be reused from NTN,

From ATG BS perspective, it's more likely that TN BS requirement could be reused for ATG BS which also depend on the coexistence study.

From ATG UE perspective, since ATG UE would utilize the GNSS to determine the UL timing requirements, therefore we think that GNSS based requirement for NTN UE could be leveraged for ATG UE. The RRM requirement related with GNSS for NTN UE could be referenced if possible.

11 – Skyworks Solutions Inc.

could it be clarified whether some beam forming will be used at the BS/Aircraft CPE? at least what antenna gain shall be assumed on each side?

12 – ZTE Corporation

To MTK:

1st understanding is correct, for your 2nd understanding is not not ,please check the diagram for ATG network in RP-213413.

13 – Intel Corporation SAS

We are fine with clarified objective that Scenario with BS on the ground and the UE in the aircraft is considered.

14 – Ericsson France S.A.S

We are fine with the proposal

15 – China Mobile Group Device Co.

some clarifications:

to Qualcomm:

1) from our understanding, the workload of ATG is much less than NTN and we can't assume ATG will require the same time as NTN which really takes much time and is still under discussion.

- NTN takes much time on following topics which will not be included in ATG WID or at least much simpler for ATG
 - o FR1/FR2 example band : even in RAN4#99 meeting(4th meeting), this issue is still under discussion. but the example band for ATG is clear i.e. n79
 - o architecture: even in RAN4#99 meeting(4th meeting), this issue is still under discussion. but the architecture for ATG is much simple
 - o regulatory information: even in RAN4 #100 meeting(5th meeting), this issue is still under discussion. but regulatory information for ATG is out of 3GPP scope and maybe we don't need to discuss it
- NTN only takes 2 or 3 meetings for RF core requirements(except for co-existence related issue), so we guess the work load of ATG RF core requirements will not be much.

2) regarding what requirement could be reused from NTN,

- for most RAN4 lead WID, this issue should be formally discussed after the approval of WID. so we still don't understand why we should discuss this issue before the approval of WID for ATG
- from RF perspective, the gNB/UE devices of ATG is much different from NTN. so during the formal discussion in RAN4 what we should do is to discuss which requirements should be based on current NR spec **rather than NTN spec.**

to Nokia:

1) to make the objective more clearly, we could update it as below:

Specify RRM core requirements for ATG UE based on ~~the outcome of Rel-17 NTN WI~~ **Rel-17 RAN1/2 design**

Perf part: Identify and specify RRM/demodulation performance requirements for ATG based on ~~the outcome of Rel-17 NTN work item~~ **Rel-17 RAN1/2 design**. [RAN4]

2) ATG is much different from HST or UAV work and the main differences are listed as below, so we don't think we should discuss them together

- the scenario difference:

- o UAV: mount the terrestrial gNB on the UAV. gNB point toward to the ground; handheld UE on the ground
- o HST: gNB is on the ground and point toward to the ground; handheld UE on the HST on the ground
- o ATG: gNB is on the ground and **point toward to the air; new UE types in the air**

- the RF requirement difference:

- o UAV: RF requirement is the same as current gNB/UE spec.
- o HST: RF requirement is the same as current gNB/UE spec
- o ATG: **new RF requirements considering the new deployment scenario**

16 – MediaTek Inc.

Thanks to ZTE and CMCC for the further info. I have a few other questions:

- Is the "air cell" deployment assuming a common aircraft height for all aircraft with ISD planned accordingly, or different heights?
- Is the same carrier frequency assumed to be used for all air cells?
- Is it assumed that inter-air-cell interference is always avoided (also for common channels) by beam-forming from the BS?
- Roughly how many aircraft per air-cell assumed?

5.2.2 Justification part

According to latest version the following justification is provided.

————— Justification —————

Air-to-ground (ATG) network refers to in-flight connectivity technique, using ground-based cell towers that send signals up to an aircraft's antenna(s) of onboard ATG terminal. As a plane travels into different sections of airspace, the onboard ATG terminal automatically connects to the cell with strongest received signal power, just as a mobile phone does on the ground.

There are several regional commercial or trial in-flight networks based on hybrid techniques of ATG and satellite communication, such as Gogo's commercial network in USA, Inmarsat's commercial network in

Europe, and CMCC's trial network in China. Regarding the hybrid network, satellite link focus on providing every-where connectivity (e.g., when cross the sea), while ATG link focus on providing high-quality data services for all service available areas (e.g., inland and coastline area).

In RAN#86 meeting, the new Rel-17 WID (RP-193234) solutions for NR to support non-terrestrial networks (NTN) was approved. The NTN work item aims to specify the enhancements identified for NR NTN (non-terrestrial networks) especially LEO and GEO with implicit compatibility to support HAPS (high altitude platform station) and ATG (air to ground) scenarios according to the following principles:

- *FDD is assumed for core specification work for NR-NTN.*
 - o *NOTE: This does not imply that TDD cannot be used for relevant scenarios e.g. HAPS, ATG*
- *Earth fixed Tracking area is assumed with Earth fixed and moving cells*
- *UEs with GNSS capabilities are assumed.*

Considering that ATG has the advantage of high throughput, low propagation delay, and low cost application, some operators and the aircraft industry have a strong request for the deployment of ATG, and it is urgent to start the standardization of ATG, especially for RAN4 requirements which is very important for the coexistence of ATG and IMT.

Although the RAN1/2/3 aspects of standardization work are generally common for satellite, HAPS and ATG, the RAN4 aspects differ very significantly. The node definitions, spectrum considerations and co-existence considerations all differ. In the case of ATG, both base station and UE will be unique types. ATG will operate within existing bands and does not need new bands and band properties to be identified. The NTN Rel-17 WI includes development of generic requirements for RAN4, however in practice the work will be separate and different for Satellite, HAPS and ATG.

The existing Rel-17 NTN WI does not specify the RF requirements of ATG, in order to avoid confusion and overloading of the NTN WI and the low dependency between RAN1-3 work and RAN4 work for ATG, it is proposed that the ATG RAN4 work is performed within the context of this ATG WI. The proposal to split off RAN4 work is exceptional for the NTN work due to the large and complex scope of covering quite different types of system and low dependency on RAN1-3.

Form the trials and commercial operation [<https://inflight.telekom.net/eat/>] of proprietary ATG solutions, some characteristics could to be considered for ATG network deployment scenarios:

- ***Extreme large inter-site distance (ISD) and large coverage range:*** In order to control the network deployment cost and considering the limited number of flights, large ISD is preferred, e.g., about 100km to 200km. At the same time, when the plane is above the sea, the distance between the plane and the nearest base station could be more than 200km and even up to 300km. Therefore, ATG network should be able to provide up to 300km cell coverage range.
- ***Utilizing non-disjoint operators' proprietary frequency for deploying both ATG and terrestrial networks:*** Operators are interested to adopt the same frequency for deploying both ATG and terrestrial networks to save frequency resource cost, while interference between ATG and terrestrial networks becomes nonnegligible and should be addressed. Especially, from China Mobile's point of view, 4.8GHz is an interesting frequency for deploying both ATG and terrestrial NR network.

- ***Much powerful on-board ATG terminal capacity:*** On-board ATG terminal can be much powerful than normal terrestrial UE, e.g., with higher EIRP via much larger transmission power and/or much larger on-board antenna gain.

Considering the particularity of ATG network deployment, the following aspects should be addressed in a new ATG work item.

- Extreme large cell coverage range (e.g., up to 300 kilometres) and flight speed (e.g., up to 1200km/h).
- Coexistence requirements between ATG and terrestrial network.
- ATG BS/UE core and performance requirements

————— Justification —————

Please provide your comment below.

Feedback Form 30:

1 – Nokia France

The justification needs to be re-written to remove the confusion between the NTN-like BS-on-aircraft scenario and the CPE-on-aircraft scenario that is actually addressed here.

5.2.3 Summary of intermediate round

8 companies supported the work and were OK with the current objectives. 5 companies still had questions and comments.

Apple proposed the change of CPE type UE. It seemed OK.

OPPO questioned if the same or different channel observed for ATG compared to IMT. CMCC responded that the adjacent channel scenario will be considered (different channel).

Mediatek had the question on the scenario. CMCC and ZTE responded that the scenario with direct radio link between BS on the ground and UE in the aircraft will be considered.

Qualcomm questioned what requirements from NTN can be reused. ZTE responded that TN BS requirements could be reused for ATG BS, the GNSS based requirements for NTN could be reused, and the RRM requirements related with GNSS could be reused. CMCC commented that which requirements could be reused should be discussed in WG after the WID was approved. Qualcomm had concern on the workload. Following ZTE responses, the moderators would like to make some clarifications in the corresponding objectives for the requirements which could be reused.

Nokia thought the scenario is different from NTN and proposed to remove the references to NTN. Nokia proposed to rename the item as “support for airborne CPE”, and asked the question about the relation to HST and UAV. CMCC proposed some change to remove the references to NTN, and clarified that ATG is different from HST and UAV. The moderator can take those modifications. In the moderator view, ATG deployment is different from HST and UAV.

Skyworks questioned if the beamforming is used at BS/CPE and what antenna gain shall be assumed. The moderator thinks that the beamforming will be used and corresponding mechanism has been specified in RAN1/2. Regarding the gain, the details can be discussed when WI starts.

Mediatek had questions on the scenarios and deployment. The moderator thinks such detailed parameters could be discussed in WG for co-existence simulation and performance evaluations. And there are some parameters provided in the justification part.

For the draft justification, Nokia proposed to remove the confusion for scenarios. The moderator proposes to make the scenario clearer in the first paragraph and remove some text related to NTN to avoid confusion.

Based on the comments and responses, the modified objectives, draft justification, suggestion on WI or SI, secondary working group and additional agreement are provided in the following section of final round for further checking.

The moderators encouraged the proponents to continue answering the questions from companies.

5.3 Final round

5.3.1 Objectives

Objectives:

- Specify features to core specifications of RF requirements for coexistence between ATG and IMT terrestrial network [RAN4]
 - Scenario:
 - BS on the ground, and the CPE type of UE mounted in the aircraft
 - A direct radio link between BS on the ground and CPE type of UE mounted in the aircraft
 - Core part: Specify core requirements for coexistence between ATG and IMT terrestrial network [RAN4]
 - Example bands include n1, n78 and n79.
 - Perform FR1 co-existence evaluation for ATG network (e.g. ACLR, ACS)
 - Identify key characteristics where it is necessary to differentiate ATG BS and UEs from ground based BS and UEs
 - Aim to reuse existing requirements for BS and UE where possible, e.g.,
 - Reuse TN BS requirements for ATG BS
 - Reuse the GNSS based NTN UE requirements for ATG UE
 - Reuse the RRM requirements related with GNSS
 - Specify RF requirements for ATG UE/BS

- Considering the results of co-existence simulations in terms of impact on emissions and RX requirements, cell sizes and link budgets, technology capabilities, likely BS and UE architectures and other relevant aspects.
 - Taking into account identified differences between ATG and ground based systems
 - Consider BS type 1-C/1-H/1-O and specify the requirements
 - Consider conducive requirements for UE
 - Specify RRM core requirements for ATG UE based on the outcome of Rel-17 NTN WI
 - Taking into account identified differences between ATG and ground based systems
 - Considering the different nature of ATG UEs and their view of the network, increased cell sizes and other relevant aspects
 - Specify new UE/BS type(s) for ATG network if necessary
- Perf part: Identify and specify RRM/demodulation performance requirements for ATG based on the outcome of Rel-17 NTN work item. [RAN4]
 - Identify key performance requirements where it is necessary to differentiate ATG BS and UEs from ground based BS and UEs
 - Aim to reuse existing requirements for BS and UE where possible, e.g.,
 - Reuse TN BS requirements for ATG BS
 - Reuse the GNSS based NTN UE requirements for ATG UE
 - Reuse the RRM requirements related with GNSS
 - Specify test procedures for ATG BS conformance testing
 - RRM performance requirements and test cases for ATG UE type. [RAN4]
 - Demodulation performance requirements and test cases for ATG UE/BS. [RAN4]

Please check and provide comments if any. Please proponent continues answering the questions from companies in the intermediate round.

Feedback Form 31:

1 – China Telecommunications

To the questions in the intermediate round, we'd also like to share our views:

- Agree that we should assume a direct radio link between BS on the ground and UE mounted in the aircraft.
- We are ok to consider CPE-type UE as first priority, since it is what has been deployed by now.
- Aircraft height: 3km (e.g., take-off stage) to 10km in practical, but we can discuss the height for co-existence study in WG level.
- We can assume the same carrier frequency to be used for all air cells. But this can be discussed in WG level.

2 – ZTE Corporation

Regarding the height mentioned by China Telecom is right and we could further discuss which height for coexistence study in WI phase.

Regarding the frequency reuse factor, it is one.

Regarding the inter-air-cell interference , Yes, BS beamforming is always used not just of interference mitigation, but also for good service link.

Regarding the number of aircraft per cell, the typical case is one.

3 – Nokia France

First, some **general comments** on the work and the intermediate round responses:

Thank you very much for the clarifications provided. We observe that there may be a misunderstanding of the UAV work, where it was stated that UAVs are base stations in the air. In fact, the UAV work is for UEs in the air, similar to how we now understand this ATG scenario.

Note also that the FR2 HST WI assumes a CPE device on the HST, which again seems to have similarities with the scenario considered for this ATG case. Could the proponents please confirm that the intention is **not** to consider the individual normal UEs of passengers on the aircraft?

The fundamental differences between the ATG scenario as now described here and conventional terrestrial networks would appear to be:

1. the UEs are airborne (as for UAV WI)
2. high Doppler (similar to HST, but even higher speed).

Therefore both the UAV and HST scenarios should be considered as the starting point before identifying any necessary changes for ATG.

Now, some **specific comments on the objectives**:

We propose the following clarification in line with the identified scenario:

- Identify key characteristics where it is necessary to differentiate ATG ground-based BS and UEs from conventional ground based BS and UEs

The following bullets need to be deleted:

- Reuse the GNSS based NTN UE requirements for ATG UE
- Reuse the RRM requirements related with GNSS

(The reason is as follows: The GNSS-based Doppler compensation scheme from NTN could in theory be applied for the BS-to-UE link, but, unlike for NTN, in this ATG scenario the BS positions are not known to the UE, so compensation in the UE-to-BS direction is not possible by means of GNSS position, and the scenario described would need to handle the 2400km/h equivalent Doppler compensation at the BS by other means. This would need to be studied and cannot just reuse the NTN or HST requirements.)

Please modify the following bullet (for clarification, as BSs in this ATG scenario are also ground-based):

- Taking into account identified differences between ATG and fully ground based systems

For the RRM requirements, please modify as follows, as already discussed:

- Specify RRM core requirements for ATG UE ~~based on the outcome of Rel-17 NTN WI~~
 - o Taking into account identified differences between ATG and fully ground based systems

For the perf part, please modify as follows, as already discussed:

- Perf part: Identify and specify RRM/demodulation performance requirements for ATG ~~based on the outcome of Rel-17 NTN work item.~~ [RAN4]
 - o Identify key performance requirements where it is necessary to differentiate ATG BS and UEs from conventional ground based BS and ground-based UEs
 - Aim to reuse existing requirements for BS and UE where possible, e.g.,
 - o Reuse TN BS requirements for ATG BS
 - o ~~Reuse the GNSS based NTN UE requirements for ATG UE~~
 - o ~~Reuse the RRM requirements related with GNSS~~
 - o Specify test procedures for ATG BS conformance testing
 - o RRM performance requirements ~~and test cases~~ for ATG UE type. [RAN4]
 - o Demodulation performance requirements ~~and test cases~~ for ATG UE/BS. [RAN4]

(note that RAN4 does not do UE test cases)

4 – Intel Corporation SAS

We are fine with updated objectives

5 – QUALCOMM JAPAN LLC.

Thank you for the comments and answers from the previous round. when the item was initially proposed, it was justified that by re-using much of the NTN work, the scope can be minimized. Unfortunately this does not seem to be the case.

We still believe this item will require a lot more time than thought. Similarly to NTN, it will take a long time for the RAN4 group to understand exactly the scenarios and be able to define the requirements. This WI touches on all aspects of RAN4 requirements, co-ex studies, UE and BS RF reqs, RRM and demod.

6 – ZTE Corporation

To Nokia, thanks for your suggestion and further clarifications and please find my following reply:

1) It's not intended for individual normal UEs of passenger, it's CPE device similar as FR2 CPE transforming NR signal into Wifi signal to provide service to passengers.

2) Regarding the GNSS related RRM requirements, in ATG system, the position of ATG BS could be indicated to ATG CPE which is also supported by RAN1. In addition, based on the GNSS position of ATG CPE then UL timing from ATG CPE could be decided. For FR1 HST requirement, the requirement cannot be reused directly since the situation is different. E.g. for FR1 HST, the main enhancement to shorten lots of RRM requirements to ensure its RRM procedure done in time since HST travelling across adjacent RRHs is quite limited (700m Ds/139m/s), however for ATG UE, ISD could be up to 300km and the ATG UE speed could be up to 1200km/h, then ATG UE travelling time across different ATG BS or ATG cells could be 0.25h which is much longer than FR1 HST. RRM requirement is not severe problem. Again, GNSS accuracy like 50m inaccuracy should be still considered for UL timing requirements. This is not considered in past for HST UE at least.

Regarding the test case for UE side, indeed in RAN4 38.133 and 38.101-4, we also defined the test cases in RAN4 for RRM and demod, the exact test procedures are specified by RAN5.

7 – China Mobile Group Device Co.

Some clarifications to Nokia:

1) The difference between ATG and UAV/HST is much different as listed as below. so ATG is independent on UAV/HST.

- The difference between UAV and ATG. Yes, the UAV in 3GPP scope is to regard the UAV as the UE and the gNB is on the ground. (our explanation of UAV in intermediate round is the UAV used for disaster relief which is not considered in 3GPP and it may belong to HAPS scope).

- o in UAV scenario, **conventional gNB on the ground use its sidelobe to serve the UAV UE in the air**. So original RF requirement in TS 38.104 could be still applicable for UAV scenario. For UE part, the height of UAV is much less than ATG aircraft, so the UE RF requirement is different as well.
- o in ATG scenario, **new ATG gNB on the ground use its main beam to serve aircraft UE in the air**. So we need to update gNB/UE requirements for ATG.

- The difference between HST and ATG.

- o RF requirements: For HST, there is no exclusive RF requirement for HST compared with conventional gNB and UE spec. but for ATG the scenario is new and we need to further analyze RF requirements for both ATG gNB and ATG UE.
- o RRM and demod part: As listed by the moderator, ATG work is suggested to be based on RAN1-2 design in R17 NTN WI rather than HST.

2) Your understanding is correct that “the intention is **not** to consider the individual normal UEs of passengers on the aircraft”

3) For the updated objectives by Nokia, we are OK except for the following: RRM performance requirements and test cases for ATG UE type. [RAN4]. For RRM, RAN4 also defines the test cases in 38.133 annex. So this should not be removed. **RRM performance requirements and test cases for ATG UE type. [RAN4]**

8 – MediaTek Inc.

We appreciate the further clarifications on the operating scenario for this. Slightly worried that all of these details are only becoming clear now. Would it be possible for all of these assumptions to be written in a document so that they can be diligently checked so that we don't find in RAN4 that there are different opinions?

5.3.2 Justifications, SI/WI and other aspects

Justifications:

Justifications

Air-to-ground (ATG) network refers to in-flight connectivity technique, using ground-based cell towers that send signals up to an aircraft's antenna(s) of onboard ATG terminal. As a plane travels into different sections of airspace, the onboard ATG terminal automatically connects to the cell with strongest received signal power, just as a mobile phone does on the ground. In this network, a direct radio link will be established between BS on the ground and CPE type of UE mounted in the aircraft

Considering that ATG has the advantage of high throughput, low propagation delay, and low cost application, some operators and the aircraft industry have a strong request for the deployment of ATG, and it is urgent to start the standardization of ATG, especially for RAN4 requirements which is very important for the coexistence of ATG and IMT.

Although the RAN1/2/3 aspects of standardization work are generally common for satellite, HAPS and ATG, the RAN4 aspects differ very significantly. The node definitions, spectrum considerations and co-existence considerations all differ. In the case of ATG, both base station and UE will be unique types. ATG will operate within existing bands and does not need new bands and band properties to be identified. The NTN Rel-17 WI includes development of generic requirements for RAN4, however in practice the work will be separate and different for Satellite, HAPS and ATG.

The existing Rel-17 NTN WI does not specify the RF requirements of ATG, in order to avoid confusion and overloading of the NTN WI and the low dependency between RAN1-3 work and RAN4 work for ATG, it is proposed that the ATG RAN4 work is performed within the context of this ATG WI. The proposal to split off RAN4 work is exceptional for the NTN work due to the large and complex scope of covering quite different types of system and low dependency on RAN1-3.

Form the trials and commercial operation [<https://inflight.telekom.net/eand/>] of proprietary ATG solutions, some characteristics could to be considered for ATG network deployment scenarios

- **Extreme large inter-site distance (ISD) and large coverage range:** In order to control the network deployment cost and considering the limited number of flights, large ISD is preferred, e.g., about 100km to 200km. At the same time, when the plane is above the sea, the distance between the plane and the nearest base station could be more than 200km and even up to 300km. Therefore, ATG network should be able to provide up to 300km cell coverage range

- **Utilizing non-disjoint operators' proprietary frequency for deploying both ATG and terrestrial networks:** Operators are interested to adopt the same frequency for deploying both ATG and terrestrial networks to save frequency resource cost, while interference between ATG and terrestrial networks becomes non-negligible and should be addressed. Especially, from China Mobile's point of view, 4.8GHz is an interesting frequency for deploying both ATG and terrestrial NR network.
- **Much powerful on-board ATG terminal capacity:** On-board ATG terminal can be much powerful than normal terrestrial UE, e.g., with higher EIRP via much larger transmission power and/or much larger on-board antenna gain.

Considering the particularity of ATG network deployment, the following aspects should be addressed in a new ATG work item.

- Extreme large cell coverage range (e.g., up to 300 kilometres) and flight speed (e.g., up to 1200km/h).
- Coexistence requirements between ATG and terrestrial network.
- ATG BS/UE core and performance requirement

Justifications

Please provide comments below.

Feedback Form 32:

<p>1 – ZTE Corporation</p> <p>we are fine with current justifications.</p>
<p>2 – China Mobile Group Device Co.</p> <p>we support above Justifications.</p>
<p>3 – Nokia France</p> <p>A few comments:</p> <p>The sentence ”Although the RAN1/2/3 aspects of standardization work are generally common for satellite, HAPS and ATG” does not seem correct, as the the scenario now discussed for ATG is quite different from satellite/HAPS, as already highlighted in the objectives discussion.</p> <p>The sentence ”In the case of ATG, both base station and UE will be unique types” should be removed, as the objectives make clear that this is still open for discussion.</p> <p>The following text should be deleted, as it has already been observed that NTN is mainly not relevant to the airborne-UE ATG scenario: ”The NTN Rel-17 WI includes development of generic requirements for RAN4, however in practice the work will be separate and different for Satellite, HAPS and ATG.</p>

The existing Rel-17 NTN WI does not specify the RF requirements of ATG, in order to avoid confusion and overloading of the NTN WI and the low dependency between RAN1-3 work and RAN4 work for ATG, it is proposed that the ATG RAN4 work is performed within the context of this ATG WI. The proposal to split off RAN4 work is exceptional for the NTN work due to the large and complex scope of covering quite different types of system and low dependency on RAN1-3.”

Thank you!

WI or SI

- Dedicated WI

Secondary working group:

- Not include any WG as the secondary work group.

Please provide your comments on WI/SI and secondary working group.

Feedback Form 33:

1 – China Mobile Group Device Co.

we support a dedicated WI.

5.3.3 Summary of final round

There were discussions between companies to clarify the differences between ATG and UAV/HST. Hope the discussions made the companies on the same page.

Nokia had concrete the proposals for modifications of objectives. The proponent could accept most of the modifications except for RRM test cases. In the moderator point of view, the RRM performance includes the accuracy requirements for RSRP/RSRP. The RRM test cases include the test cases for RRM core requirements like measure delay. So both of them are needed. So moderator suggests to keep the RRM test cases as the objective.

Qualcomm commented that the scope can be minimized by justifying which NTN work can be reused but such exercise was not done, and expressed the concern on the work load. In the moderator understanding, some bullets or sub-bullets have already been added to address that comments.

Nokia commented on the justifications. The moderators can use the modified justifications as the starting point in draft WID.

From the moderator point of view, the draft WID can be generated based on majority companies feedback. But anyhow the prioritization discusses seemed inevitable in the next RAN.

Based on the comments, the following conclusions are recommended.

Objectives:

- Specify features to core specifications of RF requirements for coexistence between ATG and IMT terrestrial network [RAN4]
 - Scenario:
 - BS on the ground, and the CPE type of UE mounted in the aircraft
 - A direct radio link between BS on the ground and CPE type of UE mounted in the aircraft
 - Core part: Specify core requirements for coexistence between ATG and IMT terrestrial network [RAN4]
 - Example bands include n1, n78 and n79.
 - Perform FR1 co-existence evaluation for ATG network (e.g. ACLR, ACS)
 - Identify key characteristics where it is necessary to differentiate ATG ground-based BS and UEs from conventional ground based BS and UEs
 - Aim to reuse existing requirements for BS and UE where possible, e.g.,
 - Reuse TN BS requirements for ATG BS
 - ~~Reuse the GNSS based NTN UE requirements for ATG UE~~
 - ~~Reuse the RRM requirements related with GNSS~~
 - Specify RF requirements for ATG UE/BS
 - Considering the results of co-existence simulations in terms of impact on emissions and RX requirements, cell sizes and link budgets, technology capabilities, likely BS and UE architectures and other relevant aspects.
 - Taking into account identified differences between ATG and fully ground based systems
 - Consider BS type 1-C/1-H/1-O and specify the requirements
 - Consider conductive requirements for UE
 - Specify RRM core requirements for ATG UE ~~based on the outcome of Rel-17 NTN WI~~
 - Taking into account identified differences between ATG and fully ground based systems
 - Considering the different nature of ATG UEs and their view of the network, increased cell sizes and other relevant aspects
 - Specify new UE/BS type(s) for ATG network if necessary
 - Perf part: Identify and specify RRM/demodulation performance requirements for ATG ~~based on the outcome of Rel-17 NTN work item.~~ [RAN4]
 - Identify key performance requirements where it is necessary to differentiate ATG BS and UEs from conventional ground based BS and ground-based UEs

- Aim to reuse existing requirements for BS and UE where possible, e.g.,
 - Reuse TN BS requirements for ATG BS
 - ~~Reuse the GNSS based NTN UE requirements for ATG UE~~
 - ~~Reuse the RRM requirements related with GNSS~~
- Specify test procedures for ATG BS conformance testing
- RRM performance requirements and test cases for ATG UE ~~type~~. [RAN4]
- Demodulation performance requirements ~~and test cases for ATG UE/BS~~. [RAN4]

Justifications:

Air-to-ground (ATG) network refers to in-flight connectivity technique, using ground-based cell towers that send signals up to an aircraft's antenna(s) of onboard ATG terminal. As a plane travels into different sections of airspace, the onboard ATG terminal automatically connects to the cell with strongest received signal power, just as a mobile phone does on the ground. In this network, a direct radio link will be established between BS on the ground and CPE type of UE mounted in the aircraft

Considering that ATG has the advantage of high throughput, low propagation delay, and low cost application, some operators and the aircraft industry have a strong request for the deployment of ATG, and it is urgent to start the standardization of ATG, especially for RAN4 requirements which is very important for the coexistence of ATG and IMT.

~~Although the RAN1/2/3 aspects of standardization work are generally common for satellite, HAPS and ATG, the RAN4 aspects differ very significantly. The node definitions, spectrum considerations and co-existence considerations all differ. In the case of ATG, both base station and UE will be unique types. ATG will operate within existing bands and does not need new bands and band properties to be identified. The NTN Rel-17 WI includes development of generic requirements for RAN4, however in practice the work will be separate and different for Satellite, HAPS and ATG.~~

~~The existing Rel-17 NTN WI does not specify the RF requirements of ATG, in order to avoid confusion and overloading of the NTN WI and the low dependency between RAN1-3 work and RAN4 work for ATG, it is proposed that the ATG RAN4 work is performed within the context of this ATG WI. The proposal to split off RAN4 work is exceptional for the NTN work due to the large and complex scope of covering quite different types of system and low dependency on RAN1-3.~~

Form the trials and commercial operation [<https://inflight.telekom.net/ean/>] of proprietary ATG solutions, some characteristics could to be considered for ATG network deployment scenarios

- **Extreme large inter-site distance (ISD) and large coverage range:** In order to control the network deployment cost and considering the limited number of flights, large ISD is preferred, e.g., about 100km to 200km. At the same time, when the plane is above the sea, the distance between the plane and the nearest base station could be more than 200km and even up to 300km. Therefore, ATG network should be able to provide up to 300km cell coverage range
- **Utilizing non-disjoint operators' proprietary frequency for deploying both ATG and terrestrial networks:** Operators are interested to adopt the same frequency for deploying both ATG and terrestrial networks to save frequency resource cost, while interference between ATG and terrestrial networks becomes non-negligible and should be addressed. Especially, from China Mobile's point of view, 4.8GHz is an interesting frequency for deploying both ATG and terrestrial NR network.

- **Much powerful on-board ATG terminal capacity:** On-board ATG terminal can be much powerful than normal terrestrial UE, e.g., with higher EIRP via much larger transmission power and/or much larger on-board antenna gain.

Considering the particularity of ATG network deployment, the following aspects should be addressed in a new ATG work item.

- Extreme large cell coverage range (e.g., up to 300 kilometres) and flight speed (e.g., up to 1200km/h).
- Coexistence requirements between ATG and terrestrial network.
- ATG BS/UE core and performance requirement

WI or SI

- Dedicated WI

Secondary working group:

- Not include any WG as the secondary work group.

6 Topic #9: HAPS

6.1 Initial round

6.1.1 Objectives

Based on RP-212682, the following objectives were proposed.

- Co-channel HAPS
 - Evaluate Co-channel interference issue between HAPS and TN;
 - Identify RF requirements for coexistence between HAPS and IMT terrestrial network
 - Identify the FR1 potential band(s) to be used as example for HAPS, and FR2 bands can also be considered as example band if needed
 - Co-existence evaluation for HAPS network (e.g. ACLR, ACS)
 - Identify UE/BS requirements for HAPS network if necessary

Please provide your comments below.

Feedback Form 34:

1 – Spark NZ Ltd

We support this work item to study the co-channel interference issues that arise between HAPS and TN. However any solutions proposed to mitigate interference must be implemented in the HAPS domain.

2 – Guangdong OPPO Mobile Telecom.

ok with content.

3 – China Unicom

HAPS deployment is very important in many scenarios, especially in disaster relief and emergency situations. Example band of [n8] can be considered and studied, and one of the main goals is to check whether the current BS RF requirements (e.g. ACLR, ACS, etc.) can be applied for NR band [n8], and/or other band(s) in which operators are interested.

We would like to propose the following objectives for the Rel-18 HAPS work:

Core part:

The objective of the work item is to complete the left-over issues in Rel-17 RAN4 HAPS, and to specify the necessary features to support NR deployment for HAPS in Rel-18.

- Identify RF requirements for coexistence between HAPS and IMT terrestrial network to support NR deployment for HAPS:
 - Identify the FR1 potential band(s) to be used as example for HAPS, and FR2 bands can also be considered as example band if needed;
 - Co-existence evaluation for HAPS network (e.g. ACLR, ACS);
 - Identify UE/BS requirements for HAPS network if necessary.

Performance part:

- Specify test procedures for HAPS BS conformance testing.
- RRM performance requirements and test cases for HAPS UE type, if needed.
- Demodulation performance requirements and test cases for HAPS UE/BS.

4 – Ericsson France S.A.S

HAPS is already in progress for Rel-17 as part of the NTN WI and it is not yet clear what needs to be done in addition. Study of co-channel interference does not lead to an impact on RAN4 requirements and not part of the RAN4 domain. If there is a need for anything further on HAPS after Rel-17, we suggest that it is carried out within the NTN WI (as in Rel-17)

5 – Apple AB

We support this work.

6 – vivo Communication Technology

We support this work.

7 – SoftBank Corp.

There is clear need to investigate the co-channel interference issues between HAPS and TN. We support this work.

8 – China Mobile Group Device Co.

We still have one question for clarification: do we consider co-channel scenario or adjacent-channel or both co-channel and adjacent-channel scenarios?

To China Union, band n8 is listed as the candidate example band for HPAS and the objective also includes the adjacent-channel ACLR and ACS analysis. Does this mean one operator use certain carrier of n8 for HAPS while another operator use adjacent-channel of n8 for TN system?

9 – Huawei Technologies France

Usually RAN4 only consider the adjacent channel co-existence issue. Based on the China Unicom's proposal, we'd like to make some adjustments of the objectives:

- Co-existence evaluation for HAPS network **based on existing RF requirements**;

In the core part, the objective is to Identify UE/BS requirements for HAPS network if necessary, then the perf part should consider the similar condition, i.e.

- Specify test procedures for HAPS BS conformance testing **if necessary**

10 – Ericsson France S.A.S

To clarify further, the China Unicom objectives and Huawei proposed adjustments look good; we should work on adjacent channel co-existence. However there is already work ongoing with HAPS co-existence and RF requirements in Rel-17 NTN. Could proponents clarify further the relation of this to the Rel-17 work? Of course anything unfinished in Rel-17 can be considered for Rel-18; right now the objectives appear to duplicate some rel-17 work though.

11 – China Unicom

We would like to clarify that the proposed objectives from China Unicom (previous comment) focuses on adjacent-channel coexistence evaluations, as only adjacent channel coexistence issues are considered in RAN4.

We appreciate companies comments and would like to provide some responses:

To Ericsson: Current R17 HAPS evaluations under the NTN WI focuses on 2GHz, the proposed work focuses on potential HAPS deployments on NR band n8. New evaluation works need to be carried out on the different spectrum. And HAPS is not included in the scope of Rel-18 NTN Work Item, hence we proposed a separate item to address the work.

To CMCC: As HAPS BS is located at distance of 20-50km above ground level, and the coverage area is expected to be much larger than ground BS, so higher BS Tx power would be needed. The proposed work is to evaluate whether existing ACLR/ACS and relevant RF requirements can be reused on n8 frequency band.

The case of HAPS operator and TN operator using different carriers in n8 could be a potential deployment scenario under the study/evaluation.

To Huawei: It is fine for us to update the objectives to base the evaluation on the existing RF requirements.

12 – Intel Corporation SAS

Co-channel co-existence can be considered with a low priority and clarification of RAN4 specifications impacts are needed. HAPS co-existences with TN and HAPS systems is also currently under discussion in the scope of Rel-17 NTN WI with a full set of simulation assumptions agreed. Is it expected to completely move the HAPS scope from Rel-17 to Rel-18? We prefer to wait for Rel-17 work conclusions before making the decision. Finally, we think that from work organization perspective this topic can be considered as a part of Rel-18 NTN WI (if it is not completed in Rel-17 timeframe).

13 – Deutsche Telekom AG

We support the further work of HAPS, any left-over from Rel17 can be added as a part of Rel-18 NTN WI.

14 – Nokia France

We recognise the interest in co-channel HAPS-TN deployments, but the objectives here are suitable for a SI. The coexistence evaluations should be completed first.

15 – MediaTek Inc.

It is not clear to us what is targeted here. Not clear how ACLR/ACS requirements help for “co-channel” deployment of HAPs and Terrestrial Network.

Normally RAN4 does not focus so much on co-channel deployment aspects (see CLI work in Rel-16 and full duplex work in Rel-18).

6.1.2 SI/WI and impacts to other WG

Please provide your comments below on whether it should be WI, WI with study phase or SI.

Feedback Form 35:

1 – Nokia France

This should be a study first, as the first step is to complete the coexistence evaluations before the scope of any other objectives can be clarified.

Please provide your comments on whether there is need to involve other WG as secondary working group.

Feedback Form 36:

6.1.3 Summary of initial round

8 companies supported this work. 1 company seems accept SI. 4 companies expressed the concern. One of the main concern is on the co-existence study or co-existence scenario. It seems that companies’ common

understanding is that adjacent channel co-existence study is needed. The other question is whether the work is duplicated from Rel-17 NTN work and whether this work should be included in Rel-18 NTN. The answer from the proponent is that the proposed Rel-18 HAPS work is the adjacent channel co-existence on band n8 while Rel-17 work focuses on 2GHz.

Besides, China Unicom and Huawei proposed the modifications on the objectives.

Based on the comment, the moderator proposes the following objectives to see if the concern can be addressed.

- Co-channel HAPS

○ Core part:

- Example band: n8
- Conduct adjacent channel co-existence evaluation between HAPS and IMT terrestrial network based on existing RF requirements to support NR deployment for HAPS
- Identify UE/BS requirements for HAPS network, if necessary, based on the outcome of co-existence study.

○ Perf part:

- Specify test procedures for HAPS BS conformance testing if necessary
- RRM performance requirements and test cases for HAPS UE type, if needed
- Demodulation performance requirements and test cases for HAPS UE/BS

In the intermediate round, the moderator encourages companies to further check the objectives and discuss how to organize the project.

6.2 Intermediate round

6.2.1 Objectives

Based on the summary of initial round, the following objectives need be discussed in the intermediate round.

- Co-channel HAPS

○ Core part:

- Example band: n8
- Conduct adjacent channel co-existence evaluation between HAPS and IMT terrestrial network based on existing RF requirements to support NR deployment for HAPS
- Identify UE/BS requirements for HAPS network, if necessary, based on the outcome of co-existence study.

- Perf part:
 - Specify test procedures for HAPS BS conformance testing if necessary
 - RRM performance requirements and test cases for HAPS UE type, if needed
 - Demodulation performance requirements and test cases for HAPS UE/BS

Please provide your comments below.

Feedback Form 37:

<p>1 – Spark NZ Ltd</p> <p>Can we clarify the objective is to study co-channel or adjacent channel or both. We believe the priority should be applied to co-channel.</p>
<p>2 – Beijing Xiaomi Mobile Software</p> <p>We support the work and are ok with the current content.</p>
<p>3 – Guangdong OPPO Mobile Telecom.</p> <p>Support the objectives above, and if understand correctly it is targeted for adjacent channel coexistence study.</p>
<p>4 – China Unicom</p> <p>We support the current objectives on adjacent channel co-existence evaluations for the example band n8. The term "Co-channel HAPS" might be removed or revised to some wordings like "Adjacent channel HAPS", as co-channel evaluations are RAN1-centric work.</p>
<p>5 – CHTTL</p> <p>We support the work and are ok with the current content.</p>
<p>6 – vivo Communication Technology</p> <p>We support this work in Rel-18.</p>
<p>7 – Ericsson France S.A.S</p> <p>The exact objectives may depend on the Rel-17 outcome and should be re-assessed at RAN.</p> <p>Assuming that HAPS is included in Rel-17, then essentially this is a co-existence study as to whether a HAPS at a lower frequency without beamforming and potentially revised ACLR/ACS.</p> <p>RAN4 co-existence studies should be for adjacent channel only, as it is only adjacent channel co-existence that impacts the RAN4 RF requirements.</p>

Our understanding though is that the ITU decision is for n1 and that n8 is under consideration in WRC-23 for HAPS. So we don't follow why to include then band in Rel-18 at this stage. It would be good to clarify the regulatory situation.

8 – Nokia France

We are in general OK with these objectives for a WID.

However:

- If "co-channel" is removed as suggested by China Unicom, it should be clearly stated that the n1 work from Rel-17 will be completed, and the co-existence studies for HAPS from Rel-17 will be leveraged.
- It should be clarified how overlap is avoided with the Rel-18 NTN WI.

9 – Huawei Technologies France

We agree with the proposal by China Unicom that co-channel should be removed

10 – ZTE Corporation

In general, we are fine with this topic for HAPS in band 8 and Rel-17 work should also be leveraged as much as possible.

11 – MediaTek Inc.

We agree with Ericsson that we should finalize the ongoing work first and then see what needs to be changed. In principle ACLR/ACS should not need to be band-specific - although we accept that different propagation conditions in different bands do have some impact. If the timetable is for WRC-23 we would also question the rush for this work.

12 – SoftBank Corp.

We support further HAPS work. The adjacent-channel study (and possible co-channel study) might be considered to include in Rel-18 NTN-enh.

6.2.2 SI/WI and impacts to other WG

Regarding how to organize the work, there would be a number of options according to feedback:

- Option 1: have a dedicated RAN4-led Rel-18 WI (China Unicom...□)
- Option 2: consider it as a part of Rel-18 NTN WI (Intel)

Please provide your comments below.

Feedback Form 38:

1 – China Unicom

Option 1. A dedicated RAN4-led Rel-18 WI is needed, as Rel-18 WI on NR NTN (Non-Terrestrial Networks) enhancements had already been approved in RAN-94e meeting (RP-213690), where HAPS (e.g. co-existence evaluation) is not part of the scope.

2 – CHTTL

Support option 1 and the reason mentioned by China Unicom above.

6.2.3 Summary of intermediate round

10 companies supported the work and had some comments on the objectives. 2 companies seemed question the urgency of the work.

Spark commented that the clarifications on co-channel or adjacent channel or both are needed. Ericsson also commented in this direction. The response from the proponent is that adjacent channel scenario is under consideration.

Ericsson commented that the exact objectives may depend on Rel-17 outcome. Mediatek shared the similar view that the on-going work should be done first and then check what needs be done. Ericsson and Mediatek commented that the ITU decision for n8 is under consideration in WRC-23 and thus questioned the urgency of the work.

Nokia commented that the co-existence study for HAPS from Rel-17 can be leveraged and questioned how to avoid the overlap with Rel-18 NTN WI. But in the moderator's view, there is no ATG scenario under consideration in Rel-18 NTN WI. And the moderator is OK to clarify in the scope that Rel-17 co-existence studies should be leveraged.

According to the feedback, companies seemed OK to have a dedicated WI for HAPS.

Based on the comments and responses, the modified objectives, draft justification, suggestion on WI or SI, secondary working group and additional agreement are provided in the following section of final round for further checking.

The moderators encouraged the proponents to continue answering the questions from companies.

6.3 Final round

6.3.1 Objectives

Objectives:

- ~~Co-channel~~ Adjacent channel HAPS

○ Core part:

- Example band: n8
- Conduct adjacent channel co-existence evaluation between HAPS and IMT terrestrial network based on existing RF requirements to support NR deployment for HAPS

- The co-existence study for HAPS from Rel-17 can be leveraged

- Identify UE/BS requirements for HAPS network, if necessary, based on the outcome of co-existence study.
- Perf part:
 - Specify test procedures for HAPS BS conformance testing if necessary
 - Specify RRM performance requirements and test cases for HAPS UE type, if needed
 - Specify demodulation performance requirements and test cases for HAPS UE/BS
- NOTE: the exact objectives may depend on the Rel-17 outcome and should be re-assessed in RAN

Please check and provide comments if any.

Feedback Form 39:

<p>1 – Spark NZ Ltd</p> <p>Spark supports the proposed way forward.</p>
<p>2 – Guangdong OPPO Mobile Telecom.</p> <p>OK with objectives.</p>
<p>3 – KDDI Corporation</p> <p>We think that the ITU decision for n8 is under consideration in WRC-23 and thus questioned the urgency of the work. It would be good to clarify the regulatory situation.</p>
<p>4 – TELECOM ITALIA S.p.A.</p> <p>The point raised by KDDI is very important. The regulatory situation must be clarified and in case a different band / band agnostic approach (if feasible) should be considered.</p> <p>As a matter of fact, I was somehow surprised by the focus on band 8 (usually operators have 2x10 MHz FDD allocation or less, therefore small amount of spectrum available; large coverage radius in terrestrial networks, therefore risking interference with more cells, ...)</p>
<p>5 – MediaTek Inc.</p> <p>We agree with KDDI/TIM that the regulatory situation needs to be clarified before we agree to do any work. Maybe the RAN plenary could look into that.</p> <p>Also it needs to be taken into account that the Rel-17 HAPs work is not yet completely mature, so that should be completed first.</p>
<p>6 – Nokia France</p> <p>The exact objectives still need to be reviewed at RAN#95e depending on the status of the Rel-17 work.</p> <p>Also, the comments above about the regulatory situation of band n8 should be carefully considered. Note that regulatory updates for spectrum for HAPS are already included in the TR 38.863.</p>

7 – China Unicom

We support the proposed objectives from moderator.

We have different understandings on the emergency scenarios for HAPS. In fact, frequency spectrum other than band n1 has already been used for HAPS in emergency scenarios (e.g. firefighting, floods), and the use of other frequency band is not prohibited regionally. The purpose of the work is only to evaluate whether existing BS RF requirements can be reused for the BS of HAPS with a higher transmission power. Considering the RAN4 workload, we can start this work at later phase in Rel-18.

8 – SoftBank Corp.

We generally support further HAPS work. For regulatory aspects, band n8 may be used under the authority of countries as China Unicom mentioned at this moment of time. In addition this band is one of the candidate bands of WRC-23 for HAPS operation, so there is a possibility to be used globally in the future. Given that situation, we don't think there is a big difficulty to study this item in Rel-18 time frame.

6.3.2 Justifications, SI/WI and other aspects

Justifications

————— Justifications —————

As for ground operators, HAPS deployment is a decent method to extend the terrestrial 5G coverage, especially in the disaster relief and high data rate coverage in remote area scenarios. It helps operators to provide communication service in areas where the whole terrestrial network is impractical to be deployed.

HAPS: An airborne vehicle operating in altitudes typically between 20 and 50 km including High Altitude Platforms.

HAPS can be used to provide services in various scenarios for coverage enhancements and emergency situations.

Hence, this new Work Item is proposed to specify relevant RF, RRM, and demodulation requirements for HAPS, to enable potential commercial deployment.

————— Justifications —————

Please provide your comments below.

Feedback Form 40:

WI or SI

- Dedicated WI

Secondary working group:

- Not include any WG as the secondary work group.

Please provide your comments on WI/SI and secondary working group.

Feedback Form 41:

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6.3.3 Summary of final round

KDDI, Telecom Italia, Mediatek, and Nokia commented that n8 for HAPS is under WRC-23 discussion and asked for clarification on the regulation situation. They questioned the urgency of this work. Telecom Italia also questioned the n8 use case with narrow bandwidth. China Unicom responded that the use of n8 for HAPS is not prohibited regionally. Softbank also commented that there is a possibility to use n8 for HAPS globally and thus do not think there is a big difficulty to start the work.

There is no specific comment for objectives and justifications. The moderator will generate WID based on them with the note that the regulation situation needs to be clarified.

The following conclusions are recommended:

Objectives:

- Adjacent channel HAPS
 - Core part:
 - Example band: n8
 - Conduct adjacent channel co-existence evaluation between HAPS and IMT terrestrial network based on existing RF requirements to support NR deployment for HAPS
 - The co-existence study for HAPS from Rel-17 can be leveraged
 - Identify UE/BS requirements for HAPS network, if necessary, based on the outcome of co-existence study.
 - Perf part:
 - Specify test procedures for HAPS BS conformance testing if necessary
 - Specify RRM performance requirements and test cases for HAPS UE type, if needed
 - Specify demodulation performance requirements and test cases for HAPS UE/BS
 - NOTE: the exact objectives may depend on the Rel-17 outcome and should be re-assessed in RAN

Issue which needs more discussions

- The regulation situation needs to be clarified

Justifications

As for ground operators, HAPS deployment is a decent method to extend the terrestrial 5G coverage, especially in the disaster relief and high data rate coverage in remote area scenarios. It helps operators to provide communication service in areas where the whole terrestrial network is impractical to be deployed.

HAPS: An airborne vehicle operating in altitudes typically between 20 and 50 km including High Altitude Platforms.

HAPS can be used to provide services in various scenarios for coverage enhancements and emergency situations.

Hence, this new Work Item is proposed to specify relevant RF, RRM, and demodulation requirements for HAPS, to enable potential commercial deployment.

WI or SI

- Dedicated WI

Secondary working group:

- Not include any WG as the secondary work group.

7 Topic #12: Support of intra-band non-collocated EN-DC/NR-CA deployment

7.1 Initial round

7.1.1 Objectives

Based on RP-212682, the potential stabilized objectives are as follows:

- Study and if feasible, support non-co-located scenario for FR1 intra-band non-contiguous EN-DC/NR-CA
 - o Work is limited to CA/EN-DC for EN-DC/NR-CA for bands 42, n77/n78
- Core part
 - o Study and if feasible, define requirements for UE which is not capable of supporting intra-band non-contiguous NR-CA and EN-DC in the same way to support inter-band CA, i.e., UE not indicating interBandMRDC-WithOverlapDL-Bands-r16
 - Study feasibility of UE RF architecture to support both DL and UL operation [RF]
 - Study and if necessary, define

- Feasible value of the power imbalance [RF]
- Feasible value of MRTD and MTTD in non-collocated deployment [RRM]
- NOTE: MTTD requirements are subject to the decision whether UL Tx is needed for both (or all) carriers
- Define requirements for UE which is capable of supporting intra-band non-contiguous NR-CA and EN-DC in the same way as to support inter-band CA, i.e., UE indicating interBandMRDC-WithOverlapDL-Bands-r16.
 - Identify feasible MRTD and power imbalance level, considering the network deployment scenario and UE implementation feasibility [RF, RRM]
- Performance part [Demodulation]
 - Specify PDSCH demodulation requirements for non-collocated scenarios for intra-band non-contiguous EN-DC and NR-CA
 - Define PDSCH demodulation performance requirement based on the applicable MRTD and power imbalance values.
 - Power imbalance between the carriers is limited to [X]dB
- NOTE: Power imbalance may be specified as the condition in the demodulation performance requirements

Please provide your comments below.

Feedback Form 42:

<p>1 – Guangdong OPPO Mobile Telecom.</p> <p>OK with the content.</p>
<p>2 – SoftBank Corp.</p> <p>We support the current objectives.</p>
<p>3 – KDDI Corporation</p> <p>We support the current objectives as a baseline.</p>
<p>4 – Nokia Corporation</p> <p>In general, we support this work. RAN4 should complete the Rel-17 work. We see this feature as being a feature which there is commercial interest. And hence, it should be high priority.</p> <p>However, we need to clarify the scope of the Core part in order to ensure clear definition of the expected work scope.</p> <p>First, this work must address requirements for inter band MRDC or CA whose actual expected implementation is based on intra band EN-DC/CA. Hence, the second main bullet is not necessary.</p> <p>Moreover, the objective must clarify that UL and DL slots among bands for EN-DC/CA and the slot boundaries should be aligned. Otherwise, this requires full duplex functionality. This is beyond RAN4 scope. Hence, we suggest the following changes. Note that for UE RF, feasible value of power imbalance has</p>

been discussed in Rel-17 TEI so that the outcome should be reflected in the objective. If the Rel-17 outcome is reused, then, there would be no UE RF work while the power imbalance assumption is used for UE demodulation discussion.

- Define requirements for inter band EN-DC or CA indicating interBandMRDC-WithOverlapDL-Bands-r16 assuming that UL and DL slots among bands for EN-DC/CA and the slot boundaries should be aligned and the bands are non-collocated.

- o Feasible value of the power imbalance [RF]

- o Feasible value of MRTD and MTTD [RRM]

NOTE: MTTD requirements are subject to the decision whether UL Tx is needed for both (or all) carriers.

5 – Apple AB

Due to the strong interests from the operators, we are OK for this work. In the WID, it is suggested to explicitly specify two phases, where phase I is to study the feasibility and phase II is to define the requirements. It should be also clarified that phase II work depends on the conclusion of phase I. Also, it seems two sets of requirements are proposed in the core part. I think we can leave it to be decided during WI and the suggested wording is provided below

Phase I: Study and if feasible, support non-co-located scenario for FR1 intra-band non-contiguous EN-DC/NR-CA

- Work is limited to CA/EN-DC for EN-DC/NR-CA for bands 42, n77/n78

Phase II:

- Phase II work will get started after the feasibility in phase I is confirmed.

- core part

- o Define requirements for UE which is capable of supporting intra-band non-contiguous NR-CA and EN-DC, i.e., UE indicating interBandMRDC-WithOverlapDL-Bands-r16.

- Identify feasible MRTD and power imbalance level, considering the network deployment scenario and UE implementation feasibility [RF, RRM]

- It is FFS if different requirements will be specified based on UE capability

- Performance part [Demodulation]

- o Same as the original proposal....

6 – QUALCOMM JAPAN LLC.

We understand that there is a commercial need for some operators so a solution must be found/standardized. The key will be what kind of power imbalance and time difference of arrival is required and what is feasible to support on the UE side.

7 – vivo Communication Technology

We support the work in general.

8 – ZTE Corporation

We are also supportive on this topic based on the operator request for a while, this could further improve the deployment flexibility of intra-band EN-DC/NR-CA deployment. Since the objectives of this WID is a bit big compared with other WIDs, it's better to be treated as separated WID instead of merging into UE FR1 UE RF enhancement.

9 – Huawei Technologies France

We are supportive of this topic to address remaining issues for the real deployment scenario.

10 – SoftBank Corp.

To: Nokia

Thank you for the comment. But it seems that your comment indicates that intra-band EN-DC/NR-CA band combinations are out of scope. They should be included because the operator's request is the intra-band EN-DC/NR-CA.

11 – LG Uplus

First of all, I appreciate moderator and all the vendors especially for understanding.

Definitely we support and agree with the proposed objectives.

Clearly this is from commercial deployment scenarios to be prepared in advance(maybe ASAP for Japan since they have non-contiguous situation right now while it is coming future for Korea). Regarding careful suggestions mentioned, it can be discussed within following discussion rounds. For the comment from ZTE, we also think that separated WID can be appropriate as working scope is related to all sub-groups of RAN4 which are RF, RRM and Demod. Anyway we open to discuss.

12 – TELECOM ITALIA S.p.A.

We support the proposal and the square bracket can be removed

13 – LG Electronics Deutschland

We support this work considering strong demand from operators and potential deployment.

14 – Intel Corporation SAS

We support this item. And it is very important to have it as a separate work item. We recognize the huge interests from Japan and South Korea operators.

The objectives are overall quite stable enough for approval.

The performance part objective "Power imbalance between the carriers is limited to [X]dB" can be removed and the value of power imbalance can be further identified as a part of studies. Otherwise, we are open to put the power imbalance restriction (e.g. 6dB as a starting point).

15 – NTT DOCOMO INC.

We also definitely support this proposal.

16 – Skyworks Solutions Inc.

We understand the use case and support the study but in general this may prevent cobanding options. one aspect that should be studied is whether 4RX need to be supported in this non-collocated case. it means a UE could support 4Rx collocated but 2Rx non-collocated. this would not prevent UEs to support 4Rx non-collocated but to enable this further signaling may be needed.

17 – Samsung Electronics Co.

We support this work considering the operators demand

18 – MediaTek Inc.

MRTD will lead to more relaxation needed in the receiver performance due to degradation. This is also being addressed in Rel-17 requirements for FR2. The same approach to any work should be applied as baseline for FR1 in Rel-18.

We do not understand the “UE supporting in the same way as inter-band” statements. We cannot generalize this discussion and don’t understand how we can differentiate the 2 proposed cases or assume any UE implementations. All reference to those scenarios should be removed and identified in any study.

7.1.2 SI/WI and impacts to other WG

Based on RP-212682, an WI was proposed.

- An WI with some study is supposed to be approved for Topic #12.
- There is no need to involve other WG as the secondary working group.

Please provide your comments below.

Feedback Form 43:

1 – Apple AB

We prefer to starting this work as SI. However, we can also compromise to a study phase in the WI.

2 – LG Uplus

Thanks Apple for careful consideration but to be honest, more aggressive approach(WI) is our preference.

3 – TELECOM ITALIA S.p.A.

Agree with LG Uplus

7.1.3 Summary of initial round

12 companies supported this work and objectives. 5 companies had comment on the objectives. Some of comments were related to two types of UE capabilities in the original objectives. The other comments were about how to organize the work. Some companies propose to have the study phase first.

Regarding Nokia comments on the assumption of UE implementation, the two UE capabilities are assumed. For each of them the different work and thus different requirements would be needed, according to the moderator understanding. In some sense, 3GPP should allow the flexibility of implementation.

Apple proposed to have study phase first and do not distinguish the different UE implementations to define the requirements, which seemed aligned with Mediatek second comment. And Mediatek also commented that the same approach to handle FR2 MRTD issue can be reused. In the moderator's view, such details can be discussed during WI phase.

Skyworks raised an issue that UE may use 4Rx for collocated case and 2Rx on each CC for non-collocated case. In the moderator's view, such use case would be undesirable since operator would like to have the full 4Rx support across all the CCs for an intra-band non-contiguous non-collocated scenario.

Based on the comments received, the moderator proposes the following objectives for discussions in the intermediate round.

- Phase I:

- Study the feasibility to support non-co-located scenario for FR1 intra-band non-contiguous EN-DC/NR-CA
 - Investigate the tolerable power imbalance between carriers
 - Investigate the required arrival time difference between CCs
 - Evaluate the UE performance under the power imbalance and arrival time difference
 - Discuss and decide reference UE architecture considering the UE capability of interBandMRDC-WithOverlapDL-Bands-r16
 - Work is limited to CA/EN-DC for EN-DC/NR-CA for bands 42, n77/n78

- Phase II:

- Phase II work will get started after the feasibility in phase I is confirmed
- Core part:
 - Specify the power imbalance if needed
 - Specify MRTD and MTTD requirements in non-collocated deployment
 - Discuss and decide if the different requirements will be specified based on UE capability of interBandMRDC-WithOverlapDL-Bands-r16.
- Perf part:

- Specify PDSCH demodulation requirements for non-collocated scenarios for intra-band non-contiguous EN-DC and NR-CA
 - Define PDSCH demodulation performance requirement based on the applicable MRTD and power imbalance values.
 - Power imbalance between the carriers is limited to [X]dB
- NOTE: Power imbalance may be specified as the condition in the demodulation performance requirements

In the intermediate round, the moderator encourages companies to check and discuss the proposed objectives.

7.2 Intermediate round

7.2.1 Objectives

The modified objectives are as follows.

- Phase I:

- Study the feasibility to support non-co-located scenario for FR1 intra-band non-contiguous EN-DC/NR-CA
 - Investigate the tolerable power imbalance between carriers
 - Investigate the required arrival time difference between CCs
 - Evaluate the UE performance under the power imbalance and arrival time difference
 - Discuss and decide reference UE architecture considering the UE capability of interBandMRDC-WithOverlapDL-Bands-r16
 - Work is limited to CA/EN-DC for EN-DC/NR-CA for bands 42, n77/n78

- Phase II:

- Phase II work will get started after the feasibility in phase I is confirmed
- Core part:
 - Specify the power imbalance if needed
 - Specify MRTD and MTTD requirements in non-collocated deployment
 - Discuss and decide if the different requirements will be specified based on UE capability of interBandMRDC-WithOverlapDL-Bands-r16.
- Perf part:

- Specify PDSCH demodulation requirements for non-collocated scenarios for intra-band non-contiguous EN-DC and NR-CA
 - Define PDSCH demodulation performance requirement based on the applicable MRTD and power imbalance values.
 - Power imbalance between the carriers is limited to [X]dB
- NOTE: Power imbalance may be specified as the condition in the demodulation performance requirements

Please provide your comments below.

Feedback Form 44:

<p>1 – SoftBank Corp.</p> <p>We are fine with the moderator’s modified objectives. And we agree the moderator’s view of having the full 4Rx support across all the CCs for an intra-band non-contiguous non-collocated scenario. We think that Skyworks comment of 2Rx on each CC is one alternative solution if it is found that full 4Rx support is difficult based on the feasibility study.</p>
<p>2 – Apple AB</p> <p>we are OK with the moderator’s proposal</p>
<p>3 – LG Uplus</p> <p>We are fine with the proposed objectives. Also regarding the careful comments for 4RX from Skyworks, we agree with SoftBank. Again thanks moderator for excellent summary and organizing.</p>
<p>4 – QUALCOMM JAPAN LLC.</p> <p>WE are fine with the proposals. the bullet on the specify the power imbalance does not have to contained”if needed”. clearly we need this, it might not be explicitly specified in RF but used as condition in the demod tests.</p>
<p>5 – TELECOM ITALIA S.p.A.</p> <p>ok with the proposal</p>
<p>6 – LG Electronics Deutschland</p> <p>We support objectives proposed by moderator</p>
<p>7 – Skyworks Solutions Inc.</p> <p>Our comment on the possibility of reduced MIMO layer support has not been captured. Under the bullet (Discuss and decide reference UE architecture considering the UE capability of interBandMRDC-WithOverlapDL-Bands-r16) another sub-bullet could be added: Study if DL MIMO layer support can be reduced to 2x2 from 4x4 to enable support of non-collocated scenario.</p>

<p>8 – Samsung Electronics Co.</p> <p>We support Moderator proposal</p>
<p>9 – Intel Corporation SAS</p> <p>In general we support the current objectives.</p> <p>One clarification question on ‘Power imbalance between the carriers is limited to [X]dB’: is the intention of [X] to specify a starting value in the final version of the WID? If not, we suggest that we remove [X]dB so we have: ‘Power imbalance between the carriers is limited’. Since we definitely are going to look for proper values in the study phase.</p>
<p>10 – NTT DOCOMO INC.</p> <p>We are OK with the moderator’s proposal.</p>
<p>11 – Huawei Technologies France</p> <p>we are OK with the moderator’s proposal</p>
<p>12 – KDDI Corporation</p> <p>We support objectives proposed by moderator. As moderator said, we would like to ask RAN4 to study having the full 4 Rx support across all CCs for an intra-band non-contiguous non-collocated scenario. On the other hand, RAN4 needs to take care of UE vendors’ comments from an implementation point of view.</p>
<p>13 – Nokia Japan</p> <p>We keep supporting this to be handled in Rel-18 and we are fine having a 2-phased approach including the listed objectives.</p> <p>We agree that this work specifies the requirements for UE to deal with non-collocated deployment scenario. We just wanted to say that EN-DC listed here, e.g., DC42An77A is classified as inter band EN-DC in 38.101-3, but said that, intra band EN-DC itself can be also within a scope so that we are ok to keep saying only intra band non-contiguous EN-DC now.</p> <p>But we still believe some clarification is beneficial. Specifically, as commented by Skyworks, we should include that comments into the objective since RAN4 has almost done for requirements for non-collocated scenarios where UEs are assumed to deal with up to 2Rx under non-collocated deployment usage. Hence, the remaining issue must be if we can specify the requirements to lift such a restriction or not at least in terms of UE RF discussion. From the current objective, that information is completely lost. Of course, the objective depends on the final outcome of Rel-17 discussion.</p>
<p>14 – MediaTek Inc.</p> <p>The 2 phase approach looks good. Not sure if we need to agree all of the details on Phase 2 right now, and this should be confirmed after Phase 1.</p>

7.2.2 WI/SI and impacts to other WG

It seemed that the following proposals in the initial round are agreeable.

- Approve an WI with study phase for Topic #12.

- There is no need to involve other

Please confirm.

Feedback Form 45:

<p>1 – SoftBank Corp.</p> <p>We support the moderator’s proposals.</p>
<p>2 – Apple AB</p> <p>we are OK with the moderator’s proposals.</p>
<p>3 – LG Uplus</p> <p>We support the proposals from moderator.</p>
<p>4 – Intel Corporation SAS</p> <p>We support this proposal. No RAN2 involvement in the beginning of the WI is needed.</p>
<p>5 – KDDI Corporation</p> <p>We support the moderator’s proposals.</p>

7.2.3 Summary of intermediate round

The main comment is about whether DL MIMO layer support can be reduced to 2x2 from 4x4 for non-collocated scenario. The operators preferred to support 4x4 but were open to further discussion if there is difficulty. Nokia supported to add clarification for such work. The moderator would like to add one objective to study if the 4-layer DL MIMO per CC can be supported for the intra-band non-contiguous non-collocated scenario and study if the maximum DL MIMO layer per CC can be reduced from 4-layer to 2-layer.

Qualcomm proposed to remove “if needed” for power imbalance. The moderator is fine.

Intel proposed the change to remove [X]dB for power imbalance between carriers. The moderator is fine.

To Mediatek, your comments seemed be captured by the sub-bullet under Phase II, i.e., Phase II work will get started after the feasibility in phase I is confirmed.

Based on the comments and responses, the modified objectives, draft justification, suggestion on WI or SI, secondary working group and additional agreement are provided in the following section of final round for further checking.

7.3 Final round

7.3.1 Objectives

Objectives:

- Phase I:

- Study the feasibility to support non-co-located scenario for FR1 intra-band non-contiguous EN-DC/NR-CA
 - Investigate the tolerable power imbalance between carriers
 - Investigate the required arrival time difference between CCs
 - Evaluate the UE performance under the power imbalance and arrival time difference
 - Discuss and decide reference UE architecture considering the UE capability of interBandMRDC-WithOverlapDL-Bands-r16
 - Study if the 4-layer DL MIMO per CC can be supported for the intra-band non-contiguous non-collocated scenario, and study if the maximum DL MIMO layer per CC can be reduced from 4-layer to 2-layer.
 - Work is limited to CA/EN-DC for EN-DC/NR-CA for bands 42, n77/n78

- Phase II:

- Phase II work will get started after the feasibility in phase I is confirmed
- Core part:
 - Specify the power imbalance ~~if needed~~
 - Specify MRTD and MTTD requirements in non-collocated deployment
 - Discuss and decide if the different requirements will be specified based on UE capability of interBandMRDC-WithOverlapDL-Bands-r16.
- Perf part:
 - Specify PDSCH demodulation requirements for non-collocated scenarios for intra-band non-contiguous EN-DC and NR-CA
 - Define PDSCH demodulation performance requirement based on the applicable MRTD and power imbalance values.
 - Power imbalance between the carriers is limited to ~~[X]dB~~
- NOTE: Power imbalance may be specified as the condition in the demodulation performance requirements

Please check and provide your comment if any.

Feedback Form 46:

<p>1 – SoftBank Corp.</p> <p>Thanks so much for the good discussion. We support the proposed objectives.</p>
<p>2 – Guangdong OPPO Mobile Telecom.</p> <p>Ok with objectives.</p>
<p>3 – LG Uplus</p> <p>We are fine also for final version. Thanks so much to Moderator and 3GPP colleagues again.</p>
<p>4 – KDDI Corporation</p> <p>We support current objectives proposed by moderator.</p>
<p>5 – LG Electronics Deutschland</p> <p>We support the objectives proposed by moderator.</p>
<p>6 – NTT DOCOMO INC.</p> <p>We support proposed objective.</p>
<p>7 – Skyworks Solutions Inc.</p> <p>We support the objectives with the added bullet on 4x4 MIMO support. the bullet is good as is but for further precision, the idea is that there could be two types of UEs: UEs that can support non-collacated with 4Rx is one or both bands but other ues may have to fall back to 2x2MIMO to enable the non-collocated scenario. Note that 4x4 DL MIMO is mandatory in n77/n78 but not in n42.</p>
<p>8 – TELECOM ITALIA S.p.A.</p> <p>We are ok with the proposal, but sorry, it is not completely clear to me the new bullet:</p> <p><u>Study if the 4-layer DL MIMO per CC can be supported for the intra-band non-contiguous non-collocated scenario, and study if the maximum DL MIMO layer per CC can be reduced from 4-layer to 2-layer.</u></p> <p>In my understanding there should be two phases:</p> <ol style="list-style-type: none"> 1. study if 4-layer DL MIMO can be supported 2. if the answer to 1 is no, "go to plan B" and define the support of 2-layer <p>As it is written now, it seems to me that 1. and 2. are independent and can be discussed in parallel.</p> <p>My recommendation is to have a clear indication that 2. is a consequence of 1. (in case of negative result).</p> <p>Could the moderator clarify?</p> <p>Thanks</p>
<p>9 – Nokia Japan</p> <p>We support this topic and thank moderator for taking into account our comments. We'll see the final outcome of Rel-17 in next RAN4 meeting and modify the current one if necessary.</p>
<p>10 – Intel Corporation SAS</p> <p>We support the objectives.</p>

11 – QUALCOMM JAPAN LLC.

We are fine with most of the objectives. The objective below is not needed since the MIMO capabilities can be signaled per CC for CA. The current framework allows UEs to reduce the number of MIMO layers from 4 to 2 and this should not be changed. Number of layers supported does not only depend on the RF capabilities, it is also related to processing capabilities.

”Study if the 4-layer DL MIMO per CC can be supported for the intra-band non-contiguous non-collocated scenario, and study if the maximum DL MIMO layer per CC can be reduced from 4-layer to 2-layer”

12 – Samsung Electronics Co.

We support moderator proposal

7.3.2 Justifications, SI/WI and other aspects

Justifications:

Justifications

In October Rel-18 email discussion (RP-212682), support of intra-band non-collocated EN-DC/NR-CA deployment was discussed as one of the potential RAN4 candidates for Rel-18, and identified its clear needs from operators. Specifically, in Rel-17 only co-located requirements are specified for FR1 intra-band non-contiguous EN-DC/NR-CA, but from operators’ perspective UE requirements for non-co-located deployment is essential to enhance EN-DC/NR-CA available areas. In other words, Tx antenna co-location at network side is not always available since the co-existence conditions are not always same for all the bands. Actually for some operators, 3 blocks in C-band were allocated at different time, which makes Tx antenna co-location cost-inefficient sometimes infeasible. The objectives of the WI is the same as the one proposed in the outcome from October Rel-18 email discussion (RP-212682)

Justifications

Please provide your comments below.

Feedback Form 47:

1 – SoftBank Corp.

We are fine with the proposed justifications.

2 – LG Uplus

We are fine with the proposed version.

3 – KDDI Corporation

We are fine with the proposed justifications.

<p>4 – NTT DOCOMO INC.</p> <p>We also fine with the justification proposed by moderator.</p>
<p>5 – Samsung Electronics Co.</p> <p>We support moderator proposal</p>

WI or SI

- Dedicated WI with a study phase

Secondary working group:

- Not include any WG as the secondary work group.

Please provide your comments on WI or SI and secondary working group.

Feedback Form 48:

<p>1 – SoftBank Corp.</p> <p>We support the moderator’s proposals.</p>
<p>2 – LG Uplus</p> <p>Fine with current proposal.</p>
<p>3 – KDDI Corporation</p> <p>We support the moderator’s proposals.</p>
<p>4 – NTT DOCOMO INC.</p> <p>We support the moderator’s proposal. It aligns with outcome of 7.3.1.</p>
<p>5 – TELECOM ITALIA S.p.A.</p> <p>support</p>
<p>6 – Samsung Electronics Co.</p> <p>We support moderator proposal</p>

7.3.3 Summary of final round

Skyworks further clarified the intention to add the objective for MIMO layer, i.e., to consider if two UE capabilities are needed. Telecom Italia commented that RAN4 should first study if 4-layer MIMO can be

supported and if not then study if the MIMO layer fallback is allowed. The current wording seemed unclear. Qualcomm commented that the existing capability signaling allows UE to reduce the number of MIMO layer. The moderator thinks that Telecom Italia comment sounds reasonable, and proposes the modifications. Maybe using the wording “MIMO layer” causes confusion. Here the focus is on the RF part. So the moderator would like to use 4Rx chain with supporting maximum 4 layer to replace the MIMO layer. Anyway this part needs more discussions in upcoming RAN and thus the moderator put them in [].

Objectives:

- Phase I:

- Study the feasibility to support non-co-located scenario for FR1 intra-band non-contiguous EN-DC/NR-CA
 - Investigate the tolerable power imbalance between carriers
 - Investigate the required arrival time difference between CCs
 - Evaluate the UE performance under the power imbalance and arrival time difference
 - Discuss and decide reference UE architecture considering the UE capability of interBandMRDC-WithOverlapDL-Bands-r16
 - [Study the feasibility for support of 4Rx chains with up to 4-layer MIMO
 - Study if the 4Rx chains with supporting up to 4-layer per CC can be supported for the intra-band non-contiguous non-collocated scenario
 - If not, study if the Rx chain number supported per CC is allowed to be reduced from 4 to 2.]
 - Work is limited to CA/EN-DC for EN-DC/NR-CA for bands 42, n77/n78

- Phase II:

- Phase II work will get started after the feasibility in phase I is confirmed
- Core part:
 - Specify the power imbalance
 - Specify MRTD and MTTD requirements in non-collocated deployment
 - Discuss and decide if the different requirements will be specified based on UE capability of interBandMRDC-WithOverlapDL-Bands-r16.
- Perf part:
 - Specify PDSCH demodulation requirements for non-collocated scenarios for intra-band non-contiguous EN-DC and NR-CA
 - Define PDSCH demodulation performance requirement based on the applicable MRTD and power imbalance values.

- Power imbalance between the carriers is limited
- NOTE: Power imbalance may be specified as the condition in the demodulation performance requirements

Issue which needs further discussions in the objectives:

- The objective in [] for the feasibility study for support of 4Rx chains with up to 4-layer MIMO.

Justifications:

In October Rel-18 email discussion (RP-212682), support of intra-band non-collocated EN-DC/NR-CA deployment was discussed as one of the potential RAN4 candidates for Rel-18, and identified its clear needs from operators. Specifically, in Rel-17 only co-located requirements are specified for FR1 intra-band non-contiguous EN-DC/NR-CA, but from operators' perspective UE requirements for non-co-located deployment is essential to enhance EN-DC/NR-CA available areas. In other words, Tx antenna co-location at network side is not always available since the co-existence conditions are not always same for all the bands. Actually for some operators, 3 blocks in C-band were allocated at different time, which makes Tx antenna co-location cost-inefficient sometimes infeasible. The objectives of the WI is the same as the one proposed in the outcome from October Rel-18 email discussion (RP-212682)

WI or SI

- Dedicated WI with a study phase

Secondary working group:

- Not include any WG as the secondary work group.

8 Topic #13: FR2 HST enhancement

8.1 Initial round

8.1.1 Objectives

Based on RP-212682, the potential stabilized objectives are as follows. There are some modifications based on the moderator understanding of the discussions.

- Core part:
 - Focus on train roof-mounted high power devices with target applicable carrier frequency up to 30GHz
 - Study the feasibility, and if feasible enable supporting HST velocity of up to a maximum of 500km/h, with carrier frequency up to 30GHz

- Specify the requirement for multi-panel operation for train roof-mounted FR2 high power devices [RAN4]:
 - Maximum 2 active panels supporting the multi-panel simultaneous reception.
 - FFS whether this objective will be merged into the other RAN4-led item
- Study on reference tunnel deployment scenario for FR2 HST and specify the channel model and corresponding core requirements
- Specify the requirements for intra-band carrier aggregation (CA) scenario
- FFS other core requirements considering the following potential objectives for the corresponding scenarios below
 - Specify the requirements to support the scenario with mixed near-to-track (i.e., Scenario-A with $D_s = 700\text{m}$ and $D_{\text{min}} = 10\text{m}$) and far-from-track (i.e., Scenario-B with $D_s = 700\text{m}$ and $D_{\text{min}} = 150\text{m}$) RRH deployment
 - Specify the new uplink timing adjustment mechanism for FR2 HST scenario with large propagation delays from different TRPs to UE

Please provide your comments below.

Feedback Form 49:

1 – China Mobile Com. Corporation

We support the potential stabilized objectives in RP-212682.

For the objective on multi-panel simultaneous reception, since it is also discussed in email thread RAN95e-RAN4-R18Prep-02, in order to avoid the duplicated discussion, suggest to discuss this issue in RAN95e-RAN4-R18Prep-02.

For the FFS part on the requirements for scenario with mixed near-to-track and far-from-track RRH deployment, we are negative. According to the agreements in RAN4 Rel-17 FR2 HST WI, different requirements are specified for different scenario. The details of the agreement are to define two sets of enhanced RRM requirements in terms of number of RX beams (i.e. RX beam sweeping scaling factor) per UE, and network signaling is introduced to configure UE to follow either Set 1 or Set 2 RRM requirements. Since the network signalling is introduced, even though in the mixed near-to-track and far-from-track RRH deployment, UE could apply the corresponding requirements following network indication. Based on this consideration, we do not see the necessity to have further study in Rel-18. But if any potential issues are observed, we are also open to discussion.

For the FFS part on new uplink timing adjustment mechanism for FR2 HST scenario with large propagation delays from different TRPs to UE, we are negative. According to the agreements in RAN4 Rel-17 FR2 HST WI, one shot large timing adjustment is supported, which can solve this issue. But if any potential issues are observed, we are also open to discussion.

2 – China Telecommunications

We support FR2 HST enhancement in R18, and support the stabilized objectives above.

For multi-panel, although it is also covered in other RAN4 work, but different scenario is targeted here. Multi-panel for HST should be covered by this WI.

3 – Nokia Corporation

We support the continuation of the FR2 HST work and this proposal. The detailed objectives would need to reflect the latest status of the ongoing Rel-17 work on FR2 HST – and hence, some adjustment may be needed to the current description.

We would like to clarify that our understanding is that the objectives cover:

- Specify the requirement for simultaneous multi-panel operation for train roof-mounted FR2 high power devices [RAN4]
 - o Maximum 2 active panels supporting the multi-panel simultaneous reception.
 - o Maximum 2 active panels supporting the multi-panel simultaneous measurements. Independent beam management per panel is assumed.

We would also think that there is a need for Demod requirements for higher speed (500km/h) if higher speed will be supported (based on the outcome from the feasibility study). New UE demod SFN scenario and requirements would also be needed for multi-panel UE.

However, if there is no immediate operator demand for support of FR2 HST up to 500km/h the feasibility study could be postponed until support is requested. This could reduce the WI work amount.

4 – Ericsson France S.A.S

We are OK to include multi-panel reception and CA.

We are not aware of a demand for 500km/h support at this time, and including such support involves significant demod work. So we prefer not to include it.

We do not see a need to include study of the tunnel scenario; a tunnel will need/have LoS and will not differ in RRM or demod requirements from the existing scenario A.

We do not see the need for objectives relating to mixed scenario A/B; the only difference is the number of RX beams assumed for RRM. If a mixed scenario is deployed then the network would need to indicate the lower or higher number of RX beams as appropriate. Intermediate distances would not need a higher number of beams.

We do not see a need to include UL timing adjustment mechanism as it has been solved for Rel-17.

5 – Apple AB

We support this work as a continuation of R17. Also, a minor revision on the target type of device is proposed as

~~Focus on~~ **Only** train roof-mounted high power devices with target applicable carrier frequency up to 30GHz **are considered in this WI**

6 – QUALCOMM JAPAN LLC.

This work should be lower priority as we are not aware of any upcoming FR2 HST deployments. Considering that the scenarios discussed so far as very specific, there is a very big risk that these enhancements are not well tailored to how the actual deployment will be.

This item could be downscoped to just extending the requirements to CA which is straightforward.

The last subbullet on the new UL timing mechanism can already be finalized in Rel.17, no need to rollover to Rel.18

7 – vivo Communication Technology

We support this work as a continuation of R17.

8 – ZTE Corporation

We also support the objectives for FR2 HST.

For the uplink timing adjustment mechanism for FR2 HST scenario with large propagation delays from different TRPs to UE, based on the Rel-17 FR2 HST one shot timing adjustment discussions, this could be resolved.

For FR2 CA, based on our experience in the past, CA is very important feature for FR2 due to the unbalanced capability on the supported channel bandwidth on BS side and UE side, therefore CA should be supported.

For multi-panel receptions, we also think that this could further improve FR2 HST performance, however whether to handle it in FR2 UE RF enhancement or FR2 HST, we are a bit open for further discussions.

9 – Huawei Technologies France

For all objectives listed, it would be better to separate them to core part and perf part.

For multi-panel simultaneous reception, currently we understand most core requirements can be covered in email thread [RAN95e-RAN4-R18Prep-02]. Based on the discussion on Rel-17 FR2 HST, only demodulation requirements for bi-directional scenarios with HST-DPS 1b and/or HST-SFN need to be defined.

We haven't observed urgent market demand for FR2 HST CA, but if other companies have strong view to include it, we think it is only related to the demodulation requirements definition for different CBW with per CC testing methodology for different FR2 HST deployment scenarios.

We did not observe necessity to define any new core requirements for mixed scenarios of Scenario A and Scenario B considering corresponding separate requirements defined in Rel-17 FR2 HST WI and UE should meet both requirements.

For the new UL TA, with the agreement of one-shot large timing adjustment in Rel-17 FR2 HST, we wonder any other new UL TA mechanisms to be defined, clarification is needed.

10 – China Unicom

We support the FR2 HST enhancement work in Rel-18, and fine with objectives.

11 – Intel Corporation SAS

We support the work on further FR2 HST evolution in Rel-18. Given a big amount of objectives certainty prioritization is needed and we support the work on the following directions:

- 1) Requirements for intra-band CA
- 2) Tunnel deployment scenarios
- 3) Multi-panel simultaneous operation for train roof-mounted FR2 high power devices
- 4) Support of speed up to 500 km/h and up to 30 GHz carrier frequency

For Multi-panel operation, we think that HST scenario can be considered in the FR2 multi-panel enhancements item and suggest to further discuss in which WI such objective needs to be handled.

12 – LG Electronics Deutschland

We support this continuation of FR2 HST in Rel-18.

13 – Samsung Electronics Co.

Simultaneous reception in e-mail thread [02] is targeting for handheld UE. Different power class (UE type in FR2) will be discussed under this WI. Therefore, we think we can use Nokia's revised bullet by adding "simultaneous" but leave the detailed discussion on independent beam management per panel to WI phase, i.e.,

- Specify the requirement for simultaneous multi-panel operation for train roof-mounted FR2 high power devices [RAN4]
 - o Maximum 2 active panels supporting the multi-panel simultaneous reception.

By saying above, we also agree with Apple to limit the scope to CPE by changing the wording, i.e.,

- Only train roof-mounted high power devices with target applicable carrier frequency up to 30GHz are considered in this WI

For CA, besides the performance requirements as identified by Huawei, RF core requirements shall be also considered to enable the CA operation scenario for FR2 HST

For tunnel scenario, it is clear in objective part it is a study phase. What Ericsson comment (no difference in RRM and Demod comparing with scenario A) is certainly one of potential observations in such study. We do have different view on that. With that, we suggest to keep this bullet as it is. It is straight-forward that if no impact to existing requirements is concluded in study phase as observed by Ericsson, we do not have corresponding specification works.

For up to 500km/h speed, as similar as tunnel scenario, it is also clear that RAN4 is only required to study the feasibility and potential impact to requirements. Whether to have specification work is certainly rely on the study outcome.

For FFS part (mixed scenarios and uplink timing), given the Rel-17 discussion is ongoing, we agreed with some companies it is too early to include these two aspects as part of Rel-18 package. The conclusion shall be clearer after Feb meeting. No harm to keep these as FFS anyway.

To address the concerns on overall workload, at least from proponents perspective, we think the below priority order can be considered

- Tunnel
- CA
- Multit-pannel
- 500Km/h
- FFS for mixed scenario & uplink timing

14 – Huawei Technologies France

Some additional comments. For the multi-panel simultaneous measurement with independent beam management assumption proposed by Nokia, based on our understanding, the RRM enhancements for FR2 HST in Rel-17 can meet the FR2 HST requirements, we did not observe any motivations to do further enhancements so far.

Also the main intention of multi-panel reception is to improve FR2 DL reception coverage and throughput. Considering the limited time, we would like to focus on the enhancement for demodulation baseband rather than RRM processing. From RRM perspective, the processing is not expected to be changed although the Rx beam pattern may be changed. In our view, we prefer to reuse all the existing FR2 HST RRM requirements rather than having fundamental changes for RRM processing.

8.1.2 SI/WI and impacts to other WG

Based on RP-212682, an WI was proposed.

- An WI is supposed to be approved for Topic #13.
- There is no need to involve other WG as the secondary working group.

Please provide your comments below.

Feedback Form 50:

1 – China Mobile Com. Corporation

In general, we support the proposals. For the proposal “no need to involve other WG as the secondary working group”, one minor comment is that if new network assistance signaling or UE capabilities are needed, RAN2 work on signaling design is expected. Except the potential impact on signaling design, we agree there is no other impact involve other WG.

2 – China Telecommunications

Agree it is an separate WI. Regarding other WG impact, we agree with CMCC that network signalling and UE capability aspects are not precluded. In addition, the timing adjustment part may has RAN1 impact.

3 – Nokia Corporation

This should be a WI.

Our understanding of the FR2 HST work is that the work can mostly be done within RAN4. However, we would prefer not to fully exclude impact on other WG e.g., if there is a further need for signalling assistance from RAN2. We are fine agreeing on this as a WI. This is high priority.

4 – Samsung Electronics Co.

We agree with moderator proposal

In our understanding, we do not need to list RAN2 as impacted WG if only capability signalling is required from RAN2 which is our current expectation for Rel-18 HST.

8.1.3 Summary of initial round

12 companies supported starting this work. 1 companies thought it should be with lower priority. But regarding the detailed objectives, 7 companies had comments.

The first issue is on mixed near-to-track and far-from-track scenario. CMCC, Ericsson, Huawei thought that such requirements are not needed consider the requirement for each scenario has been specified and there are network signaling for them.

The second issue is about the uplink timing. CMCC, Ericsson, Qualcomm, ZTE, Huawei commented that this issue is addressed in Rel-17 (one-shot large timing adjustment). Samsung would like to come back to it after February RAN4 meeting to see the progress in Rel-17.

The third issue is related to multi-panel simultaneous reception. CMCC, ZTE, Intel commented in which item the multi-panel simultaneous reception will be included needs further discussion. Nokia proposed the clarification on multi-panel simultaneous reception. Samsung responded that the UE type (power class) is different from topic #14, which is for handheld UE. China Telecom supported to have HST specific multi-panel objective in this potential WI.

The forth issue is related to support of 500km/h. Nokia, Ericsson commented that there is no clear request for it. Samsung responded that the study should be done first.

The fifth issue is on tunnel scenario. Ericsson did not think it is needed, while Intel and Samsung supported it. There seemed no or less concern on CA cases.

Based on the comment, the moderator would like to provide the modifications as follows.

- Core part:

- Only train roof-mounted high power devices with target applicable carrier frequency up to 30GHz are considered in this WI

- Specify the RF requirements for intra-band carrier aggregation (CA) scenario
- Specify the requirement for simultaneous multi-panel operation for train roof-mounted FR2 high power devices [RAN4]:
 - Maximum 2 active panels supporting the multi-panel simultaneous reception.
- Study the feasibility, and if feasible enable supporting HST velocity of up to a maximum of 500km/h, with carrier frequency up to 30GHz
- Study on reference tunnel deployment scenario for FR2 HST and specify the channel model and corresponding core requirements if any
- FFS other core requirements considering the following potential objectives for the corresponding scenarios below
 - Specify the requirements to support the scenario with mixed near-to-track (i.e., Scenario-A with $D_s = 700\text{m}$ and $D_{\text{min}} = 10\text{m}$) and far-from-track (i.e., Scenario-B with $D_s = 700\text{m}$ and $D_{\text{min}} = 150\text{m}$) RRH deployment
 - Specify the new uplink timing adjustment mechanism for FR2 HST scenario with large propagation delays from different TRPs to UE

- Perf part:

- Specify the demodulation performance requirements for for intra-band carrier aggregation (CA) HST scenario.
- Specify the necessary demodulation performance requirements for simultaneous multi-panel reception.
- Specify the other necessary RRM and demodulation performance requirements depending on the outcome of core part.

In the intermediate round, the moderator encourages companies to discuss the objectives above.

8.2 Intermediate round

8.2.1 Objectives

The modified objectives are as follows.

- Core part:

- Only train roof-mounted high power devices with target applicable carrier frequency up to 30GHz are considered in this WI
- Specify the RF requirements for intra-band carrier aggregation (CA) scenario
- Specify the requirement for simultaneous multi-panel operation for train roof-mounted FR2 high power devices [RAN4]:

- Maximum 2 active panels supporting the multi-panel simultaneous reception.
- Study the feasibility, and if feasible enable supporting HST velocity of up to a maximum of 500km/h, with carrier frequency up to 30GHz
- Study on reference tunnel deployment scenario for FR2 HST and specify the channel model and corresponding core requirements if any
- FFS other core requirements considering the following potential objectives for the corresponding scenarios below
 - Specify the requirements to support the scenario with mixed near-to-track (i.e., Scenario-A with $D_s = 700\text{m}$ and $D_{\text{min}} = 10\text{m}$) and far-from-track (i.e., Scenario-B with $D_s = 700\text{m}$ and $D_{\text{min}} = 150\text{m}$) RRH deployment
 - Specify the new uplink timing adjustment mechanism for FR2 HST scenario with large propagation delays from different TRPs to UE
- Perf part:
 - Specify the demodulation performance requirements for for intra-band carrier aggregation (CA) HST scenario.
 - Specify the necessary demodulation performance requirements for simultaneous multi-panel reception.
 - Specify the other necessary RRM and demodulation performance requirements depending on the outcome of core part.

Please provide your comments below.

Feedback Form 51:

<p>1 – Verizon UK Ltd</p> <p>We support all modified objectives!</p> <p>One more comment is for the RF requirements for carrier aggregation (CA). In our view, the scope of this work should cover the FR2 inter-band CA as well.</p>
<p>2 – China Telecommunications</p> <p>We support the modified objectives. FFS parts can be further discussed in RAN #95e, pending on Feb RAN4 progress.</p>
<p>3 – Apple AB</p> <p>we support the moderator’s proposals</p>
<p>4 – Samsung Electronics Co.</p> <p>Thanks Moderator for nice proposal. We agree with most of moderator proposals. For CA requirements, it seems there are also some missing part in our initial round comments. I intend to say besides performance requirements, both RF and RRM core requirements shall be also specified. Without RRM requirements for CA, we still cannot enable the CA operation scenario. However, for RRM requirements, RAN4 shall start</p>

to investigate which RRM requirements for CA shall be further specified for HST scenario. With above, we suggest to modify the bullet as

- Specify the RF and RRM requirements for intra-band carrier aggregation (CA) scenario

For inter-band CA proposal from Verizon, in our understanding, it was not discussed in the previous e-mail discussion and it seems too late to include the inter-band CA scenarios at this point. We suggest to focus on intra-band CA in Rel-18 considering the RAN4 workload.

For FFS part, we certainly agree with some companies, we can further check the progress after RAN4 Feb meeting. If no clear motivation for mixed scenario and also no further leftover for uplink timing remains, these FFS part can be removed

5 – QUALCOMM JAPAN LLC.

We do not think 500km/h is needed and the target scenario for deployment does not require such high speeds. This would also need RAN1 involvement, most likely. We should only keep a subset of these bullets to limit the amount of work. From what we understand, the top priority are multi-panel, CA and tunnel modeling.

6 – China Mobile Com. Corporation

We are OK with the modified objectives. And we agree with Samsung, for CA, RRM parts are also need to be considered

7 – vivo Communication Technology

We support the modified objectives, the suggested update from Samsung is also OK to us.

8 – China Unicom

We support this work and the modified objectives from moderator. Modifications provided in Samsung's comment is also fine for us.

9 – LG Electronics Deutschland

We support objectives proposed by moderator

10 – Intel Corporation SAS

HST enhancements are also included in the multi panel objective in the e-mail thread #2 (FR2 RF Enhancements). We need further discussion whether to consider it here or in FR2 RF enchantments

11 – Ericsson France S.A.S

Regarding the tunnel scenario, if it is already obvious that the channel will be LoS and the same as outdoor we don't really see the need to add an objective. During Rel-17, the need to consider tunnels differently as discussed and in our understanding, tunnels already work for Rel-17 deployments. Does the objective imply the need for some TUs for studying tunnels ?

Regarding speeds above 500km/h, a Study will need TU in an already very busy demod session. If there is not a clear deployment demand in the Rel-18 timeframe for FR2 at >350km/h then we think this can be deprioritized in favor of other demod work. So we propose to add FFS on speeds up to 500km/h and then decide based on overall demod workload (or remove).

12 – Samsung Electronics Co.

To Ericsson, whether the existing requirement can be applied in tunnel scenario is one of potential outcome of study. If the tunnel objective is included in this WI, certainly TU has to be reserved.

For 500km/h, as commented by Qualcomm and Ericsson, we can put 500km/h in []. If no strong request from operator identified, I agreed it shall be removed to save RAN4 TUs.

13 – Nokia Corporation

We support the proposed objectives from moderator.

We have one comment related to the performance part as also commented in first round: We do not see a strong need to for the first bullet about specifying demodulation requirements for CA. This would require quite some work in RAN4 while we see that the performance would be predictable. Hence, to save RAN4 time this objective could be dropped.

Additionally, we prefer to keep the RRM discussion open and do not see this only as being a question about demodulation.

We are fine with the Samsung proposal of adding [] around 500km/h

14 – Huawei Tech.(UK) Co.. Ltd

We support moderator's proposals. the inclusion of RRM requirements for intra-band CA scenario proposed by Samsung is fine for us.

8.2.2 SI/WI and impacts to other WG

As usual business, RAN2 can help defining the capability and network signaling. There seemed no need to list RAN2 as the secondary group.

So the moderator proposes

- Approve a WI for Topic #13
- There is no need to list other WG as the secondary working group.

Please provide comments below.

Feedback Form 52:

1 – China Mobile Com. Corporation

We are OK with moderator's proposal.

2 – Samsung Electronics Co.

We support moderator proposal

8.2.3 Summary of intermediate round

Companies had comments on the objectives.

Verizon proposed to add FR2 inter-band CA case. Samsung responded that intra-band CA was discussed since the beginning and inter-band CA was requested late, and preferred to focus on intra-band CA. The moderator thinks inter-band CA would need more work thus agrees with Samsung.

Samsung proposed to add RRM core requirement for FR2 HST CA scenario, while Nokia preferred to keep it open. The moderator would like to use the wording of “investigate and if needed specify” as the compromise. The same story for demodulation performance requirements for CA.

Ericsson and Qualcomm questioned the need of support 500km/h since there was no request. Samsung compromised by adding [] on the objective and leave it for future decision. The moderator is fine with this approach.

Ericsson questioned the tunnel scenario. Samsung and Qualcomm showed the interest. Samsung commented that the study will be conducted for tunnel scenario. Other companies seems OK with tunnel scenario. The moderator wonders if Ericsson can live with the current objectives since anyway there will be study.

Intel questioned if the multi-panel HST scenario should be considered here or in FR2 topic #14. In the moderator’s view, the objective in this WI is specific to FR2 HST scenario. Some note can be added to clarify the overlapping should be avoided.

Companies are OK to have a dedicated WI without involving other WG as the secondary working group.

Based on the comments and responses, the modified objectives, draft justification, suggestion on WI or SI, secondary working group and additional agreement are provided in the following section of final round for further checking.

8.3 Final round

8.3.1 Objectives

Objectives:

- Core part:

- Only train roof-mounted high power devices with target applicable carrier frequency up to 30GHz are considered in this WI
- Specify the RF requirements for intra-band carrier aggregation (CA) scenario, and investigate and if needed specify the RRM requirements for intra-band carrier aggregation (CA) scenario
- Specify the requirement for simultaneous multi-panel operation for train roof-mounted FR2 high power devices [RAN4]:

- Maximum 2 active panels supporting the multi-panel simultaneous reception.
- NOTE: Focus on FR2 HST specific requirements, and avoid the overlap with the scope of FR2 multi-Rx DL reception
- [Study the feasibility, and if feasible enable supporting HST velocity of up to a maximum of 500km/h, with carrier frequency up to 30GHz]
- Study on reference tunnel deployment scenario for FR2 HST and specify the channel model and corresponding core requirements if any
- FFS other core requirements considering the following potential objectives for the corresponding scenarios below
 - Specify the requirements to support the scenario with mixed near-to-track (i.e., Scenario-A with $D_s = 700\text{m}$ and $D_{\text{min}} = 10\text{m}$) and far-from-track (i.e., Scenario-B with $D_s = 700\text{m}$ and $D_{\text{min}} = 150\text{m}$) RRH deployment
 - Specify the new uplink timing adjustment mechanism for FR2 HST scenario with large propagation delays from different TRPs to UE

- Perf part:

- Specify the RRM test cases, and investigate and if needed specify the demodulation performance requirements for intra-band carrier aggregation (CA) HST scenario.
- Specify the necessary demodulation performance requirements for simultaneous multi-panel reception.
 - NOTE: Focus on FR2 HST specific requirements, and avoid the overlap with the scope of FR2 multi-Rx DL reception
- Specify the other necessary RRM and demodulation performance requirements depending on the outcome of core part.

Please check and provide your comments if any.

Feedback Form 53:

1 – China Telecommunications

Ok to put the 500km/h objective in [], and this can further checked in RAN #95e depending on the overall workload.

Support to define CA requirements, considering the typical single carrier CBW for FR2 is 200MHz.

2 – China Mobile Com. Corporation

Support the objectives. For CA, we see the necessity to specify RRM requirements and demodulation requirements to support CA for HST. But we are also fine to have investigation during the WI stage.

3 – ZTE Corporation

we are fine with the current objectives. For CA in FR2, we also believe that it's important feature as mentioned by China Telecom.

4 – Ericsson France S.A.S

We do not really see a need to study the tunnel scenario but can compromise to include it as other companies prefer.

We think the FFS mixed scenario and timing adjustment should be removed; if not now then in the RAN assuming that the timing is solved.

5 – Samsung Electronics Co.

We support Moderator proposal.

6 – LG Electronics Deutschland

We are fine with the proposal from moderator

7 – Huawei Technologies France

We support moderator's proposal.

Actually we also think the mixed scenario and timing adjustment can be removed now considering the current Rel-17 FR2 HST WI work progress, but we are fine to keep it FFS and remove it after RAN4 Feb meeting if company thinks that it is necessary.

8 – Intel Corporation SAS

In case requirements for HST multi-panel will be included in this item, we need to remove it from FR2 RF Enhancements item.

9 – China Unicom

We are fine with the proposal from moderator.

10 – QUALCOMM JAPAN LLC.

We are generally fine, there might still be a need to further downscope this item based on available time and what is truly essential.

The sub-objective below from the 2nd bullet should be clarified:

and investigate and if needed specify the RRM requirements for intra-band carrier aggregation (CA) scenario

There is a framework right now for RRM reqs for intra-band CA in FR2 which is based on the fact that UEs have a single analog RX beam. This device will also behave like this so the UE framework for requirements(measure a single CC in the band, etc) should be kept. There doesn't seem to be any need to investigate, it should be straightforward to specify something or do nothing and simply inherit the PC3 reqs.

11 – Nokia Corporation

We support the moderator proposal.

Just to clarify regarding the Core requirements for CA - perhaps our comment was not clear in the former round, but we support specify the RRM requirements for intra-band carrier aggregation (CA) scenario. We are also fine with this moderated version.

We do have different view on the RRM requirements and not investigate RRM requirements for the CPE which has two panel simultaneous reception capability. Not looking into this could lead to inefficiency for UE and network which is not in the interest of either.

For the mixed scenario and timing adjustment the WID can be updated based on the Rel-17 final outcome.

12 – Samsung Electronics Co.

In our understanding, RRM requirements in CA scenario shall be also specified. We support moderator proposal. To QC, RRM requirements in CA case shall be based on existing RRM requirements for CA and investigate any further enhancement for HST specific scenarios as well as multipanel assumption for CPE in HST.

8.3.2 Justifications, SI/WI and other aspects

Justifications:

Justifications

In Rel-17 work item on NR support for high speed train scenario in frequency range 2 (FR2), RAN4 has focused on train roof-mounted high-power devices for NR SA single carrier scenario in FR2, by studying the FR2 HST deployment scenario and specifying the channel modelling, RF, RRM and demodulation requirements for FR2 HST.

During the Rel-17 work item, most of focus was devoted into open space deployment scenarios (Scenario-A and B, differentiated by D_{\min} , which is the perpendicular distance between RRH site and railway track), while limited study was provided on the tunnel scenario due to the limited Rel-17 effort and relative prioritization, which is identified by operators as important high speed train scenario. Based on the requested scenario from operators, it is also of importance to support the scenario with mixed near-to-track (*i.e.* Scenario-A with $D_s = 700\text{m}$ and $D_{\min} = 10\text{m}$) and far-from-track (*i.e.* Scenario-B with $D_s = 700\text{m}$ and $D_{\min} = 150\text{m}$) RRH deployment. Furthermore, the intra-band carrier aggregation (CA) operation [and the feasibility of supporting high-speed-train velocity of up to a maximum of 500kmph] are also of interests to operators, which is not yet covered in Rel-17 work item scope.

In the Rel-17 WI, similar as FR2 handheld and other UE types, the single active panel operation was focused, *i.e.* only one active antenna panel at a time as baseline antenna assumption. Based on the Rel-17 conclusion, two panels shall be physically installed to flexibly support either forward or backward incoming signal direction; however the restriction of only one active antenna panel limits utilizing two neighbouring RRHs to serve one HST UE in the bi-directional RRH deployment scenario. Accordingly, it is of importance to introduce the support of simultaneous reception with maximum 2 active panels at the train roof-mounted FR2 high power devices for the bi-directional RRH deployment scenario.

[Another issue identified in Rel-17 work item is the large propagation delay difference from neighbouring RRHs to UE. For example in the uni-directional RRH deployment, it is identified that the signal propagation delay difference can be as much as 2.5us, which is much larger than CP length with 120kHz subcarrier spacing. In Rel-17 work item, the larger autonomous timing adjust step T_q is specified for FR2 HST UE, and the RAN4-based solutions for the uplink timing issue are focused, while other solutions involving other RAN working groups are not fully studied.]

Justifications

Please provide your comments below.

Feedback Form 54:

1 – Samsung Electronics Co.

In general, we support Moderator proposal. To be noted, some part of justifications are related to FFS part in core requirements, e.g., mixed scenarios and uplink timing. Once there are some update in the core requirements, correspondingly, the justifications shall be also updated.

2 – Ericsson France S.A.S

The sentence “Based on the requested scenario from operators, it is also of importance to support the scenario with mixed near-to-track (*i.e.* Scenario-A with $D_s = 700\text{m}$ and $D_{\text{min}} = 10\text{m}$) and far-from-track (*i.e.* Scenario-B with $D_s = 700\text{m}$ and $D_{\text{min}} = 150\text{m}$) RRH deployment.” Should be removed if the mixed scenario is removed from the objectives (The mixed scenario should be removed because it is already possible in Rel-17). At least it should be in [] for now.

3 – Nokia Corporation

We are in general fine with he proposed justification. Once Rel-17 work is more complete we can update accordingly

WI or SI

- Dedicated WI

Secondary working group:

- Not include any WG as the secondary work group.

Please provide your comments if any.

Feedback Form 55:

1 – Samsung Electronics Co.

Support moderator proposal

8.3.3 Summary of final round

Many thanks to companies for compromise on tunnel scenario and FFS part. The moderator thinks that tunnel scenario can be included and FFS part can be further checked pending on Rel-17 progress.

More comments were received on RRM part from Qualcomm, Nokia and Samsung. Regarding CA the moderator thinks that the companies are on the same page that the RRM requirement for CA should be specified. So the moderator would like to remove “if needed” but keep “investigate” to identify what kind of requirements should be specified.

Regarding the intention to further enhance RRM for multi-panel cases, the existing objective does not preclude such action. But the similar discussions on RRM objectives in the FR2 enhancement email thread is on-going. Maybe it is better for experts to come back in the future meeting to see if the modification is needed.

Qualcomm commented that further down-scoping would be needed.

For the justification, Samsung pointed out that some part is related to mixed scenario which is still FFS. Ericsson suggested to either remove them or put [] for the time being. The moderator would like to put them in [].

Based on the comments, the following conclusions are recommended:

Objectives:

- Core part:

- Only train roof-mounted high power devices with target applicable carrier frequency up to 30GHz are considered in this WI
- Specify the RF requirements for intra-band carrier aggregation (CA) scenario, and investigate and ~~if needed~~ specify the RRM requirements for intra-band carrier aggregation (CA) scenario
- Specify the requirement for simultaneous multi-panel operation for train roof-mounted FR2 high power devices [RAN4]:
 - Maximum 2 active panels supporting the multi-panel simultaneous reception.
 - NOTE: Focus on FR2 HST specific requirements, and avoid the overlap with the scope of FR2 multi-Rx DL reception
- [Study the feasibility, and if feasible enable supporting HST velocity of up to a maximum of 500km/h, with carrier frequency up to 30GHz]
- Study on reference tunnel deployment scenario for FR2 HST and specify the channel model and corresponding core requirements if any
- FFS other core requirements considering the following potential objectives for the corresponding scenarios below
 - Specify the requirements to support the scenario with mixed near-to-track (i.e., Scenario-A with $D_s = 700\text{m}$ and $D_{\text{min}} = 10\text{m}$) and far-from-track (i.e., Scenario-B with $D_s = 700\text{m}$ and $D_{\text{min}} = 150\text{m}$) RRH deployment
 - Specify the new uplink timing adjustment mechanism for FR2 HST scenario with large propagation delays from different TRPs to UE

- Perf part:

- Specify the RRM test cases, and investigate and if needed specify the demodulation performance requirements for intra-band carrier aggregation (CA) HST scenario.
- Specify the necessary demodulation performance requirements for simultaneous multi-panel reception.
 - NOTE: Focus on FR2 HST specific requirements, and avoid the overlap with the scope of FR2 multi-Rx DL reception

- Specify the other necessary RRM and demodulation performance requirements depending on the outcome of core part.

Justifications:

In Rel-17 work item on NR support for high speed train scenario in frequency range 2 (FR2), RAN4 has focused on train roof-mounted high-power devices for NR SA single carrier scenario in FR2, by studying the FR2 HST deployment scenario and specifying the channel modelling, RF, RRM and demodulation requirements for FR2 HST.

During the Rel-17 work item, most of focus was devoted into open space deployment scenarios (Scenario-A and B, differentiated by D_{\min} , which is the perpendicular distance between RRH site and railway track), while limited study was provided on the tunnel scenario due to the limited Rel-17 effort and relative prioritization, which is identified by operators as important high speed train scenario. [Based on the requested scenario from operators, it is also of importance to support the scenario with mixed near-to-track (*i.e.* Scenario-A with $D_s = 700\text{m}$ and $D_{\min} = 10\text{m}$) and far-from-track (*i.e.* Scenario-B with $D_s = 700\text{m}$ and $D_{\min} = 150\text{m}$) RRH deployment. Furthermore, the intra-band carrier aggregation (CA) operation and the feasibility of supporting high-speed-train velocity of up to a maximum of 500kmph are also of interests to operators, which is not yet covered in Rel-17 work item scope.]

In the Rel-17 WI, similar as FR2 handheld and other UE types, the single active panel operation was focused, *i.e.* only one active antenna panel at a time as baseline antenna assumption. Based on the Rel-17 conclusion, two panels shall be physically installed to flexibly support either forward or backward incoming signal direction; however the restriction of only one active antenna panel limits utilizing two neighbouring RRHs to serve one HST UE in the bi-directional RRH deployment scenario. Accordingly, it is of importance to introduce the support of simultaneous reception with maximum 2 active panels at the train roof-mounted FR2 high power devices for the bi-directional RRH deployment scenario.

[Another issue identified in Rel-17 work item is the large propagation delay difference from neighbouring RRHs to UE. For example in the uni-directional RRH deployment, it is identified that the signal propagation delay difference can be as much as 2.5us, which is much larger than CP length with 120kHz subcarrier spacing. In Rel-17 work item, the larger autonomous timing adjust step T_q is specified for FR2 HST UE, and the RAN4-based solutions for the uplink timing issue are focused, while other solutions involving other RAN working groups are not fully studied.]

WI or SI

- Dedicated WI

Secondary working group:

- Not include any WG as the secondary work group.

9 Other topics (Topic #17)

9.1 Initial round

9.1.1 Working area/Objective: FR1 HST

Based on RP-212682, the following working area was proposed.

- FR1 HST to improve the performance further in Rel-18

- Support 500km/h velocity on NR FR1 bands >1.88GHz
 - Improve downlink performance
 - Improve uplink performance requirements
- Enhance TCI switching delay RRM requirements
- Define the CHO RRM requirements for HST scenario
- Improve the HST-DPS performance
 - Improve CSI reporting requirements
 - Improve RAR and Msg4 reception performance during random access

Please provide your comments below.

Feedback Form 56:

1 – China Mobile Com. Corporation

Firstly, we want to clarify that for 30KHz SCS, 500km/h velocity with frequency carrier up to 3.6GHz is already supported in Rel-16 HST WI. For the objective of “support 500km/h velocity on NR FR1 bands >1.88GHz”, it is suggested to clearly say that it is only for 15KHz SCS. i.e. Support 500km/h velocity on NR FR1 bands >1.88GHz for 15KHz SCS.

Secondly, for 15KHz SCS, the reason only support maximum Doppler shift of 870Hz for DL is the limitation of TRS design. To support of 500km/h velocity on NR FR1 bands >1.88GHz for 15KHz SCS, we would like to know whether it is expected to have enhancement on physical layer design.

2 – Nokia Corporation

In general, we see the work needed here is more related to demod performance than to Core requirements. Concerning the proposed working areas, we have some questions for clarification:

- Concerning the first bullet and ‘Support 500km/h velocity...’ it is not clear which DL and UL improvement are targeted. Are they the same as listed under ‘Improve the HST-DPS performance’?
- Concerning the bullet related to ‘Improve the HST-DPS performance’ we would like to understand what the bottleneck? Is this addressing PDCCH scheduling or is about PDCSH reception? (hence, improve PDSCH reception performance requirements to cover RAR and msg4 during random access).

- Related to the proposed core requirements and TCI switch enhancements – is this addressing specifying the same enhancements as currently being discussed under FR2 HST WI in Rel-17?
- Concerning defining CHO RRM requirements for HST it is not clear why the existing CHO RRM requirements would not already be applicable to FR1 HST – maybe this can be clarified?

Hence, we see that RAN4 may work on demod enhancements (if time allows) while the core requirement work would need more justification.

3 – Ericsson France S.A.S

For “Improve CSI reporting requirements”, since the channel is single tap, we think that can be clarified to CQI, that is, “Improve CQI reporting requirements for single tap HST”. Regarding “Improve RAR and Msg4 reception performance during random access”; we don’t understand the necessity, nor how it would be done; there are no demod requirements or metrics currently for UE in IDLE/INACTIVE. We propose to remove this.

4 – QUALCOMM JAPAN LLC.

It is not clear what problems we are trying to solve and how as also CMCC commented. The justification for the work should be clarified. It doesn’t seem to us that another round of HST improvements is needed considering the work already done in this area in previous releases.

5 – Huawei Technologies France

We support to have the work in Rel-18. Some response for above comments are provided as below:

For support of 500km/h velocity

For FR1 DL 15kHz SCS: with NR TRS 4-symbol interval, the supported max Doppler shift is 875Hz for 15kHz SCS without any margin considering the Doppler shift positive to minus sign dramatic change, which corresponds to supporting 500km/h on 1.88GHz@15kHz SCS. But higher NR bands such as 2.1GHz@15kHz SCS, which are widely used in real network, cannot be supported that requires Doppler shift 972Hz for 500km/h velocity. There would be gap between NR and LTE. LTE CRS with 3-symbol interval which can support max Doppler shift 972Hz for 500km/h@2.1GHz/15kHz SCS

For FR1 DL 30kHz SCS: for carrier frequency higher than 3.8GHz, such as n77 and n79, the max Doppler shift by using 4-symbol interval TRS still cannot support 500km/h velocity.

There are no any UL enhancements for both HST-SFN and HST-DPS in Rel-17 to support higher velocity.

For FR1 UL 15kHz SCS: to support 500km/h on higher bands, e.g., 2.1GHz, max supported Doppler shift is 1944Hz which is higher than the existing RAN4 requirements, which is 1750Hz with DM-RS configuration 1+1+1 for 15kHz SCS, i.e. 4-symbol interval; The maximum supported Doppler shift currently is $f_d = 2333\text{Hz}$ for 15kHz SCS with DM-RS 1+1+1+1, i.e. 3-symbol interval, but with higher overhead

For FR1 UL 30kHz SCS: for carrier frequency higher than 3.8GHz, 4-symbol interval also cannot support 500km/h velocity.

The specific enhancements solution can further discuss and focus on RAN4-centric solution to minimize the physical layer impact.

The TCI switching enhancements:

The current TCI switching delay RRM requirements only consider SSB reception and processing. In the actual FR1 HST network, there are different SSB transmission schemes, SFN or DPS, also depending on

whether the max Doppler shift is within FO estimation range achieved by using TRS, TCI switching delay requirements needs to be differentiated for different cases.

CHO RRM requirements for HST scenario

CHO can be used to speed up the handover under HST scenario, maybe the current related RRM requirements can be enhanced to support reliable handover to avoid data loss or Ping-Pong handover.

Improve CSI reporting requirements for HST-DPS

The CSI reporting does not limit to CQI, it refers to the general CSI-RS measurement and reporting that should include CQI/RI/PMI. Considering the limited UE capability for supported max number of configured NZP CSI-RS resource per CC and periodic CSI report per BWP, if UE only supports to measure 1 periodic NZP CSI-RS and reports 1 CSI report that may not really reflect the current latest channel state (Case 1) considering certain reporting latency and L1 filtering, to acquire the accurate CSI measurement report, it is better to configure the NZP CSI-RS resource dynamically during TRP switch and keep consistent with TRS changing and DPS PDSCH scheduling; if UE supports to measure 2 or more NZP CSI-RS resources and only reports the limited best CSI-RS results, maybe the reported best one(s) are not always accurate considering that channel is rapidly changing, it is better to dynamically indicate the NZP CSI-RS resources for the TRP that schedules the PDSCH during TRP switching.

Improve RAR and Msg4 reception performance during random access for HST-DPS

Under contention based 4-step random access procedure, due to different SSB transmission schemes, for FR1 HST, SSB may be transmitted in SFN mode, the reliable RAR and Msg4 reception can only rely on the QCL information from SSB that is not very accurate for certain conditions, further enhancements are needed to ensure the reliable RAR and Msg4 reception.

6 – Intel Corporation SAS

Based on the previous discussion of this topic we have the following open questions from our side:

- For 500km/h - in our understanding this is already supported for 30kHz SCS for up to 3.6GHz
- Rel-17 feMIMO Tx scheme with distributed TRS Tx allows to support higher Doppler frequency compared to the baseline HST-SFN. Therefore, 500km/h requirements can be considered as a part of Rel-17 feMIMO discussion in RAN4 (it is already in scope of performance part for feMIMO)
- For HST-DPS we would like to understand whether RAN1 impacts are considered

At current stage, taking into account many uncertainties and no clear benefits, we don't support this topic.

7 – MediaTek Inc.

It seems difficult to do any work unless the highest carrier frequency is clarified, as this would impact doppler.

Also it is unclear what the RRM requirements for HST would mean:

1) for **CHO**, is this anything more than a test case with a HST scenario? Or is it requiring faster measurements? or something else? Needs clarifying and justification.

2) How do we improve **CSI reporting** without PHY spec changes? How is this different to the MIMO objective on CSI for high mobility? Clarification needed.

3) For **TCI state switching** improvements it would also be good to understand whether there are overall procedural improvements before putting more burden on the UE. UE initiated reporting was considered for MIMO which may be valid here.

9.1.2 Other working areas

Please provide your proposals below.

Feedback Form 57:

1 – ZTE Corporation

1st one should be NTN coexistence with TN standalone NB-IoT, the simulation cases and simulation assumptions have been included in Rel-17 and no coexistence study was conducted in RAN4, therefore we propose to study on NR NTN RF requirement for coexistence with TN NB-IoT and more details could be found in RP-213412(Motivation paper) and RP-213411(Proposed SID).

2nd one is the support the CRS-IM on Redcap UE, Rel-17 CRS-IM was well investigated to handle LTE CRS interfering in addition to RAN1 led Rate Matching scheme, however the evaluation scenarios mainly focus on antenna configuration 4x2 or 4x4 which is basically targeted for normal UE;

However for Redcap UE introduced in Rel-17, its receiver number could be relaxed to be 1Rx for Low band and 2Rx or 1Rx for FR1 high band to reduce the cost;

More details could be found in R4-2201483.

9.1.3 Summary of initial round

For the FR1 HST there are still questions and comments from companies, the moderator would like to ask the proponent to answer the questions in the intermediate round.

For the new proposals on NTN co-existence with TN standalone NB-IoT and CRS-IM for RedCap UE, the moderator would like to give one more round to collect the comments.

9.2 Intermediate round

9.2.1 Working area/Objective: FR1 HST

The moderator encourages the proponents answer the questions in the initial round. Based on the proponents answer, further comments can be provided.

Feedback Form 58:

1 – Huawei Technologies France

As per moderator's suggestion, here we provide our further responses for intermediate round discussion.

@CMCC: For DL: it is target for FR1 bands > 1.88GHz with 15kHz SCS and FR1 bands > 3.8GHz with

30kHz SCS, such as n79

For UL: it target for FR1 bands > 2.1GHz with 15kHz SCS and FR1 bands > 3.8GHz with 30kHz SCS

For support 500km/h velocity for those FR1 higher bands, further enhancements on the TO/FO estimation are needed. RAN4 can further discuss the specific enhancements method. From our understanding, either RAN4 centric, such as timing and frequency tracking based on single symbol or limited RAN1 impact method can be considered. e.g. The current TRS design does not need any changes, RAN2 signalling already supports the flexible TRS pattern configuration, but other flexible time and frequency domain configurations for TRS need to be specified to support higher Doppler shift rather than only those very limited TRS pattern specified in TS 38.214.

@Nokia: For the support of 500km/h velocity, it target for both HST-SFN and HST-DPS for DL PDSCH and UL PUSCH.

For improvement of HST-DPS performance, we observed those limited UE capability for CSI-RS measurement and reporting will limit BS configuration of CSI-RS resources and following scheduling and then seriously impact the UE performance;

The bottleneck is the RAR and Msg4 reception under contention based 4-step random access procedure for HST-DPS. Due to different SSB transmission schemes,SSB may be transmitted in SFN mode,the reliable RAR and Msg4 reception can only rely on the QCL information from SSB that is not very accurate for certain conditions, further enhancements are needed to ensure the reliable RAR and Msg4 reception.

With responses in the 1st round discussion, we are not sure if any other clarification/justification is needed?

@Ericsson: As we replied in the 1st round, the NZP CSI-RS resource and reporting are for accurate CQI/PMI/RI measurement and reporting to facilitate the BS scheduling and improve the HST system performance;

We observed the degradation during the access procedure and think that it bottleneck for the UE access the network under HST, it is beneficial to do some enhancements. Also we observed the similar situation of discussion of "3.2.7 Beam correspondence requirements for RRC_INACTIVE and initial access" in email thread [RAN95e-RAN4-R18Prep-02]

@Qualcomm: We ever shared the detailed motivation in RP-213442 and RP-213443 in last RAN#94 plenary.

@Intel: The support of 500km/h is target for FR1 bands > 3.8GHz with 30kHz SCS, such as n77 and n79; HST-SFN enhancements Scheme A in Rel-17 is to improve the accuracy of Doppler shift and channel estimation with distributed TRS, we don't think that it allows to support higher Doppler frequency. Also Scheme B is to eliminate the Doppler spread under HST-SFN, the supported highest Doppler shift are still constrained by 4-symbol interval TRS. For HST-DPS, please refer to the response to CMCC.

UE experience under HST is very important, especially with the widely deployed HST nowadays.

@MediaTek: With more and more NR bands are available for use, the support of higher Doppler shift needs to be taken into account. Also due to the Doppler shift positive to minus sign dramatic change, especially under HST-DPS, still some marge of 875Hz Doppler for 15kHz SCS to 972Hz for Band 2.1GHz that has operator's request.

We observed the beneficial to use CHO for HST and not fully sure if some RRM enhancements are needed under HST scenario and would like to do some investigation.

CSI-RS configuration reporting enhancements have RAN2 signalling impact and maybe very limited RAN1 specification impact from our current understanding, but no physical layer design change, i.e. all is based on the current CSI-RS measurements and reporting mechanism.

TCI switching delay enhancements, can refer to our 1st round response, any further concerns, please let's know.

2 – Ericsson France S.A.S

Regarding msg4/RAR: The question is how this test should work ? RAN4 UE demod test is triggered by TE. For example, PDSCH/PDCCH tests are triggered by DCI on PDCCH, and CSI reporting test is triggered by CSI request from TE. Also TE needs feedback from UE to calculate Tput, decoding error, CSI reports.

RAN4 has defined PBCH demodulation requirements, but it was agreed it is not tested because 1) TE cannot trigger to read PBCH, and 2) TE cannot receive feedback from UE on PBCH demodulation.

The UE transmits HARQ-ACK for Msg4 so TE can check the Msg4 decoding success rate. But the question is how to initiate random access procedure. Even if TE can trigger random access, it takes very long time to complete one test. For example, if we defined the requirements as SNR to achieve Msg4 decoding success rate with 99%, at least TE need to check more than 1000 times, but unlike connected mode where TE can receive HARQ-ACK every DL slots, TE can get HARQ-ACK once per random access procedure.

Since HST has been introduced in Rel-16, is it so obvious that RACH performance is insufficient ?

Regarding CQI/CSI: HST-DPS uses the single tap channel with Doppler shift. Also the current HST-DPS channel model fix the SNR level. In such a condition, the UE reports the same CQI/PMI/RI almost all the time anyhow. Is the intention to consider some different model ?

3 – Huawei Tech.(UK) Co.. Ltd

@Ericsson, we think that similar testing issue with "3.2.7 Beam correspondence requirements for RRC_INACTIVE and initial access" under discussion in email thread [RAN95e-RAN4-R18Prep-02], we can follow that discussion and list "Study the potential impact on testability aspects (i.e., test time)."

9.2.2 Other working areas

More comments on NTN co-existence with TN standalone NB-IoT and CRS-IM for RedCap UE can be provided below.

Feedback Form 59:

1 – China Telecommunications

For CRS-IM for RedCap, if we understand correctly, the major work is to define LLR weighting requirements for 1Rx UE, while all other parameters can be reused from 2Rx/4Rx requirements. If so, we think the workload is small. We are ok with this work, and perhaps it can be discussed in the demod thread.

2 – Apple AB

we agree with China Telecom that this topic should be discussed in the demod thread and should be considered together with other adv. receiver proposals.

3 – QUALCOMM JAPAN LLC.

this is a demod topic. However, considering that RedCap is supposed to be a low complexity device, we have doubts this work is justified

4 – ZTE Corporation

To CTC and Apple, this could be discussed in demod part as well.

To QC, indeed LTE with 1Rx UE targeted for wearable device also support CRS-IC in Rel-15, therefore we think that NR redcap UE is also supposed to support at least CRS-IM .

5 – Intel Corporation SAS

As for CRS-IM for RedCap UE, we share the same view as China Telecom and Apple, it is better to discuss this topic in Demod e-mail. As for workload, we assume that new requirements should be defined for 1 Rx and 2 Rx TDD, because typical CBW is 40 MHz for normal UE, but RedCap UE supports up to 20 MHz.

Another way, in case such feature is supported by many companies, probably we can check whether it can be handled by Rel-17 RedCap WI. In the previous meeting, we just had the initial discussion on the scope.

6 – Ericsson France S.A.S

Regarding CRS-IM and Redcap, we tend to agree that the workload should be relatively small. Still, there is a very large amount of work already proposed for the demod session. As mentioned by China Telecom and Apple, we could consider this in the demod thread in the context of the overall demod workload, bearing in mind that the load is smaller for this than other items.

Regarding NTN co-existence to standalone NB-IoT, one concern is on the amount of co-existence work that is already in Rel-18 considering NTN Ka band. NTN NB-IoT, FD-MIMO, ATG, HAPS leftovers (if needed) etc. Adding even more co-existence work may not be feasible from a workload perspective

7 – MediaTek Inc.

We wonder whether this NTN coexistence with NB-IoT TN work is really essential. We have already agreed the ACLR/ACS requirements based on the NR scenarios. It could be left until later in the Release for example or even later.

8 – Huawei Technologies France

This is a demod topic, considering that RedCap is lower complexity device, we prefer to reduce the testing cost.

9.2.3 Summary of intermediate round

Many thanks for your comments and responses. Due to limited time in this email discussion and because there is no consensus on those late proposed topics, the moderator would like to stop the discussions on other topics. Please continue discussions in March RAN plenary.

10 Summary of recommended conclusions

In this section, the moderator puts the objectives as well as remaining issues for the individual topics in one place.

Topic #1: Simplification of band combination specification

Objectives:

- Investigate and simplify the working procedure for approving documents for TS and TR to improve the efficiency to specify band combinations and the quality of specifications
 - Improve the efficiency considering
 - RAN4 reduces the redundant and unnecessary work for big CRs, draft CRs and/or TPs, if any
 - The following rules will be investigated and defined if necessary
 - Investigate whether the workflow can be improved under the condition that quality can be guaranteed.
 - Develop rules or guidelines covering the process of not for block approval.
 - Develop the necessary tools to reduce RAN4's workloads if feasible
 - Improve the quality considering
 - RAN4 improves the procedures for cross-checking to avoid conflict between big CR/CRs across basket WIs and other WIs
 - RAN4 captures the agreements about the rules and guidelines including but not being limited to the outcome of the above sub-bullets in the corresponding TR
- Investigate the feasibility and optimize the specification structure and reduce the test burden
 - Study the methodology to simplify the test efforts for a UE supporting multiple features, e.g., NR-CA, EN-DC on the same band combination
 - Study of similarity and dependency of RF requirements for different features on the same band combination
 - Study the methodology to simplify RF requirement specifications for
 - MSD requirements in 38.101-1 and 38.101-3, e.g., reducing the test configurations with different bandwidth combinations
 - For Delta_TIB and Delta_RIB requirements, investigate and define the framework of the general principle or requirements with band-combination specific exceptions
 - For Delta_TC,c, investigate whether it can be removed in low boundary formula for P_{cm}

- NOTE 1: The requirements applicable to UE won't be increased.
- NOTE 2: The work should be applied to all the power classes

Other tentative agreement:

The consolidation/re-alignment for Rel-18 basket WI will be discussed before the Rel-18 basket WIs are approved.

Topic #2: Enhancement for 700/800/900MHz band combinations

Objectives:

- Investigate the feasibility and solutions to enable simultaneous transmission on two UL bands and simultaneous reception on two or three bands for the band combination of 700, 800 and 900MHz spectrum for smart phone form factor
 - The following band combinations will be considered. And the technical discussion on three band combination will start after the completion of feasibility study of all the fallback band combinations.
 - CA_n8-n20-n28 with uplink configurations of CA_n8-n20, CA_n8-n28, CA_n20-n28, and the fallback modes
 - [CA_n5-n8-n28 with uplink configurations of CA_n5-n8, CA_n5-n28, CA_n8-n28, and the fall back modes]
 - [CA_n5-n8 with uplink configurations of CA_n5-n8, and the fallback modes]
 - CA_n20-n67 with uplink on band n20
 - The following aspects need be studied
 - UE architecture including n-plexing, PA
 - Study feasibility of low band wideband antenna
 - Performance due to impacts including inter-modulation products
 - Method to manage the inter-modulation product impacts
 - Power class 3 (PC3) is considered in this study
- Identify necessary RAN4 requirements including Tx and Rx RF requirements

Issues which need further discussions in the objectives

- Should CA_n5-n8-n28 with uplink configurations and CA_n5-n8 be included as the example band combinations given that the downlink of band n5 overlaps with uplink of band n8?

Additional tentative agreement:

A nine months duration for the SI should be agreed followed by a Rel-18 WI, if the outcome of the study demonstrates the feasibility.

Topic #5: BS RF requirement evolution

Objectives:

- Home base station (HBS)
 - Example band is n41
 - Phase I: Study phase
 - Study if NR local area BS requirements can be applied to HBS or LTE home eNB requirement could be used as baseline to define the requirement for HBS.
 - Phase II: Normative work, which starts only if the study concludes that the new requirements are necessary
 - Specify RF requirements for BS
 - Specify conformance testing requirements
 - No new demodulation performance requirement is needed.
- mmWave multi-band BS
 - Example bands: 26+28GHz, 28+39GHz, 26+40GHz, 28+40GHz
 - Target at studying and defining the generic requirements
 - Phase I: Study phase
 - Investigate the feasibility and performance of wideband RF and antenna architectures covering multiple FR2 bands
 - Investigate if FR1 multi-band methods are re-usable for FR2, and (if so) agree on the appropriate inter-RF BW gaps
 - Investigate if FR1 exceptions are acceptable for FR2
 - Investigate whether a generic solution for all combinations within FR2-1 is possible and/or a solution for all or a part of the 24-29GHz frequency range in which n257/n258/n261 overlap should be targeted
 - Study the definition of FR2 multi-band BS
 - Phase II: normative work depending on the conclusion of phase I
 - Core part:

- Specify the definition of multi-band for FR2, if needed
- Specify RF core requirements for FR2 multi-band BS, if deemed feasible
 - Define RF core requirements to include FR2 multi-band BS
 - Dependent on the study phase outcome, this may be all or part of FR2 bands
 - Define EMC requirements
- Perf part:
 - Specify the BS conformance test requirements, if needed
- NOTE 1: The requirements for mmWave multi-band BS are to be defined for the synchronized operating bands.
- NOTE 2: No change is needed for 37 series specification since FR2 is not included in MSR AAS BS specifications.

Topic #8: ATG

Objectives:

- Specify features to core specifications of RF requirements for coexistence between ATG and IMT terrestrial network [RAN4]
 - Scenario:
 - BS on the ground, and the CPE type of UE mounted in the aircraft
 - A direct radio link between BS on the ground and CPE type of UE mounted in the aircraft
 - Core part: Specify core requirements for coexistence between ATG and IMT terrestrial network [RAN4]
 - Example bands include n1, n78 and n79.
 - Perform FR1 co-existence evaluation for ATG network (e.g. ACLR, ACS)
 - Identify key characteristics where it is necessary to differentiate ATG ground-based BS and UEs from conventional ground based BS and UEs
 - Aim to reuse existing requirements for BS and UE where possible, e.g.,
 - Reuse TN BS requirements for ATG BS
 - Specify RF requirements for ATG UE/BS

- Considering the results of co-existence simulations in terms of impact on emissions and RX requirements, cell sizes and link budgets, technology capabilities, likely BS and UE architectures and other relevant aspects.
 - Taking into account identified differences between ATG and fully ground based systems
 - Consider BS type 1-C/1-H/1-O and specify the requirements
 - Consider conductive requirements for UE
- Specify RRM core requirements for ATG UE
 - Taking into account identified differences between ATG and fully ground based systems
 - Considering the different nature of ATG UEs and their view of the network, increased cell sizes and other relevant aspects
- Specify new UE/BS type(s) for ATG network if necessary
- Perf part: Identify and specify RRM/demodulation performance requirements for ATG. [RAN4]
 - Identify key performance requirements where it is necessary to differentiate ATG BS and UEs from conventional ground based BS and ground-based UEs
 - Aim to reuse existing requirements for BS and UE where possible, e.g.,
 - Reuse TN BS requirements for ATG BS
 - Specify test procedures for ATG BS conformance testing
 - RRM performance requirements and test cases for ATG UE. [RAN4]
 - Demodulation performance requirements for ATG UE/BS. [RAN4]

Topic #9: HAPS

Objectives:

- Adjacent channel HAPS
 - Core part:
 - Example band: n8
 - Conduct adjacent channel co-existence evaluation between HAPS and IMT terrestrial network based on existing RF requirements to support NR deployment for HAPS
 - The co-existence study for HAPS from Rel-17 can be leveraged
 - Identify UE/BS requirements for HAPS network, if necessary, based on the outcome of co-existence study.

- Perf part:
 - Specify test procedures for HAPS BS conformance testing if necessary
 - Specify RRM performance requirements and test cases for HAPS UE type, if needed
 - Specify demodulation performance requirements and test cases for HAPS UE/BS
- NOTE: the exact objectives may depend on the Rel-17 outcome and should be re-assessed in RAN

Issues which needs more discussions

- The regulation situation needs to be clarified

Topic #12: Support of intra-band non-collocated EN-DC/NR-CA deployment

Objectives:

- Phase I:
 - Study the feasibility to support non-co-located scenario for FR1 intra-band non-contiguous EN-DC/NR-CA
 - Investigate the tolerable power imbalance between carriers
 - Investigate the required arrival time difference between CCs
 - Evaluate the UE performance under the power imbalance and arrival time difference
 - Discuss and decide reference UE architecture considering the UE capability of interBandMRDC-WithOverlapDL-Bands-r16
 - [Study the feasibility for support of 4Rx chains with up to 4-layer MIMO
 - Study if the 4Rx chains with supporting up to 4-layer per CC can be supported for the intra-band non-contiguous non-collocated scenario
 - If not, study if the Rx chain number supported per CC is allowed to be reduced from 4 to 2.]
 - Work is limited to CA/EN-DC for EN-DC/NR-CA for bands 42, n77/n78
- Phase II:
 - Phase II work will get started after the feasibility in phase I is confirmed
 - Core part:
 - Specify the power imbalance

- Specify MRTD and MTTD requirements in non-collocated deployment
- Discuss and decide if the different requirements will be specified based on UE capability of interBandMRDC-WithOverlapDL-Bands-r16.
- Perf part:
 - Specify PDSCH demodulation requirements for non-collocated scenarios for intra-band non-contiguous EN-DC and NR-CA
 - Define PDSCH demodulation performance requirement based on the applicable MRTD and power imbalance values.
 - Power imbalance between the carriers is limited
- NOTE: Power imbalance may be specified as the condition in the demodulation performance requirements

Issue which needs further discussions in the objectives:

- The objective in [] for the feasibility study for support of 4Rx chains with up to 4-layer MIMO.

Topic #13: FR2 HST enhancement

Objectives:

- Core part:
 - Only train roof-mounted high power devices with target applicable carrier frequency up to 30GHz are considered in this WI
 - Specify the RF requirements for intra-band carrier aggregation (CA) scenario, and investigate and specify the RRM requirements for intra-band carrier aggregation (CA) scenario
 - Specify the requirement for simultaneous multi-panel operation for train roof-mounted FR2 high power devices [RAN4]:
 - Maximum 2 active panels supporting the multi-panel simultaneous reception.
 - NOTE: Focus on FR2 HST specific requirements, and avoid the overlap with the scope of FR2 multi-Rx DL reception
 - [Study the feasibility, and if feasible enable supporting HST velocity of up to a maximum of 500km/h, with carrier frequency up to 30GHz]
 - Study on reference tunnel deployment scenario for FR2 HST and specify the channel model and corresponding core requirements if any
 - FFS other core requirements considering the following potential objectives for the corresponding scenarios below

- Specify the requirements to support the scenario with mixed near-to-track (i.e., Scenario-A with $D_s = 700\text{m}$ and $D_{\text{min}} = 10\text{m}$) and far-from-track (i.e., Scenario-B with $D_s = 700\text{m}$ and $D_{\text{min}} = 150\text{m}$) RRH deployment
- Specify the new uplink timing adjustment mechanism for FR2 HST scenario with large propagation delays from different TRPs to UE

- Perf part:

- Specify the RRM test cases, and investigate and if needed specify the demodulation performance requirements for intra-band carrier aggregation (CA) HST scenario.
- Specify the necessary demodulation performance requirements for simultaneous multi-panel reception.
 - NOTE: Focus on FR2 HST specific requirements, and avoid the overlap with the scope of FR2 multi-Rx DL reception
- Specify the other necessary RRM and demodulation performance requirements depending on the outcome of core part.