**3GPP TSG-RAN WG4 Meeting # 98-e R4-21xxxxx**

**Electronic Meeting, January 25th – February 5th, 2021**

**Agenda item:** 11.11.1

**Source:** Moderator (Qualcomm)

**Title:** Email discussion summary for [98][312] NR\_Repeater\_General

**Document for:** Information

# Introduction

A new WI on the definition of RF repeaters was approved in RP-202927. This e-mail discussion will focus on the general issues regarding the work for developing the requirements for these devices.

The following topics are covered in this e-mail discussion

* 1st round:
  + work plan
  + Applicable bands
  + Requirements and specification handling
  + Handling of TDD repeaters
  + Bandwidth Configuration
  + Others
* 2nd round: TBA

# Topic #1: Work Plan

This section discusses the work plan proposed by the rapporteur.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2102834 | Qualcomm | RAN4#98-e (This meeting)  Agreement on work plan targeting RAN4 RF conclusion by RAN#95 and RAN4 RRM by RAN#96  Discussion of parameters to be specified  Discussion on bands to be included  Discussion on regulatory limits  Discussion on which TS document(s) are needed  Discussion on EMC  RAN4#98-bis-e  Discussion on parameters to be specified  Agreement on bands to be included  Discussion on regulatory limits  Agreement on which TS document(s) are needed  RRM topics TBD  RAN4#99  Normative values CR into draft TSs  Normative value CR for regulatory limits  Draft TSs provided to RAN#93 for information  RRM topics TBD  RAN4#100 bis  Normative values CR into draft TSs  RRM topics TBD  RAN4#100 bis  CRs into draft technical standard(s)  RRM topics TBD  RAN4#101  CRs into draft technical standard(s)  TSs to be provided in RAN#94 for approval  RRM topics TBD  RAN4#102  CRs into draft technical standard(s)  RRM topics TBD  RAN4#102 bis  RRM topics TBD  RAN4#103  RRM topics TBD |
| R4-2102108 | Ericsson | **Observation 1: Some attention may need to be paid to the TDD conducted test definition and setup**  **Observation 1: The OTA test setup requires at least two spatially separated test gear transmission/reception points around the DUT.**  **Observation 2: Both the signal generator and DUT transmit in the test setup. Additional consideration is needed for emissions measurement.**  The conformance discussion will start at a later stage in the WI. The purpose of this contribution is to highlight that conformance testing for repeaters is not a trivial re-use of BS and UE test principles and that a sufficient number of meetings should be planned for the conformance phase. |

## Open issues summary

The work plan should be discussed and agreed in this meeting such that the work can be organized accordingly.

### Sub-topic 1-1

Need for RRM requirements

The proposed work plan contains also work on RRM requirements as the WID TU allocation, this is like a miss from the TU allocation spreadsheet.

**Issue 1-1: RRM Work**

* Is there any need for any RRM related work?
  + Option 1: No
  + Option 2: Yes
* Recommended WF
  + No

### Sub-topic 1-2

Overall work plan

Whether the work plan as proposed by the rapporteur, without the RRM part that is discussed separately, is agreeable or changes have to made. Especially, it should be discussed how to handle the conformance part.

**Issue 1-2: Overall workplan**

* Proposals
  + Option 1: Yes, agreeable as is
  + Option 2: No, changes are needed
* Recommended WF
  + Option 2

The conformance part needs to be reflected in the work plan, companies should provide inputs on how the work should be organized.

### Sub-topic 1-3

WID Revision

If the answer to Sub-topic 1-1 is no, should the WID be revised in upcoming plenary to eliminate baseband TUs?

**Issue 1-3: WID Revision**

* Proposals
  + Option 1: WID should be revised to remove baseband core TUs
  + Option 2: No, baseband core TUs should be kept
* Recommended WF
  + Option 1

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Issue 1-2: Overall workplan**  The revised WID should include a plan for the conformance specifications; as we point out in our contribution this is not copy/paste and needs sufficient time. |
| Huawei | **Issue 1-1: As this is RF only repeater there is no need for demodulation hence no need for RRM – recommended WF ok**  **Issue 1-2: Few comments on workplan –**  **channel BW’s are mentioned as RF parameter, existing repeaters do not really use the concept in the same way using “passband”, this should be discussed further.**  **It seems a conformance requirement will be needed this should be planned.**  **As existing repeater specs are not that big do we really need to split? For BS we currently split the conformance but all core are in 1 spec and this will be much smaller document.**  **Issue 1-3: IS this not the same as 1-1? There should be no need for demod or BB.** |
| ZTE | **Issue 1-1: RRM and Dmod is not needed as this RF repeater.**  **Issue 1-2: Few comments on workplan –**  **As mentioned by Ericsson ad HW, for repeater OTA testing, we need more time to study it.**  **Issue 1-3: option 1 to remove the baseband part.** |
| CMCC | Sub-topic 1-1: RRM may be needed for some requirements, e.g. delay, UL timing.  Sub-topic 1-2: option 2, conformance test should be added in the work plan. |
| CATT | **Issue 1-1: RRM Work**  **Agree with the recommended WF. Current WI assumes RF repeater which doesn’t have RRM function in our understanding.** | |
| Nokia, Nokia Shanghai Bell | **Issue 1-1: RRM Work**  We support option 1. There should not be RRM works for this WI, however, in case RRM impact is identified later on, then this may be reconsidered.  **Issue 1-2: Overall workplan**  We agree that conformance part is missing in WID. Thus, it should be reflected in updated WID appropriate to include conducted and OTA tests. | |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

|  |  |  |
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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

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| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: Applicable Bands

This section discuss which bands will be applicable for repeaters.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2100832 | CMCC | **Proposal 3: NR repeater is suggested to be designed for all operating bands specified in TS 38.104 including both FR1 and FR2.** |
| R4-2101041 | NTT Docomo | **Observation 2: NR repeater is expected to be widely used for covering areas and filling the gap of areas in NR bands including corresponding LTE FDD and TDD bands.**  **Proposal 1: RAN4 considers all of NR bands defined in TS 38.104 as NR repeater’s operating bands.** |
| R4-2102580 | Huawei | **Proposal 1**: NR Repeater specification shall consider all the duplex modes considered in the NR work so far, i.e. FDD, TDD, SDL, SUL. |
| R4-2100635 | CommScope | **2.3** The NR repeater specification should include requirements for all NR operating bands (cf. TS 36.106 clause 5.5). The list of bands shall be prioritized to ensure that the most commonly used bands are included in the initial release of the specification. |

## Open issues summary

It should be discussed which bands should be applicable for the repeaters and whether there would be any priorities. Based on the input from several companies, there is a strong desire to have all the defined bands applicable.

### Sub-topic 2-1

Supported bands

**Issue 2-1: Which bands should be applicable to Repeaters and in the scope of the current WI**

* Proposals
  + Option 1: All bands defined so far
  + Option 2: Only some of the bands, criteria to choose/prioritise to be discussed
* Recommended WF
  + Option 1

Based on the inputs, Option 1 is recommended. Given the large operator interest, it would be very difficult to include only some bands in the scope or set some priorities. The proposal in R4-2102580 would be automatically covered within Option 1.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | In principle all bands is OK; specific bands could be ruled out if they have some specific issue. Do we assume that there is no such thing as a multi-band repeater ? Do we assume that the passband of a repeater is contiguous ? If the answer to either of those is yes then we need to consider multi-band/multi-carrier requirements… |
| Huawei | Issue 2-1: The requirements don’t really differ to much with bands, co-location should of course include all bands (as its a protection req). It doesn’t seem too much effort to include all bands. Non-consecutive channels are included in the existing repeater definition of passband, but multi-band is not. |
| ZTE | Fine with all bands, since repeater RF requirement should be band agnostic in most cases. Open to further discuss the multiband repeater. |
| CMCC | Considering NR repeater will be widely deployed, it would be better to design all the operating bands for NR repeater without any priority. |
| CATT | Agree that taking option 1 as a beginning is ok. | |
| Docomo | Issue 2-1: We agree with recommended WF. | |
| Nokia, Nokia Shanghai Bell | **Issue 2-1:**  We support option 2. It should be concluded first which frequency ranges and duplex modes are part of the work.  The current WID only states to “consider” FR1 (FDD and TDD) and FR2. It would be beneficial to aim to understand the complexity and implications of supporting all these cases first. When complexity is better understood for each case then it can be seen whether it is reasonable and feasible to develop requirements for all of them. | |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: Requirements and Specification Handling

The scope of the work in terms of conducted and OTA requirements and how to handle the specification has to be clarified. Several papers provided proposals, one of the topics that is not clear is whether radiated requirements for FR1 will be handled or not.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2100375 | CATT | **Proposal 1: No need to define NR repeater types, the requirement can be defined according to FR1 (conducted) and FR2 (radiated) frequency ranges.** |
| R4-2100635 | CommScope | The NR repeater specification shall include requirements for repeaters with both conducted and radiated interfaces (external and internal antennas). |
| R4-2100832 | CMCC | **Proposal 1: Two specifications are the baseline for NR repeater RF requirements, one for RF core requirements and the other for conformance parts, both including the conducted and radiated requirements just as how the IAB specifications have been categorized.** |
| R4-2101963 | ZTE | **Proposal 1**: non-AAS based repeater should be prioritized for FR1 FDD NR based repeater;  **Proposal 2**:use the requirements of TS 36.106 spec as starting point for FR1 FDD NR based repeater;  **Proposal 3:** non-AAS based repeater should be prioritized for FR1 TDD NR based repeater |

## Open issues summary

Several contributions are discussing which specifications should be defined(conducted or radiated), how they should be handled(single spec vs. splitting in multiple specs). The main discussion point seems to be whether FR1 radiated requirements are needed or not, this will be treated in a separate sub-topic.

### Sub-topic 3-1

Conducted and Radiated Requirements

**Issue 3-1: Conducted and Radiated Requirements**

* Proposals
  + Option 1: Define both conducted requirements(for FR1) and radiated requirements (FR2)
  + Option 2: other proposals
* Recommended WF
  + Option 1

Considering how all NR RF requirements are defined, there is a clear need for both conducted(FR1) and radiated requirements (FR2)

### Sub-topic 3-2

Radiated Requirements for FR1

Whether there is a need for FR1 radiated requirements is not yet clear, this issue needs discussion

**Issue 3-2: Need for Radiated Requirements in FR1**

* Proposals
  + Option 1: Yes, radiated requirements are needed for FR1
  + Option 2: No, only conducted requirements are enough in the current WI
* Recommended WF
  + Option 1

AAS type of devices are not ruled out, deployment should be possible in the higher FR1 bands.

### Sub-topic 3-3

Specification handling

One of the issues raised is the spec handling, whether specifications should be split into conducted and radiated or not. Considering the WI just started, the moderator is proposing to focus on the RF core requirements for now and discuss the handling of the conformance specifications closer to the start of the performance part.

**Issue 3-3: Handling of RF Core Specifications**

* Proposals
  + Option 1: Single specification covering both conducted and radiated
  + Option 2: Separate specifications for conducted and radiated
* Recommended WF
  + Option 1

The RF core specifications defined so far for network nodes are using a single specification covering both.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Issue 3-1: Conducted and Radiated Requirements**  Agree with option 1 FR1 conducted and FR2 OTA. OTA is necessary for FR2; for FR1 there is no real need for OTA for repeaters.  **Issue 3-2: Need for Radiated Requirements in FR1**  Option 2. A cost-effective RF repeater would not include a large AAS array which would not accommodate connectors in FR1. It is worth to consider that developing OTA requirements means developing conformance tests and MUs, and these tests and MUs are not the same as the OTA test/MU for a BS as explained in our contribution. It would be better to focus the effort in analyzing the test scenario on FR2 where OTA is unavoidable. |
| Huawei | **Issue 3-1: Option 1 is ok**  **Issue 3-2: The WI states the repeater does not perform adaptive beam forming towards the UE so effectively has fixed antennas, hence its unlikely an AAS would be useful. Without this its clearly easier to specify a conducted interface so for the moment we can concentrate on conducted for FR1 but such product defining issues should perhaps be specified in the WID** |
| ZTE | **Issue 3-1: Conducted and Radiated Requirements**  **Agree with option 1**  **Issue 3-2: Need for Radiated Requirements in FR1**  **Agree with Option 2**  Since no adaptive beamforming is needed for FR1 and FR2, then not sure whether we still need to have AAS based architecture. Of course, if operators have strong interest on that and can also manage the cost for repeater instead of IAB, then it should be also fine for us. |
| CMCC | Sub topic 3-1: we support option 1, at least defining conducted requirements for FR1 and radiated requirements for FR2  Sub topic 3-2: we support option 1, radiated requirements are needed for FR1.  In some cases, FR1 NR repeater could only be tested by radiated requirements not conducted requirements. For example, donor BS is 1-O type and the requirements are tested only by radiated requirements. The repeater amplifies and forwards the received signal which could still only be tested by radiated requirement rather than conducted requirements.  Sub topic 3-3: we suggest option1, only one specification covering both conducted and radiated requirements, the same as how the RF core requirements have been designed for other network nodes. |
| CATT | **Issue 3-1: Conducted and Radiated Requirements**  Agree with the recommended WF.  **Issue 3-2: Need for Radiated Requirements in FR1**  Option 2, repeater antenna design is different with BS, FR1 radiated requirements are not reasonable.  **Issue 2-1: Handling of RF Core Specifications**  Ok with the recommended WF. | |
| Docomo | **Issue 3-1: Conducted and Radiated Requirements**  OK with the recommended WF.  **Issue 3-3: Handling of RF Core Specifications**  OK with the recommended WF. | |
| Nokia, Nokia Shanghai Bell | **Issue 3-1: Conducted and Radiated Requirements**  As commented for issue 2-1 above: first we need to understand complexity and use cases.  **Issue 3-2: Need for Radiated Requirements in FR1**  It might be beneficial to prioritize non-AAS repeaters for FR1 FDD and TDD and use it as starting point.  **Issue 3-3: Handling of RF Core Specifications**  We support option 1 to introduce only single core specification for conducted and radiated parts, as it was already done for both legacy BS NR and IAB core spec. | |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #4: Handling of TDD Repeaters

TDD repeaters present several problems such as whether they have to be synchronized to the network, whether or not they have to be aware of the UL/DL configuration and how to handle dynamic TDD. These issues are discussed in this section.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2102018 | Nokia | **Observation 2: Discussion is needed on how to handle synchronization in case TDD repeaters are decided to be worked on.**  **Proposal 1: Use cases and deployment scenarios need to be discussed and agreed to provide the starting point for requirement discussions.** |
| R4-2100375 | CATT | **Proposal 2: Transmitter off power needs to be defined for TDD repeaters, the same requirements as BS can be defined.**  **Observation 1: It’s not easy to define transient period requirement for TDD repeater.**  **Observation 2: TDD synchronization related requirements need more discussion.** |
| R4-2100832 | CMCC | **Proposal 2: at first, we should focus on the RF architecture discussion and clarify whether/how to distinguish different DL/UL terminologies at least for repeaters supporting TDD operating bands.** |
| R4-2101156 | Mediatek Inc | **Observation 1: NR repeater has no idea about the UE-specific information (e.g., SFI or DCI) that may overwrite the static UL/DL configuration in SIB.**  **Proposal 1: RAN4 to discuss how to enable NR repeaters to get the SFI and scheduling DCI information for dynamic TDD deployments.**  **Observation 2: How the repeater determines the starting time for UL transmission is not clear.**  **Observation 3: How the repeater determines the starting time and duration for UL signal listening is not clear.**  **Proposal 2: RAN4 to discuss how to the repeater determines the starting time for UL transmission as well as the starting time and duration for UL signal listening.** |
| R4-2101963 | ZTE | **Observation 1: f**or TDD NR based repeater, without explicit DL-UL pattern information or with static DL-UL pattern only at repeater, the deployment would be limited to certain scenarios;  **Proposal 4:** for TDD NR based repeater, group delay introduced by repeater’s filter should be studied and clarified as this would impact DL-UL gap period and NCS configuration of PRACH channel. |
| R4-2102829 | Qualcomm | A TDD repeater can benefit from being able to switch direction matching the uplink and downlink slot structure used by the gNodeB. A repeater may be able to determine the subframe boundaries if the UL/DL pattern is fixed, however the uplink/downlink pattern can change with dynamic TDD. The fixed UL/DL repeater configuration would preclude network changes. An option is to include signalling from the gNodeB to the repeater, informing the repeater of the configuration. This allows flexibility in the network. It also allows higher gain TDD repeaters, additional coverage extension, and better end-to-end performance.  **Proposal 3: Companies should discussion whether signalling would be beneficial for the TDD repeater.** |

## Open issues summary

Many papers are discussing the behaviour of repeaters in TDD bands, the need for synchronization and UL/DL configuration awareness. Other topics brought up are support for dynamic TDD and definition of requirements related to TDD such as Rx-Tx switching time, whether the repeater should be aware of the exact timing when UL starts.

### Sub-topic 4-1

Synchronization for TDD

It should be discussed whether the repeater has to be synchronized to the network and know the exact symbol timing.

**Issue 4-1: Synchronization for TDD**

* Proposals
  + Option 1: Repeater has to synchronize to the gNB timing
  + Option 2: Synchronization is not needed
* Recommended WF
  + Option 1

In order for the repeater to function correctly in a TDD network, it needs to synchronize to the gNB timing

### Sub-topic 4-2

UL/DL Configuration Awareness

Some companies raised the problem that besides synchronization, the repeater also has to be aware of the UL/DL configuration.dd

**Issue 4-2: UL/DL Configuration Awareness**

* Proposals
  + Option 1: Repeater needs to be aware of the UL/DL split
  + Option 2: Repeater does not need to be aware of the UL/DL split
* Recommended WF
  + Option 1

### Sub-topic 4-3

UL/DL Configuration Signaling

If the repeater should be aware of the UL/DL configuration, how will it acquire this information?

**Issue 4-3: UL/DL Configuration Signaling**

* Proposals
  + Option 1: Repeater can acquire the UL/DL Configuration by reading the cell broadcast information(e.g. SIB)
  + Option 2: Dedicated signaling would be needed to inform the repeater about the UL/DL configuration
* Recommended WF
  + TBA

As multiple options are possible, this point will require some discussion, companies are invited to provide their views or proposals.

### Sub-topic 4-4

Support for dynamic TDD

Support for dynamic TDD was brought up in multiple papers. While the static or semi-static UL/DL configuration can be acquired from the broadcast information, this will not enable support for dynamic TDD

**Issue 4-4: Support for dynamic TDD**

* Proposals
  + Option 1: Dynamic TDD should be supported
  + Option 2: There is no need to support dynamic TDD
* Recommended WF
  + Option 1

To enable deployment flexibility and forward compatibility, dynamic TDD should be supported

### Sub-topic 4-5

Requirements for TDD – Repeater Group Delay

Some companies brought up the need to introduce a requirement for group delay introduced by the repeater

**Issue 4-5: Repeater Group Delay Requirement**

* Proposals
  + Option 1: Group delay requirement is needed
  + Option 2: Group delay requirement is not needed
* Recommended WF
  + Option 1

Since the delay introduced by the repeater will impact the guard period needed for UL-DL switching, such requirement is needed

### Sub-topic 4-6

UL Timing

The issue whether the repeater should be aware of the exact UL timing (when to start amplifying signals in UL) was brought up and should be discussed.

**Issue 4-6: UL Timing Knowledge**

* Proposals
  + Option 1: Repeater needs to be aware of UL timing
  + Option 2: Repeater does not need to be aware of the exact UL timing
  + Option 3: Repeater can derive the UL timing autonomously
* Recommended WF
  + TBA

Companies are encouraged to provide their views. If Option 1 is chosen then proposals on how to derive the timing would be needed. If Option 2 or 3 is chosen then the behavior of the repeater should be explained.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Issue 4-3: UL/DL Configuration Signaling**  Another option is for the repeater to be made aware of the DL/UL configuration by O&M configuration as opposed to signaling.  **Issue 4-4:**  Applying dynamic TDD assumes some potentially complex functionality in the repeater and also likely RAN1/2 changes. Also, in general dynamic TDD causes degradation to neighbor networks and so the scenarios in which it can be used are quite specialized (indoor, shielded from other networks). In the first step it may be better to focus on general repeaters.  **Issue 4-5: Repeater Group Delay Requirement**  To some extent the delay from the repeater to the UE can be managed by adjusting the UE timing advance, which will indirectly impact the repeater timing. However, there may be some issues handling UEs at different distances from the repeater and with overlapping DL RX / UL TX (if the GP is not large enough to absorb the group delay) that need investigation.  **Issue 4-6: UL Timing Knowledge**  As with 4-5; the network can control TA at the UE, which can indirectly control the timing of the repeater transmission. Problems will arise if the group delay and propagation delay become large enough that the guard periods between DL and UL cannot accommodate the additional delays. An analysis of delay budget may be needed. |
| Huawei | **Issue 4-1: UL/DL switching is clearly required for TDD otherwise the system wouldn’t work as it cant transmit and receive at the same time in eh same direction on the same frequency. The current TDD UTRA spec includes UL/DL switching of gain sbut does not explicitly specify how the timing is derived (only that its specified wrt the BS). As such it can be considered left up to implementation. This seems a reasonable approach**  **Issue 4-2: As above it clearly needs to be able to switch and hence needs to be aware, ideally it can do this from signals it receives from the BS or is the proposal the BS transmits new information to the repeater? If so that seems to be outside the WID**  **Issue 4-3: This is a RAN4 WI to define the RF parameters, it seems a configurable repeater with specific info from the BS is outside that scope.**  **Issue 4-4: If dynamic TDD can be supported within the scope we should investigate a way but the scope should not creep without readdressing the WID. The co-existence for dynamic TDD may also need o be addressed when using repeaters as the potential fr interference between cells is greater and will not have been examined in existing repeater analysis.**  **Issue 4-5: Group delay is not specified for existing repeaters which implies it was either not needed or possible not thought about. Certainly we should study if it is necessary but its to early to definitively say yes or no.**  **Issue 4-6: Again, existing TDD repeaters have a timing requirement but do not explicitly specify how it is derived. Clearly there should one or more conceivable ways of extracting the timing from the on air signals but this does not need to be explicitly specified.** |
| ZTE | **Issue 4-1: Synchronization for TDD**  Support the option 1 as NR is different from UTRA TDD and E-UTRA TDD where only cell specific timing is defined, therefore sync between donor and repeater could be left up to implementation.  **Issue 4-2: UL/DL Configuration Awareness**  Support the option 1.  **Issue 4-3: UL/DL Configuration Signaling**  This need some RAN plenary level discussion as this will impact other group.  **Issue 4-4: Support for dynamic TDD**  This need some RAN plenary level discussion as this will impact other group.  **Issue 4-5: Repeater Group Delay Requirement**  At least we need to have some common understanding on its impacts, then we could further discuss its necessity to define the requirements.  **Issue 4-6: UL Timing Knowledge**  It might be difficult to know per UE UL timing, if configured appropriately on DL-UL timing and then UL signal could be well captured we think. |
| CMCC | Sub topic 4-1: repeater should synchronize to the gNB timing.  Sub topic 4-2: option 1, repeater needs to align its time reference with the known UL/DL split and determine to switch to UL or DL.  Sub topic 4-3:  we think option 1 is the baseline and option 2 is not excluded at current stage. If NR repeater is transparent to gNB and UE, one extra baseband processor would be required to decode the control information without any specification impact to other groups. Of cause the cost of this baseband processor should be managed.  Besides, pre-defined configuration is also suggested as one cost-effective method without decoding any signaling.  Of cause, some monitoring methods without any signaling could also identify the DL/UL by detecting signal strength and duration e.g. envelop detector. However the accuracy of this simple detection couldn’t be guaranteed considering the feasible deployment scenarios. It is excluded for NR repeater.  Sub topic 4-4: we are OK with option 1, at least current stage, dynamic TDD should be included in the scope. Some co-existence issue may need to be analyzed considering the cross-link interference introduced by the dynamic TDD repeater.  Sub topic 4-5: group delay requirement caused by repeater is not needed because group delay introduced by filter is dozens of nanoseconds, much less than the CP.  Sub topic 4-6: repeater should know the exact UL timing.  If we assume the repeater know the exact DL and UL configuration and is synchronized with gNB, then repeater would switch from DL to UL to amplify the UL signals during the DL-UL GP, before the beginning time of the first UL slot. Time advance between repeater and gNB could help repeater to determine the time advance before the beginning of UL slot to amplify the UL signal.  For sub topic 4-3, 4-4, 4-6, at current stage, we suggest to maintain these features. Some analysis are necessary to study the impact to RAN4 specification and then we could decide whether to include them in the final scope. We should find the trade-off between the feasible function and cost-effective. Form our point of view, one baseband processor could help to enable more feasible functions if we could manage the implementation complexity. |
| CATT | **Issue 4-1: Synchronization for TDD**  **Option 1 direction is correct but the issue 4-5 is also related to this one. So we think the repeater-BS synchronization is not the same as BS-BS and IAB-parent.**  **Issue 4-2: UL/DL Configuration Awareness and**  **Issue 4-3: UL/DL Configuration Signaling**  **Our current understanding is that it can be left to implementation.**  **Issue 4-4: Support for dynamic TDD**  **Dynamic may be a little difficult for some implementations, not sure if it’s defined as mandatory.**  **Issue 4-5: Repeater Group Delay Requirement**  **We don’t have clear view yet, but think it may be left for the deployment consideration. And traditional RF repeater’s Group delay should be very small.**  **Issue 4-6: UL Timing Knowledge**  **This is related to 4-2 and 4-3, we also think it can be left to implementation.** | |
| Docomo | **Issue 4-3: UL/DL Configuration Signaling**  Option 2 may be out of the WI scope. If RAN4 does not adapt Dynamic TDD, then Option 1 will be preferable.  **Issue 4-4: Support for dynamic TDD**  As mentioned by Ericsson, it may be better to focus on simple repeater.  **Issue 4-5: Repeater Group Delay Requirement**  OK with recommended WF. | |
| Nokia, Nokia Shanghai Bell | **Issue 4-1: Synchronization for TDD**  We think that further discussion is needed on how to handle synchronization in case TDD repeaters are decided to be worked on.  In case TDD repeater is not properly synchronized, there is a potential for harmful interference in the network. As the work item is contained to cover only RAN4, it is not possible to specify synchronization in PHY-layer. Therefore, a question remains whether synchronization requirements need to be developed in RAN4, or whether this is left purely for implementation. When this is discussed, it is important consider the possible negative impacts caused by synchronization errors.  **Issue 4-2: UL/DL Configuration Awareness Issue 4-3: UL/DL Configuration Signaling and Issue 4-4: Support for dynamic TDD:**  Discussion configuration awareness, signalling and support of dynamic TDD pattern changes starts to look like we are returning back to the smart repeaters which were scoped out of the WI. Therefore, RAN4 should aim at the simplest possible solutions. As the WID is contained within RAN4, additional signalling solutions do not appear feasible. It should be evaluated how accurately the repeater can synchronize with the fixed TDD pattern, and whether this level of accuracy makes TDD operation attractive e.g. from interference point of view. At least for now dynamic TDD does not appear easily feasible for simple analog repeater.  **Issue 4-5: Repeater Group Delay Requirement**  Does group delay here mean the potential processing delay of the repeater? It seems reasonable that there is a limit for the delay to avoid L1-changes. If this is achieved, then gNB will just configure TA accordingly for the UEs served via the repeater.  **Issue 4-6: UL Timing Knowledge**  It seems signalling exact UL timing is not possible as the work is purely contained within RAN4. Before agreeing to specify requirements, it would be good to understand the interference potential from misaligned UL timing. The impact of difference in UL timing can possibly be mitigated if only the repeater signal is being received by the gNB, though imposing such restriction may not be feasible. | |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #5: Bandwidth Configuration

NR offers a lot of flexibility for the channel bandwidth configuration including configuring dedicated channel BWs to different UEs. Also, the channel bandwidth broadcast by the gNB is not necessarily the actual channel bandwidth used by the gNB.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2101156 | Mediatek Inc | **Observation 4: It is not clear whether an NR Repeater does not have the knowledge aboutis able to acquire the real CBW signaled through dedicated RRC message to UE.**  **Proposal 3: RAN4 to discuss how an NR repeater gets the information to the actual CBW used by the gNB.** |
| R4-2102829 | Qualcomm | One option the passband(s) is/are preconfigured during installation and is/are not a dynamically changeable.  Another option is repeater passbands may be configured under network control.  **Proposal 2: Interested companies should discuss the method for passband configuration.** |

## Open issues summary

The repeater should be configured to operate with a certain channel bandwidth, this could be pre-configured(manual configuration) or under network control

### Sub-topic 5-1

Channel Bandwidth Configuration

**Issue 5-1: Channel Bandwidth Configuration**

* Proposals
  + Option 1: Repeater channel bandwidth is pre-configured
  + Option 2: Repeater channel bandwidth is derived from the network
* Recommended WF
  + TBA

Companies are invited to provide their opinions and if Option 2 is preferred, what would be the mechanism used.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 5-1:  Sub topic 5-2:  ….  Others: |
| Huawei | Issue 5-1: Within the scope of the current WID it is difficult to see how the repeater can be configured by the network. Based on existing repeaters the passband seems to be pre-configured. |
| ZTE | **Issue 5-1: Channel Bandwidth Configuration**  It should be pre-configured or customer based design. |
| CMCC | **Sub topic 5-1: the channel bandwidth for NR repeater may be the same as donor gNB. To simplify implementation, option 1 is preferred.** |
| CATT | **Issue 5-1: Channel Bandwidth Configuration**  Our understanding is that repeater is a network similar node, not UE, so BW can be configured. |
| Docomo | **Issue 5-1: Channel Bandwidth Configuration**  Based on existing repeaters the channel bandwidth is pre-configured. (Option 1) |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #6: Other Topics

Several other issues were brought up by different companies. The observations and proposals are summarized in Section 6.1.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2102018 | Nokia | **Observation 3: Beamforming and antenna array assumptions need to be discussed for both the backhaul between parent BS and NR repeater as well as for the access link between repeater and the UE.**  **Observation 5: Possible output power limitations need further clarifications**  **Observation 6: Understanding on use cases and deployment scenarios is needed before it can be evaluated how much LTE repeater and IAB RF specifications can be leveraged.**  **Proposal 1: Use cases and deployment scenarios need to be discussed and agreed to provide the starting point for requirement discussions.** |
| R4-2101156 | Mediatek | **Observation 5: The repeater may be only in the coverage of a specific DL Tx beam in FR2, but it is not clear whether the repeater has no idea is able to identify when the DL traffic will be transmitted along with that the Tx beam direction.**  **Proposal 4: RAN4 to study how to inform repeater on which slot to forward or not to forward in FR2.** |
| R4-2101963 | ZTE | **Proposal 5:** RF architecture for FR2 NR based repeater should also be discussed firstly. |
| R4-2102829 | Qualcomm | **Proposal 1: RAN4 should discuss network control of repeater gain.**  **Proposal 5: Donor side repeater antennas can use the same technologies and beam steering methods as a UE.**  **Proposal 6: Service side repeater antennas may be fixed or autonomously adjustable.** |

## Open issues summary

Some other issues than the ones discussed in the previous sections were also brought up. These are summarized below for further discussion

### Sub-topic 6-1

Deployment scenarios

R4-2102018 brought up the issue on discussing use cases and deployment scenarios, however, this issue was not brought up in any other paper. It should be clarified what exactly is not clear and whether there is any impact expected on the requirements to be defined

**Issue 6-1: Deployment Scenarios**

* Proposals
  + Option 1: There is no need for further discussion, the scenarios are clear.
  + Option 2: Further discussion is needed on which scenarios to be supported
* Recommended WF
  + TBA

Companies are invited to provide their views and potential impact to the future work and specification

### Sub-topic 6-2

RF Architecture and beam steering in FR2

Multiple papers brought up the need to discuss the RF architecture, especially for FR2. One issues is also whether the repeater could support beam steering or not

**Issue 6-2: RF Architecture**

* Proposals
  + Option 1: Repeater will support active antennas with some beam steering
  + Option 2: Repeater will have an antenna array with fixed gain and direction
  + Option 3: other RF architecture
* Recommended WF
  + TBA

Companies are invited to provide their comments on this issue and possible impact to the future work and RF requirements

### Sub-topic 6-3

Beam and slot awareness

In R4-2101156 the problem whether the repeater should be aware of which gNB Tx beam it should forward and how to be made aware of the slot in which this beam is transmitted

**Issue 6-3: Beam and slot awareness**

* Proposals
  + Option 1: Does the repeater need to know which beam to forward and the slot in which it should forward it?
  + Option 2: Repeater does not need to be aware
  + Option 3: others
* Recommended WF
  + TBA

Companies are invited to provide input on this issue and possible solutions or explanations of the repeater behavior in FR2

### Sub-topic 6-4

Repetear Gain Control

R4-2102829 proposes to discuss the possibility for the network to control the gain of the repeater

**Issue 6-4: TBA**

* Proposals
  + Option 1: Network should be able to control the gain of the repeater
  + Option 2: no need for the gain to be controlled by the network
  + Option 3: Others
* Recommended WF
  + TBA

Companies are invited to provide their input on this proposals

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Issue 6-1: Deployment Scenarios**  It is useful to clarify whether wide area, medium range or local area scenarios are being targeted (or all of these). If dynamic TDD is considered, it should be clarified what is the deployment scenario since in many scenarios dynamic TDD causes cross-operator interference.  **Issue 6-2: RF Architecture**  The WI assumes that there is not active beamforming between the repeater and the UE. The reason for this is to target developing “simple” repeater specifications before moving on to “smart” repeaters. This implies option 2 for the repeater – UE link.  **Issue 6-3: Beam and slot awareness**  Since the aim of the WI is to derive RF requirements for “simple” repeaters, this should be considered later as a part of smart repeaters to keep to the current WI scope. |
| Huawei | Issue 6-1: The use cases need to be clear, particularly for: TDD, scenarios where BS is beam sweeping, UE has beam steering, etc  Issue 6-2: The WI specifically does not include active beam forming, some form of installation based static beamforming could be within scope however could complicate matters. As antenna isolation is extremely important for repeater operation currently the antenna selection and deployment is done on installation to ensure the required isolation. As each installation may have very different limitations this can only be done on sight and there are a number of ways it can be achieved. If the repeater antennas could change its nature then this could cause the system to oscillate and would be very difficult to test without knowing the exact installation scenario. Without some good reason to include such functionality we should probably avoid it.  Issue 6-3: Again this would require specific information to be communicated to the repeater, this is outside the scope so option 2 is the target  Issue 6-4: 2 issues here: 1) once again its outside the scope of the WI, 2) the repeater gain is optimised for the isolation which can be achieved. Clearly you could reduce this gain without issues but you could not increase it without risk of oscillation. |
| ZTE | **Issue 6-1: Deployment Scenarios**  No strong opinions on that, in general, it should be supported for all scenarios we think.  **Issue 6-2: RF Architecture**  Support the option 2.  **Issue 6-3: Beam and slot awareness**  Support the option 2 which is aligned with WID. |
| CMCC | Sub topic 6-1: Option 1, no need to further discuss the scenarios. High-speed train is one typical deployment scenario to extend the coverage considering the ~30dB penetration loss of the high-speed train. From our point of view, all MA/LR/LA are the target scenario for future flexible deployment.  Sub topic 6-2:  we prefer option 2 that repeater will support active antennas with some beam steering for both FR1 and FR2  In high-speed train scenario, donor antennas would be deployed on the high-speed train to connect the donor BS. In this case the repeater is moving relative to the fixed deployed BS, fixed-directional or omnidirectional antenna would reduce the coverage range compared to feasible beam steering capability. As for how to adjust beam steering, it is up to repeater implementation.  Sub topic 6-3: option 1. repeater need to know which beam to forward and the slot in which it should forward it to reduce power consumption for FR2.  Sub topic 6-4: option 2, gain is controlled by repeater itself. |
| CATT | **Issue 6-1: Deployment Scenarios**  **We think it may not be needed for FR1 because LTE study can be refered. FR2 repeater has not discussed before, but if the feature support is based on declaration, we need to understand what’s the expected discussion output for this issue.**  **Issue 6-2: RF Architecture**  **If the feature can be based on declaration, we may not need that discussion.**  **Issue 6-3: Beam and slot awareness and 6-4**  **Need to discuss if they’re in the WI scope.** | |
| Docomo | **Issue 6-1: Deployment Scenarios**  If RAN4 adapts new assumption such as repeater class (similar with BS class), then it is needs to be discussed each assumptions.  **Issue 6-2: RF Architecture**  Align with the scope of the WID, Option 2 is preferable.  **Issue 6-3: Beam and slot awareness**  Align with the scope of the WID, Option 2 is preferable.  **Issue 6-4: TBA**  Align with the scope of the WID, Option 2 is preferable. In order to control repeater’s gain by network, some additional information is needed. | |
| Nokia, Nokia Shanghai Bell | **Issue 6-1: Deployment Scenarios**  Option 2: Normally 3GPP RF requirements are based on a set of agreed deployment scenarios and use cases. In case of repeaters understanding the deployment scenarios will help to evaluate whether current NR and/or IAB RF requirements are possible to be re-used and whether there are need for multiple different classes of repeaters.  **Issue 6-2: RF Architecture**  Beam steering was ruled out by the WI. However, likely both omni and fixed antenna array options are possible. Discussion on the use cases and deployment scenarios would help. For example, if FR2 repeater has an antenna array, it can only serve rather narrow geographical area, potentially limiting the usefulness of the repeater.  **Issue 6-3: Beam and slot awareness**  In our understanding repeater will forward what it receives, without understanding the contents of the signal. Therefore, beam awareness does not appear feasible for simple repeater.  **Issue 6-4: Repeater gain control**  **T**he need for gain control depends on use cases. If the channel conditions are expected to be vary greatly, then gain control could be useful. However, as the WI is contained within RAN4, there seems to be no way to specify such gain control. | |

### CRs/TPs comments collection

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| **CR/TP number** | **Comments collection** |
| XXX | Company A |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |