**[RAN93e-R18Prep-17] Potential RAN4 enhancements - Version 0.0.7**
**RAN**

**3GPP TSG-RAN#93e RP-211667**

**Electronic Meeting, September 13 – 17, 2021**

**Agenda item:** xx.xx.

**Source:** RAN4 Chair (Huawei)

**Title:** Moderator's summary for discussion [RAN93e-R18Prep-17] Potential RAN4 enhancements

**Document for:** Information & Decision

# 1 Introduction

The discussion in this email thread covers the topic #17 in RWS-210659 [1] "**Potential RAN4 enhancements**".

Deadline and NWM organization are based on the guidelines provided by the RAN Chair is in RP-211639 [2]. As per guidance RWS-210659 of the RAN Chair, the discussion in this email thread should be based on the (RAN REL-18 workshop) RWS submission. The aim is to converge on a set of areas with a reasonable scope as a "high-level description" – where "high-level description" herein is not a "draft SID/WID" rather something like a single slide with a set of bullets for the possible objectives with some high-level notes.

During the discussion, it is not expected to provide any input like "we support/we do not support" as this is not "number counting" driven discussion, rather focus on tangible commercial interests in both near and longer terms.

# 2 Initial round

## 2.1 General

**Feedback Form 1: General views**

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|---|
| **1 – LG Uplus**<br>General view is that we can start from the items with strong commercial requirements or interests that we could not include them into Rel-17 due to full of TU during last RAN Plenary. One of the items is "Specification for intra-band non-colocation deployment scenario" as it was discussed for RRM while its scopes reach to RF and Demod as well. More thought will be provided in 2.1.2. |
| **2 – SoftBank Corp.**<br>Agree with LG Uplus.<br>In addition, we would emphasize that RAN4 items proposed by operators are basically linked to commercial demand. Given the unfortunate situations in Rel-15 and 16, we would propose not to assign too many RAN4 |

TUs to RAN1 future topics.

**3 – Huawei Technologies France**

- In general the WI proposals should be balanced among UE RF, BS RF, RRM and Demod areas. The new WIs should also consider the balance among in-field issues, leftover issues in Rel-17 and new enhancements for Rel-18.
- The RAN4 package for Rel-18 discussion should also include spectrum related basket WIs, and handling of basket needs to be discussed.
- TU budget needs to balance the TU allocated to RAN1/2/3 led WIs and those reserved for RAN4 led topics

**4 – China Mobile Com. Corporation**

In general, we think Rel-18 should prioritize the areas and technologies to meet clear and concrete commercial applications. For the Rel-17 enhancements, RAN4 should really focus on the essential and effective enhancements and leftovers that are critical for 5G develpment.

We propose that R18 RAN4 package can be treated as a two-phase approach. The 1st phase focuses on the new areas that do not depend on Rel-17 completion. 1st phase items are discussed and approved in December together with RAN1/2/3 packages. The 2nd phase focuses on the Rel-17 extension/enhancement WIs, which are highly depend on the completion of Rel-17. By using this approach, we believe it would allow RAN4 has more time for our own Rel-17 WIs instead of fully booked by other WGs items.

**5 – China Mobile Com. Corporation**

To correct one typo in the last sentence of my previous comments:

By using this approach, we believe it would allow RAN4 has more time for our own **Rel-18 WIs** instead of fully booked by other WGs items.

**6 – MediaTek Inc.**

The problem we had in Rel-17 are

- RAN4 capacity was already fully booked in the beginning. Even if some issues were later identified by operators or during RAN4 discussions, RAN4 has no extra bandwidth to deal with them.
- Many Rel-16 WIs have deadline extensions (e.g., 2 quarters) in RAN4. Therefore RAN4 started Rel-17 late, which may eventually lead to deadline extension again.

To avoid the same problem in Rel-18, we suggest

- Reduce the RAN4 TUs for RAN1/2/3-led WIs. In other words, RAN4 can have its own down-selection on which features we will introduce the corresponding requirements.
- Leave some TU margins in the beginning of Rel-18. This extra margin can be utilized to handle Rel-17 WIs with extensions in the early Rel-18 stage and to handle some new important issues in late Rel-18 stage.

**7 – QUALCOMM JAPAN LLC.**

One important thing for the RAN4 items will be to balance the overall time between RAN1/2/3 led items with RAN4 impact and RAN4 led items.

Overall, priority should be given to items that are prerequisites to successful deployments of features. These are generally RAN4 requirements for already defined features (e.g. 8Rx) and testing solutions for existing requirements/features or features that will be introduced in the near future. FR2 testing solutions have fallen behind actual deployments and this is becoming an issue for the industry.

**8 – NTT DOCOMO INC.**

As stated by many companies, we also generally think that Rel-18 RAN4 enhancement should prioritize the topics which will be widely employed near future and enhancement of existing requirement rather than requirement for brand-new features, e.g. non-co-located deployment for FR1 NR-CA/EN-DC.

**9 – LG Electronics Deutschland**

We're expecting Rel-18 starting as F2F meeting. Considering F2F is time-limited for actual discussion, RAN4 should estimate RAN4 TUs more accurately in RAN4 part of Rel-18 RAN1/2 led WIs, RAN4 led WI, and Rel-17 performance parts.

One possible way would be reserving some TUs for RAN4-led WIs and needs to inform RAN1/2 of the available RAN4 Tus. For RAN4-led WI, the enhancements need to be included for the existing RF (FR1 & FR2) & RRM requirements.

**10 – China Telecommunications**

**1) RAN4 non-spectrum items**

RAN4-led proposals are more relevant to product or deployment roadmaps, and the priority from each individual company perspective may become clearer in the later phase of Rel-17. In addition, RAN4 Rel-18 work would probably start from June 2022.

So, in general, we support to approve RAN4 non-spectrum package in March 2022. Meanwhile, few items, with the clear operator demands and consensus, can be approved in December 2021.

**2) RAN4 spectrum items**

For RAN4 spectrum items, we can just follow the way in Rel-17. More specifically, there are two groups:

Group #1: Spectrum basket items

− Group 1A): Continuation of Rel-17 basket WIs. They can be approved at March 2022.

− Group 1B): New basket WIs that cannot be foreseen at the beginning of Rel-17. To accommodate operators' requests in a timely way, not limit the approval of these items to certain meetings or time period, if the objectives are agreeable.

Group #2: Spectrum non-basket items

− To be treated in the same way as for group 1B), i.e., not limit the approval of these items to certain meetings or time period, if the objectives are agreeable.

**3) RAN4 impact of RAN1/2/3-led WIs**

RAN4 TUs for RAN1/2/3-led WIs need to evaluated after the RAN1/2/3 Rel-18 package approval and before the RAN4 package approval, i.e., between December 2021 and March 2022.

Simply reducing the TUs for other WG-led WIs may not help, if the scope is not changed. The TU numbers need to reflect the exact RAN4 workload. Down-scoping of RAN4 work for other WG-led WIs can be considered if needed.

**11 – Samsung Electronics Co.**

For Rel-18 package, we have similar view as MTK, Qualcomm and Huawei; a well balance between RAN1/RAN2/RAN3 led WIs and RAN4 led SIs/WIs from RAN4 work load and TU arrangement perspective with well assessment and planning TU budget need to be considered.

Typically, RAN4 led proposals were motivated by urgent business request i.e. new product types, new spectrum or performance optimization based on real field experience i.e. RF, RRM and baseband requirements enhancement. Overall, RAN4 led proposals shouldn't be deprioritized compared to other WGs' proposals. Enough TU budget need to be reserved for RAN4 led proposals. Taking the experience from previous release, half RAN4 TU need to be reserved for RAN4 led proposals including spectrum and non-spectrum proposals.

Regarding timeline for RAN4 package approval, we proposed to have "single step approval "approach on March 2020 RAN-P other than currently 2 step approach (New areas on Dec 2021 RAN-P and Rel-17 continued on March 2022) with following reason:

· No clear definition on "new areas", this will introduce debate and confusions among companies

· Treating all RAN4 led proposals together as a package facilitate the decision with well TU planning and workload control

· Splitting other WGs package and RAN4 package approved in separate RAN-plenary meetings i.e. RAN#94-E for other WGs and RAN#95-E for RAN4 led will ease the work load and make the discussion more concentrated on RAN-P. In RAN#94E, RAN4 can focus on the assessment on the RAN4 impact from other WGs' proposals.

Note: Early approval for some urgent spectrum WIs can be considered in RAN#94E as special cases.

**12 – CATT**

For Rel-18 package, we have similar view as previous companies that a well balance between RAN1/RAN2/RAN3 led WIs and RAN4 led SIs/WIs should be considered from RAN4 work load and TU arrangement perspective with well assessment and planning TU budget need to be considered.

Regarding timeline for RAN4 package approval, we agree with samsung to have "single step approval "approach on March 2020 RAN-P. This will give a reasonalbe time period for RAN4 to well evaluate the workload and TU between RAN1/2/3 led WIs and RAN4 led WIs. single step approval on March 2020 does not mean RAN4 items have lower priority that items led by other working group. enough number of TU should be reserved for RAN4 items.

**13 – Ericsson LM**

**On RAN4 requirements in RAN1-3 led WIs**:

By default RAN4 requirements should be part of all RAN1-3 led WIs, which impact RAN4. However, exceptionally RAN4 requirements in some of the RAN1-3 led WIs, which are not time critical for commercial deployment, can be postponed to future release.

In December 2021, RAN1-3 led WIs can contain high level RAN4 related objectives. RAN4 parts can be further refined in March 2022. We did similar activity in Rel-17. At that stage (e.g. March 2022) we can also decide whether RAN4 requirements for some RAN1-3 led WIs can be skipped in Rel-18 e.g. postponed to Rel-19 or later subject to commercial demand. Otherwise we see big risk that skipping RAN4 requirements as general rule will lead to non-standardized requirements.

**14 – Nokia Japan**

- Rel17 R4 SI may become WI and shall be taken into account into R4 TU budget
- Balance between WI by other WGs and WI by R4: Leave some room to R4 WIs when other WGs WIs are approved.
- R4 workload consideration (from WI/SI led by other WGs as well as those by R4): Only topics providing sufficient gains and/or having clear market demand and/or urgency can be candidates from which work items may be selected.
- Topics which may be covered by WIs led by R1 like ”Simultaneous Rx/Tx in FR1 RF“ must not be considered as separate R4 items
- Extension of existing features requires a stable foundation. For instance, 3UL with 700+800+900 must have requirements 2UL/3DL or 4Tx must have stable requirements for 2Tx in advance.

**15 – KDDI Corporation**

We agree with Softbank and NTT DoCoMo’s view.

**16 – vivo Communication Technology**

- In general, we believe some TUs should be potentially reserved for RAN4 Rel-17 leftover/extensions, at the beginning of Rel-18 timeline, considering we always need some extra meeting time to finalize all the open issues “after deadline” for each release.
- For spectrum WIs, it seems the procedure to differentiate spectrum or non-spectrum WI/SI proposals is not very clear, there are some middle places existing. We think RAN plenary should discuss a clear guidance to categorize these two kinds of proposals.
- To make use of RAN4 TU more efficiently, the 3 parallel sessions in RAN4 should also be taken into account when TU budget is evaluated. Though RAN4 TU is separated into RAN4 RF and RAN4 RD, the RRM topics and demodulation topics do not compete TUs actually. This may give additional TU room for RRM and demod respectively.
- For package approval of RAN4 WIs, we prefer not to differentiate “new areas” and “old areas”. We are fine with 2-phase approach for RAN4 WIs package approval. However, reasonable TUs should be reserved for the 2nd phase package which would depend on Rel-17 progress.

**17 – vivo Communication Technology**

- Based on the meeting guidance, “As per guidance RWS-210659 of the RAN Chair, the discussion in this email thread should be based on the (RAN REL-18 workshop) RWS submission”, we are not sure whether all the proposals in this email thread are from RAN R18 WS, maybe clarification discussion is needed.

**18 – TELECOM ITALIA S.p.A.**

We agree with the statements made by several operators.

- 1. we should prioritize on clear market requirements, such as non-co-located deployment for FR1 NR-CA/EN-DC
- 2. we should approve the main RAN4 activities already in December to avoid RAN1/2/3 to hijack all the TUs in RAN4

**19 – ZTE Corporation**

Similar as other companies, we think that well balanced TU budget between RAN1/2/3 and RAN4 should be taken into account,otherwise some RAN4 leading topics which is important to operators/vendors might be deprioritized unfortunately based on our experience in the past. Therefore we think that RAN4 impacts and TU budget from RAN1/2/3 leading topics should be clarified clearly before March 2022 RAN-P,then RAN4 package approval could be done at March,2022 with well balanced TU budget.

In addition, if there were some urgent spectrum issues e.g. LS to other regulatory body or ITU, these kind of work could also been approved in Dec,2021 as exceptional cases.

**20 – Intel Corporation (UK) Ltd**

- Scope
  - Similar to previous releases the RAN4 package should consider further evolution in RF (UE RF/BS RF), OTA, RRM and Demodulation areas.
  - Also agree with many companies that new WIs should also consider the balance among in-field issues, leftover issues in Rel-15/16/17 and new enhancements for Rel-18.
  - Further discussion of Rel-17 leftover topics is required at a later stage once the RAN4 approaches Rel-17 work completion for the Core part to make sure that important Rel-17 leftovers are properly addressed.
- Timelines
  - Approval of RAN4 Spectrum & Non-spectrum WIs packages may be split into different meetings.
  - Recommend a “single step” non-spectrum WIs approval in March 2021. We should also strive to minimize the split of RAN4 WI package approval for non-spectrum items across multiple meetings. It is also preferable to treat all RAN4 proposals altogether to ensure a fairness between new and leftover topics (i.e. we do not see value to split the discussion for new/old topics).
- TU considerations
  - Agree with many companies that we need to balance the overall time between RAN1/2/3 led items with RAN4 impact and RAN4 led items. Further discussion on the best approaches is encouraged.
  - Sufficient TU budget needs to be reserved for RAN4 led proposals. In addition, a certain amount of RAN4 TUs shall be reserved to accommodate urgent market requests, which may arise during Rel-18 timeframe. Agree with Samsung that we can assess the required capacity for RAN4-led items based on previous releases as a starting point.

- We also agree that proper analysis of the RAN4 TUs for RAN1/2/3-led WIs is required. However, it may not always help and the scope of RAN4 requirements for RAN1/2/3-led WIs shall be discussed as well in more details (e.g., RAN4 may not always have bandwidth to define requirements for all cases and a reasonable prioritization is required).

**Apple comments due to NWM issues:**

1. R17 drop-off issues: a significant number of R17 proposals are dropped off due to TU/objective limitations. Some of them are essential to be fixed earlier than later.

2. Newly identified issue in R17: this work depends on the ongoing R17 discussion. We may not be able to get the full picture in Dec. plenary. It is reasonable to make the decision in March plenary in 2022. Also, WG level agreements can be very helpful to facilitate the discussion in the plenary.

3. Newly identified issues in R18: Such work does not depend on R17 completion. However, approving this work earlier than 1) and 2) may introduce some priority and TU allocation concerns.

We agree with the observations from others on the challenges we are facing in R17. Consequently, it is proposed.

1. Balance between RAN4-oriented innovation/proposals and RAN4 impacts due to other WG-led work. The rule of ”3 objectives” per RAN4-led WI is simply because the RAN4 TU budget is overwhelmed by other WG-led work. Unfortunately, it is not well justified such other WG-led work is more important or should be prioritized over RAN4-led proposals. Instead, this is simply the result of different approval timelines. With this, it is proposed to approval all RAN4 TU budgets and the related RAN4 objectives in the same meeting, i.e. March 2022.

2. The level of popularity, e.g. number of supporting companies, can still be considered as a classic way to prioritize the proposals. While acknowledging the importance of operators' inputs on the commercial demand, the design limitation from NW and UE sides should be also considered.

3. RAN4 should consider taking/sharing some responsibilities for ”forward-looking” study items. For example, the impact of AI/ML on channel estimation can be very receiver design and demod performance related. Another example can be related to full-duplex operation. The corresponding RF/baseband limitation and interference mitigation techniques should also fall into RAN4 expertise.

## 2.2 Proposals

**Feedback Form 2: Proposals for potential RAN4 enhancements**

**1 – LG Uplus**

As mentioned above general part and also mentioned in ”RWS□210276” from Softbank. Intra-band non-colocation scenario is important for operators with following remarks:

-Intra-band non-colocation deployment specification can provide flexibility of deployment for operators who have non-contiguous spectrum.

-It seems the situation is the only serious story of Japan and South Korea mostly now, but it will become other operators' story soon if they have next spectrum from their 2nd, 3rd spectrum auction and most likely it will be non-contiguous from initially obtained one.

-To do this, the related works seem wide where RF, RRM, and Demod should be specified with respect to RF power imbalance defining, MRTD/MTTD, and demodulation performance respectively.

**2 – SoftBank Corp.**

We are interested in the following 2 topics.

- UE 8Rx performance requirement (R4-2112143)
- intra-band non-colocated deployment scenario(RWS□210276 and R4-2112144) - same opinion as LG Uplus

Please note that these two items come from our strong commercial demand.

Also, we see the need to include leftover topics from Rel-17, e.g. RRM as discussed in RAN#92e.

**3 – Huawei Technologies France**

**Spectrum related topics**

- Enhancement for 700+800+900 band combinations:
  - Enable 2 or 3 band transmitting simultaneously, and enable simultaneous reception on all three bands for smart phone.
- Simplification of band combination specifications:
  - Consider further systematically investigating the solution to simplify specifications and reduce the test burden for UE

**Non-spectrum related topic:**

- UE RF
  - FR1 enhancement
    - Enable 4Tx for CPE type UE device
    - Enhance UL CA RF requirements
      - HPUE, e.g, PC1.5 for UL CA
      - Specify RF requirements for inter-band UL CA with UL-MIMO on one band
    - Investigate and improve MSD for inter-band combinations
  - FR2 enhancement
    - UL 256QAM
  - Investigate and define low power class for UE
- BS RF
  - mmWave multi-band BS
    - to specify RF requirements for mmWave BS capable of multi-band operation
- RRM

- FR2 RRM enhancement
  - Enhance FR2 beam measurement requirements to allow UE to measure a subset of the configured resources
    - Motivation: UE BM related processing capability is limited, network either configures limited BM resources which results in frequent reconfiguration of BM resources; or network configures more resources over UE capability, in which resources to be measured are up to UE implementation
  - Define FR2-FR2 DAPS requirements
  - SCell activation enhancement in FR2
    - Further reduce the SCell activation delay in FR2 (e.g., minimize TCI indication and/or L1-RSRP measurement)
    - Define requirements for Multiple SCell activation/deactivation in FR2 inter-band CA
  - Enhancement type 2 BWP switch in FR2
    - New capability can be considered

- Demodulation
  - Single-cell scenario performance enhancement
    - Soft IC: Cancel inter-stream interference in SU-MIMO scenario
    - E-MMSE-IRC, RML: Cancel inter-user interference for MU-MIMO
  - Multi-cell scenario performance enhancement
    - Inter-cell CSI-RS(TRS)/SSB interference mitigation
      - When the CSI-RS for tracking (TRS) or SSB configuration between neighboring cell are colliding, serious interference from CSI-RS(TRS)/SSB of the neighboring cell
    - E-MMSE-IRC under uneven interference
      - When the spatial characteristics of interference is uneven within a slot
- Items cross RF, RRM and demodulation
  - Enable and specify requirements for downlink 8Rx reception for FR1 CPE

For detailed information, please refer to contributions in last RAN Rel-18 workshop:

UE RF: RWS-210455

BS RF: RWS-210456

RRM: RWS-210457

Demod: RWS-210458

**4 – Ericsson LM**

In Rel-18 WS we provided our input on EMC enhancement for both UE and BS (an Umbrella WID in RWS-210420: http://3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_AHs/2021_06_RAN_Rel18_WS/Docs/RWS-210420.zip). This was initially proposed for Rel-17 and the contents were agreeable. But due to work load the WI proposal is moved to Rel-18. This is new area. Therefore this WI can be approved when the RAN4 led Rel-18 WIs on new areas are approved. Companies are further welcome to provide their views on the objectives, timelines etc.

**5 – Guangdong OPPO Mobile Telecom.**

For the UL enhancement, our view is that if keep staying with current 2Tx assumption, handheld UE UL performance is quite limited and no more can be enhanced actually. For example,

- the max achievable power is 26+26 which has already been supported in Rel-16.
- the max MIMO+CA capability is 2layer+200MHz contiguous CA, and no MIMO in non-contiguous CA or inter-band CA.
- only 1Tx in LTE and 1Tx in NR in EN-DC band combinations. And the max supported concurrent bands is two.

Above leads to the fact that in order to reduce the imbalance in UL and DL and further enhance the UL performance, the limitation of 2Tx chain assumption has to be broken through. And considering the implementation constrains in handheld UE especially smartphone, the most realistic way is to **introduce the 3Tx chain UE in Rel-18 NR**. (3Tx means 3Tx chain, and the ability of 3PAs activated simultaneously)

Generally, UL performance can be enhanced in following aspects with 3Tx:

**1. Power enhancement with 3Tx**

- UE max power can be improved with 3Tx, e.g. the power can reach 31dBm with 3 PC2 PAs, and 30dBm with 1PC3+2PC2 PAs, etc.
- Potential power enhancement approaches could be introduce new power class, or remove Pcmax upper limit, or apply power boosting, etc.

**2. MIMO enhancement with 3Tx**

- 3 layer MIMO can be supported in 1CC or 2 contig CC
- 2 layer MIMO can be supported in non-contig UL CA, inter-band UL CA, or EN-DC at one CC which are currently not be able to be supported with 2Tx assumption
- TxD with 3Tx can be supported if interested

**3. 3CC or 3 bands Tx simultaneously**

- 3 bands with 1Tx in each band concurrent transmission can be supported, e.g. in UL CA or EN-DC

**4. Tx switching transmission enhancement**

- With 3Tx, low band and high band 3Tx concurrent transmission can be achieved

**6 – China Mobile Com. Corporation**

**ATG**

ATG was proposed as a Rel-17 RAN4 WI from 2019. The WI scope is already quite stable after at least 4 rounds of email discussions tasked by RAN. Due to the high work load in Rel-17 RAN4, this WI proposal was postponed. Considering the urgency of commercialization, we propose to treat ATG as high priority topic in Rel-18 RAN4.

The work item will focus on FR1 in Rel-18, specify RF core requirements and conformance requirements for ATG, RRM core and performance requirements, and demodulation requirements.

The detailed objectives can be found in the following contributions:

- RWS-210337 Motivation for new WI on air-to-ground network for NR
- RWS-210338 New WID on air-to-ground network for NR

**HBS**

Home base station (HBS) can be utilized to enhance indoor coverage without requiring high base station output power, considering that Wide Area BS and indoor power distribution system in some scenarios cannot meet the coverage of 5G network deployment. 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, we propose to introduce HBS and specify related RF specifications in Rel-18.

The work item will specify RF core and conformance requirements. The detailed objectives can be found in the following contributions:

- RWS-210340 Motivation for Home Base station for NR
- RWS-210341 New WID on Home Base station for NR

**7 – Beijing Xiaomi Mobile Software**

The EMC umbrella WID refer to the Rel-18 WS document RWS-210420 has been discussed for the Rel-17 round and both operators and BS/UE vendors are interested. However, it is postponed due to limited R17 TU in RAN4. During the RAN4#100-e meeting, an LS from Chinese regulation has been received by RAN4 and a corresponding WF has been agreed within the same meeting to capture the gap between regulation concern and current 3GPP UE EMC specification for both Chinese and European regulations. Based on the above, we see the completeness of the WID as well as the urgency to further enhance the EMC topic to address regulation concern. The detail document can be found as:
The EMC umbrella WID: RWS-210420
The EMC umbrella WID motivation: RWS-210419
The RAN4 received LS:R4-2111718
The RAN4 agreed WF: R4-2115664

**8 – MediaTek Inc.**

The items we are interested are

RF/RRM/Demod 8Rx UE

RRM Enhancement type 2 BWP switch in FR2

RRM ULframe boundary offset reporting (intended to resolve the uncertainty about starting point of the symbol-level interruption)

**9 – QUALCOMM JAPAN LLC.**

Qualcomm has to following proposals for RAN4 -led items for Rel.18.

**Requirements for 8Rx**

NR already has support for 8Rx but RAN4 requirements (RF and demod) are not yet defined. There is some discussion now in FeMIMO that was triggered by introduction of 1T8R, however, it seems unlikely a full set of requirements for 8Rx will be defined.

Proposed objectives are in-line with the 8Rx work for LTE (see RP-202630)

- UE RF requirements – Definition of REFSENS (based on LTE methodology)
- Demod and CSI requirements
- Maximum rank, from the set {4, 6, 8}, to be determined in the WID definition phase
- No impact to RRM requirements

Proposal is to define support for bands n41, n77, n78 and n79. Other bands can be added anytime based on proposals from operators.

**Requirements for 4-Layer DL in FR2**

Introduce requirements for 4-Layer in FR2, at least for a multi-panel framework (dual TCI). The handling of this will also depend on the outcome of the ongoing discussion in the Rel.17 FeMIMO WI.

The work will have to cover RF requirements, RRM requirements (e.g. beam management, tests) and demod (4-L demod tests for FR2)

**OTA Testing Enhancements**

**Dynamic OTA and 4L OTA testing for FR2/FR2-2**

This item is very important to address the industry need for more advanced UE testing in environments that are closer to field operation

• Fast changes in signal directions and/or fast channel variation

• Current tests for RRM/beam management are very simplistic, with most 2 signals coming from different directions and long dwell time(time for UE to acquire signals)

• We believe such tests are needed during device development even if there will not be 3GPP conformance tests in the future if they are very difficult to define.

The most important part of this item is to develop a standardized test environment and test methodology that benefits everyone. Test solutions are very expensive without having a standardized setup that TE vendors can build

Multi panel UEs should be considered for forward compatibility (see FR2 4-layer proposal). Multi panel enhancements are part of Rel-17 eMIMO work, currently there is no ongoing work to define a test setup.

Multi panel could also be treated separately, however, a unified test solution(to the extent possible) would be desirable to save cost.

**Testing framework for FR2 FWA devices (PC1/PC5 in FR2)**

Power classes targeting FWA devices in FR2 have been introduced from Rel.15(PC1, more recently PC5). RF and RRM requirements were defined, however, there is no testing methodology in 3GPP. RAN4 and subsequently RAN5 should start working on the methodology to enable the deployments of such devices.

**MSD Improvements for CA/EN-DC combinations**

RAN4 was already tasked to study the feasibility of introducing a “low MSD” capability for existing combinations. Depending on the outcome of the RAN4 study, this work should be part of some Rel.18 enhancements. The scope of this work is expected to be limited to RF.

**10 – LG Electronics Deutschland**

As mentioned in General section, we have interest in the enhancement which was pointed out in RWS-210249

- **Further enhancement for FR1 RF**

- Simultaneous Rx/Tx for Intra-band non-contiguous CA/DC in TDD band
- New power class for 14dBm device in NR-U 6GHz if not finalized in Rel-17

- **Further enhancement for FR2 RF**

- Vehicular UE requirement for
  : Power Class in 39GHz
  : Inter-band UL/DL CA (e.g. 28GHz + 39GHz)
- Inter-band UL CA based on CBM

- **Further enhancement for RRM**

- RRM for different RX beam sets in FR2

**11 – China Telecommunications**

Based on the inputs to Rel-18 workshop and RAN4 #100e (other new proposals may come up later), there seems 3 categories for the non-spectrum proposals:

1) Proposals within one of the four areas (FR1 RF, FR2 RF, RRM and Demod)

The number of objectives in each area needs to be limited, to control the overall workload.

2) Cross-area proposals

Perhaps they can further split into two sub-categories, e.g.,

− Proposals involving 2 areas with major work in 1 area: FR1 4Tx, FR1 8Rx, FR2 UL CA with CBM, FR2 UL 256QAM, which can be put into the area with major work.

− Proposals involving more than 2 areas: FR2 multi-beam (4-layer), FR1 ATG, FR1 non-co-located intra-band NR-CA/EN-DC, which can be treated in separate items.

3) Testability and EMC related proposals

As usual, they are discussed separately.

For the priority of different proposals, we need to consider the performance benefits as well as the popularity/probability of the corresponding scenarios happen in real networks or implemented in commercial UEs.

**12 – Samsung Electronics Co.**

No particular comments on the proposals till now. Overall, as we commented on general part, we hope all RAN4 proposals can be decided as package including new proposals and other Rel-17 continued proposals e.g. RF enhancement, RRM enhancement, baseband enhancement, and some other left over/continued working areas.

Another thing, we want to emphasize RAN4 proposals can be categorized to following areas:

- RRM related proposal
- BS RF related proposal
- UE RF related proposal
- Demod related proposal
- Spectrum related proposalTest related proposal

- Across areas proposal

The proposals related to spectrum meanwhile lack of generic requirements in RAN4, these proposals should be taken as RF related proposals with example spectrum or bands other than purely spectrum proposals. Some balance among these areas also need to be considered.

**13 – NTT DOCOMO INC.**

Our most interested topics are following three topics:

- Non-co-located deployment for FR1 NR-CA/EN-DC
- FR1 8Rx performance requirement
- FR2 UL 256QAM

And also, if we have room, other RRM enhancement leftovers should be treated.

**14 – CATT**

We think both new proposals and Rel-17 continuations should be considered as candidates and well balanced between different sessions. the following areas should be considered

- Furhter enhancement in RRM area
- Further enhancement in BS RF area
- Further enhancement in UE RF area
- Further enhancement in Demod area
- spectrum related area

We think all the input proposals in RAN#92e and RAN4#100e should be consdiered in the scope of Rel-18.

**15 – KDDI Corporation**

We are interested in topics below;

□Non colocated deployement scenario of intra band non contiguous CA

□8Rx UE

□FR2 DL 256QAM

□4 layerDL in FR2

□Enhancement of CRS-IC

**16 – Nokia Japan**

**Possible candidate objectives:**

**UE RF:**

- "Leftover" objectives that are not included or completed in Rel-17 RF enhancement WIs, e.g, FR2 coverage enhancements like FR2 Beam Correspondence requirements for RRC_INACTIVE and IDLE(if not completed in Rel-17)
- Multi-antenna and modulation enhancements, like FR1 8Rx, FR2 4Rx and FR2 256QAM
- NW optimization by identifying UEs with better performance like UEs with small A-MPR [and low MSD]

**BS RF:** All the proposed topics need further clarification of scope and necessity

**RRM:** The following could be candidates:

- Leftovers, specifically FR1-FR1 NR DC
- Dropped topics from Rel-16/17 WI like NeedForGap, Per-FR Gap
- Some FR2 specific RRM enhancements

**BS/UE demod:** Inclusion of proposals shall be subject to corroborated sufficient performance gain. In particular for cases, where new or changed, NW assistance information is required.

**Others:** ATG, Dynamic OTA testing

**17 – vivo Communication Technology**

Based on the inputs to Rel-18 workshop, our proposals:

**UE RF:**

- Lower UE power class(s) for Uu and sidelink in Rel-18

• Both power class 5 (20dBm) and power class 6 (14dBm) can be considered

**RRM:**

- It is pre-mature to discuss RRM areas for now as there are only limited inputs in the workshop. There will be more proposals depending on Rel-17 progress and company evaluation. Balance has to be made among all potential proposals.

**UE Demod:**

- IRC receiver performance enhancement

• RAN1 based enhancement of IRC receiver performance including signaling and RS design, e.g. blank REs

**18 – CATT**

To complement our previous comments.

We would be interested in RRM further enhancement in the following area,

(1) Enhancement for CSI-RS based L3 measurement

(2) RRM requirements for FR1+FR1 NR-DC

(3) HO with PSCell for new scenarios

(4) Enhanced indication of UE per-FR gap capabilities

(5) TCI switching enhancement

(6) Inter-RAT NR measurement without gaps

And BS RF further enhancement int he following area,

(1) Define the reference architecture for NTN BS type 1-O.

(2) Develop overall OTA RF requirements for NTN BS type 1-O.

(3) Develop OTA testing requirements for NTNBS type 1-O.

**19 – TELECOM ITALIA S.p.A.**

- non-co-located deployment for FR1 NR-CA/EN-DC
- >4Tx performance requirements (see discussion on UL improvements)

**20 – ZTE Corporation**

We are interested in the following topics:

**Cross area:**

**ATG:**

Similar view as CMCC,this ATG topic has been extensively discussed before and well recognized by the industry, therefore we propose to complete this ATG WID in Rel-18.

**Co-channel HAPS:**

In Rel-17 HAPS coexistence study, only adjacent channel case between HAPS and TN was considered, however we think that co-channel case between HAPS and TN should been considered as well in Rel-18.

**BS RF:**

**FR2 multi-band BS:**

We are also interested in this topic, however some feasibility study to support multi-band operation might be needed.

**UE RF:**

**FR1: Improved MSD**

To improve UE capability on handling UE IMD/harmonic/band proximity is beneficial to network performance,we support this improvement in UE RF.

**FR1: 8Rx**

Since LTE 8Rx has been supported in early release, therefore it's natural that NR could also support that 8Rx, in addition, this might be also beneficial for SRS antenna switching up to 8 antennas.

**FR2: Inter-band UL CA CBM**

This feature was precluded in Rel-17, we think that we could further study it in Rel-18.

**FR2: Simultaneous RxTx**

**FR2: UL 256QAM**

To further enhance uplink capacity in FR2, we think that UL 256QAM should be one promising feature to ensure the uplink capacity gain.

**21 – China Unicom**

We think both new proposals and R17 left-overs should be considered for RAN4 R18 package. Following areas may be included:

- Spectrum related topics (HPUE, basket WIs, etc.)
- RRM topics
- UE/BS RF related topics
- Demod topics

**22 – CATT**

Reference to CATT proposal

**R4-2113449** New WID on further RRM enhancement in R18

**R4-2113452** New WID on NTN BS type 1-O

**23 – Intel Corporation (UK) Ltd**

Below we provide candidate topics for requirements definition based on Rel-18 workshop discussion and also including additional proposals.

**1. FR2 multi-panel simultaneous DL reception [cross-Area] [RWS-210375]**

- RAN4 FR2 requirements for single carrier case are defined under an assumption that UE is capable of single panel reception only. Support of FR2 multi-panel simultaneous reception was assumed in the scope of Rel-16 eMIMO WI, but no RAN4 requirements were defined. Further extension of FR2 UE capabilities to support simultaneous reception is required to extract full FR2 benefits including improved FR2 RF, RRM and demodulation performance. Multi-panel reception can be considered for generic FR2 deployments and for FR2 HST scenario.

- Objectives: Define requirements for UEs capable of simultaneous multi-panel DL reception in FR2
  - Enhanced RRM requirements: RRM measurement delay reduction, FR2-FR2 DAPS HO
  - Enhanced RF requirements: New spherical coverage requirements for devices with 2 panels
  - UE demodulation requirements: simultaneous and non-simultaneous RX from different directions, 4 DL MIMO layers.
  - Study OTA test methodology

**2. Non-co-located scenario for FR1 intra-band non-contiguous EN-DC/NR-CA [cross-Area] [RWS-210375]**

- Different coexistence conditions apply for different part of the same frequency band, so collocated Tx is not always available even for intra-band EN-DC and CA. RAN concluded MRTD/MTTD are not specified in Rel-16 or Rel-17. RRM requirements are missing for type 2 UE (2-19) implementation when it supports intra-band NC MR-DC with the same assumption that it handles MRTD > 3us.
- Objectives: Specify requirements for FR1 intra-band non-contiguous EN-DC/NR-CA for non-co-located scenario
  - MRTD/MTTD Requirements
  - PDSCH demodulation requirement based on the applicable MRTD and power imbalance values

**3. RF enhancements [RF]**

- **FR2-2 RF enhancements**
  - Intra-band and inter-band CA support for FR2-2 based on IBM/CBM
    - CA support for FR2-2 may not be introduced in Rel-17 timeframe and can be considered for Rel-18. Comparing to FR2-1 the max frequency separation in FR2-2 band is much larger and IBM can be considered for intra-band CA on top of CBM.
  - Switching time enhancements (ON/ON transient time)
    - ON/ON transient time has a big impact on the overall spectral efficiency of FR2-2 and further tightening of RF requirements can be beneficial to improve the performance and enable operation with high order modulations.

- *Note: Rel-17 WI is ongoing and additional objectives can be considered subject to RAN4 progress*

- **FR1 RF enhancements**
  - MSD improvement
    - Improved MSD performance will have a positive impact on the overall network performance and can be considered as one of the key improvements in Rel-18. The work is expected to have relatively large scope and recommended to be performed in Rel-18 (rather than in Rel-17)

**4. RRM enhancements [RRM]**

- **FR2 enhancements**
  - FR2-2 enhancements: Leftover deployment scenarios in Rel-17 (e.g., FR2-2 NR-DC, FR2-1 - FR2-2 NR CA/DC)
    - Some of the deployment scenarios are deprioritized in Rel-17 (R4-2115351), while they still received popularity among operators and vendors
  - Network controlled gaps for UE Rx beam switching
    - To have awareness of the UE beam switching moments and apply the scheduling restrictions accordingly, Network can allocate the certain time intervals for UE to switch its beam. The UE will be allowed to change its beam during these configured intervals, and the with this awareness the system performance with very short CP length is boosted (R4-2114189)
  - FR2 delay reduction enhancements (e.g., measurement delay reduction by assuming reduced number of Rx beams in certain scenarios, SCell activation and BWP switching delay reduction)
    - FR2 RRM requirements consider the number of UE Rx beams, and this leads to rather long delay of procedures, while practical scenarios require much less delay. Selected RRM requirements in FR2 can be revisited to reduce the delay caused as much as reasonable
  - FR2-FR2 DAPS handover requirements
    - FR2-FR2 DAPS handover requirements are missing in the current RRM spec. For the UE with capability of FR2 MR-DC, it is beneficial in terms of mobility performance if they can make use of DAPS handovers
- **General RRM requirements enhancements/leftovers**
  - FR1 + FR1 NR-DC RRM requirements
    - FR1 + FR1 NR-DC band combinations were introduced in R16 timeframe but a very limited set of RRM requirements was defined in R16. Only MRTD/MTTD requirements were defined
  - CMTC
    - CMTC concept for L3 CSI-RS based measurements has been proposed since R16 and group consensus is that CMTC is beneficial to both UE and network in terms of efficient measurement configuration
  - RLM enhancements
    - The second IS/OOS BLER has already been supported in RAN1 since R15. However, it cannot be correctly implemented since no corresponding RAN4 requirements
  - TCI state switch enhancements
    - In Rel-16 TCI switching requirement, there was a time gap where UE is not required to receive DL data; it will have impact on the throughput performance in case the first SSB arrives relatively later
- **Measurement Gap related enhancements**

- No-gap measurement requirements related to NeedForGapInfoNR capability
  - RAN2 introduced NeedForGapInfoNR capability in TEI16 and RAN4 consensus is that measurement requirements need to be updated
- Per-FR gap UE capability enhancement
  - In Rel-16 RAN4 discussed enhancements in indicating UE per-FR gap capabilities and companies indicated interest to continue the work to study UE baseband constraints
- Measurement gap sharing enhancements
  - Leftovers can be expected for measurement gap enhancements and measurement gap sharing is certainly one of the popular aspects. It was proposed in R17 but not included due to limited room in the item

- **FR2 HST enhancements**
  - HST CA FR2
    - CA support for HST UEs in FR2 is straight forward. Carrier aggregation for FR2 HST boosts data performance and provides flexibility in network deployments.
  - HST FR2 multi-panel reception (e.g., reduction of number of Rx beams)
    - for UE with multi-panel simultaneous receptions, assuming reduced number of Rx beams when having measurements is much beneficial in terms of mobility performance
  - HST FR2 UE type enhancements (e.g., specifying applicable RRM req-s for non-HST UE-s in HST network)
    - Rel-17 does not allow non-HST to access to the HST FR2 network and the network does not clearly differentiate different types of UE in the network. From cost of operation perspective, allowing the non-HST UE-s to be served also by the network is of crucial importance

**4. Demodulation enhancements [Demod]**

- **UE enhanced interference mitigation receivers**
  - MMSE-IRC receivers for time selective inter-cell interference [RWS-210375]
    - Baseline UE MMSE-IRC receivers are based on DMRS-based interference estimation and assume constant interference structure on a full slot duration. Such receivers have bad performance for scenarios with dynamic time-selective interference signal
  - Enhanced E-MMSE-IRC and R-ML DL MU-MIMO receivers [RWS-210375]
    - Rel-16 MU-MIMO requirements are focus on definition of requirements for MMSE-IRC receiver
    - Objective: Study performance benefits and feasibility of enhanced DL MU-MIMO receivers including E-MMSE-IRC and R-ML and required network assistance.
  - Enhanced DL receivers for multi-DCI multi TRP scenario
    - Rel-16 eMIMO requirements for multi-DCI multi TRP scenario are defined for scenarios with non-overlapping PDSCH allocation and MMSE-IRC receiver. CW-IC receiver can be used to improve PDSCH performance for multi-DCI multi TRP scenario with overlapping or partially overlapping PDSCH allocations.
  - Soft IC DL SU-MIMO receivers
    - DL SU-MIMO requirements are defined for MMSE-IRC and R-ML receivers. Further possible performance enhancement are possible in case of using IC receivers. Meantime a study stage is recommended to asses the performance benefits

- **BS requirements**
  - MMSE-IRC for inter-cell interference [RWS-210375]

        - Existing BS requirements are defined for noise limited conditions and do not allow verification of BS interference rejection capabilities under practical conditions. Recommend to define FR1 BS MMSE-IRC demodulation requirements for inter-cell interference scenarios for SU-MIMO cases

- **FR1/FR2 HST enhancements**
    - FR2 HST CA requirements
    - FR2 HST UEs with simultaneous multi-panel reception
- **Rel-16 leftovers demodulation requirements**
    - eMIMO: Two UE rate matching CRS patterns in multi-DCI Tx scheme
    - IAB: BS 30% throughput requirements, DL CA requirements, URLLC requirements, Enhanced UE receiver requirements (R-ML, …), High speed UL requirements for IAB-DU
    - Note: topics can be treated in Rel-17 as well

**Apple comments due to NWM issues**

RRM enhancement:

- R17 drop-iff issues:
    - TCI switching enhancement
    - FR1+FR1 NR-DC RRM
    - CGI reading requirement for NR-U cell
- Newly identified issue in R17:
    - RRM requirement with NeedForGap
- Newly identified issue in R18
    - Harmonized RLM/BM
    - RRM enhancement for large CC number
    - allowInterruption for deactivated SCell measurements
    - CSI-RS based CFRA in RRM requirement

RF:

- FR2-1 and FR2-2 UE antenna scaling
    - As a technique to reduce FR2-1/FR2-2 power consumption, UE may enable/disable antenna elements & RF chains (antenna scaling)
    - During antenna scaling, the analog beam forming codebook undergoes an instantaneous change, and NW performance is impacted
        - If the UE performs antenna scaling autonomously (as can already be done in currently available FR2 devices), then NW performance losses are possible
        - Power and throughput gains relative to current device behavior are possible if the network can be aware of UE antenna scaling operation

- A RAN4-led study into this topic can quantify the impact on network/UE performance
  - E.g. UE scales from 4x1 to 2x1 and from 2x1 to 4x1
  - UE may determine different antenna switching points based on Rx signal strength, Rx signal quality, Tx output power level, or Tx power headroom
  - Optimal allocation of the number of UE antenna elements to meet desired downlink and uplink coverage can be different
- The study should identify potential solutions to mitigate impact on NW performance
  - Including quantifying the benefit to the NW being aware of the UE antenna switching capability and/or operation
- The study should identify the impact of antenna scaling on UE RF requirements (e.g. TPC, max input level) and testability
- Preliminary system level simulations have quantified gain loss due to fixed beam mapping. The details will be submitted in coming RAN#93e

# 3 Intermediate round

## 3.1 General

In general section, mainly three issues were discussed:

- Balance TU budget between RAN4-led work and RAN4 impact of work led by other WGs
- General principle for scope of Rel-18 RAN4-led work
- Timeline for approval of RAN4-led package

Based on the discussions and previous experience it seems that companies have consensus on the general principle and balancing TU budget. Regarding the timeline for approval of RAN4 package, there are two different views, i.e., one-phase approval or two-phase approval, although RAN has given the guidance before.

Besides the other issues were also raised by some companies, including

- Consider WI following Rel-17 RAN4 SI in the TU budget
- How to differentiate spectrum or non-spectrum WI/SI proposals
- Whether and how to account three parallel sessions in TU budget table
- Rel-17 leftover topics need further discussion after RAN4 completes Rel-17

Regarding how to differentiate spectrum or non-spectrum WI/SI, there seemed some discussions in previous RAN plenary. Regarding further splitting TUs among RRM and demodulation part, RAN4 leadership can take the input into account to have further discussion.

In moderator view, the following aspects are recommended for further discussion and endorsement in the intermediate round.

- Balance TU budget between RAN4-led work and RAN4 impact of work led by other WGs
  - Reserve TU for RAN4-led work
  - Refine RAN4 objectives after RAN1, RAN2 and RAN3 packages are approved to meet the commercial demand
- General principle for scope of Rel-18 RAN4-led work
  - Balance work among in-field issues, leftover issues from early release(s), and new enhancement
  - Meet the clear market demand for practical deployment
- Timeline for approval of RAN4-led package
  - More discussions are needed based on the following alternative approach
    - Alt 1: one-phase approach
      - Approve the whole RAN4 package in March 2022
    - Alt 2: two-phase approach
      - Approve new areas that do not depend on Rel-17 completion in December 2021
      - Approve the Rel-17 extension/enhancement WIs in March 2022
    - Alt 3:
      - Approve the minimum number of WIs based on consensus in December 2021
        - FFS whether only to consider spectrum related WI or WI that operator has urgent request
      - Approve the RAN4 package in March 2022

**Feedback Form 3: Feedback for general principle for RAN4 package approval**

**1 – Samsung Electronics Co.**

Alt-1 is our preference but Alt-3 seems the best flexible way of handling RAN4 package approval considering the urgent spectrum related topics. Also, considering the controversial of justifying the operator urgent request, it is suggest to revise Alt-3 to only focus on spectrum related WI with urgent request and still approve the RAN4 package including operator strong request ones in March 2022.

**2 – SoftBank Corp.**

Thanks for the good moderator's summary. Alt-3 looks good to us.

**3 – Apple AB**

Spectrum related WI/SI can be treated separately as always. For non-spectrum related one, Alt.1 is preferred.

**4 – Guangdong OPPO Mobile Telecom.**

Alt 2 is ok to us.

**5 – China Telecommunications**

- Balance TU budget between RAN4-led work and RAN4 impact of work led by other WGs

"Reserve TU for RAN4-led work" seems a good proposal. Perhaps we need to also discuss how many or percentage of TUs will be reserved for RAN4-led work, keeping in mind that many RAN1/2/3 features defined in previous releases are still lack of RAN4 requirements by now.

− Timeline for approval of RAN4-led package

Perhaps here the timeline is for the non-spectrum WI. Spectrum WI to Dec 2022 RAN plenary meeting would still have a chance to be in Rel-17.

For Rel-18 non-spectrum WIs, regardless of whether it is approved in Dec 2021 or Mar 2022, the time to start the work in RAN4 may not be changed. The issue is the allocation/competing of TUs, not only among RAN4-led work, but also with other WG work.

For Alt 1, the question is how many TUs will be reserved for RAN4-led work.

For Alt 2, it would be difficult to differentiate the "old" and "new" area. Not sure if all the objectives not discussed in Rel-17 belongs to the "new" area.

For Alt 3, based on the initial round discussion, it seems clear operators' interests are shown to topics like FR1 non-co-located intra-band NR-CA/EN-DC and ATG, which are also postponed from Rel-17. Not sure whether companies have the same understanding on for which ones are with urgent operator request.

**6 – LG Electronics Deutschland**

**1. Balance TU budget between RAN4-led work and RAN4 impact of work led by other WGs : Reserve TU for RAN4-led work**

For the TU, we think RAN4 needs to consider reserving TUs per high-level topic first. After that, we can consider which sub-areas are candidates considering TUs per each high-level topic.

**2. General principle for a scope of Rel-18 RAN4-led work**

**Balance work among in-field issues, leftover issues from early release(s), and new enhancement**

We are OK

**Meet the clear market demand for practical deployment**

Potential market demand for future deployment needs also to be considered.

**3. Timeline for approval of RAN4-led package**

We prefer Alt1 with one-phase approach in March 2022.

**7 – NTT DOCOMO INC.**

Thank you for summarizing. Alt-3 is fine for us.

**8 – MediaTek Inc.**

− Balance TU budget between RAN4-led work and RAN4 impact of work led by other WGs

We want to know about how to achieve this TU balance. Some more discussions would be helpful.

− Timeline for approval of RAN4-led package

Alt. 3 is OK to us. Handling the spectrum-related WI first could help to address the urgent requests from operator as well as to off load some discussion from one single meeting.

**9 – China Mobile Com. Corporation**

We support the principles for TU and scope of Rel-18 RAN4-led work summarized in the intermediate round.

For the timeline, we support two-phase approach. In the initial round, we propose alt. 2. Alt 3 is also acceptable to us. To consider and approve the urgent commercial demand and request is very important for 5G development.

**10 – LG Uplus**

**[Balance TU budget between RAN4-led work and RAN4 impact of work led by other WGs]**
That is a good point and ,as companies mentioned, how many RAN4-led TUs can be assigned need further discussion.
**[General principle for scope of Rel-18 RAN4-led work]**
Agree with moderator on this point.
**[Timeline for approval of RAN4-led package]**
Alt 1 or Alt 3 is fine to us where we also think like China Telecom that for Rel-18 non-spectrum WIs, the time to start the work in RAN4 may not be changed regardless of when it is approved between Dec 2021 or Mar 2022.

**11 – Beijing Xiaomi Mobile Software**

Alt 2 is our preference. Based on the moderator's summary in the first round, there are huge working areas proposed in R18 currently. it is very difficult to handle them in one meeting with reasonable scope and objectives achieved.

**12 – KDDI Corporation**

We are fine for Alt-3.

**13 – QUALCOMM JAPAN LLC.**

We believe that the following 3 issues have to be solved in order to avoid a heavy RAN4 overload and a balanced approach:

- How to set aside enough TUs for RAN4 led items while ensuring that priorities are properly set for the RAN wholistic package(basically how to know how many RAN4 TUs are needed).
- How to prioritize between RAN1/2/3 and RAN4 led items. Some RAN4 items that may be of higher interest compared to RAN1/2/3 led items could be left out because of lack of time
- How to handle RAN4 led items with RAN1/2/3 impact. if some time will not be set aside in the other WGs for such items, they might be left out just because of these reason

In our view, to solve these problems we think it would be best to approve everything at the same time with the RAN1/2/3 items, in December. Some items that are simple continuation of Rel.17 items(for example, some simple leftovers from the RF/RRM/demod enhancements could be considered later based on available time). In this sense none of the alternative is good so further discussion is needed.

We do not think it is a good idea to drop some of the RAN4 objectives for RAN1/2/3 led items. Since features cannot be deployed without RAN4 requirements, if definition of RAN4 requirements is postponed then it means there is no traction for the entire feature so it can postponed/dropped altogether.

**14 – ZTE Corporation**

We intend to agree with Samsung that Alt.3 would give some flexibility to accommodate urgent request on spectrum related issue especially from other standardization community, for rest of RAN4 package could be approved at March, 2022 with more clear and balanced TU budget.

**15 – Huawei Technologies France**

We prefer alt 3, but alt 1 is also ok for us. Spectrum related topics can be treated as usual, which depends on deployment demand, and is not limited by specific timeline in Rel-18 framework.

**16 – TELECOM ITALIA S.p.A.**

**Balance TU budget between RAN4-led work and RAN4 impact of work led by other WGs : Reserve TU for RAN4-led work**

This is a key aspect, and agree as a minimum to reserve TUs for RAN4-led work. But most importantly, a clear indication on RAN4 impact should be provided when approving RAN1/2/3 led WIs.

Therefore we recommend to

- reserve TUs for RAN4-led work
- identify the numbers of TUs available for non RAN4-led work
- RAN1/2/3 led WIs should provide when approved clear RAN4 objectives and estimate of required RAN4 TUs
- if the request for non-RAN4 TUs exceed the available amount, prioritization/downscoping of non-RAN4 WIs to be performed before approval

As a consequence we support Qualcomm proposal to approve together (in December) RAN1, 2, 3 AND 4 WIs.

**Timeline for approval of RAN4-led package**

as indicated above, the best solution would be to approve all RAN1-4 WIs together in December. Alternatives 2 and 3 are also acceptable, stated that TUs are reserved for RAN4-led activities

**17 – Nokia Japan**

Regarding “Timeline for approval of RAN4-led package”, we believe Alt 1 is better than the others. In March, we will have much better visibility on how much time would consume other Rel-18 WG-led items, RAN4 Rel-17 status on which objectives are not closed for Rel-17 and how important they are comparing to other new R4 proposals.

For Alt 2, RAN will consume time to categorize which WI/SI are into new areas and which ones are not. And we need to discuss how to split the total TU into each area.

For Alt 3, without having a clear boundary between spectrum related WI and the others, this cannot be an option at this moment.

**18 – Intel Corporation (UK) Ltd**

- **Balance TU budget between RAN4-led work and RAN4 impact of work led by other WGs**
  - We agree to ”Reserve TU for RAN4-led work”. Further discussion on the amount of TUs is needed and Rel-16/17 RAN4 TU budget can be a good starting point.

- As we understand the proposal means that RAN4 shall refine RAN4 objectives for RAN1/2/3-led item and suggest to clarify this ("*Refine RAN4 objectives **for RAN1/2/3-led WIs** after RAN1, RAN2 and RAN3 packages are approved to meet the commercial demand"*).
- From our point of view RAN4 does not need to define the requirements for all possible use cases and scenarios and a reasonable prioritization is needed to meet the TU constraints. Actually this is what RAN4 typically did for all prior releases for many items. Meantime, it may not always be possible to apply prioritization right after WI approval.

- **Timeline for approval of RAN4-led package**
  - Prefer one-phase approach with approval in March 2022 (Alt 1). We are also fine to consider spectrum related WIs or WI that operator has urgent request in December 2021.

**19 – AT&T GNS Belgium SPRL**

We are OK with Alt 1 or Alt 3. However, we agree with Qualcomm that the RAN4 impact and the commercial needs of the RAN4 WIs need to be considered during the confirmation of scope for the RAN1/2/3 led WIs to ensure a balanced package and adequate capacity in RAN4.

**20 – Ericsson LM**

We are fine with general principles.

In our view it is very important to review RAN4 related objectives and TUs in RAN1-3 led WIs 1-2 quarters after their approval.

on "Timeline for approval of RAN4-led package":

We support Alt # 3, which is realistic and good balance.

Alternative 1 is too aggressive since status/progress of R17 ongoing WIs will not be sufficiently clear.

On the other hand Alt #2 is too conservative since there may be some TUs after December and WIs on some new areas can be approved.

**21 – vivo Communication Technology**

**− Balance TU budget between RAN4-led work and RAN4 impact of work led by other WGs**

We agree with the principle that TU budget should be reserved for RAN4-led work. Further discussion is needed on how much percentage of TUs could be reserved.

**− General principle for scope of Rel-18 RAN4-led work**

The general principle seems okay. In addition, we think fixing broken RRM requirements in RAN4 specification is also very important though there may be no clear market demand in short term.

**− Timeline for approval of RAN4-led package**

Alt 1 is our preference. But, if Alt 3 only considers spectrum related WI proposals, then Alt 3 is also acceptable for us. As mentioned before, clear decision on which WI/SI should be spectrum proposal need to be discussed first.

## 3.2 Proposals

Based on the proposals of high level working areas/categories and the existing work splitting among three RAN4 sessions, the following high level topics are recommended.

- Spectrum related enhancement
- UE RF1 requirement focus evolution
- UE RF2 requirement focus evolution
- BS RF requirement focus evolution
- RRM requirement focus enhancement
- Demodulation focus requirement evolution
- Testing enhancement
- Evolution of requirements across RF, RRM and demodulation

Please note that *it is not expected to provide any input like "we support/we do not support as this is not "number counting" driven discussion rather focus on tangible commercial interest in both near and longer terms*. And"*high-level description" herein is not a "draft SID/WID" but is something like a single slide with a set of bullets. In other words, it can be viewed as a skeleton of the possible objectives with some high-level notes*.

The target in this intermediate round is to converge on the high level topics (top level bullets) and provide the whole set of proposed working areas listed under the proper topics. We leave the detailed description of each working areas for next round discussion.

Please provide your comments on the following top topics as well as list of working areas under each topic. You can suggest which working areas should be put under which topic.

**Spectrum related topics**

- Spectrum related enhancement, with the following areas:
  - Enhancement for 700+800+900 band combinations (enable 2 or 3 band transmitting simultaneously and enable reception on all three bands for smart phone)
  - Simplification of band combination specifications

**Feedback Form 4: Spectrum related topics**

| |
|---|
| **1 – Samsung Electronics Co.**<br>Further clarification on the scope of Enhancement for 700+800+900 is required. If the motivation is related to flexible spectrum integration, it shall be discussed as a package together with such item. |
| **2 – Guangdong OPPO Mobile Telecom.**<br>We noticed current RAN4 has introduced the B8+B20+B28 for large form factor UEs, and for smart phone is a potential enhancement which can be further considered in Rel-18. |

**3 – CATT**

What is the scope for 700+800+900 spectrum related issue? is it RAN4 only work or also has impact on other working groups? if yes, Clarification is needed on the impact.

**4 – China Telecommunications**

It is related to Rel-17 progress, since we already proposed a 700+800+900 CA combination with two uplink bands for handled UEs in Rel-17 basket WI. We can start from two uplink bands in Rel-17.

Meanwhile, we understand the implementation difficulty of LB-LB combination for handled UEs, and we can first discuss the UE architecture / RF requirements in RAN4 Rel-17.

For the relation with "flexible spectrum integration" or other WG work as asked by Samsung and CATT, our understanding is that the RF requirements are common and apply to the band combination regardless of whether flexible spectrum integration or other Rel-18 new features is considered or not, i.e., the requirements apply to the existing CA.

**5 – Skyworks Solutions Inc.**

For three LB combinations beyond the nplexing and PA issues, the key is the antenna tuning and BW issue thus even if we were to enable more of these type of combination the deployement of those for smartphone is questionable in terms of additional performance. It should be clarified if this would target 2UL (we assume 3UL is out of scope).

**6 – Ericsson LM**

The concept is not clear.

Can you explain if it means at least 2-3 UL CCs in 2-3 different bands and at least 3 DL CCs in 3 different bands? If it is simple CA-BC then it can be done under CA basket WI. Or does it mean something else? If so please explain the concept. Is it backward compatible - impact on legacy UEs operating on these bands. Details are needed to better understand the concept.

**7 – QUALCOMM JAPAN LLC.**

For the 700+800+900 we need to understand the use case, as far as we are aware there are no operators that own spectrum in all these 3 bands. Another important thing is to understand the antenna performance. Even if the filters would be feasible, if the antenna performance is not good then overall implementation feasibility is questionable.

Simplification of band combination specs could be very interesting, we would need to understand if significant improvements can be made to justify the time spent on this.

**8 – TELECOM ITALIA S.p.A.**

To Qualcomm: we own 700+800+900 MHz band :-), and I expect many other European Operators to be in the same situation.

On the practical proposal, some more details are needed, also taking into account that refarming to NR of some of the above bands may not be feasible in the short term. On the other hand dual connectivity could be of interest in the shorter term

**9 – Nokia Japan**

For enhancement for 700+800+900 band combination, it depends on what we can finish in Rel-17 for FWA type device. Even DC_8A-20A*n28A whose UL configurations are* DC*8A-n28A or* DC_20A-n28A targeted

at FWA has around 24 dB MSD. Towards simultaneous 3 band transmission, RAN4 needs to finish all the three 2 bands UL with 3 bands DL first for FWA. Then, RAN4 can study feasibility study for smartphone to enable all the three 2 bands UL with 3 bands DL. Then, handling of 3 band simultaneous transmission can be discussed from procedure perspective.

For simplification of band combination specifications, this should not be categorized as "enhancement" while this is needed to optimize RAN4 operation and specifications to accommodate newly introduced band configurations.

**10 – Huawei Technologies France**

**700+800+900MHz band combinations**

The benefit of enhancement for 700+800+900MHz band combination is to facilitate fully utilizing those available spectrum. The available spectrum on those bands are relatively small. It is not attractive to re-farm them individually, e.g., re-farming 10MHz bandwidth on 800MHz for NR. So it is more attractive to aggregate them to provide wider aggregated bandwidths and good coverage. Ideally, we would like to enable supporting 3UL transmitting simultaneous and 3DL reception simultaneously, and thus make them look like one wideband carrier with good coverage, although many implementation challenge should be addressed. The sub-optimal achievement would be to support 3DL reception simultaneously and support any two band for uplink simultaneously.

Here we discussed the RAN4 RF requirements, which can apply for all the features like CA, DC, EN-DC… on the band combinations. It is unnecessary to tightly link it to a certain feature. In RAN4, we can start with CA. If the other feature has additional requirements on top of the general RF requirements, those requirements can be discussed separately.

Besides, operators may have diverse band combinations, e.g., 700+800, 800+900, 700+900, 700+800+900. In our view, UE should be able to support diverse marketing demand. Like for the other bands, we would like to have a better RF component design and unify the design. In the long run it would be helpful to reduce the cost/complexity for the front end and improve the performance.

**Simplification of band combinations:**

Now RAN4 is discussing the simplification of band combinations. The discussion is contribution-driven. We would like to have systematically study for simplification. Currently we specify the whole set of RF requirements for EN-DC, CA, DC separately for a band combination. And in the certification, UE should fulfil all those sets of requirements individually. But for EN-DC, CA, DC… many requirements are the same.

We would like to abstract pure RF requirements for a certain band combinations as "common RF requirements", and on top of them the additional RF requirements specific for features like CA, DC, EN-DC will apply for UE. Thus we can simplify both the specification and the certification.

**11 – Intel Corporation (UK) Ltd**

- "Enhancement for 700+800+900 band combinations (enable 2 or 3 band transmitting simultaneously and enable reception on all three bands for smart phone)"
  - Multiple band serving cell concept should be discussed separately in RAN1/2, while RAN4 can focus on a basic CA concept.
  - Further operator comments are encouraged to identify market interest.
  - We are also interested on whether the scope limited to FWA/CPE only and expected number of UL CCs.
- Simplification of band combination specifications

- Work on simplification of band combinations is important. The current amount of BCs becomes an issue for UE implementation and testing. Further discussion on the detailed objectives is needed.

**12 – vivo Communication Technology**

3 Band transmitting simultaneously is challenging the current assumptions for at most 2Tx uplink.

**UE RF1 requirement focus evoluation**

- UE RF1 requirement focus evolution, with the following areas
  - Enable 4Tx for CPE type device
  - Introduce the 3Tx chain UE (including power enhancement with 3Tx, MIMO enhancement with 3Tx, 3CC or 3 bands Tx simultaneously, Tx switching transmission enhancement) (new proposal to RAN#93-e)
  - UE 8Rx requirements
  - New low power class for Uu and/or sidelink (e.g., 14dBm device in NR-U 6GHz)
  - Enhance UL CA RF requirements (including HPUE, e.g., PC1.5 for UL CA, and specify RF requirements for inter-band UL CA with UL-MIMO on one band)
  - Investigate and improve MSD for inter-band CA/EN-DC combinations
  - Investigate and improve UE performance with small A-MPR
  - Simultaneous Rx/Tx for intra-band non-contiguous CA/DC in TDD band

**Feedback Form 5: UE FR1 requirement focus evolution**

**1 – Samsung Electronics Co.**

Enhancement of number of Tx/Rx chain including 4 TX for CPE, 3Tx UE and 8 RX shall be the foundemental discussions in REl-18 as a package. It is desired to build the baseline for Rel-18 UE/CPE capability in terms of number of Rx and Tx chains. Other RF related proposals shall take such baseline capability assumption into accound to avoid refragement in Rel-18 and future release, i.e., RF enhancement in Rel-18 still assume existing 4Rx and 2Tx but still requiring further enhancement in Rel-19 and beyond assuming more Tx/Rx chain if approved in Rel-18.

**2 – Guangdong OPPO Mobile Telecom.**

We believe there is benefits in enhancing UE Tx chain numbers to further evoluting UEs like CPE and smart phone. The 2T4R can be the baseline for UEs as in Rel-15/16/17, however, for UEs with higher capabilities can apply 3Tx for smart phone and 4Tx for CPE/FWA large form factor UEs. With one more chain supported the power capability, MIMO capability, Tx bands can be enhanced and throughput improved.

For 8Rx, it is expected this is for CPE/FWA.

Low power class for small form factor UEs like wearable device could be also considered.

**3 – Apple AB**

1. On ”3Tx chain”, we acknowledge 3TX chain UEs may bring benefits. At the same time, we know that implementing one more TX chain will increase UE circuitry real estate, power consumptions and heating dissipation, as well as UE cost. In addition, with limited form factor, how much MIMO performance

improvement with 3TX compared to 2TX remains to be seen, considering antenna correlation. Also, it should be also clarified if existing RAN1 design can support 3Tx MIMO.

2. On "8Rx", we expect UE support of 8RX will be limited select high frequency bands. Also, is it a common understanding that both 4Tx and 8Rx features are primarily targeting on CPE and/or large form factor UE?

3. For inter-band UL CA with UL-MIMO on one band, does it mean UE will have three active TXs?

**4 – China Telecommunications**

1. For 8Rx requirements, maybe the major work is demod work, since we just need to add a delta for the RefSens in RF. We don't have a strong view, but just wonder the criteria on putting one proposal into the area.

2. For inter-band UL CA with UL-MIMO on one band, we'd also like to clarify is it for UE capable of 3Tx? With Rel-16/17 Tx switching for 2Tx UE, inter-band UL CA with UL-MIMO on one **or two** band have already been supported, and the UL CA and MIMO are not supported/scheduled at the same time. Then if the proposal is for 3Tx UE, not sure whether the existing per band requirements can be directly applied. We are interested in it, and just to ask for clarification.

**5 – LG Electronics Deutschland**

We suggest to have 4 merged areas below. Key idea is to categorize the similar proposals under high level lists and let later proposals be in and out under these lists. Wording can be improved.

1) Enhancement FR1 CA/DC RF requirements

- Intra-band NC CA/DC in TDD Band : Simultaneous Rx/Tx
- Inter-band UL CA with UL-MIMO on one band for HPUE(, e.g., PC1.5)
- Inter-band CA/EN-DC : investigate and improve MSD

2) New Power Class

- New low power class for Uu and/or sidelink (e.g., 14dBm device in NR-U 6GHz)

3) Tx RF with multiple chains (more than 2 Tx Chains)

- 4Tx for CPE
- 3Tx UE (including power enhancement with 3Tx, MIMO enhancement with 3Tx, 3CC or 3 bands Tx simultaneously, Tx switching transmission enhancement)

4) Rx RF with multiple chains

-8 Rx requirement

**6 – Skyworks Solutions Inc.**

8Rx and 4Tx for CPE (large form factor) is of interest. as a starting point it should focus on NR TDD bands >2.3GHz

It is unclear what the benefit of 3Tx is vs 2Tx if small antena isolation is assumed as currently.

it is unclear where 3CC (conbtiguous?) UL is needed given there is no operator spectrum with 300MHz the only case is possibly n96 but with 4CC (320MHz BW)

3 band UL is really an issue in terms of coexistence and triple beat MSD issues which will require a completely new framework, going through block approval is unlikely. May be non-simultaneous Tx/Rx TDD cases can be looked at but coex might still be an issue. clear use cases are needed.

PC1.5 for UL CA has the issue that Pmax can only be achieved for equal power in each CC, the additional 3dB it thus only achievable for equal allocation in each CC, may be scheduling restriction should be studied.

Simultaneous Rx/Tx for intra-band non-contiguous CA/DC in TDD band. we do not understand how this can be achieved without major de-sense to gether with high MPR (for simultaneous Tx part). Use case must be clearly defined and for example, 4Rx bands with high antenna isolation (FWA/large form factor) may allow 2Rx for sumultaneous Tx/Rx intra band non contiguous.

**7 – China Mobile Com. Corporation**

Some of our views are provided here:

- Enable 4Tx for CEP type device: we support this work
- Introduce the 3Tx chain UE: we are wondering whether 3Tx chain UE is a common design for smart phone in Rel-18 timeline? If so, we are positive to support the related features and requirements.
- UE 8Rx requirements: we support this work
- New lower power class for Uu and/or sidelink: need to understand the motivation and use case why lower power class e.g. 14dBm is needed for Uu.
- Enhance UL CA RF requirements: we support this work
- Investigate and improve MSD/small A-MPR: we support this work

**8 – LG Uplus**

We think ”Simultaneous Tx/Rx for Intra-band non-contiguous CA/DC in TDD band” can be the ”middle point between now and full/flexible duplex utilization”. So corresponding specification with defining the capability of UE needs to be in Rel-18 in advance if you want to see FDR in UE side in Rel-18 or Rel-19.

**9 – QUALCOMM JAPAN LLC.**

There are many items here, discussion would be needed to understand the motivation for many of these items. UE 8Rx requirements was proposed in Rel.17 as a demod item because by far most of the work will be on the demod requirement. The RF impact is really small, the 8Rx requirements can be simply copied from LTE since the same RF chain implementation would be used.

For some of the items there was already clear commercial interest shown (8Rx, MSD improvements, higher power transmission for UL). The other items clearly need more discussion. For the simultaneous Rx/Tx for intra-band NC CA in TDD, we have doubts this is feasible to implement.

**10 – ZTE Corporation**

**UE RF1:**

○ UE 8Rx requirements

We support this feature to increase DL coverage and performance capacity, however as mentioned by China Telecom that RF impacts might be limited except for Ref delta and SRS antenna switching, most of work should be demod part.

○ Introduce the 3Tx chain UE (including power enhancement with 3Tx, MIMO enhancement with

Similar as other companies,we would like to check whether this is typical implementation for most of commercial UEs.

○ Investigate and improve MSD for inter-band CA/EN-DC combinations

We support this to further improve network performance since improved MSD is achievable based on some vendors' feedback.

○ Simultaneous Rx/Tx for intra-band non-contiguous CA/DC in TDD band

It's not clear how to handle to Tx/Rx interference for intra-band case in UE side, by the implementation of XDD at UE side?

**11 – TELECOM ITALIA S.p.A.**

We support 8 Rx (good explanation from Qualcomm on the required work) and more than 2 Tx chains (it can be further differentiated on the basis of the form factor) - This is also linked to the uplink improvement discussion (R18Prep-2), which have some RAN4 dependencies

**12 – NTT DOCOMO INC.**

According to the guidance from moderator, we provide not which topic should be supported but which topic seems to have impact on commercial network from operator perspective. We think following 5 topics have impact on existing and near future network:

- Introduce the 3Tx chain UE (including power enhancement with 3Tx, MIMO enhancement with 3Tx, 3CC or 3 bands Tx simultaneously, Tx switching transmission enhancement) (new proposal to RAN#93-e)
- UE 8Rx requirements
- Enhance UL CA RF requirements (including HPUE, e.g., PC1.5 for UL CA, and specify RF requirements for inter-band UL CA with UL-MIMO on one band)
- Investigate and improve MSD for inter-band CA/EN-DC combinations
- Investigate and improve UE performance with small A-MPR

**13 – Nokia Japan**

For 4Tx for CPE type device, we should have one single UE RF architecture assumption to avoid the situation that we can see in intra band UL CA discussion in Rel-17.

For 3Tx chain UE, one of the aspects to be considered is shared in 700+800+900 topic. In addition, huge amount of workload is expected for this topic. RAN4 has been struggling from even intra UL CA with UL MIMO where so many complications can be seen because of multiple UE architecture assumptions, and huge relaxation may be introduced. We should avoid the same situation. Otherwise, this just consumes RAN4 TU, but does not provide gain. Thus, we should see rough estimation of the issues and the amount of relaxation before the WI.

For simultaneous Rx/Tx for intra-band non-contiguous CA/DC in TDD band, in the end, this would require full duplex so that it would be good to be discussed in Full duplex topic led by RAN1.

**14 – Intel Corporation (UK) Ltd**

- 4TX and 3TX chain UEs
  - Overall, the support of larger number of TX chain can be helpful to improve UL performance.
  - We propose to create a general objective "*Enable 3TX or 4TX chain UE*" and further downselection between 3TX and 4TX is needed taking into implementation feasibility and considering target device types.

    - For non-FWA/CPE use cases 3TX can be a more reasonable goal for Rel-18 timeframe. Meantime, 3TX support may have RAN1 impacts (SRS, precoder, 3 MIMO layers) and it shall be clearly identified
- UE 8Rx requirements
    - Is the intention to focus on FWA/CPE use cases only? In general, 6RX use case can be considered in addition to 8RX. Recommend to keep a generic objective "> 4RX antennas for FR1" and further discuss whether 6 RX and/or 8 RX shall be considered.
- New low power class for Uu and/or sidelink (e.g., 14dBm device in NR-U 6GHz)
    - Further justification of using low power class is needed. Is it limited to NR-U only? For cellular bands support of low power class may have a big impact on coverage/performance and should be assessed. Also, the sidelink use case should be clarified.
- Enhance UL CA RF requirements (including HPUE, e.g., PC1.5 for UL CA, and specify RF requirements for inter-band UL CA with UL-MIMO on one band)
    - Coverage and performance improvement for UL CA is important. Recommend to further discuss the detailed sub-objectives and a reasonable prioritization should be considered. Also, dynamic power aggregation is being discussed under thread 02 and we think it could be treated along with these proposals.
- Investigate and improve MSD for inter-band CA/EN-DC combinations
    - We agree that possible improvements are important to improve network performance and have strong market interest.
- Investigate and improve UE performance with small A-MPR
    - We agree that AMPR improvement is beneficial to improve UL performance. Does the proposal consider band-specific improvements or some general framework?
- Simultaneous Rx/Tx for intra-band non-contiguous CA/DC in TDD band
    - The use case is not very clear. Is the proposal limited to certain TDD bands? Is it planned that operators will use different TDD UL/DL configurations for different carriers within one band? If so, how to handle adjacent channel co-existence?

**15 – Ericsson France S.A.S**

Regarding 4Tx: The 4TX should be considered as part of the full-power UL-MIMO (ULFPTx) framework. The current requirements discussed apply for 2TX connectors (Rel-16 and Rel-17), further work is needed for 4TX. We are open to completing full-power requirements for 4TX.

Regarding 3TX: What prevents a UE from implementing 3TX today, then this UE could support UL-MIMO (or PC1.5 in mid-band combined with UL CA). Otherwise agree that likelihood of such an implementation should be considered.

Regarding CA, TX switching (with 2TX), the single-TAG restriction should be removed at least for UL CA to enable UL-MIMO and UL CA in non-collocated deployments (not impossible for DC but harder). A real improvement that can be used with existing 2TX UE architectures and a low-hanging fruit

Regarding simultaneous TX/RX for intra-band non-contiguous in a TDD does not appear feasible (someone has to find 140 dB somewhere), but the CGs need not be collocated. In the latter case the GP of the TDD needs to be set accordingly to avoid any simultaneous RX/TX in the UE and similar issues in the BS RX due to different cell sizes

MSD improvements should be general (all band combinations)

**16 – vivo Communication Technology**

First, as mentioned before, guided by RAN Chair, we do not think 3Tx chain is a proposal from RAN R18 WS, thus should not be discussed in this email thread. In addition, for 3Tx chain UE, we believe there are many feasibility problems from product implementation perspective.

For lower power class, we think it has not be limited UU and/or sidelink, which should be a general consideration to extend the UE type for some specific scenarios.

UL CA RF requirements can be further enhanced.

Improve MSD for certain inter-band CA/EN-DC combinations can be studied in Rel-18.

**17 – China Unicom**

Higher number of Tx/Rx chains in UE (i.e. CPE, smart phones, etc) would bring benefits to the network performance and user experience. We are interested in areas that enhances UE capabilities (4 Tx for CPE, 3Tx UE and 8 Rx).

**18 – AT&T GNS Belgium SPRL**

We see the following items as important aspects to address in Rel-18 to support necessary deployment scenarios and improving performance/user experience.

- 8Rx and 4Tx for FWA/CPE
- Investigate and improve MSD for inter-band CA/EN-DC combinations
- Enhance UL CA RF requirements
- Investigate and improve UE performance with small A-MPR

**19 – Huawei Technologies France**

**UE with multiple chains**

We would like to enable 4Tx and 8Rx for CPE type device on a single band (supporting single carrier or intra-band CA, and at least single carrier). The target scenario is for toB service. The benefit is to improve the spectrum utilization efficiency and improve both downlink and uplink throughput. By using 4Tx, the transmission power can be further boosted. We observe that there are some open issues related to transmission power for 2Tx is under discussion. But we think we can address those issues in Rel-17. And for 4Tx we can refer to the design of 2Tx and even come up with better general schemes. For 3Tx, we think that can be considered for inter-band CA with UL MIMO. Also for spectrum topic of 700+800+900MHz band combination, it's also an applicable scenario.

**MSD improvement**

We think some feasibility study is needed in Rel-18 to address the issues identified and discussed in Rel-17

**UE RF2 requirement focus evolution**

- UE RF2 requirement focus evolution, with the following areas
  - Support of UL 256QAM
  - Vehicular UE requirements for
    - Power class in 39GHz
    - Inter-band UL/DL CA (e.g. 28GHz+39GHz)

- Inter-band UL CA based on CBM
- Intra-band and inter-band CA support for FR2-2 based on IBM/CBM
- Switching time enhancements (ON/ON transient time)
- FR2-1 and FR2-2 UE antenna scaling (new proposal to RAN#93-e)

**Feedback Form 6: UE RF2 requirement focus evolution**

**1 – Samsung Electronics Co.**

It is observed there are overlapping area, e.g., between vehicular inter-band CA, inter-band UL CAbased on CBM and FR2-2 CA. Further clarifications are required to have relative isolated objectives for further discussions. It is suggested to revise the high level working area bullets as

- Vehicular UE requirements for power class in 39GHz
- Inter-band DL/UL CA
  - Vehicular UE requirements for inter-band DL/UL CA, e.g, 28 + 39 GHz
  - Inter-band UL CA based on CBM
  - Inter-band CA supports for FR2-2 based on CBM/IBM
- Intra-band CA for FR2-2

**2 – Guangdong OPPO Mobile Telecom.**

It seems there might be some items in Rel-17 can not be finished on time or be downscoped due to not much inputs, these items could be further considered in Rel-18. Besides that, new items could be further considered. However, whether they are all included in a single WI or separate WI could be further discussed.

**3 – Apple AB**

1. On ”UL 256QAM”, it is better to have some study first on the potential real system gain vs. UE implementation challenges before going into the normative work.

2. On ”Inter-band UL CA based on CBM”, similar as the discussion R17, this work should be subject to the availability of BC from operators.

3. On ”Intra-band and inter-band CA support for FR2-2 based on IBM/CBM”, as this was discussed in R17 FR2-2, we would prefer to consider this proposal after the R17 discussion is concluded.

4. On ”FR2-1 and FR2-2 UE antenna scaling”, the study is primarily targeting on saving UE power while limiting NW/UE performance impacts.

**4 – LG Electronics Deutschland**

We tends to agree with Samsung’s idea to categorize similar topics under high-level lists. We have slightly modified suggestions below. Wording can be improved later and further input can be accommodated.

**RF enhancement in FR2-1:**

: Vehicular UE requirements for power class in 39GHz

: Inter-band DL/UL CA

- Vehicular UE requirements for inter-band DL/UL CA, e.g, 28 + 39 GHz
- Inter-band UL CA based on CBM

**RF enhancement in FR2-2:**

:Intra/Inter-band DL/UL CA

- Inter-band CA supports for FR2-2 based on CBM/IBM
- Intra-band CA for FR2-2

**5 – China Mobile Com. Corporation**

We support the introduction of 256QAM for FR2

**6 – China Telecommunications**

We support the further enhancement for FR2 area in Rel-18 as well. Priority of different proposals can be further discussed.

**7 – QUALCOMM JAPAN LLC.**

For most of the proposals above, we need to understand the commercial interest. Some of them are leftovers from Rel.17 but they were likely left out because of lack of interest.

Switching/transient time enhancements could bring benefits in FR2 and should be feasible to implement as there is a already a capability for FR1.

For the antenna scaling, we need to understand what is really needed from a specification point of view. Antenna scaling is already possible within the current requirement framework and we do not believe additional relaxations(especially for UL) should be allowed since this will affect the system coverage.

**8 – ZTE Corporation**

**UE RF2:**

○ Support of UL 256QAM

We support the UL 256QAM in FR2 to further improve the uplink capacity for UEs with good sinr condition, from gNB perspective, it's feasible to support both DL and UL 256QAM and we would like to see the support from UE side.

○ Inter-band UL CA based on CBM

We support this study in Rel-18 since this is not considered yet and it's also important to reduce the BM overhead with CBM;

**9 – NTT DOCOMO INC.**

We think following 4 topics have impact on existing and near future network:

- Support of UL 256QAM
- Vehicular UE requirements for
  - Power class in 39GHz
  - Inter-band UL/DL CA (e.g. 28GHz+39GHz)
- Switching time enhancements (ON/ON transient time)

**10 – Nokia Japan**

The objectives for vehicular UE requirements would not be a kind of enhancement. RAN4 needs to discuss handling of these a kind of "mirror" requirements from the existing requirements.

Any IBM/CBM related requirements must be handled based on operators' real demand.

For FR2-2, it is reasonable to start with intra band CA. We need clarification on what inter band CA support for FR2-2 means. Is it FR1 + FR2-2, FR2-1 + FR2-2 or something else?

For switching time enhancements, if we specify this, its gain needs to be discussed before approving it.

For antenna scaling, we need a detail on antenna scaling to understand it better.

**11 – Intel Corporation (UK) Ltd**

- Intra-band and inter-band CA support for FR2-2 based on IBM/CBM
  - Support of CA for FR2-2 is important to ensure the NR technology can fully extract the benefits from the support of FR2-2 operation and can cover full unlicensed band.
  - Our original proposal covers in general both DL and UL CA and separate objectives can be considered. Suggest rephrasing as "*Intra-band and inter-band **DL and UL** CA support for FR2-2 based on IBM/CBM*".
- Switching time enhancements (ON/ON transient time)
  - Switching time improved is required for FR2-2 to allow efficient use of 64QAM operation and ensure the NR has comparable performance with other technologies in NR > 52GHz tange
  - Our original proposal covers FR2-2 and suggest to adjust the objective: "***FR2-2** Switching time enhancements (ON/ON transient time)*"
- FR2-1 and FR2-2 UE antenna scaling
  - FR2 power consumption reduction is an important factor and possible enhancements should be considered. Further clarification on possible network impacts in case of using UE-based solution would be appreciated.

**12 – vivo Communication Technology**

For Inter-band UL CA based on CBM, and Intra-band and inter-band CA support for FR2-2 based on IBM/CBM, seem to be natural extension from Rel-17□

**13 – Ericsson France S.A.S**

Regarding FR2 UL 256QAM, it is not clear whether there would be significant gain for uplink; it would be good to clarify whether high SNR is available on the UL side. OTA testability may also be an issue.

Regarding the antenna scaling, what aspects are not possible with current specifications ? If there would be a need to study gain or signalling changes, it does not seem within RAN4 scope.

**14 – China Unicom**

We are supportive to introduce support of 256QAM in FR2 bands to enhance uplink performance for mmWave.

**15 – Huawei Technologies France**

We support UL 256QAM for FR2. For other band combination related topics, we think that depends on deployment scenario and demands from operators. We don't think Switching time enhancements is necessary in Rel-18. For FR2-1 and FR2-2 UE antenna scaling, it is a RAN1 related topic, whihc should not be considered in RAN4 before PHY aspects are clear.

**BS RF requirement focus evolution**

- BS RF requirement focus evolution, with the following areas
  - mmWave multi-band BS (specify RF requirements for mmWave BS capable of multi-band operation)
  - HBS (Home base station, including RF core and conformance requirements)
  - Requirements for NTN BS Type 1-O (including reference architecture, RF requirements, testing requirements)

**Feedback Form 7: BS RF requirement focus evolution**

**1 – Samsung Electronics Co.**

Requirements for NTN BS type 1-O is related to leftover issues in ongoing REl-17 NTN WI. It is one of bullets shall be discussed in the RAN4 package as suggested to be approved in March 2022 together with leftover issues.

**2 – CATT**

For millimetre wave multi-band BS, what is the example band combination? We need the example combination to do implementation analysis and develop requirements.

For HBS, what's the intended deployment scenarios for HBS? Re-using 36.104 requirement should be the starting point if agreed.

Further evolvement on satellite requirements is an important aspect to be considered in the Rel-18 package. Due to new system nature, different operating bands and different regulations which are completely different from the terrestrial network, there are a lot of issues to be solved further in RAN4. we agree with samsung that furhter evolvement in Rel-18 is essential for this important verticals.

**3 – China Mobile Com. Corporation**

We support HBS. From CMCC perspective, we have clear market demand for HBS in NR. Home base station (HBS) can be utilized to enhance indoor coverage without requiring high base station output power, considering that Wide Area BS and indoor power distribution system in some scenarios cannot meet the coverage of 5G network deployment. The application of Home Base Station for NR is a cost-effective solution in some scenarios. Also, most LTE HBS can be considered as baseline. We believe the workload will be small.

**4 – QUALCOMM JAPAN LLC.**

At least the top 2 bullets need some discussion to understand the deployment likelihood and the need to introduce requirements(what is the foreseen delta with the current specs)

**5 – ZTE Corporation**

**BS RF:**

○ mmWave multi-band BS (specify RF requirements for mmWave BS capable of multi-band operation)

We need to check the feasibility to support the multi-band BS especially from different frequency groups (e.g. 28+39GHz)

○ HBS (Home base station, including RF core and conformance requirements)

For HBS, maybe requirement in TS36.104 could be starting point as pointed by other companies;

○ Requirements for NTN BS Type 1-O (including reference architecture, RF requirements, testing requirements)

This is still under discussion in Rel-17 NTN WID, we cannot see the motivation to propose it in Rel-18 for the time being.

**6 – Huawei Technologies France**

mmWave MB-BS:

We support this proposal. Same band group, e.g. 26_28G, and different band group, e.g. 28+39G, could both be considered in for mmWave MB-BS. For BS spec, the requirements are more general compared to that in UE spec. Similar to FR1 MB-MSR, for BS capable of multi-band operation, some specific requirements should be considered, e.g. spurious emission, out-of-band blocking in the frequency range of the other band, which are different from that for single band.

Requirements for NTN BS Type 1-O:

Full OTA requirements are more complicated compared to conductive based requirements. We understand there are some discussion in Rel-17. Given the current progress, we prefer to consier 1-O requirements in Rel-18.

**7 – Nokia Japan**

For mmWave multi-band BS, we need to understand the necessity and urgency of this specification first. Currently, operators do not hold many operating bands in FR2 as they have those in FR1.

For NTN BS Type 1-O, as mentioned in the approved WF of R4-2115640, RAN4 needs to check the status of progress of NTN WI first.

**8 – Ericsson France S.A.S**

Regarding the multi-band BS for mm wave, considering workload this should be prioritized only if there are operator requests and tangible deployment scenarios.

Regarding home BS, we do not fully understand why a separate BS class is needed and why the scenarios can't be covered by the LA BS class. The specifications do not prevent development of an LA BS with a low TX power.

Regarding NTN BS type 1-O, this should be considered in Rel-17 NTN.

**9 – China Unicom**

Introduction of mmWave multi-band BS would bring benefits in allowing more flexible deployment for operators having multiple carriers and multiple bands in FR2.

**RRM requirement focus enhancement**

- RRM requirement focus enhancement, with the following areas

- FR2 RRM enhancement
  - Enhancement RF beam measurement requirements to allow UE to measurement a subset of the configured resources
  - Define FR2-FR2 DAPS requirements
  - SCell activation enhancement in FR2
  - Enhancement type 2 BWP switch in FR2
  - RRM for different Rx beam sets in FR2
  - Network controlled gaps for UE Rx beam switching
  - FR2 delay reduction enhancements
- UL frame boundary offset reporting
- FR1-FR1 NR DC RRM requirements
- Enhancement for CSI-RS based L3 measurement
- HO with PSCell for new scenarios
- TCI switching enhancement
- CMTC
- RLM enhancements
- NeedForGap
- Per-FR Gap
- Inter-RAT NR measurement without gaps
- Measurement gap sharing enhancement

**Feedback Form 8: RRM requirement focus enhancement**

| |
|---|
| **1 – Samsung Electronics Co.**<br>Going detailed discussions for RRM is too early considering the ongoing RRM in REl-17. Overall RRM enhancement in Rel-18 shall be considered once the leftover issues in Rel-17 are clear, |
| **2 – Apple AB**<br>It seems companies have different understanding if RAN4 proposals can be submitted in R18 workshop. More RRM related proposals are expected in the Sept. plenary. In Sept. and Dec. plenary, we can focus on R17 drop-off and R18 new issues. R17 leftover issue can be discussed after the WG meeting in Q1, 2022.<br>Among the existing proposals, we are interested in following topics<br>(1) R17 drop off topics:<br>•TCI switching enhancement<br>•FR1+FR1 NR-DC RRM<br>•CGI reading requirement for NR-U cell<br>•CMTC<br>•RRM requirement with NeedForGap<br>(2) Newly identified topics in R18:<br>•Harmonized RLM/BM<br>•RRM enhancement for large CC number<br>•allowInterruptionfor deactivated SCell measurements<br>•CSI-RS based CFRA in RRM requirement |

**3 – China Telecommunications**

We support the further enhancement for RRM area in Rel-18 as well. In general, the priority of different proposals depends on the performance benefit as well as the popularity/probability of the corresponding scenario/event happens, which can be discussed later after all candidate proposals are submitted to Sep meeting.

**4 – LG Electronics Deutschland**

Some categorization seems necessary. For example, we can consider high-level lists such as leftover Rel-17 and new features but not limited to.

For FR2 RRM requirement, we suggest to have a Rx beam enhancements merging 2 areas as below

**: UE Rx beam enhancement**

- Enhancement RF beam measurement requirements to allow UE to measurement a subset of the configured
- RRM for different Rx beam sets in FR2

**5 – China Mobile Com. Corporation**

In general, we should really focus on the RRM requirements enhancement that are essential, have clear benefits and market demand.

From CMCC perspective, we support:

- FR1-FR1 NR DC RRM requirements: this is the leftover issue, RAN4 needs to fix the missing requirements.
- HO with PSCell for new scenarios: the new scenarios are all practical deployment including SA-NEDC, SA-NR DC, LTE-ENDC, and the work for extension to new scenarios are very small.
- NeedForGap: feature is introduced in Rel-16 already, and this is a very useful feature to reduce the gap overhead. Support to specify the requirements in Rel-18
- Inter-RAT NR measurement without gaps: inter frequency without gap is already supported in Rel-17, extension to inter-RAT is very straightforward.

**6 – CATT**

We also think RRM further enhancement should be considered in R18 including the R17 leftover issues and possible new issues based on the input in Sep. meeting. From our side, the following R17 leftovers can be considered□

(1) Enhancement for CSI-RS based L3 measurement. e.g. CMTC and othe important items.

(2) RRM requirements for FR1+FR1 NR-DC which is basic requirements to be included.

(3) Requirements for 'NeedForGap' in which both SSB based and CSI-RS based requirements can be considered

(4) HO with PSCell for new scenarios to extend the scenarios

(5) Enhanced indication of UE per-FR gap capabilities

(6) TCI switching enhancement

(7) Inter-RAT NR measurement without gaps

(8) RLM enhancements

A larification question, what's the exact meaning of harmonized RLM/BM? what is the intended enhacement for this one?

Since the Rel-17 RRM completion is targated at Mar 2020. We support single package approval at Mar 2020 without differentiating different stages.

**7 – Ericsson LM**

There will certainly be RRM enhancement in Rel-18. On MG enhancement, we may expect some leftover from R17 e.g. combination of features in R17. Like in R17, it will be reasonable to have 2 WIs: one one RRM enhancement and another one on MG enhancements. The list of RRM/MG enhancement related objectives will become quite long. The list needs to be short listed and should be based on commercial interest. In terms of specific areas in our view following are most critical:

Need for gap

SCell activation enhancement

TCI switching enhancement

Measurement gap enhancement e.g. concurrent NCSG and Pre-MG (but wait for R17 progress)

**8 – ZTE Corporation**

**RRM:**

In general, we support further RRM enhancement in Rel-18 as usual, in addition we would like to also see the performance gain before the approval to give the industry more confidence to enable the such kind of advanced RRM features.

**9 – Huawei Technologies France**

Regarding RRM requirements, we support to at least define some newly identified R18 objectives. We think new release is not only to find and fill gaps based on previous release, but new enhancements related to near and mid-term commercial deployments should be involved in R18. FR2 operation provides ultra-high throughput and ultra-low latency and we expect it to be more widely deployed in Rel-18 time frame compared to earlier releases. However current FR2 related RRM requirements may not be able to fully realize the potential of FR2 operation, e.g., latency is long, requirements are not complete, etc. therefore we suggest that R18 new identified topics focus on FR2 RRM enhancement.

Herein we would like to provide justification on some enhancement of FR2 RRM enhancement we proposed.

- Enhance FR2 beam measurement requirements to allow UE to measure a subset of the configured resources
  - UE BM is subject to the UE measurement capability, which is limited. Network either configures limited BM resources which results in frequent reconfiguration of BM resources; or NW configures more resources over UE capability which may results in no valid report to the NW and waste of UE power. Allowing UE to measure a subset of the configured resources can lead to better power efficiency and more reliable measurement performance.
- Define FR2-FR2 DAPS requirements

- UE who supports independent beam management (IBM) for two bands in FR2 can Tx/Rx from different directions at the same time. Therefore it may be feasible to introduce FR2-FR2 DAPS HO for inter-band scenario. Of course the UE capability (whether depends on IBM) are open to be further discussed.

- SCell activation enhancement in FR2
  - Large activation delay in FR2 was caused by the assumption that UE needs to receive the TCI indication from NW for PDCCH, PDSCH and CSI-RS for CSI, and for unknown case UE needs to perform L1-RSRP measurement and reporting. Therefore further reduce the SCell activation delay in FR2 need to be enhanced.

- Enhancement type 2 BWP switch in FR2
  - Currently there are two types of BWP switching delay based on UE capability. The switching delay for type 2 UE is rather large for FR2 or FR2-2. The enhancement is expected.

The above are examples for FR2 RRM enhancement, we are open to other FR2 enhancements.

**10 – NTT DOCOMO INC.**

We think following 6 topics have impact on existing and near future network:

- FR2 RRM enhancement
  - SCell activation enhancement in FR2
  - RRM for different Rx beam sets in FR2
  - FR2 delay reduction enhancements
- HO with PSCell for new scenarios
- RLM enhancements
- Per-FR Gap

**11 – Nokia Japan**

Since RRM is fully loaded and RAN4 is still in the progress of working on Rel-17 WIs, which will not finalize within the coming meetings (no CR work has started), at this moment, it is sufficient to know the potential candidate topics. The list of candidate topics can then be starting point for selecting the possible RAN4 RRM led WIs. It is necessary to share details of the objectives specifically for something new. To ensure a manageable work-load in RAN4 RRM it is necessary to account the impact originating from WIs led by other WGs and which need RAN4 RRM work.

**12 – vivo Communication Technology**

The RRM requirements enhancements are needed in Rel-18 since there are leftovers in Rel-16 and Rel-17 which are important from market demand and/or requirements completeness perspective. There could also be new RRM enhancements. It is too early to discuss Rel-17 leftovers for now. For the next RAN plenary discussion, it would be better to discuss RRM enhancements by taking more proposals coming in.

**Demodulation focus requirement evolution**

- Demodulation focus requirement evolution, with the following areas
  - UE advanced receiver

        - Soft IC to cancel inter-stream interference in SU-MIMO scenario
        - Enhanced DL receivers for multi-DCI multi TPR scenario
        - E-MMSE-IRC, RML to cancel inter-user interference for MU-MIMO
        - Inter-cell CSI-RS(TRS)/SSB interference mitigation
        - E-MMSE-IRC under uneven interference (including time selective inter-cell interference)
        - Enhancement of CRS-IC
    - BS advanced receiver
        - MMSE-IRC for inter-cell interference
    - Other leftovers
        - eMIMO: two UE rate matching CRS patterns in multi-DCI Tx scheme
        - IAB BS performance requirements including 30% throughput requirements, DL CA requirements, URLLC requirements, enhanced UE receiver requirements (RML…), High speed UL requirements for IAB-DU

**Feedback Form 9: Demodulation focus requirement evolution**

**1 – Apple AB**

•We propose to first study the benefits and feasibility to introduce requirements with UE advanced receivers

•We also propose to explore and investigate RAN1 enhancements if feasible to address issues like un-even/ time selective interference

•The necessity of defining requirements for left-over items should be justified

**2 – China Mobile Com. Corporation**

In general, it is too early to discuss the Rel-18 demodulation enhancement considering that Rel-17 performance part completion time is by the end of 2022. Some of the enhancements are highly depends on the progress of Rel-17.

**3 – China Telecommunications**

In general, the enhancement of receiver can achieve more robust performance gain under various channel conditions compared to transmitter-side enhancement, and also without additional complexity on the RF part.

We agree the above working areas belong to demod part, and we'd like to add one new proposal, which will be submitted to RAN #93e:

− UE MMSE-IRC receiver for inter-cell and intra-cell MU-MIMO scenario with CA

With the corresponding single carrier requirements defined in Rel-17, it is straightforward to extend the requirements for baseline MMSE-IRC receiver to CA scenario.

In addition, our understanding on the scenario, benefit and complexity aspects on some of the objectives:

UE side:

− E-MMSE-IRC, RML to cancel inter-user interference for MU-MIMO.

In Rel-17, only MMSE-IRC receiver is used for MU-MIMO scenario. As MU-MIMO is largely used for NR, further enhancement on receiver is beneficial. E-IRC only requires additional channel estimation for the co-scheduled UE(s) in the same cell, and R-ML has been used for SU-MIMO.

− Soft IC to cancel inter-stream interference in SU-MIMO scenario

For the complexity, as mentioned by other company, if we limit number of iterations for each LDPC decoding, the total number of iterations will not be increased.

− FR1 8Rx

For demod part, we need to discuss the transmission rank (<=4, or >4) as well as the receiver type (MMSE or MMSE-IRC or R-ML).

− Inter-cell CSI-RS (TRS)/SSB interference mitigation

Originally we did not see the clear need of this proposal. However, in Rel-17 discussion for inter-cell interference IRC, chipset/UE companies have concerns on configuring SSB in the same time/frequency location for neighboring/interfering cells, to avoid performance degradation due to time/frequency tracking error. From this perspective, further enhancement on inter-cell CSI-RS(TRS)/SSB interference mitigation is beneficial for time/frequency tracking and thus PDSCH/PDCCH performance.

BS side:

We support MMSE-IRC for inter-cell interference, which has been defined for LTE BS. It can achieve considerable gain with moderate complexity increase.

**4 – China Telecommunications**

To clarify the relationship with Rel-17 work as asked by CMCC, all the bullets listed by moderator excepting CRS-IC enhancement are not depending on Rel-17 completion, i.e., not included in Rel-17 scope.

**5 – QUALCOMM JAPAN LLC.**

Similarly to the comments on the RRM enhancements, it is clear that it will not be possible to approve many items. Going forward, discussion should focus on items that are likely to bring significant benefits from a system point of view and also have a good trade-off between implementation complexity and gains. WE do not think it is worth discussing proposals that are addressing some corner cases or deployments that are not widely used.

**6 – Huawei Technologies France**

As we proposed in RWS-210458 and R4-2113806:

**Soft-IC** is very necessary to be used for the cancellation of the inter-layer interference for SU-MIMO sceanrio to address the performance degradation caused by imbalanced SNR between multiple layers, especially considering only one CW is defined for up to 4 layers in NR. As per our initial evaluation,round 1.5dB performance gain can be achieved over RML receiver for higher modulation order by keeping the same number of LDPC decoder as RML. Also based on our understanding, no limitation on the applicable scenarios for Soft-IC when UE is scheduled with multiple layers within one CW or two CWs.

**CW-IC for multi-DCI multi TRP scenario**: based on our understanding, the CW-IC is limited to scenario of multi-DCI based multi-TRP transmission with full/partial overlapping PDSCH allocation.

**Inter-cell CSI-RS(TRS)/SSB IM**: As per the discussion for CSI-RS/SSB configuration for ongoing Rel-17 MMSE-IRC for inter-cell interference, companies agreed that CSI-RS/SSB colliding configuration is very typical in the real network. TRS/SSB is used for time-frequency tracking and PDP estimation, accurate time-frequency tracking is important to ensure good performance. However, there is serious interference from TRS/SSB of neighbour cells in the real network due to the colliding TRS/SSB configuration, it is

beneficial to investigate the performance gain for TRS/SSB-IM to improve UE robustness. Based on our initial evaluations, up to 1.8dB for 64QAM and 2.1dB for 256QAM performance gain with SSB-IC, 3.2dB performance gain for 64QAM with TRS-IC under the low network load.

**E-MMSE-IRC for MU-MIMO**: E-MMSE-IRC is the leftover for the ongoing Rel-17 further performance enhancement and can be considered in the later release.

**RML for MU-MIMO**: Performance requirements with RML for SU-MIMO are defined in NR release 15, but the corresponding performance requirements with RML for MU-MIMO is not defined yet, related performance gain can be investigated in the later release.

**E-MMSE-IRC for uneven interference** is an important scenario considering NR flexible configuration, due to limited TU and possible complex combinations for uneven interference, it has lower priority in Rel-17, to address the related performance degradation, practical scenarios and related performance gain can be investigated in Rel-18.

Clarification is needed for enhancement of CRS-IC, considering the mass evaluations and conclusion for Rel-17 ongoing CRS-IM receiver in scenarios with overlapping sprectrum for LTE and NR, we wonder other possible enhancements for CRS-IC from proponent.

Clarification is needed for other leftovers:

eMIMO: what is difference between the evaluated ”Scheme #3: Rel-16 CRS-RM for 2 interference cells” conducted in Rel-17 CRS-IM and the proposal?

All others: we would like to know the motivation and real market request to define those performance requirements.

**7 – Nokia Japan**

Concerning UE advanced receivers, it is evident that too many options are on the table. Given the (potentially) negative TUs in RRM starting from next year, extensive down selection needs to be done.
We also want to highlight that no specific implementation of the advanced receivers should be mandated. The advanced reivers should be characterised by the scenario, where substantial performance gains are achieved.

Concerning BS advance receivers, it is unclear how such requirements would be tested with the current BS demod test setups. In particular, more than one cell does not seem to be currently supported by TEs and test setups. A study on test feasibility is needed before requirement definition can be discussed.

Concerning further IAB MT/DU performance requirements. There are no leftovers from the Rel-16 R_HST. RAN4 demod took the conscious decision to exclude the mentioned requirements (URLLC, high speed, low TPUT, etc.) as they are not relevant to the deployment scenarios of Rel16, and likely also Rel-17, IAB nodes (non-dynamic high TPUT backhaul. The IAB requirements can be removed from this discussion.

**8 – Intel Corporation (UK) Ltd**

1) The set of areas looks fine for use and a prioritization of objectives is required in the future taking into account market interest

2) Further details on “Enhancement of CRS-IC” are encouraged. Is it proposed to improve control channel performance for DSS scenarios?

**9 – Ericsson France S.A.S**

There will obviously need to be a strong scoping and prioritization in order to end up with a realistic amount of work.

Regarding UE advanced receivers, it would be good to see some more focus on the most beneficial cases. TRS/SSB interference is not so likely to be significant over time from a system perspective. Regarding

uneven interference, the benefit is only if networks are consistently using different slot lengths in different cells for most slots. Unsynchronized slots are relevant for FDD, but likely to be less so with time. Regarding CRS-IC, this should be solved in the Rel-17 WI.

Regarding BS IRC; this could be done but most BS already do IRC and it may not be the most useful use of RAN4 time.

Regarding IAB; we do not think further enhancements are needed. URLLC and IAB have not been considered as a scenario. During Rel-16 discussions, HST and IAB was also not seen as a common use case.

**Testing enhancement and EMC enhancement**

- Testing enhancement and EMC enhancement, with the following areas
  - EMC enhancement for both UE and BS
  - OTA testing enhancement
    - Dynamic OTA and 4DL OTA testing for FR2/FR2-2
    - Testing framework for FR2 FWA devices (PC1/PC5 in FR2)

**Feedback Form 10: Testing enhancement and EMC enhancement**

**1 – Guangdong OPPO Mobile Telecom.**

It is understood that the EMC enhancements are for testing simplification purpose, from this point of view, it can be considered in Rel-18 and see how to benefit the industry.

**2 – China Telecommunications**

We agree OTA testing methodology and EMC enhancement can be discussed as separate topics.

Enhancement of testing methodology is to ensure the proper testing of all the related requirements.

**3 – Beijing Xiaomi Mobile Software**

As we all know, 3GPP defines global technical specs and regulatory bodies derive their own regulations based on the 3GPP specs. We have pointed out the gap between regulation concern and current 3GPP EMC specs in our first round comments. Without properly defined test configuration, R&D doesn't have consolidate test basis and also product certifications cannot be guaranteed. Hence we see the urgency that 3GPP to enhance the EMC test configuration to help to benifit the industy. Furthermore, with the WID, simiplified test configuration can be agreed with less test burden, e.g.. test time and cost reduction can be achieved.

**4 – QUALCOMM JAPAN LLC.**

This is a very important area in which RAN4(and 3GPP as a whole) should invest more time to provide solutions to the industry. Deployment of some features is or risks to be gated by the lack of adequate test solutions. FR2 testing is an area where improvements and new solutions are needed. Also, the development of these solutions (from RAN4 study to actual TE implementation and test availability) takes a significant of time so an "early start" is highly desirable.

**5 – TELECOM ITALIA S.p.A.**

Same view as Qualcomm

**6 – Nokia Japan**

For OTA testing enhancement, we need to check the detail objectives further in future meetings. Some of RAN1 Rel-17/18 WIs as well as new /existing WIs led by RAN4 may require establishment of testing methods to have performance requirements. We need to list them and discuss how to handle them if the number of topics needing testing enhancement is huge.

**7 – Intel Corporation (UK) Ltd**

1) For OTA testing enhancements we think that FWA proposal is good. We also suggest to further discuss extending testing framework for the remaining power classes and different form factors (not limited to FWA).

**8 – vivo Communication Technology**

For UE EMC, the intention of study is to simplify the test configurations, this would be beneficial to reduce the test burden.

For FR2 dynamic MIMO OTA testing, we think it would be good to check first the progress of basic "static" FR2 MIMO OTA requirements work of Rel-17, which is intended to meet the fundamental conformance test purpose.

**9 – AT&T GNS Belgium SPRL**

Similar view as Qualcomm. Delays in conformance testing due to test method limitations severely impacts deployment deadlines and increases the risk of features/performance levels not meeting expectations. RAN4 needs to start on test method work early to allow TE to be available in a timely fashion.

**10 – Huawei Technologies France**

There have already existed OTA testing for RRM and demodulation, and MIMO OTA testing to verify FR2 antenna plus baseband. In our view, basic FR2 functions have already been tested. And in practice, there will be field testing where the performance under more real propagation conditions will be verified. We try to understand the intention to have more testing which would more likely become certification test. With those testing, we still cannot save the field testing. But those testing some kind of mimic real life.

For FR2 MIMO OTA, the test methodology is still under discussion in RAN4 that the validation procedure and metrics cannot be justified on consistency until the latest RAN4 meeting. Thus, the corresponding FR2 MIMO OTA requirement evaluations are totally blocked by the unclear test methodology.

It can be observed that even the 'static' MIMO OTA test and requirement definition are not easily finalized in RAN4, and its conformance test among different chambers still need thorough analysis before it becomes part of certification process. We don't think dynamic OTA is a practical target to be considered given the current status on MIMO OTA test topic in RAN4.

**Evolution of requirements across RF, RRM and demodulation**

- Evolution of requirements across RF, RRM and demodulation, with following areas
  - Support of intra-band non-collocated EN-DC/NR-CA deployment (including RF, RRM and demodulation performance requirements)
  - ATG (air-to-ground network, including RF core requirements and conformance requirements for ATG, RRM core and performance requirements)
  - Co-channel HAPS (including co-existence study)

- Requirements for 4-layer DL in FR2 with or without multi-panel framework (including RF, RRM and demodulation requirements), and FR2 multi-panel simultaneous DL reception.
- FR1/FR2 HST enhancements (including CA FR2, multi-panel reception, UE type enhancements for FR2)

**Feedback Form 11: Evolution of requirements across RF, RRM and demodulation**

**1 – Apple AB**

1. On "Support of intra-band non-collocated EN-DC/NR-CA deployment", as many operators are requesting to support from the perspective of commercial deployment, it is reasonable for RAN4 to study it. However, due to the potentially large MRTD, the impact on UE should be carefully studied first.

2. On "Co-channel HAPS", in thread [RAN93e-R18Prep-15], support of HAPS is being discussed. It would be good to clarify the relationship between the two threads.

3. On "Requirements for 4-layer DL in FR2", a clarification question first, does "Requirements for 4-layer DL in FR2 without multi-panel framework" mean UE will support 4-layer MIMO with one panel? How feasible is that? On DL support with multi-panel framework, RAN4 should carry out study first to understand the performance gain and the related form factor/power limitations.

4. On "FR1/FR2 HST enhancements", if the FR2 related HST enhancement is targeting on the handheld UE, a feasibility study is needed.

**2 – LG Electronics Deutschland**

For the intra-band non-collocated EN-DC/NR-CA, based on the situation in last RAN where many operators showed their interest, we think this needs to be studied in RAN4.

For ATG, we think this can be included in Rel-18.

**3 – Samsung Electronics Co.**

We are interesting and open to discuss on the potential FR2 HST enhancement items including CA supporting, multi-panel simultaneously operation, high velocity supporting up to 500km/h. Meanwhile any new proposals from upcoming RAN-P meetings shouldn't be excluded considering Rel-17 FR2 HST still ongoing which may bring some left-over issues in later phase.

**4 – China Mobile Com. Corporation**

ATG has clear and urgent commercial demand, and CMCC has already conducted some technical trial for ATG. Vertical applications like ATG are essential for operators to explore new 5G business and promote the 5G ecosystem.

Also, ATG was proposed as a Rel-17 RAN4 WI from 2019. The WI scope is already quite stable after at least 4 rounds of email discussions tasked by RAN. Due to the high work load in Rel-17 RAN4, this WI proposal was postponed. Considering the urgency of commercialization, we propose to treat ATG as high priority topic in Rel-18 RAN4.

**5 – China Telecommunications**

We agree all the bullets listed by moderator belong to cross-area topics.

For co-channel study between HAPS and TN, we wonder if any operator is interested in it. For the others, we see the motivation, either well discussed in Rel-17, and straightforward extension of Rel-17 work.

**6 – LG Uplus**

As many times emphasized from LG Uplus and many operators, **"support of intra-band non-collocated EN-DC/NR-CA deployment (including RF, RRM and demodulation performance requirements)"** is important specification for operators who have(or will have) non-contiguous intra-band spectrum where initially deployed base station mostly cannot support wide band gap and then the next base station should be placed in non-collocated area. As many experts can expect, the real commercialization of Rel-18 would be 2024 2025 where the Rel-18 Stage 3 completion will be Sep. 2023 with 18 months duration. Then this is the last chance we can prepare or find the way against the mentioned spectrum situation.

**7 – QUALCOMM JAPAN LLC.**

This set of proposal is relatively large, and very diverse. Discussion to understand the commercial interest, the objectives and the amount of time will be needed. Some of the items are new while others are continuation/enhancements of existing items(e.g. HST) or just RAN4 part of existing items(non-collocated deployments for CA/EN-DC, 4 layers for FR2). A simple prioritization among these items does not make sense so putting them all in one bucket for discussion might not be the best way to handle them. It also has to be clarified what is the possible impact to other WGs from some of these items.

**8 – ZTE Corporation**

**ATG:**

As we mentioned before, this ATG WID has been extensively discussed before and well recognized by the industry, therefore we propose to complete this ATG WID in Rel-18.

**Co-channel HAPS:**

Yes,this was discussed in other thread, we don't have strong preference where to be treated, we could also see some operators interest on this deployment. For sure, no coexistence issues should be guaranteed with proper network deployment.

**9 – Telstra Corporation Limited**

Requirements for 4-layer DL in FR2 is of interest. ATG could be included as a lower priority.

**10 – NTT DOCOMO INC.**

We think following 3 topics have impact on existing and near future network:

- Support of intra-band non-collocated EN-DC/NR-CA deployment (including RF, RRM and demodulation performance requirements)
- Requirements for 4-layer DL in FR2 with or without multi-panel framework (including RF, RRM and demodulation requirements), and FR2 multi-panel simultaneous DL reception.
- FR1/FR2 HST enhancements (including CA FR2, multi-panel reception, UE type enhancements for FR2)

**11 – Nokia Japan**

Some topics like 4-layer DL in FR2 with or without multi-panel framework and FR2 multi-panel simultaneous DL reception may additionally require enhancement of testing methods. Relation between these topics and required testing method should be considered.
In particular, the connections and boundaries between NTN, ATG, and HAPS must be clarified to allow for non-overlapping requirement and scenario work.

**12 – Intel Corporation (UK) Ltd**

- **Support of intra-band non-collocated EN-DC/NR-CA deployment**
  - During prior 3GPP discussions there was a clear operator/market request to enable such functionality and we believe RAN4 should address it in Rel-18 timeframe.
- **Requirements for FR2 with 4-layer DL …**
  - In our view further enhancement for FR2 performance in terms of throughput / delays / robustness are critical to ensure success of FR2 technology. The functionality with multi-panel reception was introduced by RAN1 in the previous releases and RAN4 needs to enable the scenario.
  - We suggest restructuring the objective as follows:
    - *Requirements for FR2 multi-RX chain DL reception including 4-layer DL MIMO (including RF, RRM and demodulation requirements and OTA test methods)*
      - *Requirements for multi-panel simultaneous DL reception*
      - *Requirements without multi-panel simultaneous DL reception*
  - For "4-layer MIMO with one panel" we are not sure if it is feasible and we recommend to focus on multi-panel case.
  - To Apple, we agree that RAN4 needs to assess the feasibility and technical details of support of multi-panel reception. It is unlikely the 3 remaining meetings of Rel-17 will be sufficient to complete the task. Therefore, it is suggested to properly plan the work in Rel-18.
- **FR1/FR2 HST enhancements**
  - There was a typo in our proposal and we focused on FR2 HST (i.e. we meant *FR2 HST enhancements (including CA FR2, multi-panel reception, UE type enhancements for FR2)*
  - To Apple, we consider CA FR2 and multi-panel reception for CPE type of devices. With respect to "UE type enhancements" we consider allowing the non-HST UE-s to be served also by the HST network (no need to support high speed conditions).

**13 – Ericsson France S.A.S**

Regarding ATG, we note that this proposal has been around since Rel-17 and is pretty mature.

Regarding co-channel HAPS, co-channel interference effects are in the scope of RAN1, not RAN4. We believe that anyhow the tools are present in the RAN1 specification and co-channel interference management is mainly a proprietary issue.

Regarding HST enhancements for FR2: We do not see this as so urgent unless specific needs are identified in deployments. We note that it is possible to operate 2 panels for FR2 deployment if each panel is operated as a separate UE in uni-directional; this will double the throughput.

# 4 Final round

## 4.1 General

According to feedback from companies, almost all the companies can agree on the following principles

- Balance TU between RAN4-led work and RAN4 impact of work by other WGs
- Reserve TU for RAN4-led work
- Balance the work among in-field issues, leftover issues from early release(s) and new enhancement

But how many TU should be reserved for RAN4-led work to ensure that the critical issues for deployment can be addressed needs more discussion. And companies questioned how to balance/prioritize the RAN4-led work and RAN4 work for WI led by other WGs, and how to handle RAN4 led items with other WG's impact.

In my view those issues are not brand new. As commented by Intel, when starting any previous release (e.g., Rel-15/16/17), RAN4 Chairs all provided the TU budget plan with some TUs reserved for RAN4-led WI and some TUs reserved for other WG RAN4 related work. In this email discussion, it seems pre-mature to decide any value or percentage of TU reserved for RAN4, because of lack of justification. And as pointed out by Ericsson, the TU situation is a little complex. At the beginning of release there is less TU requested by RAN1/RAN2-led WI and almost no TU requested by RAN1/RAN2-led SI, and there are a lot of TU requested for release which is just completed, while a lot of TUs will be requested to complete RAN1/RAN2-led WI when approaching the completion date of the current release. The more realistic approach is to look at the available TUs at first and second quarters of Rel-18 phase and also consider the TU splitting between RAN4-led and other WG-led work in long run.

In this week email discussion, moderator suggest not to further discuss the detailed value for reserved TU rather to agree on the high level principle, i.e., reserve TU for RAN4-led work, and encourage all the experts go back to carefully check the numbers for previous releases. In my view, RAN4 leadership will provide the input about TU budget for Rel-18 including the reserved TU for RAN4-led work in future RAN meetings to trigger further review and discussion.

The key point of this discussion is to keep enough room for critical RAN4-led work and avoid the situation that those important items are barred simply due to lack of TU. According to feedback, it seems that all RAN4 colleagues are on the same page. To fairly treat the impact on RAN4 of other work groups and RAN4-led work, it seems feasible to discuss them together. One approach is to follow Alt 1 one-phase. But more companies prefer to Alt 2 and can accept Alt 3.

It is the impacts on RAN4 of other WG-led work that need RAN4 TU and will impact TU for RAN4-led work. It is not the work in other WGs that impact TU for RAN4-led work. In moderator view, the compromised way would be to discuss the impacts on RAN4 of other WG-led work and RAN4-led work in the same meeting based on the agreeable RAN4 TU splitting to decide the proper scopes for both. More feasible way is to do such exercise after RAN1/RAN2/RAN3 WI/SIs are approved. Otherwise, we cannot identify the impacts on RAN4 of those WI/SIs.

At the same time, it is usual business for each RAN to discuss and approve spectrum related WI based on the request from operators. So in moderator view, Alt 3 would be a good compromise, which allow the proper exception for Rel-18 spectrum related work. Besides, it is encouraged to consider the real situation, i.e., there would be quite amount of Rel-17 maintenance work in the first quarter of 2022. Even if some non-spectrum related work is approved, it would be still challenging to start the work right away.

Regarding which is spectrum related work, it would be clear that the WI which only includes the band or band combination related requirements can be viewed as a spectrum related WI. If the general requirements or band agnostic requirements need specified, then the WI cannot be viewed as spectrum related. But I wonder if the above definition can be easily agreed during this email discussion.

Based on the above clarifications, moderator would like to propose to endorse the following principles with some modification capturing comments from companies, and leave the detailed TU budget for further discussion.

**Proposal #1: Endorse the following principles for approve RAN4-led WI/SI package in Rel-18**

- Balance TU budget between RAN4-led work and RAN4 impact of work led by other WGs
  - Reserve TU for RAN4-led work.
  - Refine RAN4 objectives for WI/SI lead by other WGs after WI/SI packages for other WGs are approved. The intention is to ensure that there is room to address critical RAN4 related issues.
- General principle for scope of Rel-18 RAN4-led work
  - Balance work among in-field issues, leftover issues from early release(s), and new enhancement.
  - Meet the commercial demand for practical deployment.
- Timeline for approval of RAN4-led package
  - Alt 3:
    - Approve the minimum number of WIs based on consensus in December 2021
      - Consider spectrum related WI which has urgent request.
    - Approve the RAN4 package for non-spectrum related topics in March 2022.

**Feedback Form 12: General part in final round**

| |
|---|
| **1 – Guangdong OPPO Mobile Telecom.**<br>Agree with proposal. |
| **2 – Apple AB**<br>Support the proposals |
| **3 – QUALCOMM JAPAN LLC.**<br>The proposed principles are too high level, we believe something more actionable needs to be discussed/agreed. Moderator wrote that in previous releases some time was reserved by the RAN4 leadership for RAN4 led items, I do not remember this being the case. What has happened was that RAN1/2/3 package was approved and then we tried to squeeze in more RAN4 items leading to overload and many objectives getting dropped or pushed to another release. The issues that we pointe out were not really addressed.<br>In order to have something agreeable, it would be useful to have better guidelines on how to reserve TUs for RAN4 led work and how to make sure that items from other WGs will not fill up RAN4 capacity(or even worse, go over). RAN4 objectives and TUs for RAN1/2/3 led items should at least be discussed early and an estimate of RAN4 load should be done at the time the package for other WGs is approved. RAN1/2/3 items should already have RAN4 scope when approved. |

Approval of spectrum items can be considered separate as these items are given a free pass in any plenary. These could even be taken out from this discussion.

Overall, Alt. 3 does not really address our concerns that some way to consider all items that are on RAN4's table is needed. We maintain our view that the best way is to have a 1 shot approval with everything on the table. If approval of RAN4 package is separate then we need to have a proper mechanism to ensure that RAN1/2/3 will not take all the RAN4 capacity.

**4 – China Telecommunications**

We agree with moderator's summary that the key point of the timeline discussion is to keep enough room for critical RAN4-led work.

To achieve this goal, we can either to "discuss the RAN4 impacts of other WG-led work and RAN4-led work in the same RAN plenary meeting (as suggested by moderator)" or "approve the RAN1/2/3 package and RAN4 package together in this Dec (as suggested by QC, Telecom Italia)".

Maybe Proposal 1 is something we can have for now.

**5 – LG Electronics Deutschland**

Generally we agree the moderator's proposal but also understand the concern from Qualcomm. In Rel-17 when we discuss the RAN4-led RF/RRM core WI approval, only approve Top 3 objectives could be included and the others were mostly deferred to next release due to the heavy workload of RAN4 from other WGs. So to prevent the similar situation in Rel-18, we think in any way reasonable TUs for RAN4-led WI should be reserved for Rel-18. The exact value for reasonable TUs can be discussed further.

On Alt-3, we would like to check our understanding that the WI to be approved in Dec. '21 would be urgent spectrum requested by operator and all the non-spectrum will be approved in March '22.

**6 – Intel Corporation (UK) Ltd**

1) Agree with proposal.

2) With respect to definition of "spectrum related work", we agree with moderator clarification that "If the general requirements or band agnostic requirements need specified, then the WI cannot be viewed as spectrum related". We agree that a clear boundary shall be set.

3) Also, we would like to make a suggestion on general conclusions of discussion on "Proposals" for different technical areas. First of all, we think that ideally the discussion should strive to clarify the candidate areas and identify candidate topics with a clear scope. We do acknowledge that it may be difficult to converge on certain topics since some proposals have just been made. Therefore, we recommend not to exclude companies' proposals to give companies time for further check (i.e., example areas can include an extended set of topics). Meantime, we think that we should be careful to further extend the scope of discussion for additional topics/areas in the future (ideally a deadline for new proposals should be set).

**7 – Samsung Electronics Co.**

Agree with moderator proposals. Early input from RAN4 leadership on reserved RAN4 TU for RAN4 led items are suggested, i.e., before Dec RAN. RAN4 overall Rel-18 TU budget shall be confirmed together with approval of other WG led package.

**8 – China Mobile Com. Corporation**

We don't quite understand the subbullet of alt.3 about considering the spectrum related WI which has urgent request. Since Dec is still within Rel-17 timeline, the spectrum WIs discussed in Dec plenary should be

Rel-17 WIs. If the purpose is to discuss Rel-18 spectrum WIs, will the work start directly from the next RAN4 meeting? Or should wait until the completion of Rel-17?

And since it is usual business for each plenary to discuss and approve spectrum WIs, we don't think spectrum WIs need a package approval.

We propose to modify the alt. 3 as follows:

- Approve the minimum number of WIs based on consensus in December 2021
- Consider WI which has urgent request.
- Approve the RAN4 package for non-spectrum related topics in March 2022.

**9 – KDDI Corporation**

We agree with proposal.

**10 – LG Uplus**

We are supportive with the proposal from moderator where also agree with the opinion from other companies that TUs for RAN4-led WI should be reserved with some way as RAN4 is really important WG to reflect operator's spectrum/deployment-related requirement timely.

**11 – HuaWei Technologies Co.**

Moderator: to Qualcomm, China Telecom, CMCC, it seems difficult to agree on Alt1 according to feedback from other companies. I would like to provide modifications to try to address your concern. Please other companies also check if they are agreeable.

**Balance TU budget between RAN4-led work and RAN4 impact of work led by other WGs**

•Reserve TU for RAN4-led work

<Sub-bullet>: The exact value for reserved TUs will be discussed further based on input from RAN4 leadership and companies

•Stabilize RAN4 objectives as well as requested TUs for other WG-led WI/SI and approve RAN4-led WI/SI with TUs in the same RAN plenary.

•The intention is to ensure that there is room to address critical RAN4 related issues.

**General principle for scope of Rel-18 RAN4-led work**

•Balance work among in-field issues, leftover issues from early release(s), and new enhancement.

•Meet the commercial demand for practical deployment

**Timeline for approval of RAN4-led package**

•Approve the minimum number of WIs based on consensus in December 2021

<Sub-bullet>:Consider WI which has urgent request

•Approve the RAN4 package for non-spectrum related topics in March 2022

**12 – ZTE Corporation**

In general, we are fine with moderators' proposals, however as mentioned by other companies, how to ensure the balanced TU in Dec, 2021 for RAN4 lead items when RAN1/RAN2/RAN3 WID/SID were approved could be further discussed for the benefit of future RAN4 work. Maybe one feasible approach is

to have high level of review of RAN4 lead items in Rel-18 and detailed analysis of RAN1/RAN2/RAN3 lead items in Dec, 2021 and indicate to RAN-P for further decision. We understand this might be impossible to have balanced TU budget for RAN4 without the guidance from RAN-P and the potential compromise of other RAN1/RAN2/RAN3.

**13 – TELECOM ITALIA S.p.A.**

We share the same concern expressed by Qualcomm on the proposal:

- Refine RAN4 objectives for WI/SI lead by other WGs after WI/SI packages for other WGs are approved. The intention is to ensure that there is room to address critical RAN4 related issues.

If we refine RAN4 objectives after approval of RAN1/2/3 activities, RAN4 will certainly run out of capacity. We should have the reverse approach:

- identify a suitable capacity for non-RAN4 led activities
- RAN1/2/3 proposals need to clearly identify (in detail) RAN4 impact and required TUs
- if the pre-allocated RAN4 capacity is exceeded, downscoping / prioritization of RAN1/2/3 proposals is required

We also share China Mobile concerns on the limitation on spectrum Work Items in December, and support their proposed modification to option 3.

**14 – NTT DOCOMO INC.**

We agree with the moderator's proposal.

**15 – Nokia Japan**

Regarding "Timeline for approval of RAN4-led package", we understand that moderator's suggestion is one of the choices considering comments from companies and it may be challenging to have a common consensus on the definition of "spectrum related WI" in the remaining time of this e-mail discussion. We, however, still believe that definition of "spectrum related WI" must be clarified before approving WI/SI in the long run. Hence, we would like to modify the Alt 3 a little bit as follows.

· Approve the minimum number of WIs based on consensus in December 2021 **if a common consensus on the definition of "spectrum related WI" is reached**.

o **Only** consider spectrum related WI which has urgent request.

Approve the RAN4 package for non-spectrum related topics in March 2022.

**16 – Nokia Japan**

We understand the intention of the moderator. But "Simplification of band combination specifications" is just a continuation of the existing Rel-17. Hence, it may not be a good idea to mix this SI continuation and 700+800+900 proposal in the same category.

Our alternative is as follows.

Proposal #2: Endorse the continuation of "Rel-17 SI of Simplification of band combination specifications" in Rel18.

Note: how to handle 700+800+900 as one of the potential candidate topics needs further discussion with more clarification

**17 – Ericsson LM**

The general principles look fine. Some detail can be discussed at RAN eg. how many TUs are needed for RAN4 led WIs.

On alt # 3, is the intention to only approve the spectrum WIs in December? As general principle spectrum WIs can be approved anytime. So alt #3 wording is bit confusing. In our view any urgent non-spectrum WI for which TUs are available in Q1 should also be approved. However, quota of TUs should be maintained for RAN4 led non-spectrum package in March 2022

**18 – AT&T GNS Belgium SPRL**

We are generally OK with the moderator proposal and support it as a way forward. However, we share the same concerns as Qualcomm. We will need a way to balance the RAN4 objectives in WIs led by other WGs with RAN4-led WIs when the RAN1/2/3 packages are approved to ensure that RAN4 overload situation does not result in deferring critical RAN4 items for Rel-18. Concerning the CMCC comment, we already have an approved Rel-18 WI for the RAN4 work associated with NR Broadcast. Therefore, it seems possible to consider critical spectrum-related WIs in December for Rel-18 as it would not make sense for them to be Rel-17 WIs when the core work is supposed to complete in March 2022.

**19 – vivo Communication Technology**

We agree with the proposal from moderator, and also thanks for the clarification on the boundary of spectrum and non-spectrum related topics.

## 4.2 Proposals

### 4.2.1 Spectrum related topic

According to feedback from companies, it seems that the companies can accept the work areas for simplification of band combination specifications. For enhancement for 700+800+900, there are a number of questions to be answered. So moderator would like to list those questions and please proponent provides the answers.

It seems that the companies share the common interests for the following working areas. To capture Nokia comments that such work should not be categorized as “enhancement”, so moderator would like to change “spectrum related enhancement” to “spectrum related requirement evolution”.

Check if proposal #2 is agreeable in the final round.

**Proposal #2: Endorse the following high level topic with example working areas**

- Spectrum related requirement evolution, with the following example areas:
  - Systematically study, and simplify the band combination specifications

The proponent needs provide the responses to following questions from the intermediate round:

- Whether the enhancement of 700+800+900 band combination has impacts on other WG (answers from other companies: no, it can be based on EN-DC or CA)

- Should we target at 2UL (we assume 3UL out of scope)?
- Can this simply be done in the CA basket WI?
- Is there any backward compatible issue – impact on legacy UEs operating on these bands.
- There is implementation feasibility issue especially considering antenna performance
- Should we limit it to FWA/CPE?

**Feedback Form 13: Spectrum related topic**

**1 – China Telecommunications**

Thanks moderator for the good summary. For 700+800+900MHz CA, our understanding on the questions summarized by moderator:

− Whether the enhancement of 700+800+900 band combination has impacts on other WG (answers from other companies: no, it can be based on EN-DC or CA)

No. As we replied in the intermediate round, the RF requirements are common and apply to the band combination regardless of whether flexible spectrum integration or other Rel-18 new features is considered or not, i.e., the requirements apply to the existing CA/DC.

− Should we target at 2UL (we assume 3UL out of scope)?

We can start from two uplink bands in Rel-17.

− Can this simply be done in the CA basket WI?

As replied in the intermediate round, we already proposed a 700+800+900 CA combination with two uplink bands for handled UEs in Rel-17 basket WI.

Meanwhile, we understand the implementation difficulty of LB-LB combination for handled UEs, and we can first discuss in Rel-17 basket WI, and check the next step based on RAN4 progress.

− Is there any backward compatible issue – impact on legacy UEs operating on these bands.

Not quite understand what it means by saying “backward compatible issue”. This is just the CA/DC combination, which is the same as other combinations we discussed. The only difference is that LB-LB combination is difficult to handle UE from implementation perspective.

But to answer the question, for us, we have no legacy NR UEs on the low bands.

− There is implementation feasibility issue especially considering antenna performance

We can further discuss the technical details in RAN4.

− Should we limit it to FWA/CPE?

No. We are aware of the RAN4 discussion on DC_8A-20A_n28A for large form factor UEs. But considering the rather scarce spectrum in the low bands, we are not planning to limit the use case to FWA/CPE UE.

**2 – QUALCOMM JAPAN LLC.**

We agree to have more discussion on the study to simplify the CA specs. More details of the proposals are needed before it would be possible to say whether this is an area worth pursuing or not. There should be some clear objectives, not just an open ended study on what kind of improvements are possible.

For the 700+800+900, we look forward to the answers from the proponents. This can be further discussed in the extended round.

**3 – Skyworks Solutions Inc.**

We think this cannot be done in a basket WI as companies need to align on architecture and filter performance. These assumptions need to be spelled out and verified. we should limit to 2UL and when performance can be gained look into 1UL or SUO.

**4 – HuaWei Technologies Co.**

Moderator: to Qualcomm, in my understranding the proponent has provdied the documents for the simplification of band combiantions in June workshop, where the details are provided. To your comments, I am a little puzzled. According to guidance from RAN Chair, we should first decide working area and then work on the detailed objectives. It seems that you request deciding objectives and then decide whether it can be a working areas.

**5 – ZTE Corporation**

**For band combination simplification:**

In principle, we agree to make further optimization of RF requirements for band combinations in the stage of R18.However,up to now, the specification has come from R15 to R17. How to handle the existing band combination with NBC issue is a big problem. As in current SI FS*NR*ENDC*combo*rules,a rule based optimization method has been proposed for delta TIB/RIB simplification.But how to handle the legacy data with table format in the previous releases is still under discussion. If the structure of spec has a big change compared to the previous versions,it may cause confusion.Anyway, considering the possible benefits, we are open to this optimization.

**6 – Nokia Japan**

We understand the intention of the moderator. But “Simplification of band combination specifications” is just a continuation of the existing Rel-17. Hence, it may not be a good idea to mix this SI continuation and 700+800+900 proposal in the same category.

Our alternative is as follows.

Proposal #2: Endorse the continuation of “Rel-17 SI of Simplification of band combination specifications” in Rel18.

Note: how to handle 700+800+900 as one of the potential candidate topics needs further discussion with more clarification

**7 – VODAFONE Group Plc**

Thank you moderator for the summary. Whilst we appreciate the implementation challenges, we are supportive of enhancements for the 700+800+900 band combination that is inclusive of smartphone form factors.

**8 – vivo Communication Technology**

we agree with the observation from moderator. The 3UL should be removed out of scope of this spectrum proposal.

### 4.2.2 UE FR1

Based on feedback from companies, some tentative agreements seems agreeable. For other working areas, we still observe some interests as well as questions. Please the proponent tried to answer the questions.

Try to use proposal #3 to derive agreeable conclusions in the final round

**Proposal #3: Endorse the following high level topic with example working areas**

- UE RF1 requirement focus evolution, with the following example areas
  - Enable 4Tx for FWA/CPE (FFS framework and architecture) on a single band, [and enable 3Tx]
  - Enable >4Rx (including 8Rx, [6Rx]) for FWA/CPE on higher frequency bands (e.g., > 2.3GHz NR TDD bands)
  - Enhance UL CA RF requirements (e.g., PC1.5 with necessary investigation on scheduling restriction, [specify RF requirements for inter-band UL CA with UL-MIMO on one band])
  - Investigate and improve MSD for inter-band CA/EN-DC combinations
  - Investigate and improve UE performance with small A-MPR

Note: moderator will move 8Rx to demodulation topic later after the agreement is achieved for this proposal.

And one clarification: in moderator understanding, in RAN1 package they mainly target at enabling 8Tx. 4Tx can be supported already but no RF requirement for it is specified.

**For the proponents for 3/4Tx, 8Rx, please answer the following question:**

- What is the baseline capability assumption in terms of number of Tx and Rx for other work areas under this topic? (Moderator observations: 1/2Tx and 2/4Rx are baseline assumptions, 3/4Tx and 8Rx are optional features focusing on single band use case)

**For 3Tx related, please proponent answer the following questions:**

- How much MIMO performance improvement with 3Tx compared to 2Tx can be achieved, considering the increasing complexity and heating issue?
- For inter-band UL CA with UL-MIMO case, can the existing per-band RF requirements be applied on each band for the inter-band UL CA combination?
- It is unclear what the benefit of 3Tx is vs 2Tx if small antenna isolation is assumed.
- 3 band UL is really an issue in terms of co-existence and triple beat MSD issues

- Whether 3Tx chain UE is a common design for smart phone in Rel-18 timeline.
- What prevents a UE from implement 3Tx, then this UE could support UL-MMO.
- For Tx switching based on CA, the single TAG restriction should be removed.

**For lower power class, please the proponent answers the following questions:**

- Need to understand the motivation and use case why lower power class, e.g., 14dBm, is needed for Uu.
- Further justification of using low power class is needed. Is it limited to NR-U only? For cellular bands, support of low power class may have a big impact on coverage/performance.

**For simultaneous Rx/Tx for intra-band non-contiguous CA/DC in TDD band, please the proponent answer the following questions:**

- We do not understand how this can be achieved without major de-sense to gether with high MPR. Use case must be clearly defined.
- It is not clear how to handle Tx/Rx interference for intra-band case in UE side.

**For inter-band UL CA with UL-MIMO on one band, please answer the following question:**

- Does it mean UE will have three active Tx?

**Feedback Form 14: UE FR1**

**1 – Guangdong OPPO Mobile Telecom.**

**For the proponents for 3/4Tx, 8Rx, please answer the following question:**

What is the baseline capability assumption in terms of number of Tx and Rx for other work areas under this topic? (Moderator observations: 1/2Tx and 2/4Rx are baseline assumptions, 3/4Tx and 8Rx are optional features focusing on single band use case)

**[OPPO] Agree with moderator, that the 2t4r is baseline as today. And 3T/4T/8R are optional features.**

**For 3Tx related, please proponent answer the following questions:**

How much MIMO performance improvement with 3Tx compared to 2Tx can be achieved, considering the increasing complexity and heating issue?

**[OPPO]**

- **More than 50% throughput gain is observed under high SNR areas in our simulations.**
- **Certain level complexity is increased but not big since the 3Tx is only for high freq bands like n77/n78/n79 which currently already have two PAs/front end chains supported.**
  - **To support 1T@band X+2T@band Y concurrent transmission, the only thing to be added is one power supply, however, it is not necessarily to be a separate PMIC but can be a power supply link added to current PMIC. Therefore, the complexity is not high in this case.**
  - **To support 3T at one band, additional Tx front end is needed.**

- **Regarding heating issue which is quite similar to SAR issue. And currently restriction of Tx time is widely adopted for HPUE to solve SAR, and actually it also can solve the heating issue since Tx time is reduced in this case, and UE doesn't always transmit at its max power. Therefore, heating issue is not expected to be a key issue to implement 3Tx.**

For inter-band UL CA with UL-MIMO case, can the existing per-band RF requirements be applied on each band for the inter-band UL CA combination?

**[OPPO] Currently the inter-band UL CA doesn't support UL MIMO in any CC. When enabling UL MIMO in one of the CC, whether the existing requirements can all be reused may depends on some conditions like PA configurations, power class, etc. But for the Rx requirements, most likely they can be reused.**

It is unclear what the benefit of 3Tx is vs 2Tx if small antenna isolation is assumed.

**[OPPO] To enable 3Tx, antenna configurations needs to be considered, however, current UE already support 4Rx antennas and 4DL layers in high freq bands, no antenna isolation issue is found. And 3Tx actually reuse the same antennas as 4Rx antenna, therefore, no antenna isolation issue exists.**

3 band UL is really an issue in terms of co-existence and triple beat MSD issues

**[OPPO] Same view of the complexity of supporting 3bands UL, and it depends on Operator deployment requests in the end. 3Tx only gives the ability of such implementation.**

Whether 3Tx chain UE is a common design for smart phone in Rel-18 timeline.

**[OPPO] 3Tx chain is a feature that doesn't require all UEs to support as the 8Rx or other features. From implementation perspective, we see the feasibility to support this feature in some bands in Rel-18 timeline.**

What prevents a UE from implement 3Tx, then this UE could support UL-MMO.

**[OPPO] It can be understood that supporting 3Tx will add some costs and complexity, but meanwhile can improve performance in UL.**

For Tx switching based on CA, the single TAG restriction should be removed.

**[OPPO] No strong view, can be further discussed.**

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**2 – Guangdong OPPO Mobile Telecom.**

**For inter-band UL CA with UL-MIMO on one band, please answer the following question:**

Does it mean UE will have three active Tx?

**[OPPO] It is one scenario to be covered with 3Tx, i.e. 1T@band X+ 2T@band Y**

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**3 – QUALCOMM JAPAN LLC.**

The high level topics are a good start. A good prioritization exercise will be needed since there are quite a lot of items and some of them have bigger RF impact compared to others.

To address the question on 8Rx baseline capability: first of all, Tx and Rx capabilities should be separated as they have on dependency on each other. For an 8Rx UE, the baseline capability would be the number of layers mandatory for each band(e.g. 4Rx in the bands >2.5GHz).Our understanding is that 8Rx will be an optional feature. In terms of dependencies with other proposals, the other proposed enhancements could consider just the basic capability as baseline. If needed, combinations(e.g. 8Rx + 3Tx, 8Rx + switching, etc) can be considered after the baseline requirements are finalized.

We assume that discussion on some of the topics will continue in the extended round after proponents provide answers to the questions.

**4 – China Telecommunications**

Ok with the moderator summary as a starting point for future discussion.

For 6Rx, since it is a new proposal in the intermediate round, and not checked by other companies yet. We wonder whether it is a typical UE implementation.

For UL CA with PC 1.5, in general we support the work. Sorry that we have a late clarification question: whether 26dBm + 23dBm for TDD+FDD CA is also covered?

For lower power class, we also have concern on the impact to network coverage/performance if it is considered for cellular bands.

**5 – LG Electronics Deutschland**

Moderator's proposal is generally fine for us and we need to be open to the proposals under question. If the questions are addressed with reasonable answers from the proponent, these should also be included as an example working area.

Regarding the questions on lower power class, the motivation and use cases can be found in Rel-17 NR-U WI discussion for other countries (NR_*6GH*_unlic_full) in RAN4 #100e meeting where VLP (Very Low Power) mode of operation with 14dBm power is proposed to reflect the regulation from South Korea and other countries. We intend to specify the power class of this 14dBm device in a 6GHz unlicensed band for Uu in Rel-18 if RAN4 cannot finalize this discussion in Rel-17. Regarding SL, we don't have a strong opinion.

Regarding simultaneous Rx/Tx for intra-band non-contiguous C/DC in TDD band, this discussion is motivated from Rel-17 SL enh. WI where Uu+PC5 SL can be operated concurrently and thus simultaneous Tx/Rx can happen under this scenario. RAN4 concluded this scenario can be discussed after simultaneous Rx/Tx Uu in intra-band is specified first. And it seems many companies are looking at this as similar to FDR or XDD. We would like to clarify this is not something related to FDR or XDD at least from our proposal perspective since this is CA not a single carrier and there is simultaneous Tx/Rx for inter-band CA but no scenario for intra-band CA. On the question of de-sense and MPR, we think there should be a study to know how much frequency gap between Tx and Rx is needed to have reasonable MPR or de-sense without any interference cancellation scheme. That is why we focus our scenario on non-contiguous CA. In summary, by having a frequency gap between Tx and Rx, self-interference inside UE can be addressed along with reasonable MPR and de-sense but the detailed values should be studied in Rel-18.

**6 – LG Electronics Deutschland**

Adding on the previous comments on simultaneous Rx/Tx for intra-band non-contiguous CA/DC in TDD, there is potential use case in Korea as commented by LG Uplus.

**7 – Skyworks Solutions Inc.**

Without a real use case and description of the deployment Intra-band simultaneous Tx/Rx is hard to understand: cannot happen in a TDD band and exists de facto in an FDD band

3UL bands really need some identified use cases and potentially check which restrictions may apply

**8 – HuaWei Technologies Co.**

To Qualcomm and LGE, yes, if the questions or concerns are addressed, we can add more working areas. Otherwise, the related proposal will be postponed for further discussion. According to feedback so far, most part of proposal #3 seems agreeable except for 3Tx and PC1.5. The further responses are needed for PC1.5 (CTC whether 23+26 is included) and some questions on 3Tx.

To move forward, I make some modfication to see if we are OK with those example working areas:

**UE RF1 requirement focus evolution, with the following example areas:**

•Enable 4Tx for FWA/CPE (FFS framework, architecture and bands) on a single band, [and enable 3Tx]

•Enable >4Rx (including 8Rx, [6Rx]) for FWA/CPE on higher frequency bands (e.g., > 2.3GHz NR TDD bands)

•Enhance UL CA RF requirements (e.g., PC1.5 with necessary investigation on scheduling restriction, [specify RF requirements for inter-band UL CA with UL-MIMO on one band])

•Investigate and improve MSD for inter-band CA/EN-DC combinations

•Investigate and improve UE performance with small A-MPR

NOTE: further prioritization for above items are needed in future meeting.

**9 – Ericsson France S.A.S**

Regarding the proposed WF:

Regarding the 4TX, we propose to put [for CPE/FWA] in square brackets and double check whether applicability to handheld should be considered:

Enable 4Tx for [FWA/CPE] (FFS framework and architecture) on a single band, [and enable 3Tx]

Regarding the CA RF requirements, as we commented in the intermediate round we thing that removal of the single TAG restriction should be considered:

· Enhance UL CA RF requirements (e.g., PC1.5 with necessary investigation on scheduling

restriction, [specify RF requirements for inter-band UL CA with UL-MIMO on one band], [removal of single TAG restriction for TX switching])

A clarification:

**For inter-band UL CA with UL-MIMO on one band, please answer the following question:** − Does it mean UE will have three active Tx?

If the UE supports TX switching then it will be 2 TX

**10 – Intel Corporation (UK) Ltd**

- We are fine with the adjusted list as a starting point of discussion
- For "4TX/3TX" we suggest rephrasing the example area as
  - *Enable > 2Tx on a single band including 4Tx for FWA/CPE (FFS framework and architecture), and/or [3Tx]*

**11 – AT&T GNS Belgium SPRL**

We are OK to use the moderator's adjusted list in further discussions towards defining the scope.

**12 – vivo Communication Technology**

For low power class, the intension is to cover new type of UEs, e.g. IoT devices, device only working with Indoor scenario, wearable devices. For LTE eMTC and NB-IOT, there are devices supporting power class 5 (20dBm) and power class 6 (14dBm). We think similar NR devices for low power use cases can be developed.

Ok with 8Rx+3Tx for CPE devices. But for smartphone, we have concern on developing 3Tx within Rel-18 timeline.

**13 – Huawei Technologies France**

Regarding 4Tx and >4Rx, we think the targeted UE type is for FWA/CPE.

Enhance UL CA RF requirements, for the question by CTC, we think PC1.5 for one band is not precluded.

For enhance MSD for inter-band CA/EN-DC combinations, in general, we are fine to have MSD improvement study to address the larger REFSENS degradation issue, but since there are lots of issues to be considered, without a clear understaing of all the issues under discussion in RAN4, we think a SI first would be better.

Investigate and improve UE performance with small A-MPR, not clear of the specific issue for small A-MPR. Since A-MPR is band specfic, would like to understand the improvement is for which band?

### 4.2.3 UE FR2

Based on the feedback from companies, some tentative agreements seems agreeable. For other working areas, we still observe some interests as well as questions. Please the proponent tried to answer the questions.

Try to use proposal #4 to derive agreeable conclusions in the final round

**Proposal #4: Endorse the following high level topic with example working areas**

- UE RF2 requirement focus evolution, with the following example areas
  - Investigate (gain, operating SNR, implementation aspects) and if possible enable UL 256QAM
  - RF enhancement in FR2-1, including
    - Vehicular UE requirements for power class in 39GHz
    - Inter-band DL/UL CA
      - Vehicular UE requirements for inter-band DL/UL CA, e.g., 28+39GHz
      - [Inter-band UL CA based on CBM, depending on input from operators]
  - RF enhancement in FR2-2, including
    - Intra/inter-band DL/UL CA
      - [Inter-band CA supports for FR2-2 based on CBM/IBM depending on the conclusion of Rel-17]
      - Intra-band CA for FR2-2
    - [Investigate (gain) and if possible enhance FR2-2 switching time (ON/ON transient time)]
  - Other Rel-17 leftover topics

**For switching time enhancement, please proponent address the following comment:**

- Whether the switching time enhancement is necessary.

**For UE antenna scaling, please proponent answer the following questions:**

- We need understand what is really needed from a specification point of view. Antenna scaling is already possible. What aspects are not possible with current specifications?
- Need a detail on antenna scaling to understand it better (please refer to the initial round section)
- It is a RAN1 related topics which should not be considered in RAN4 before PHY aspects are clear.

**Feedback Form 15: UE FR2**

**1 – Apple AB**

**For UE antenna scaling, please proponent answer the following questions:**

*We need understand what is really needed from a specification point of view. Antenna scaling is already possible. What aspects are not possible with current specifications?*

**[Apple]:** Indeed, any UE implementation can enable and disable tx/rx chains driving the corresponding FR2 antenna elements transparently to the network, and we do observe this behavior in the field. Our motivation for this study is rooted in the observation that when the UE performs this scaling autonomously, there is a delay till the network knows by receiving UE measurement report or PHR report. The cause for performance degradation is how fast the UE can inform the network of its scaling with such reports. Before the network receives such updates, the network would rely on previous reports and there is a mismatch between what the network assumes and what the UE uses, which leads to performance degradation. The major questions here are how much degradation in system performance does transparent antenna scaling involve, and how this degradation can be mitigated.

*Need a detail on antenna scaling to understand it better (please refer to the initial round section)*

**[Apple]:**Antenna scaling is the UE action of powering down or powering up a tx/rx chain driving an FR2 antenna element. This changes the total number of active antenna elements in an FR2 array and, consequently, changes the total number of available beams. There are many possible conditions which can trigger antenna scaling, such as Rx signal strength reaching a certain threshold, power headroom reaching a certain threshold, etc. The motivation from the UE side is, as always, power savings. As the network creates more opportunities for the UE to reduce the number of active antenna elements, while minimizing deviation from optimal performance, the UE's overall battery lifetime can increase without impacting the end user's experience.

*It is a RAN1 related topics which should not be considered in RAN4 before PHY aspects are clear.*

**[Apple]:** We feel it is better to fully discuss this topic in RAN4 first, due to RAN4 expertise in practical implementations of FR2 antenna arrays and their performance. Once it is clearly defined and recognized in RAN4, we are fine to consider this topic in RAN1 too if RAN1 needs to get involved.

**2 – China Telecommunications**

Ok to have a study phase for UL 256QAM, similar to what we did for the DL FR2 256QAM.

**3 – QUALCOMM JAPAN LLC.**

For the vehicular UE in 39GHz, what is the use case? so far we are not aware of any vehicular UEs in any of the FR2 bands.

The general topics are a good start, more discussion will be needed to better understand the needs for these requirements to be able to prioritize accordingly.

**4 – LG Electronics Deutschland**

We are OK with moderator's proposal. Regarding [Inter-band UL CA depending on the conclusion of Rel-17], our understanding is that CBM for inter-band DL CA is discussed in Rel-17 as UE capability and not based on the input from operator. Therefore, the same logic can be applied to FR2 inter-band UL CA with CBM in Rel-18.

**5 – HuaWei Technologies Co.**

Moderator: Please proponent answer questions from Qualcomm. If still there is question from one or some companies, I can put [ ] on vehicular UE in 39GHz for the time being.
**UE RF2 requirement focus evolution, with the following example areas:**

•Investigate (gain, operating SNR, implementation aspects) and if possible enable UL 256QAM

•RF enhancement in FR2-1, including

<Sub-bullet>: [Vehicular UE requirements for power class in 39GHz]

<Sub-bullet>: Inter-band DL/UL CA

<Sub-Sub-bullet> Vehicular UE requirements for inter-band DL/UL CA, e.g., 28+39GHz

<Sub-Sub-bullet> [Inter-band UL CA based on CBM, depending on input from operators]

•RF enhancement in FR2-2, including

<Sub-bullet>: Intra/inter-band DL/UL CA

<Sub-Sub-bullet> [Inter-band CA supports for FR2-2 based on CBM/IBM depending on the conclusion of Rel-17]

<Sub-Sub-bullet> Intra-band CA for FR2-2

<Sub-bullet>: [Investigate (gain) and if possible enhance FR2-2 switching time (ON/ON transient time)]

• Other Rel-17 leftover topics

**6 – Ericsson France S.A.S**

To the moderator: The note about prioritization of the example areas in a future meeting needs to be added here too.

Regarding the antenna scaling and the signalling to the network; in the current specifications the UE cannot modify it's PHR report to the network as a result of deactivating parts of it's antenna. Is the intention to enable the UE to reduce it's output power in good SNR conditions ?

**7 – Intel Corporation (UK) Ltd**

- We are fine with the list as a starting point of discussion
- For Intra-band CA for FR2-2 we suggest to clarify that CBM/IBM can be considered
  - *"Intra-band CA **support** for FR2-2 b**ased on CBM/IBM** "*
- For Inter-band CA for FR2-2 the motivation was to consider CA between FR2-2 and FR2-1. Suggest to updated as:
  - "*Inter-band CA support **between FR2-1 and FR2-2** based on CBM/IBM depending on the conclusion of Rel-17"*

- For "**switching time enhancement**" the motivation is to improve FR2-2 performance for high SCS. Current switching time can have a negative impact on FR2-2 throughput performance since the transient period may occupy several symbols and further enhancements are important to improve performance. We are ok to have a study on this.

**8 – Huawei Technologies France**

RF enhancement in FR2-2

For inter-band case, some clarifcaion is needed whether it is for bands in FR2-2 only or between FR2-1 and FR2-2?

FR2-2 switching time

Since RAN4 just made conclusion on transient period for FR2-2 in #100e meeting, not sure whether need to consider it in Rel-18. Some further discussion is needed.

UE antenna scaling

Power saving or beam mangement are RAN1 topics, it's not clear for the purpose of power saving, whether it it is necessary to consider antenna scaling. Necessity should be justified by RAN1 firstly.

### 4.2.4 BS RF

Based on the feedback from companies, it seems that more discussion is needed. For other working areas, we still observe some interests as well as questions. Please the proponent tried to answer the questions.

Try to keep proposal #5 for high level topic

**Proposal #5: Endorse the following high level topic**

- BS RF requirement focus evolution

**For mmWave multi-band BS, please proponent answer and reply the following questions:**

- What is the example band combination?
- What is the deployment and what requirements need be introduced?
- Need to check the feasibility to support multi-band BS especially from different frequency groups (e.g. 28+39GHz)
- Need understand the necessity and urgency. Need see the request from operators.

**For HBS, please proponent answer and reply the questions and comments:**

- What is the intended deployment scenarios for HBS? (some response from CMCC already)
- We do not understand why a separate BS class is needed and why the scenarios can't be covered by LA BS class?

**For NTN BS Type 1-O, please proponent replies the following comments:**

- Requirements is leftover issue in on-going Rel-17 NTN WI. Cannot see the motivation to propose it in Rel-18 for the time being.

**Feedback Form 16: BS RF**

**1 – China Mobile Com. Corporation**

HBS From CMCC perspective, it is necessary to choose suitable BS class to achieve low cost, easy realization and popularization while meeting the requirements of indoor applications. Defining HBS class separately is to take into account that HBS and LA BS could have different RF requirements resulting in cost differences, such as ACLR, Transmitter spurious emissions, etc. And co-existence evaluation of HBS should be based on lower output power rather than the output power level of LA BS. We need to introduce BS class suitable for indoor scenarios, and there may be further relaxation of RF requirements for HBS. So this HBS WI is aimed to further evaluate and define HBS new BS class to meet deployment demand. Not only the application demand side, but also cost reduction as a major factor. We have defined the class of HBS in LTE phase, and we need to give full play to the advantages of HBS in 5G.

**2 – Huawei Technologies France**

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

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.

For BS capable of multi-band operation, the operating band frequency range cannot be considered as out-of-band frequency range as single band operation, and the requirements similar to FR1 MB-BS should be considered, e.g. additional consideration for SE and OBB. For detailed info, the existing MB requirements for FR1 in TS 38.104 could be a reference. Whether different frequency groups could be supported, we are open to have further study.

Regarding the urgency issue, we see BS is different from UE side. 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, we see Massive MIMO is a very popular deployment scenario nowadays around the world. As inter-band CA for FR2 was already introduced from Rel-16, in our view, it's the right time to consider mmWave MB-BS for 5G-advanced in Rel-18.

**3 – HuaWei Technologies Co.**

Moderator: Thanks for reply from proponent. I wonder if those responses addressed the concerns. Either adopting the high level topics or adopting the high level topics as well as some working areas in [ ] are OK for me. Please provide your suggestsion.

**4 – Ericsson France S.A.S**

Regarding the home BS, if the output power is low then the absolute ACLR will become less stringent than relative ACLR and will apply. So the ACLR requirement will anyhow relax compared to an LA operating at the maximum LA output power. Is it just the OBUE mask that would differ in the end ?

Regarding the multi-band BS, this is not the same issue as CA for UEs, it is about whether BS generate carriers using the same RF or not, not whether the UE is served on multiple carriers. For combinations of 26-28GHz and 39-40GHz, we do not see a need to prioritize in the Rel-18 timescale. For 26/28 we would welcome comments on the relevance for that in Rel-18 timescale. Overall creating a specification is feasible, but not urgent if the other workload is high for Rel-18.

**5 – Nokia Japan**

The proposal from the moderator looks reasonable. In order to shorten the list of working areas in the future meetings as mentioned by the moderator in RRM area, we believe it is necessary and important to share details of the objectives well in advanced.

**6 – ZTE Corporation**

We are open to further discuss the mmWave multi-band BS, however as deployment scenarios and feasibility study are needed before triggering the normative work in RAN4.

**7 – China Unicom**

In our view, multi-band BS is better than single-band BS in terms of network deployment flexibility. In the long run, we are positive to the introduction of enhancements in BS capabilities.

### 4.2.5 RRM

Based on the feedback from companies, it seems that companies are not ready to discuss the details about the working areas for this topic. So moderator would like to propose agreeing on high level topic and try to agree on some working areas in high levels. And more discussion should be expected in the following meeting to short the list of working areas.

**Proposal #6: Endorse the following high level topic**

- RRM requirement focus enhancement

**Feedback Form 17: RRM**

**1 – Apple AB**

We agree with the observations from the moderator. For time being, it is still beneficial to categorize for the high-level topics as (1) R17 drop off topics (2) newly identified topics in R17 (3) Newly identified topics in R18; Such practice will help to balance the work among in-field issues, leftover issues from early release(s), and new enhancement.

**2 – QUALCOMM JAPAN LLC.**

This high level is very generic and there are many proposals. A further categorization would be useful to

drive the discussions. It is unlikely we would be able to accommodate more than a few objectives given the amount of proposals and the fact that the RRM room has been overloaded for a very long time.

**3 – LG Electronics Deutschland**

We agree with moderators view since Rel-17 RRM has just begun in RAN4 and some time is required to assess what is really necessary areas in Rel-18. On FR2 RRM we think enhancement of UE Rx beam operation can be one of topics to be considered but open to further discuss.

**4 – Ericsson LM**

We agree that at this stage it is not possible to agree on any concrete objective for RRM since it depends a lot on progress of existing Rel-17 WIs involving RRM. Agree with Apple that aim should be to have balance between new areas and leftovers from previous releases. In the latter case (leftovers) now we have leftovers from RAN1/2 specs (e.g. need for gap) as well as from R17 WIs.

**5 – Huawei Technologies France**

We support to at least define some newly identified R18 objectives. We think new release is not only to find and fill gaps based on previous release, but new enhancements related to near and mid-term commercial deployments should be involved in R18. FR2 operation provides ultra-high throughput and ultra-low latency and we expect it to be more widely deployed in Rel-18 time frame compared to earlier releases. However current FR2 related RRM requirements may not be able to fully realize the potential of FR2 operation, e.g., latency is long, requirements are not complete, etc. therefore we suggest that R18 new identified topics focus on FR2 RRM enhancement.

**6 – Intel Corporation (UK) Ltd**

- We agree that it may be difficult to converge on the set of topics. However, we think it is helpful to make categorization of possible proposes as a part of this email discussion. For categorization we suggest at least
  - *FR2 enhancements*
  - *General RRM requirements enhancements and leftovers*
  - *Measurement Gap related enhancements*
  - *FR2 HST enhancements*
- We think that the set of candidate topics provided in this meeting should be a starting point of further discussions. In particular, we would like to avoid starting the next round of discussions from the very beginning. Therefore, we recommend to capture the list from the intermediate summary in email discussion summary (for information).

**7 – HuaWei Technologies Co.**

Moderator: according to feedback, I try to adopt some working areas in [ ] as starting point to check if it is acceptable for everyone.

RRM requirement focus enhancement

- FR2 RRM enhancement
- Leftovers from previous release
- Others

| |
|---|
| **8 – Nokia Japan**<br>We agree with moderator's views and proposal #6. In order to shorten the list of working areas in the future meetings as mentioned by the moderator, we believe it is necessary and important to share details of the objectives well in advanced. |
| **9 – vivo Communication Technology**<br>Agree with the proposal from moderator. |
| **10 – vivo Communication Technology**<br>Regarding the detailed sub-bullets, we have the following suggestions:<br>RRM requirement focus enhancement<br>-Leftovers from previous releases<br>-Newly identified areas<br>-Others |
| **11 – CATT**<br>we agree that it's not possible to agree on any details at this moment. so we support the moderator's recommendation to only agree on the high level proposal now. |

### 4.2.6 Demodulation

Based on the feedback from companies, it seems that companies are not ready to discuss the details about the working areas for this topic. So moderator would like to propose agreeing on high level topic and try to agree on some working areas in high levels. And more discussion should be expected in the following meeting to align the scenario and agreement on performance gain.

**Proposal #7: Endorse the following high level topic with some working areas**

- Demodulation focus requirement evolution, with the following areas
  - UE advanced receiver
  - [BS advanced receiver]
  - Other leftovers

**Feedback Form 18: Demodulation**

| |
|---|
| **1 – Apple AB**<br>We are OK with moderator's suggestion. Also it is proposed that demodulation requirements evolution shall be introduced based on market demand, feasibility study and benefits of the proposed enhancements. |
| **2 – China Telecommunications**<br>Ok with the moderator recommendation to only agree on some working areas in high levels in this week, and hope to have more detailed discussion during RAN #93e meeting. |

**3 – QUALCOMM JAPAN LLC.**

For now this is ok but here also, probably further categorization will be needed to be able to prioritize the work accordingly. We would also like to propose a work item on defining requirements for Application Layer throughput considering tha the RAN5 led SI was just closed and the RAN4 part was found feasible.

**4 – ZTE Corporation**

**Demod:**

Similar as other companies comments, it might be not possible to approve lots of items, then how to find most useful and meaningful use case might be needed especially from in-field problems identified already.

**5 – Intel Corporation (UK) Ltd**

- We are fine with the list as a starting point of discussion (and of course further prioritization is needed)
- We think that the set of candidate topics provided in this meeting should be a starting point of further discussions. In particular, we would like to avoid starting the next round of discussions from the very beginning. Therefore, we recommend to capture the list from the intermediate summary in the email discussion summary (for information).

**6 – Huawei Technologies France**

We are fine with moderator's recommendation.The further categorization and priority can be based on NR specific features and real network issues identified, such as Soft IC for MU-MIMO, especially up to 4 layers for one CW that cannot be addressed by CW-IC; TRS/SSB IM considering the TRS/SSB colliding configuration in the current real network and serious interference caused; E-MMSE-IRC for uneven interference considering the flexible time and frequency domain resource allocation in NR. The detailed work scope for each topic can be further discussed during RAN#93.

**7 – HuaWei Technologies Co.**

Moderator: agree with most companies that we should focus on the technique to provide benefit. For Qualcomm new proposal we can further discuss it in upcoming RAN plenary like what RAN Chair requested.

Demodulation focus requirement evolution, with the following areas

- UE advanced receiver

S advanced receiver

- Other leftovers

**8 – Ericsson France S.A.S**

It is not quite clear what is agreed here. Is it that the scope of demodulation is advanced receivers and leftovers only ? There are proposals for e.g. 8RX and 256QAM; these involve RF but there will also be a demodulation part; how about those ? And if there are issues that are seen from deployments ?

**9 – Nokia Japan**

We agree with the shared moderator's view and the proposal. One clarification is that what is the [ ] for BS advanced receiver intended for here?

We also want to stress again that test feasibility for BS inter-cell/user interference advanced receivers is unclear at the moment. Providing further observations on this topic in the future is strongly encouraged.

**10 – HuaWei Technologies Co.**

**Moderator:**

to Ericsson: 8Rx will be moved here. And UL 256QAM needs both RF and demodulation. We put it under "UE RF requirement **focus** evlaution". We follow the comments from CTC in first round for this categorization. After all at the current stage, following RAN Chair guidance, we focus on working out the working area rather than mapping the working are to specific WID.

To Nokia: [ ] means there is a few companies experssed some concern and most companeis seemed OK. If companies had concern, I could remove it for the time being. We can further discuss it in the future.

Modified proposals as below:

Demodulation focus requirement evolution, with the following areas

- UE advanced receiver
- Other leftovers

### 4.2.7 Testing and EMC

Based on the feedback from companies, it seems that we can agree on the high level topic. For the working areas, some questions need be answered.

**Proposal #8: Endorse the following high level topic with some working areas**

- Testing enhancement and EMC enhancement, with the following areas
  - EMC enhancement for both UE and BS
  - [OTA testing enhancement]
    - [Testing framework for FR2 FWA devices (PC1/PC5 in FR2)

For OTA testing enhancement, please proponent respond the following comments

- For dynamic MIMO OTA testing, it would be good to check first the progress of basic "static" FR2 MIMO OTA requirements work of Rel-17, which is intended to meet the fundamental conformance test purpose.
- Even "static" MIMO OTA test and requirement definition are not easily finalized, and we would like to understand the intention to have more testing.

**Feedback Form 19: Testing and EMC**

**1 – China Telecommunications**

For dynamic OTA testing, with the purpose of guaranteeing FR2 UE performance/requirements in mobility and rotation status, we see the benefit of this study.

**2 – QUALCOMM JAPAN LLC.**

Why is the entire OTA testing enhancements in []? Testing framework for FR2 FWA devices in this is not related to the proposal on dynamic testing and is clearly an area where 3GPP conformance testing is lacking.

For the proposal on the dynamic OTA testing, this is not related to the "static" MIMO OTA testing. MIMO OTA testing is addressing the MIMO performance of the device while the proposal on dynamic OTA testing is about studying a more advanced test methodology focusing on beam management. For example, one of the possible figures of merit will be to see how often the UE falls into beam failure.

As stated in the materials already submitted, the current tests are too simple and cannot assess the actual performance of a device in an environment closer to "real life". This is a study, whether conformance testing will also be defined is still unknown. We do not understand the comment that more testing is not needed. Even if field testing cannot be completely omitted with such a test environment, this could be simplified and debugging is much simpler because the same conditions can be recreated. This very difficult to do just with field testing.

**3 – Intel Corporation (UK) Ltd**

- For OTA testing we think that it can be helpful to list some example areas and the following aspects can be a starting point:
  - *[Testing framework for additional FR2 device types]*
  - *[FR2 dynamic OTA testing]*
  - *[FR2 OTA testing for UEs with multi-panel reception]*

**4 – Huawei Technologies France**

We are fine with moderator's recommendation.The further categorization and priority can be based on NR specific features and real network issues identified, such as Soft IC for MU-MIMO, especially up to 4 layers for one CW that cannot be addressed by CW-IC; TRS/SSB IM considering the TRS/SSB colliding configuration in the current real network and serious interference caused; E-MMSE-IRC for uneven interference considering the flexible time and frequency domain resource allocation in NR. The detailed work scope for each topic can be further discussed during RAN#93.

**5 – HuaWei Technologies Co.**

Moderator: The reason to put OTA testing enhancement in [] is because that the sub-bullet is in [ ] and another sub-bullet is under checking. But I can remove it.

**6 – Nokia Japan**

We have a similar question as we did in the proposal #7. What is the [ ] for OTA testing enhancement intended for here? Does it mean EMC enhancement for both UE and BS is prioritized and/or OTA testing enhancement requires more clarification on its objectives?

**7 – AT&T GNS Belgium SPRL**

We agree with Intel's proposal to list some example areas. We also think that there will be a need for further study on test methods for FR2-1 and FR2-2 in order to address testing of many performance requirements which cannot be tested due to significant test requirement relaxations and/or high MU.

[Study alternative FR2 test methods for areas where conformance testing is blocked due to significant test requirement relaxations and.or high MU]

**8 – Huawei Technologies France**

Sorry for our comments above for demod part, sth wrong duing the paste.

For FR2 dynamic OTA testing, the proposed dynamic OTA test has high relation with the current 'static' MIMO OTA test methodology, because the proposed dynamic OTA test environment is relied on multi AOA/multi-probe chamber which requires the validation principle to ensure the conformance. Until the latest RAN4 meeting, the validation principle and metric for MPAC chamber is still unclear and not standardized. The corresponding test parameter is private implemented, which has big difference among different vendors. So, before we have substantial progress on 'static' FR2 MIMO OTA test methodology, we don't see the possibility to study dynamic OTA that do not have any prerequisite knowledge. Meanwhile, we don't see the necessity on dynamic OTA tests that has already been covered by existing tests and well performed by industry.

**9 – vivo Communication Technology**

For FR2 dynamic MIMO OTA testing, we have interests to study the feasibility of the novel test methodologies. However, the potential impacts on RRM aspects should be clarified, are we going to define new RRM test cases/requirements in 133, based on this new test method?

**10 – HuaWei Technologies Co.**

**Moderator:** i

Testing enhancement and EMC enhancement, with the following areas

- EMC enhancement for both UE and BS
- OTA testing enhancement
  - *[Testing framework for additional FR2 device types]*
  - *[FR2 dynamic OTA testing]*
  - *[FR2 OTA testing for UEs with multi-panel reception]*

**11 – Guangdong OPPO Mobile Telecom.**

For clarification, does the dynamic MIMO OTA rely on static MIMO OTA in Rel-17? If it is, the starting time of dynamic MIMO OTA might be very late according to current Rel-17 static MIMO OTA status.

**12 – Huawei Technologies France**

We do not agree with moderator suggestion. We are not ready to accept the three sub-working areas for OTA testing enhancement. We do not know what is the relation between it and field testing. We have concern on the workload. And any new complext OTA testing will cause unnecessary burden to UE.

### 4.2.8 Across areas

Based on the feedback from companies, it seems that we can agree on the high level topic. For the working areas, some questions need be answered. Each working area seems big. More discussion on the scope is needed. And the prioritization within this topic would be needed.

**Proposal #9: Endorse the following high level topic with some working areas**

- Evolution of requirements across RF, RRM and demodulation, with the following example areas
  - Support of intra-band non-collocated EN-DC/NR-CA deployment (including FR, RRM and demodulation performance requirements)
  - ATG (air-to-ground network)
  - [Co-channel HAPS]
  - [Requirement for FR2 multi-Rx chain DL reception including 4-layer DL MIMO (including RF, RRM and demodulation requirements and OTA test methods)]
  - [[FR1]/FR2 HST enhancement (including CA FR2, multi-panel simultaneous operation, high velocity supporting up to 500km/h)]

**Please proponent answer the questions:**

- It also has to be clarified what is the possible impact to other WGs from some of these items.

**For ATG, please proponent answer the following questions:**

- ATG should be included as a lower priority.
- Connections and boundaries between NTN, ATG and HAPS must be clarified to allow for non-overlapping requirement and scenario work.

**For Co-channel HAPS, please proponent answer the following questions:**

- What is the relation between this and thread [RAN93e-R18Prep-15]?
- For co-channel study between HAPS and TN, we wonder if any operator is interested in it. (ZTE: no coexistence issues should be guaranteed with proper network deployment)

**For FR2 HST enhancement, please proponent answer the question and address the following comment**

- Is the FR2 related HST enhancement targeting on the handheld UE? A feasible study is needed.
- We do not see this as so urgent unless specific needs are identified in deployments. We not that it is possible to operate 2 panels for FR2 deployment if each panel is operated as a separate UE in uni-directional; this will double the throughput.

**Feedback Form 20: Across areas**

**1 – SoftBank Corp.**

***For Co-channel HAPS, please proponent answer the following questions:***

*What is the relation between this and thread [RAN93e-R18Prep-15]?*

*For co-channel study between HAPS and TN, we wonder if any operator is interested in it. (ZTE: no coexistence issues should be guaranteed with proper network deployment)*

Sorry for jumping in so late. I didn't notice that HAPS discussion is taking place here. Yes, We are the company considering co-channel deployment.

**2 – Apple AB**

As what we have commented in the last two rounds, we understand operators' demands on intra-band non-collocated EN-DC/NR-CA deployment. Due to significant impact on existing UE architecture, the related feasibility and performance degradation study is necessary.

**3 – QUALCOMM JAPAN LLC.**

Why is the 4L DL MIMO proposal in FR2 in []? This has not impact on other WGs. It would actually be a left over from FeMIMO since it is unlikely that RAN4 will be able to finalize the requirements for it. In our understanding all the needed framework is already supported, only RAN4 requirements are lacking.

to Apple: requirements can be defined in an agnostic way of the number of needed panels. UEs could potentially have one or multiple panels and still support 4L. This can be discussed when the requirements are defined. We do not see the need for any feasibility study, this is clearly feasible to implement. As far as we are aware, there are commercial UEs in the market that have multiple panels. This feature is introduced in RAN1, there is no need to study the performance gain since this was established when feature was introduced.

To Nokia: We agree that testing enhancements are needed, please see our proposals on testing to also enable multi panel testing together with more advanced testing.

To Intel: What is the intention to have the restructuring of the objectives? As we commented to Apple, requirements could be defined in an agnostic way. Detailed objectives can be discussed in the next round of discussions.

**4 – China Telecommunications**

For intra-band non-collocated EN-DC/NR-CA deployment, there is a typo, "FR" to "RF".

For ATG, we don't think it should be treated as lower priority. ATG is targeting different scenarios compared to NTN and HAPS, and the scope has been well discussed in previous RAN meetings.

**5 – KDDI Corporation**

To Apple : We understand that in last August RAN4 meeting R4-2114905 [WF on Type 2 UE RX Imbalance Requirement] was agreed, and to us it seems the relevant discussion has already started in RAN4. So, we are wondering why study is necessary.

**6 – China Mobile Com. Corporation**

− ATG should be included as a lower priority.

**[CMCC]** We would like to ask what does "RAN4 low priority" mean? What are the criteria for prioritizing? Why are the urgent commercial demands of operators, which have been continuously voiced for more than

a year, defined as low priority only because several companies have no interest in this WI? We strongly suggest that priority should be given to the clear demands of operators, the expansion of 5G business and the urgent needs of the industrial chain for ATG business.

− Connections and boundaries between NTN, ATG and HAPS must be clarified to allow for non-overlapping requirement and scenario work.

**[CMCC]** RAN4 related WIs need to consider the differences in deployment scenarios and device types. We cannot simply assume that ATG, NTN, and HAPS are associated with non-ground services and therefore are overlapping requirements or scenarios. There are differences in deployment scenarios and device types that make it necessary to define ATG WI separately. For deployment scenarios, ATG involves communication between ATG base stations on the ground and aircraft as CPE in the air, which is completely different from NTN and HAPS deployment scenarios. For device types, ATG ground-base stations unique to the ATG system need to be defined, and the biggest difference is that the new UE types for airborne ATG CPE are completely absent from NTN and HAPS systems. We have been discussing the difference between ATG and NTN systems for more than one year, and ATG WI is quite stable, it is necessary to have a separate ATG WI Led by RAN4 in REL-18. RAN4 independently carried out ATG WI, which also avoided the multi-scenarios, multi-device types and multi-requirements set that brought a very large workload to 3GPP RAN4 and caused confusion of WI scope.

**7 – SoftBank Corp.**

Regarding the comment from Apple about intra-band non-collocated EN-DC/NR-CA deployment, my understanding is that the detailed scope is the next stage discussion. Since we have a plan to submit a contribution talking about the potential scope, let's start the discussion based on that.

**8 – ZTE Corporation**

**ATG:**

We fully disagree to treat ATG with lower priority, this has been well recognized by vertical industry from Rel-17, we should respect the vertical industry request to explore more 5G NR application scenarios.

**Co-channel HAPS:**

we think that it might reasonable to have co-channel HAPS study, however as we mentioned previously, with appropriate RF requirements and network deployment, it's not expected to have any performance degradation from coexistence perspective with other terrestrial network.

**9 – Samsung Electronics Co.**

For FR2 HST, at least in our understanding, roof mounted CPE are still targeting UE type as Rel-17. No intention to invovle handheld UE unless clear request from operators are proposed. For multipanel reception, at least our understanding is to enable 2 active panels with simultaneous recetpion capability in Rel-18 for identified scenarios including both unidirectional and bi-direction scenarios.

**10 – Intel Corporation (UK) Ltd**

- We are fine with the list as a starting point of discussion
- For 4 MIMO layers and multi-panel reception
  - We do not see any RAN1 impact for this item and it is already possible from RAN1 perspective starting from Rel-16.
  - To QC: We think that multi-panel reception is a more realistic use case to enable 4 DL MIMO layers, but open to consider feasibility of single panel use case.

- Overall multi-panel simultaneous reception can bring benefits on top of 4 MIMO layers and such UEs will have enhanced baseband capabilities which can be beneficial to improve RRM performance as well.

- For FR2 HST enhancements:
  - We think that enhancements shall focus on CPEs. Meantime we think it is important to allow regular non-CPE devices to operate in the network as well and further enhancements can be considered.
  - Support of multi-panel operation can increase CPE throughput and allow more flexibility for network deployments.

**11 – Ericsson France S.A.S**

For co-channel HAPS, another question to the proponent is which RAN4 requirements aspects the co-channel study would impact ?

**12 – HuaWei Technologies Co.**

Moderator: put [Requirement for FR2 multi-Rx chain DL reception including 4-layer DL MIMO (including RF, RRM and demodulation requirements and OTA test methods] in [ ] because I use the proposal from Intel to replace the prevoius one. And it seems that some companies still have question on the panel number.

And since the proponent comment that FR1 for HST is a typo. Can we remove FR1?

Some modificaitons to address commetns from companies, Please check if it is OK for every experts:

Evolution of requirements across RF, RRM and demodulation, with the following example areas

- Support of intra-band non-collocated EN-DC/NR-CA deployment (including FR, RRM and demodulation performance requirements)

- ATG (air-to-ground network)

Co-channel HAPS

- Requirement for FR2 multi-Rx chain DL reception including 4-layer DL MIMO (including RF, RRM and demodulation requirements and OTA test methods)

rting up to 500km/h)

**13 – Huawei Technologies France**

For FR2 multi-Rx chain DL reception including 4-layer DL MIMO, we would like to better understand what's the difference with that under discussion in RAN1 for multi-TRP for multi-beam in Rel-17? Some clear conclusion by RAN1 is needed.

**14 – Nokia Japan**

In this "across area", the moderator mentioned that "the prioritization within this topic would be needed". Is this the reason that some topics have [ ] while the others don't?

**15 – HuaWei Technologies Co.**

**Moderator:**

To Nokia, [ ] does not mean prioritization. [ ] means that there is a few companeis who have concern while most companies seemed OK. The items for which people have diverse view are not in the list so far.

# 5 Extended round (if needed)

<TBD>

# 6 Moderator summary and recommendation for further discussion

## 6.1 Sumamry for general part

There were mainly two issues discussed in final round. The first is how to ensure the RAN4 objectives from other WG-led WI/SI won't fill up RAN4 capacity. The second is whether only spectrum WI can be approved in December 2021 or not, and the related issue is what definition of spectrum related WI/SI are.

For the first issue, we could modify the proposal #1 based on the concrete suggestion from Telecomitalia to check if the modified proposal is acceptable to the group. For the second issue, we see the strong views from both sides. Some companies proposed not to limit to "spectrum related", while others prefer to put such limitation (for Rel-18 items). The compromise would be to remove such sub-bullet.

Moderator suggests to endorse the following modified proposal #1.

**Proposal #1: Endorse the following principles for approve RAN4-led WI/SI package in Rel-18**

- Balance TU budget between RAN4-led WI/SI and RAN4 related objectives of WI/SI led by other WGs for Rel-18 (controversial)
  - Reserve RAN4 TUs for RAN4-led WI/SI and WI/SI led by other WGs
    - The exact value for reserved TUs will be discussed further based on inputs from RAN4 leadership and companies
  - Clearly identify RAN4 related objectives as well as required TUs for Rel-18 WI/SI led other WGs
  - If the pre-allocated RAN4 TUs for Rel-18 WI/SI led by other WGs are exceeded, down-scoping of RAN4 objectives for Rel-18 WI/SI led by other WGs would be required
- General principle for scope of Rel-18 RAN4-led WI/SI (non-controversial)
  - Balance work among in-field issues, leftover issues from early release(s), and new enhancement
  - Meet the commercial demand for practical deployment
- Timeline for approval of RAN4-led WI/SI package (controversial)
  - Approve the minimum number of non-spectrum WIs for Rel-18 based on consensus in December 2021

    - Approve the RAN4 package for non-spectrum related WI/SIs for Rel-18 in March 2022

- Clarify the boundary between spectrum related and non-spectrum related WI/SIs (non-controversial)

## 6.2 Summary for proposal part after final round

NOTE: In the following the slides, we list the topics with example working areas which can be endorsed as starting point for further refinement

- Some working areas put in [ ] needs more checking and discussions.
- The whole lists of all the topics with proposed working areas are provided in summary of intermedaite round , which can be further discussed in future meetings or email discussions.

The following proposals are recommended to be endorsed.

Based on the feedback, moderator suggest to endorse the following modified proposal #2 by changing the high level topic to avoid the ambiguity related "spectrum-related". To modify proposal #2, moderator take comment #6 as reference. According to moderator understanding and clarified by companies, the proponent proposed the method different from what were discussed in Rel-17. Continuation of Rel-17 SI is one method to form item, while a new items to have systematically study and optimize the specification is another approach. So to name a high level topic, moderator suggest to have a more common description.

**Proposal #2: Endorse the following high level topic**

- Simplification of band combination specification (FFS whether to be approved as continuation of Rel-17 SI) (controversial)
- NOTE: how to handle 700+800+900MHz band combination as one of potential candidate topics needs further discussion with more clarification. (controversial)

Based on the further comments, moderator would like to propose endorse the following proposal. The proposal of removal of single TAG restriction for Tx switching is not added for the time being in the proposal since it was not proposed in the initial round and was not listed in the proposal in the intermediate round. But we encourage companies to further look into it.

**Proposal #3: Endorse the following high level topic with example working areas**

- UE RF1 requirement focus evolution, with the following example areas (non-controversial)
    - Enable > 2Tx on a single band including 4Tx for [FWA/CPE] (FFS framework and architecture) and/or [3Tx] (controversial for 3Tx)
    - Enable >4Rx (including 8Rx, [6Rx]) for FWA/CPE on higher frequency bands (e.g., > 2.3GHz NR TDD bands) (non-controversial)
    - Enhance UL CA RF requirements (e.g., PC1.5 with necessary investigation on scheduling restriction, [specify RF requirements for inter-band UL CA with UL-MIMO on one band]) (controversial for inter-band UL CA with UL-MIMO, i.e., 3Tx)

- Investigate and improve MSD for inter-band CA/EN-DC combinations (non-controversial)
- Investigate and improve UE performance with small A-MPR (non-controversial)
- NOTE: further prioritization for above items are needed in future meeting.

**Proposal #4: Endorse the following high level topic with example working areas**

- UE RF2 requirement focus evolution, with the following example areas
  - Investigate (gain, operating SNR, implementation aspects) and if possible enable UL 256QAM (non-controversial)
  - RF enhancement in FR2-1, including
    - [Vehicular UE requirements for power class in 39GHz] (controversial)
    - Inter-band DL/UL CA (non-controversial)
      - Vehicular UE requirements for inter-band DL/UL CA, e.g., 28+39GHz (non-controversisal)
      - [Inter-band UL CA based on CBM, depending on input from operators] (controversial)
  - RF enhancement in FR2-2, including
    - Intra/inter-band DL/UL CA
      - [Inter-band CA support between FR2-1 and FR2-2 based on CBM/IBM depending on the conclusion of Rel-17] (controversial)
      - Intra-band CA for FR2-2 based on CBM/IBM (non-controversial)
    - [Investigate (gain) and if possible enhance FR2-2 switching time (ON/ON transient time)] (controversial)
  - Other Rel-17 leftover topics
  - NOTE: further prioritization for above items are needed in future meeting.

**Proposal #5: Endorse the following high level topic**

- BS RF requirement focus evolution (non-controversial)

**Proposal #6: Endorse the following high level topic**

- RRM requirement focus enhancement (non-controversial)

**Proposal #7: Endorse the following high level topic with some working areas**

- Demodulation focus requirement evolution, with the following areas
  - UE advanced receiver (non-controversial)
  - Other leftovers

**Proposal #8: Endorse the following high level topic with some working areas**

- Testing enhancement and EMC enhancement, with the following areas
  - EMC enhancement for both UE and BS (non-controversial)
  - OTA testing enhancement (controversial)

**Proposal #9: Endorse the following high level topic with some working areas**

- Evolution of requirements across RF, RRM and demodulation, with the following example areas
  - Support of intra-band non-collocated EN-DC/NR-CA deployment (including FR, RRM and demodulation performance requirements) (non-controversial)
  - ATG (air-to-ground network) (non-controversial)
  - [Co-channel HAPS] (controversial)
  - Requirement for FR2 multi-Rx chain DL reception including 4-layer DL MIMO (including RF, RRM and demodulation requirements and OTA test methods) (non-controversial)
  - [FR2 HST enhancement (including CA FR2, multi-panel simultaneous operation, high velocity supporting up to 500km/h)] (non-controversial)
  - NOTE: further prioritization for above items are needed in future meeting.

# 7 Reference

[1] RAN Chair, RWS-210659, Summary of RAN Rel-18 Workshop, https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_AHs/2021_06_RAN_Rel18_WS/Docs

[2] RAN Chair, RP-211639, Additional Guidance on RAN Rel-18 Email Discussion during August 30th and September 3rd, https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_93e/Docs/RP-211639.zip