[95e-08-RAN4-R18-Demod] - Version 0.0.8
RAN

3GPP TSG-RAN Meeting #95-e RP-22xxxx

Electronic Meeting, March 17 - 23, 2021

Agenda item: 9.1.4.4

Source: Moderator (China Telecom)

Title: Moderator's summary for discussion [95e-08-RAN4-R18-Demod]

Document for: Discussion

1 Introduction

During the pre-RAN #95e RAN4 Rel-18 email discussion, the moderator summary for [RAN95e-RAN4-R18Prep-04] Demod Enhancements was provided in [1], and the corresponding WID on NR demodulation performance evolution was provided in [2]. Based on the latest Chair guidance in RAN #95e [3], the following two objectives of demodulation performance requirement enhancements WI are kept:

- *Evaluate and specify advanced receiver to cancel inter-user interference for MU-MIMO*
  - *Phase I: Study the performance gain, reference receiver assumption, testability, required signalling overhead, as well as impact on other WGs*
    - *Further, discuss reference receiver assumption with below candidates*
      - *E-MMSE-IRC*
      - *R-ML*
    - *Target scenario: Focus on slot based transmission*
  - *Phase II (if any pending on the conclusion for phase I):*
    - *Specify PDSCH demodulation requirements under MU-MIMO scenario with advanced receiver*
      - *Note: Performance requirements shall be specified under single reference receiver assumption*

undefined *Note: To check the status of the study in RAN #100.*

- *Specify absolute physical layer throughput requirements with link adaption*

- *Note: Rel-17 RAN4 study outcome is a starting point for this objective*

In [3], TU allocation for this WI is also provided as 0.5 ~ 1 TU per meeting and starting from Q4 2022. In this email discussion, the objectives and justifications as well as other parts of draft WID can be further discussed and finalized for approval.

2 Initial round

2.1 Collection of companies' views

2.1.1 Justification

Justification is updated to keep alignment with the objectives based on the guidance in [3].

The UE demodulation single carrier performance requirements with MMSE/MMSE-IRC and R-ML receivers for scenario of single-cell single-user with multi-layer transmission were defined in NR Rel-15. In NR Rel-16, requirements for MMSE/MMSE-IRC receiver for scenario with single-cell single-user were extended to CA/DC cases. For NR Rel-17, the single carrier performance requirements for MMSE-IRC receiver with DM-RS based covariance matrix estimation for intra-cell inter-user interference under MU-MIMO scenario and inter-cell interference scenario, and CRS-IM receiver based on LLR weighting for overlapping spectrum of LTE and NR scenario are agreed to be defined.

Considering the demodulation requirement enhancement in Rel-18, for the purpose of further enhancing DL throughput and coverage performance, it is beneficial to study and specify (if feasible) requirements for more advanced UE receiver~~s~~ for following scenario~~s~~:

- *MU-MIMO scenario: Further improve the performance with advanced receiver to cancel inter-user interference.*
- ~~*[SU-MIMO scenario: Further improve performance with Soft-IC receiver to cancel inter-layer interference.]*~~

~~[~~In Rel-17, RAN4 concluded the feasibility of defining absolute physical layer throughput requirements with link adaption under RAN5 Rel-16 SI FS_UE_5GNR_App_Data_Perf. It's worth to specify absolute physical layer throughput requirements with link adaption in Rel-18 taking the study outcome of Rel-17 as the starting point.~~]~~

~~*[Uplink inter-cell interference scenario: Existing BS requirements are defined for noise limited conditions and do not allow verification of BS interference rejection capabilities under practical conditions. Interference-limited conditions are quite typical for 5G deployments and support of MMSE-IRC processing is important to guarantee good performance in the field.]*~~

Companies are encouraged to provide comments (if any) on the justification.

Feedback Form 1: Comments on justification

1 – Intel Corporation SAS Justification above is fine for us.
2 – MediaTek Inc. The current version is fine to us
3 – Ericsson France S.A.S We are OK with the proposed justification
4 – Qualcomm Incorporated We are ok with the proposal.
5 – AT&T GNS Belgium SPRL We are OK with the proposed justification.
6 – Apple GmbH We are ok with the proposed justification.
7 – China Mobile Com. Corporation We are ok with the updated justification
8 – vivo Communication Technology Ok with the updated justification
9 – Huawei Technologies France Generally we are fine with the current justification. One minor wording comment: *It's ~~worth~~**feasible** to specify absolute physical layer throughput ...*
10 – China Telecommunications Justification above is fine for us
11 – ZTE Wistron Telecom AB We are fine with the justification texts.
12 – Orange We think that SU-MIMO with soft-IC could bring significant performance improvement for 4 spatial layer DL transmission which will translate in better spectral efficiency of our 5G networks. It should be investigated in a Rel. 18 study phase and it is also an opportunity to clarify the R-ML performance benchmark.

13 – Nokia

We agree with the proposed justification.

Concerning Huawei's wording comment, changing "worth" to "feasible" change the intent of the phrase slightly.

If this part is changed, then it could be turned into "both meaningful and feasible".

2.1.2 Objective 1 on advanced receiver for MU-MIMO

Companies are encouraged to provide further comments on objective 1 in [3].

- *Evaluate and specify advanced receiver to cancel inter-user interference for MU-MIMO*
  - *Phase I: Study the performance gain, reference receiver assumption, testability, required signalling overhead, as well as impact on other WGs*
    - *Further discuss reference receiver assumption with below candidates*
      - *E-MMSE-IRC*
      - *R-ML*
    - *Target scenario: Focus on slot based transmission*
  - *Phase II (if any pending on the conclusion for phase I):*
    - *Specify PDSCH demodulation requirements under MU-MIMO scenario with advanced receiver*
      - *Note: Performance requirements shall be specified under single reference receiver assumption*

For example, it is proposed in [9] and [11] that:

- *Proponent of [9] would like to replace the 'testability' by 'interference profile' in the first bullet Phase I.*
- *Proponent of [11] suggests to remove "Note: Performance requirements shall be specified under single reference receiver assumption" and further discuss the details in RAN4.*

Feedback Form 2: Comments on objective 1

1 – Intel Corporation SAS

As for "testability", based on our understanding of the previous, this part is related to MU-MIMO modelling. However, it is not clear for us why Rel-17 MU-MIMO modelling approach (which is testable) cannot be considered here.

Replacing by "interference profile" is not clear for us. Usually, such terminology is used for inter-cell

interference level (INR). Probably proponents of this change can provide more details.

As for Note "Performance requirements shall be specified under single reference receiver assumption", we think that this note can be removed from WID and we can have more detailed discussion in RAN4 based on outcome of Phase I to define the scope the enhanced MU-MIMO requirements.

2 – MediaTek Inc.

- We support to replace testability by interference profile, which is more specific. At least from our understanding, this includes the PRB bundling, rank, pre-coder, MCS, ... of the interference.
- We prefer to keep the Note "*Performance requirements shall be specified under single reference receiver assumption*". We think this helps to control the RAN4 Demod workload. This is important in this Demod-heavy Rel-18.

3 – Ericsson France S.A.S

We prefer to keep the note "*Performance requirements shall be specified under single reference receiver assumption"* as there should be a single minimum requirement in the end.

4 – Qualcomm Incorporated

We are not sure how testability and interference profiles are related. Is it related to how precoding will be done at the TE? Any reason why we cannot reuse one of the options that we had in Rel-17 for MU-MIMO tests?

We prefer to keep the note "*Performance requirements shall be specified under single reference receiver assumption"* to limit the demod workload. It is already agreed for RAN4 to study multiple candidate receivers and RAN4 should choose only one receiver to define the performance requirements based on performance gain, UE complexity and other necessary aspects.

5 – Apple GmbH

We don't understand why testability should be replaced by 'interference profile'. The current wording is fine.

We prefer to keep the note based on agreement that requirements will be defined with only 1 reference receiver, since we have evaluating multiple candidates in the study phase.

6 – China Mobile Com. Corporation

Generally, we are ok with the objective.

Regarding whether to replace the 'testability' by 'interference profile', we think the "interference profile" means 'interference modeling'. If our understanding is correct, we prefer to use 'testability' here, since the 'performance gain' and 'testability' are derived from interference modeling. The interference modeling will be discussed anyway.

7 – Samsung Electronics Co.

It is not clear about the reason of replacing ”testability” with ”interference profile”. On the other hand, in our understanding, interference profile has to be discussed eventaully for introducing the test cases. Therefore, to address the concerns, it is suggested to add interference profile in the scope of study phase, i.e.,

- *Phase I: Study the performance gain, reference receiver assumption, testability, required signalling overhead, interference profile, as well as impact on other WGs*

We also perfer to keep the note, i.e., RAN4 shall specify the minimum requirements based on single baseline receiver.

8 – China Telecommunications

First, we agree the wording ‘testability’ can be replaced, which will make the objective clearer. We think ‘testability’ is of a more generic concept which is also related to performance gain and reference receiver assumption. Based on Intel’s concern on ‘interference profile’ may be misunderstood as the inter-cell interference level, **we suggest using the ‘interference modeling’ instead**.

It is also worth noted that the wording of the objective of MMSE-IRC receiver for suppressing inter-cell interference in the Rel-17 demodulation performance enhancement WID:

‘*Phase I: Evaluate the performance under practical MU-MIMO* ***interference profile*** *for the candidate reference receiver.*’

Second, we are fine to remove the “*Note: Performance requirements shall be specified under single reference receiver assumption*” and further discuss in RAN4. We understand usually we will only choose one candidate receiver for the requirement definition, but since we have not done any evaluation on this objective yet, it is a bit early to make this decision before the WI starts.

9 – ZTE Wistron Telecom AB

We would like to keep the note on the single reference receiver, which is important for the sake of potential workload. And the term ”testability” is too general. The wording ”required signaling overhead” can be changed to ”signaling overhead if needed”.

10 – Huawei Technologies France

We share the similar view with MTK to replace ‘testability’ by ‘interference profile’, since the later one has a more specific meaning, which has also been used in R-17 WID. From our now understanding, ‘interference profile’ refers to the INR, MCS, rank, precoding matrix, traffic loading and etc., for the interference modelling., But the testability mainly imply whether the test case is testable from limitation of testable SNR generated by TE and the feasibility of the test setup.

It is fine for us to remove the note “Performance requirements shall be specified under single reference receiver assumption” in the current WID, because it is too earlier to make such decision without any evaluations. We can discuss the performance requirements definition further based on the outcome of Phase I. Until then, it is still not late to decide to use one or both two receivers to define performance requirements. We do not think limit one receiver in the current WID can limit the demod workload, since anyway we have to evaluate the two receivers in Phase I. The remaining work after Phase I is just to define the performance requirements based on the evaluation results.

11 – Nokia Concerning the treatment of ”testability”, we see no harm in leaving it in. As others have pointed out, there exists a Rel-17 MU modelling approach that is testable, so a-priori the feature should be testable, but we are fine leave it in. Though we are also fine with adding ”interference modelling” to the list of tasks, and we share the concerns that the term ”profile” is linked to specific INR discussions and should thus be avoided. Concerning the note, we don’t have a strong opinion, but slightly prefer leaving it in, to upper bound the workload. Additionally, we have a preference to prioritise E-MMSE-IRC over R-ML, as E-MMSE-IRC is well defined (from LTE and prior NR discussions), while R-ML has a large number of possible implementations. As such we would like to propose to further mark E-MMSE-IRC as baseline.
12 – VODAFONE Group Plc We agree with replacing ’testability’ by ’interference profile’, which is more specific.

2.1.3 Objective 2 on link adaptation throughput requirements

Companies are encouraged to provide further comments on objective 2 in [3]. Note that a typo has been corrected.

- *Specify absolute physical layer throughput requirements with link ~~adaption~~adaptation*
  - *Note: Rel-17 RAN4 study outcome is a starting point for this objective*

Feedback Form 3: Comments on objective 2

1 – Intel Corporation SAS In general objective is fine for us. In the note we suggest to add the reference to SI analysis (i.e. Section 5.10 in TR 37.901-5)
2 – MediaTek Inc. The objective is fine to us.
3 – Ericsson France S.A.S The objective is fine for us
4 – Qualcomm Incorporated The objective is fine for us.

5 – AT&T GNS Belgium SPRL We are OK with the proposed objective.
6 – Apple GmbH We are ok with the objective.
7 – China Mobile Com. Corporation The objective is fine for us.
8 – Huawei Technologies France We are fine with the objective
9 – Samsung Electronics Co. We are fine with objectives
10 – China Telecommunications The objective is fine to us.
11 – ZTE Wistron Telecom AB We are fine with the objective.
12 – Nokia We agree with the objective. If it is administratively possible to reference the study in the objectives, then we are also in favour of Intel's suggestion to add it.

2.1.4 TR completion date

For objective 1 on advanced receiver for MU-MIMO, the following note is added in Chair guidance [3]. To moderator's understanding, this note can be reflected in the TR completion date.

Note: To check the status of the study in RAN #100.

Therefore, moderator proposes that:

Moderator's Proposal: *The TR capturing the Phase I evaluation outcome will be completed (i.e., for approval) in RAN #100.*

Companies are encouraged to provide comments on TR completion date.

Feedback Form 4: Comments on TR completion date

1 – Intel Corporation SAS

The moderator's proposal is fine for us.

2 – MediaTek Inc.

We are fine with moderator's proposal.

One minor comment is that perhaps moving this note under phase I could avoid some confusion.

3 – Ericsson France S.A.S

It is OK for us, although it is changing the meaning of the note slightly. "check the status of the study" could mean that the study is not complete, but the status is checked and a decision made how to proceed. The new proposal is to aim to complete the study. Anyhow it is OK.

4 – Qualcomm Incorporated

It is ok for us.

5 – Apple GmbH

RAN#100 is ok for for TR approval. But could we capture something like- "Note: Phase 1 target completion RAN#100". Check status of study phase is a bit mis-leading.

6 – China Mobile Com. Corporation

We are fine with moderator's proposal

We also slightly prefer to move the note under Phase I to make the objective clearer

7 – Huawei Technologies France

We support Moderator's new proposal which ensures that Phase I will be completed in RAN #100, it is a little confusing to check the status of the study as stated in the original Note, as if there is controversial issue to be decided by RAN plenary. Also, we prefer to add the note under 'Phase I' to make it clearer.

8 – China Telecommunications

Support the moderator's proposal. Agree with CMCC and HW to add this target date under the Phase I bullet.

9 – ZTE Wistron Telecom AB

Fine with the proposal.

10 – Nokia

We share the understanding that "checking status" is not the same as "approving the study".

However both are fine for us.

We also support to either move the note under the "Phase I" bullet, or mention "Phase I" explicitly in the note.

2.1.5 Need of Secondary WG

In the WID in [2], the responsible WG is listed as follows:

- *RAN WG4*
- *Note: FFS on Secondary responsible Working Group(s); if needed RAN WG2 and/or RAN WG1 can be added pending on the study outcome in study phase.*

In moderator's understanding, the need of secondary WG is pending on the outcome of Phase I study, similar to the Rel-17 CRS-IM discussion. So, it is proposed to not add the secondary WG for now, and further discuss the need of the Secondary WG in RAN #100.

Moderator's Proposal: *Not add the secondary WG for now, and further discuss the need of the Secondary WG in RAN #100.*

Companies are encouraged to provide comments on the need of secondary WG.

Feedback Form 5: Comments on the need of secondary WG

1 – Intel Corporation SAS The moderator's proposal is fine for us.
2 – MediaTek Inc. We are fine to re-visit the 2nd responsible WG(s) later. In this case, we suggest to still keep the Note in the WID.
3 – Ericsson France S.A.S Agree, there is no need for a secondary group right now, but if can be added as needed.
4 – Qualcomm Incorporated We have same comment as MediaTek. Ok not to have secondary WG now but suggest to keep the note.
5 – Apple GmbH We don't have to have a secondary WG right now, but we propose to keep the Note as MediaTek and Qualcomm also suggest.
6 – China Mobile Com. Corporation The moderator's proposal is fine for us.
7 – Huawei Technologies France It is not necessary to add the secondary WG and note for now and even for the future, because RAN4 can send LS to other WG for the possible impacts as did for many other WIs before.

For CRS-IM, many companies did not think that it is necessary to add WG2 as secondary working group during the previous discussion, still LS was sent to RAN2 even we added WG2 as secondary group finally.

8 – Samsung Electronics Co.

Agree to moderator proposals and also keep the notes. In current version of study phase, impact to other WG is one of study point. 2nd WG can be considered based on study phase outcome.

9 – China Telecommunications

Support moderator's proposal.

It has been already noted in ***4.1 Objective of SI or Core part WI or Testing part WI*** section in the WID (RP-220050) that:

For some of objectives, pending on the outcome in study phase; other WG impact if identified can be added in later stage during WI phase.

Therefore we think it is not needed to add this note in section 7, which may confuse MCC.

10 – ZTE Wistron Telecom AB

Moderator's proposal is fine for us.

11 – Nokia

Agree with CTC's comment. We can remove the note and add other WG later, if found necessary.

2.1.6 Others

Feedback Form 6: Any other comments?

2.2 Initial round summary

2.2.1 Summary of initial round discussion

1) Justification

11 companies are ok with the updated justification.

1 company suggests one wording update "*It's ~~worth~~ **feasible** to specify absolute physical layer throughput*". Moderator thinks this update is not essential, and recommends to follow majority companies' view to keep the original wording.

1 operator emphasizes the importance of soft-IC for 4-layer SU-MIMO. Moderator understands the request from operators. Meanwhile, it seems difficult to add new objective in this meeting. As Chair clarified in Thursday GTW session, there will be a checking point later to see whether new objective can be added for the approved items, and so SU-MIMO soft-IC can be further discussed later.

2) Objective 1 on advanced receiver for MU-MIMO

On "interference profile", based on the comments received, it is more accurate to update it as "interference modeling". In addition, it looks common understanding that interference modeling will be discussed in Phase I regardless of whether it is explicitly captured in the objective. In moderator's understanding, it is at least no harm to add "interference modeling" in the objective.

On "testability", companies have different interpretations on its meaning:

- Some companies interpret it as the feasibility of test setup from TE perspective. With this interpretation, 2 companies thinks the Rel-17 approach can be used, and 1 company thinks it is no harm to further check it in Rel-18.
- Some other companies interpret it as a more generic concept including whether testable gain can be achieved. With this interpretation, it seems it is duplicated with the term "performance gain".

Considering the interpretation of "testability" is different, and the necessity or additional benefit of keeping it is not clear, moderator recommends to remove it from the objective.

Regarding whether to keep or remove "Note: Performance requirements shall be specified under single reference receiver assumption", 5 companies suggest to keep it to minimize the RAN4 workload, while 3 companies think it is too early to make such decision. In moderator's understanding, anyway, the phase II objective (including whether to add core objective) will be updated at RAN #100, so removing the note for now will not impact the Phase I study. Instead, we can add a note under phase II saying that "Detailed objective will be added in RAN #100".

In addition, 1 company suggests that the wording "required signaling overhead" can be changed to "signaling overhead if needed", and 1 company has a preference to prioritize E-MMSE-IRC over R-ML. Moderator recommends to not make these changes considering the status of discussion in February.

3) Objective 2 on link adaptation throughput requirements

10 companies are ok with the objective 2, and 2 companies suggest to add the reference to SI analysis (i.e. Section 5.10 in TR 37.901-5).

Moderator recommends to check whether it is agreeable to all companies to add the reference in the intermediate round.

4) TR completion date

All companies are ok with the proposal that "The TR capturing the Phase I evaluation outcome will be completed (i.e., for approval) in RAN #100."

For the note of "To check the status of the study in RAN #100", if another note of "Detailed objective will be added in RAN #100" is to be added, this note can be removed to avoid duplication.

5) Need of secondary WG

All companies are ok with the proposal to not add the secondary WG for now, and some further suggestions are provided:

- Suggestion #1: 4 companies suggest to keep the note on the secondary WG
- Suggestion #2: 1 company thinks RAN2 work can be triggered by RAN4 LS even without adding RAN2 as secondary WG
- Suggestion #3: 2 companies suggest to keep the note in section 4.1 of WID on core part objective, and to remove the note on the secondary WG to avoid potential confusion to MCC

Moderator recommends to go with the Suggestion #3, and will check whether it is agreeable to all.

6) Others

No other comment is provided.

2.2.2 Proposed agreements after initial round discussion

The following agreements are proposed since they are agreeable to all companies in the initial round.

Agreement #1: The TR capturing the Phase I evaluation outcome will be completed (i.e., for approval) in RAN #100.

Agreement #2: Not add the secondary WG for now.

3 Intermediate round discussion

3.1 Collection of companies' views

3.1.1 Justification

Moderator suggests to keep the justification proposed in the initial round:

The UE demodulation single carrier performance requirements with MMSE/MMSE-IRC and R-ML receivers for scenario of single-cell single-user with multi-layer transmission were defined in NR Rel-15. In NR Rel-16, requirements for MMSE/MMSE-IRC receiver for scenario with single-cell single-user were extended to CA/DC cases. For NR Rel-17, the single carrier performance requirements for MMSE-IRC receiver with DM-RS based covariance matrix estimation for intra-cell inter-user interference under MU-MIMO scenario and inter-cell interference scenario, and CRS-IM receiver based on LLR weighting for overlapping spectrum of LTE and NR scenario are agreed to be defined.

Considering the demodulation requirement enhancement in Rel-18, for the purpose of further enhancing DL throughput and coverage performance, it is beneficial to study and specify (if feasible) requirements for more advanced UE receiver~~s~~ for following scenario~~s~~:

- *MU-MIMO scenario: Further improve the performance with advanced receiver to cancel inter-user interference.*
- ~~*[SU-MIMO scenario: Further improve performance with Soft-IC receiver to cancel inter-layer interference.]*~~

[In Rel-17, RAN4 concluded the feasibility of defining absolute physical layer throughput requirements with link adaption under RAN5 Rel-16 SI FS_UE_5GNR_App_Data_Perf. It's worth to specify absolute physical layer throughput requirements with link adaption in Rel-18 taking the study outcome of Rel-17 as the starting point.]

~~*[Uplink inter-cell interference scenario: Existing BS requirements are defined for noise limited conditions and do not allow verification of BS interference rejection capabilities under practical conditions. Interference-limited conditions are quite typical for 5G deployments and support of MMSE-IRC processing is important to guarantee good performance in the field.]*~~

Please comment if there is a strong concern:

Feedback Form 7: Comments on justification

1 – Verizon UK Ltd Justification above is fine for us although we can see the benefit from SU-MIMO with soft-IC and possible performance improvement.
2 – China Telecommunications On the one hand, we share a similar view with Verizon and Orange (commented in the initial round) that soft-IC receiver performance under SU-MIMO scenario should also be investigated. On the other hand, based on the chairman's clarification that there will be a checking point in the future RAN-P meetings to see whether new objective can be added, we are fine with the proposed justification above.
3 – VODAFONE Group Plc We share similar view with Orange, Verzion and China Telecommunications about the benefit from SU-MIMO with soft-IC.
4 – Nokia We are fine with current wording. In case "worth" is changed, then it should be changed to "both meaningful and feasible", in order to keep aligned with the original intent.
5 – Huawei Technologies France We also think that it is valuable to do investigation on performance gain of SU-MIMO Soft-IC by a study phase. The objective for RAN4 in RAN5 SI for absolute physical layer throughput is to investigate the feasibility of introduing the corresponding performance requirements, RAN4 just confirmed the feasibility to define the related performance requirements, we did not observe any RAN4 conclusion on the "meaningful" for such work, maybe clarification from Nokia is needed. As per RAN4 investigation agreement on ATP, we still think that it is necessary to change "worth" to "feasible".

3.1.2 Objective 1 on advanced receiver for MU-MIMO

The objective 1 is updated as follows:

- *Evaluate and specify advanced receiver to cancel inter-user interference for MU-MIMO*
  - *Phase I: Study the performance gain, reference receiver assumption, ~~**testability,**~~**interference modeling,** required signalling overhead, as well as impact on other WGs*
    - *Further discuss reference receiver assumption with below candidates*
      - *E-MMSE-IRC*
      - *R-ML*
    - *Target scenario: Focus on slot based transmission*
  - *Phase II (if any pending on the conclusion for phase I):*
    - *Specify PDSCH demodulation requirements under MU-MIMO scenario with advanced receiver*
      - *Note: **Detailed objective will be added in RAN #100.**~~**Performance requirements shall be specified under single reference receiver assumption**~~*

Please comment if there is a concern:

Feedback Form 8: Comments on objective 1

1 – Verizon UK Ltd

The updated objective is fine as we also believe more detail performance requirements could emerge from phase I and be further updated at RAN #100.

2 – Qualcomm Incorporated

We still prefer to keep the previous note. In LTE, we only defined the requirements with R-ML receiver. R-ML receiver should anyway perform better than E-MMSE-IRC receiver. So, we don't see any strong need to remove the note to specify performance under single receiver assumption. We would rather limit the RAN4 workload instead of keeping it vague and increase more work than necessary.

Regarding removing testability, we don't have any strong concern. But our understanding is that if any testability concern is brought up during SI or WI phase, it will be discussed and considered. If that is not the common understanding, we would rather keep both testability and interference modeling in the objective.

3 – China Telecommunications

We support the recommended wording on objective 1.

We would also like to answer Qualcomm's feedback:

First, regarding the previous note, as said in the initial round, we understand usually we will only choose one candidate receiver for the requirement definition, and it is also our preference to only define the requirements with R-ML receiver. But it seems not a typical procedure that we have begun to choose the phase II receiver even before phase I starts. In this sense, we support coming back to the note on single reference receiver assumption later.

Second, in our understanding, the phase I study on performance gain, reference receiver assumption, and interference modeling, are all related to 'testability'. If there is any 'testability' aspect we have ignored, we are open to discuss whether should be also added.

4 – MediaTek Inc.

The revised note is a bit vague, because it is not 100% which detailed objective it refers to. Without detail for this 'detail objective', it seems opening a door to any possibilities. Therefore, we still prefer to original note.

In our understanding, if there is no consensus to remove/revise the note, we should go back to package approved in RP-220068 in which the appendix still have this note of single reference receiver assumption.

5 – Apple GmbH

Firstly, after initial round we understand what interference modeling is a better term and agree to add it, but we dont see why testability is removed, it is also one of the aspects that should be discussed in Phase 1 in our understanding like the others and is not replaced by interference modeling.

Regarding the Note: We prefer to keep the note based on previous agreements that requirements are defined only for single receiver assumption. We dont think adding the current wording of "detailed objective will be added..." replaces that.

To China Telecom: We dont think we are choosing the receiver for Phase II with the note that requirements shall be defined with only 1 receiver.

6 – China Mobile Com. Corporation

We are fine with adding interference modeling if companies think the objective can be clearer with it. However, we don't see the necessity of removing the testability, we have the same understanding with Qualcomm that if any testability concern is brought up during SI or WI phase, it will be discussed and considered. Therefore, we prefer to keep both in the objective.

7 – Samsung Electronics Co.

In general, we are fine with moderator proposals.

Based on moderator explaination, we can understand the intension on adding checking point after study phase complete. We can compromise to moderator proposal even though we also prefer to specify single requirement based on the baseline receiver concluded in the study phase.

8 – Ericsson France S.A.S

We would also prefer to keep the previous note to consider a single receiver when specifying requirements.

9 – ZTE Wistron Telecom AB

The revised note is not clear, and may not be included in the WID.

10 – China Telecom Corporation Ltd.

Moderator:

A brief summary based on the comments received so far:

a) On "interference modeling": no company has concern to keep it.

b) On “testability”:4 companies (QC, MTK, Apple, CMCC) prefer to add it in addition to “interference modeling”

c) On the note: 5 companies (QC, MTK, Apple, Samsung, E///) still prefer the previous note of “Performance requirements shall be specified under single reference receiver assumption” instead of the revised one.

As such, moderator would like to ask whether there is strong concern on the following updated proposals:

- Add “testability” in addition to “interference modeling”
- Change the note under phase II to: **As baseline,** performance requirements shall be specified under single reference receiver assumption.

11 – Intel Corporation SAS

We support the updated objective provided at the beginning of the section. We think it is too early to make the agreement on scope of requirements without the detailed analysis of difference receivers. We think that typical RAN4 procedure should be considered for this item, that all conclusions will be made based on technical analysis. As usual we think that balance between test coverage and test burden will be discussed in RAN4.

During the RAN4 discussion we can face the situation that some companies support E-MMSE-IRC due to less complexity and some companies support R-ML due to higher gain and potential compromise solution will be defining of requirements with two receiver and test only one receiver depending on UE capability. Therefore, to ensure that we will have certain flexibility in future discussion, we suggest not to restrict the number of requirements at current stage. To move forward we suggest the following note: **Testing shall be done under single reference receiver assumption.**

12 – Nokia

No strong opinion on the inclusion of ”testability”. Both is fine from our point of view.

We agree with the addition of ”interference modelling”.

Concerning the note ”Performance requirements shall be specified under single reference receiver assumption”, we slightly prefer leaving it in, to upper bound the workload.

However, as a compromise we would also be fine with Intel’s suggestion of ”Testing shall be done under single reference receiver assumption”; even if that means that much effort will be spent in RAN4 to consider both receivers, instead of a single one.

13 – Ericsson France S.A.S

We would prefer the note to refer to the requirement development, not just testing. We prefer the original note, but can compromise to the solution proposed by the moderator.

14 – Huawei Technologies France

The wording from moderator is fine for us to replace testability with interference modelling. based on the first round discussion, companies have common understanding about the interference modelling. for the testability aspect, currently we did not forsee any testability issue for either requirements for E-MMSE-IRC or R-ML, if proponent of company insists on adding testability in the WID, some clarification is needed on the aspects to study.

As Intel commmented, maybe it is hard to conclude which advanced receiver is used for final performance requirements definition if only sinle receiver assumption is agreed without any criteria, hot discussion can be expected during Phase II. So we prefer to add the criteria of performance gain for the receiver assumption selection.

3.1.3 Objective 2 on link adaptation throughput requirements

Is the following update agreeable?

- *Specify absolute physical layer throughput requirements with link adaptation*
  - *Note: Rel-17 RAN4 study outcome* ***documented in section 5.10 of TR 37.901-5*** *is a starting point for this objective*

Feedback Form 9: Comments on objective 2

1 – Verizon UK Ltd The objective is fine to us.
2 – Qualcomm Incorporated It is fine for us.
3 – AT&T GNS Belgium SPRL The modification of the Note in the objective is fine with us.
4 – China Telecommunications The above objective is fine for us.
5 – MediaTek Inc. OK to us
6 – Apple GmbH Yes, the proposed wording is agreeable.
7 – China Mobile Com. Corporation The above modification is fine for us.
8 – Ericsson France S.A.S The objective is fine for us.
9 – ZTE Wistron Telecom AB We are fine with the revised note.

10 – Intel Corporation SAS We support the updated objective
11 – Nokia If it is administratively possible to reference the study in the objectives, then we are also in favour to add ”documented in section 5.10 of TR 37.901-5”, as detailed by the moderator.
12 – Huawei Technologies France We are fine with obove objective.

3.1.4 Need of secondary WG and/or core part objective

Is it agreeable to remove the note on the secondary WG to avoid potential confusion to MCC and keep the following note in section 4.1 of WID on core part objective?

Note: Pending on the outcome in study phase, other WG impact if identified can be added in later stage during WI phase.

Feedback Form 10: Comments on the need of secondary WG and/or core part objective

1 – Qualcomm Incorporated Ok with the proposal.
2 – AT&T GNS Belgium SPRL We are OK with the moderator proposal.
3 – China Telecommunications Support the proposal above.
4 – MediaTek Inc. We support moderator’s proposal.
5 – Apple GmbH We support the Moderator’s proposal.
6 – China Mobile Com. Corporation We are OK with moderator’s proposal.
7 – Ericsson France S.A.S OK with the proposal

8 – ZTE Wistron Telecom AB The note seems a general principle, ok to include into the WID.
9 – Intel Corporation SAS We are fine with proposal.
10 – Nokia Ok with proposal. We can remove the note on secondary WG and add other WG later, if found necessary.
11 – Huawei Technologies France Ok with the proposal.

3.2 Intermediate round summary

3.2.1 Summary of intermediate round discussion

1) Justification

For the objectives included in the endorsed package:

The situation is the same as in the initial round: all other companies are ok with the justification, excepting one wording update from one company"*It's ~~worth~~**feasible** to specify absolute physical layer throughput*". As seen in the initial round summary, moderator thinks this update is not essential. Meanwhile, if company has strong view, we can check whether this update is acceptable, given that anyway the objective will not be impacted.

For SU-MIMO soft-IC:

5 companies including 4 operators (Orange, Verizon, China Telecom, Vodafone) see the benefit from SU-MIMO with soft-IC. Meanwhile, since this objective is not included in the endorsed package, moderator proposes to postpone and revisit it in the checking point in future RAN plenary meetings.

2) Objective 1 on advanced receiver for MU-MIMO

On "interference modeling": no company has concern to keep it.

On "testability": 3 companies (QC, Apple, CMCC) prefer to add it in addition to "interference modeling", and 1 company (HW) thinks there should be no testability issue if the testability means the test feasibility from TE perspective. Based on the discussion, proponents of adding "testability" interpret it as a more generic concept including whether testable gain can be achieved. With the interpretation, moderator proposes to follow majority view and add the "testability" in the objective.

On the note:

- 5 companies (QC, MTK, Apple, Samsung, E///) still prefer the originial note of "Performance requirements shall be specified under single reference receiver assumption".
- 2 companies (Intel, China Telecom) do not want to restrict the number of requirements at this early stage.

- 1 company (Huawei) thinks if only single reference receiver will be selected, the selection should be based on the performance gain achieved.

In moderator's understanding, the typical approach in RAN4 is to define the requirements based on single reference receiver. Although the study has not been started for this objective, it is no harm to mention the RAN4 typical approach as baseline. Hope this could be the compromise.

3) Objective 2 on link adaptation throughput requirements

All companies are ok with the updated objective.

4) Need of secondary WG and/or core part objective

All companies are ok with the moderator's proposal.

3.2.2 Proposed agreements after intermediate round discussion

Agreement #1 (after initial round): The TR capturing the Phase I evaluation outcome will be completed (i.e., for approval) in RAN #100.

Agreement #2 (after initial round): Not add the secondary WG for now.

Agreement #3 (after intermediate round): Include the following objective in the WID:

- *Specify absolute physical layer throughput requirements with link adaptation*
    - *Note: Rel-17 RAN4 study outcome* ***documented in section 5.10 of TR 37.901-5*** *is a starting point for this objective*

Agreement #4 (after intermediate round): Remove the note on the secondary WG and keep the following note in section 4.1 of WID on core part objective

Note: Pending on the outcome in study phase, other WG impact if identified can be added in later stage during WI phase.

4 Final round discussion

4.1 Collection of companies' views

4.1.1 Justification

Is the following justification agreeable (with one typo corrected)?

The UE demodulation single carrier performance requirements with MMSE/MMSE-IRC and R-ML receivers for scenario of single-cell single-user with multi-layer transmission were defined in NR Rel-15. In NR Rel-16, requirements for MMSE/MMSE-IRC receiver for scenario with single-cell single-user were extended to

CA/DC cases. For NR Rel-17, the single carrier performance requirements for MMSE-IRC receiver with DM-RS based covariance matrix estimation for intra-cell inter-user interference under MU-MIMO scenario and inter-cell interference scenario, and CRS-IM receiver based on LLR weighting for overlapping spectrum of LTE and NR scenario are agreed to be defined.

Considering the demodulation requirement enhancement in Rel-18, for the purpose of further enhancing DL throughput and coverage performance, it is beneficial to study and specify (if feasible) requirements for more advanced UE receiver for following scenario:

- *MU-MIMO scenario: Further improve the performance with advanced receiver to cancel inter-user interference.*

In Rel-17, RAN4 concluded the feasibility of defining absolute physical layer throughput requirements with link ***~~adaption~~adaptation*** *under RAN5 Rel-16 SI FS_UE_5GNR_App_Data_Perf. It's* ***feasible~~worth~~*** *to specify absolute physical layer throughput requirements with link adaption in Rel-18 taking the study outcome of Rel-17 as the starting point.*

Feedback Form 11: Comments on justification

1 – Nokia "Worth" and "feasible" do not have the same meaning and/or intent. As stated before, we can only accept to change "worth" to "both meaningful and feasible", in order to keep aligned with the original intent. @Huawei: Would this be acceptable as a compromise? We cannot agree to remove the notion of there being an advantage to ATP requirement inclusion.
2 – Qualcomm Incorporated Ok with Nokia's proposal.
3 – Apple GmbH We are fine with Nokia's proposal.
4 – China Telecommunications "worth" or "beneficial" is preferred, and the latter one is to align the wording with MU-MIMO. The point is that we cannot define requirements for all things that are feasible, and we define requirements since it is worth or beneficial. But we don't think it is a big issue, so either way is acceptable.
5 – Verizon UK Ltd We are okay with the proposal!
6 – Intel Corporation SAS Both proposals, i.e. from moderator and from Nokia, are fine for us.

7 – CATT We are OK with both proposals.
8 – Huawei Technologies France @Nokia Could you share any investigation or justification during the RAN4 work and conclusion captured in TR 37.901-5? from our understanding, RAN4 only justified the feasibility to define the requirements for ATP. To move forward, we are fine to update to "**some company thinks that it is benefical...**" to clearly reflect the current discussion status.
9 – ZTE Wistron Telecom AB Ok with both proposals from Nokia and Moderator.
10 – Ericsson France S.A.S We are OK with "worth" or "beneficial and feasible" or "meaningful and feasible". Clearly it is possible to be feasible without being beneficial and vice versa; something might be e.g. beneficial for the network but not feasible for the UE.

4.1.2 Objective 1 on advanced receiver for MU-MIMO

Considering all the feedback in the initial round and intermediate round, is the following updated objective agreeable?

- *Evaluate and specify advanced receiver to cancel inter-user interference for MU-MIMO*
  - *Phase I: Study the performance gain, reference receiver assumption,* ***interference modeling,*** *testability, required signalling overhead, as well as impact on other WGs*
    - *Further discuss reference receiver assumption with below candidates*
      - *E-MMSE-IRC*
      - *R-ML*
    - *Target scenario: Focus on slot based transmission*
  - *Phase II (if any pending on the conclusion for phase I):*
    - *Specify PDSCH demodulation requirements under MU-MIMO scenario with advanced receiver*
      - *Note:* ***As baseline,p****erformance requirements shall be specified under single reference receiver assumption*

Feedback Form 12: Comments on objective 1

1 – Nokia

Both the moderator proposal and the earlier compromise proposal ”Testing shall be done under single reference receiver assumption” are fine for us.

2 – Qualcomm Incorporated

Ok with current proposal.

3 – Apple GmbH

We are fine with the above wording proposed by Moderator.

4 – China Telecommunications

According to the moderator’s summary, ‘proponents of adding testability interpret it as a more generic concept’, by this, we are really curious about what testability aspects we have ignored in the objective other than ‘performance gain, reference receiver assumption, and interference modeling’. And we also have a little concern about what will be captured in the ‘testability’ section in the future TR. However, to move forward, we are ok with the moderator’s wording suggestion.

Regarding the updated note, we are fine with the current version as a compromise.

5 – MediaTek Inc.

We are fine with the proposal from moderator

6 – Verizon UK Ltd

We are fine with the updated proposal.

7 – Intel Corporation SAS

We would like to check more companies views on our proposal for note: **Testing shall be done under single reference receiver assumption.** We think that it will be beneficial to have certain flexibility in the future discussion on scope of requirements. We think that all decision on the scope, as usual, should be done in RAN4 based on technical analysis. Without technical analysis, reduction of the scope of requirements at current stage may overcomplicate the future discussion on this item.

8 – CATT

OK with the updated proposal.

9 – Huawei Technologies France

It is beneficial of proponents of adding ”testability” in the objectives to share the meaning of ”testability” from their perspective. Based on RAN4 previous discussions, the testability always mean the testable SNR and/or test setup from TE perspective, we don’t know what will be studied for it in the Phase I and what will be captured in the TR as CTC pointed? if it really means ”testable gain” like moderated summarized, how to justify one performance gain is testable or not? usually RAN4 evalutes one performance gain is large or small based on discussion.

We are fine to update to as basedline of performance requirements shall be specified under single reference receiver assumption. But like we commented in the intermediate round, without specific criteria to choose which receiver between E-MMSE-IRC and R-ML for the final performance requirements definition, hot and complicated discussion can be expected in the future discussion.
10 – China Mobile Com. Corporation We are fine with the updated proposal.
11 – ZTE Wistron Telecom AB Fine with Moderator's proposal.
12 – Ericsson France S.A.S We are fine with the moderator proposal. Our understanding is that we need to discuss consider whether to create one or two requirements (based on different reference receivers); one is the baseline but the baseline could be cancelled if there would be a strong justification to create two sets of requirements. Test is different; that would be in the case that two requirements are created and the discussion is which one to test.
13 – VODAFONE Group Plc We are fine with the moderator's proposal.

4.1.3 Supporting company list

If you'd like to be included in the supporting company list in the final version of WID (i.e., with final agreeable objectives), please comment below:

Feedback Form 13: Supporting company in the final WID

1 – Huawei Technologies France Huawei and HiSilicon would like to be added into the supporting company list
2 – ZTE Wistron Telecom AB Please add ZTE into the supporting company list.
3 – Ericsson France S.A.S Please add Ericsson to the supporters
4 – Samsung Electronics Co. Please add Samsung to the supporting list
5 – Orange Please add Orange in the list of supporting companies

6 – Nokia Please add ”Nokia” and ”Nokia Shanghai Bell” to the list of supporting companies. Thanks!
7 – MediaTek Inc. Please add ”MediaTek inc.” to the list of supporting companies. Thx!

4.2 Final round summary

Moderator’s summary for discussion [95e-08-RAN4-R18-Demod] is provided in RP-220868.

5 References

1. RP-220022, Moderator’s summary for discussion [RAN95e-RAN4-R18Prep-04] Demod Enhancements, RAN4 Vice Chair (Samsung), RAN #95e.
2. RP-220050, New WID: NR demodulation performance evolution, RAN4 Vice Chair (Samsung), RAN #95e.
3. RP-220068, Summary for RAN Rel-18 Package: RAN4 Part, RAN Chair, RAN4 Chair, RAN #95e.
4. RP-220541, Views on Demod enhancements, Qualcomm Incorporated, RAN #95e.
5. RP-220581, Views on Rel-18 Demod Enhancement WI, China Telecom, RAN #95e.
6. RP-220582, New WI: NR demodulation performance evolution, China Telecom, RAN #95e.
7. RP-220644, Discussion on demodulation Enhancements, CMCC, RAN #95e.
8. RP-220656, Further discussion on NR demodulation evolution in Rel-18, ZTE, Sanechips, RAN #95e.
9. RP-220723, Consideration and motivation for Rel-18 new WI on UE performance requirements for advanced receiver, Huawei, HiSilicon, RAN #95e.
10. RP-220724, New WID: UE demodulation performance evolution , Huawei, HiSilicon, RAN #95e.
11. RP-220779, Views on RAN4 Rel-18: Demodulation enhancements, Intel Corporation, RAN #95e.
12. RP-220780, Draft New WID: NR demodulation performance evolution, Intel Corporation, RAN #95e.