**3GPP TSG-RAN WG4 Meeting # 100-e R4-210xxxx**

**Electronic Meeting, 16th – 27th August, 2021**

**Agenda item:** 9.5.1

**Source:** Moderator (Qualcomm Incorporated)

**Title:** Email discussion summary for [100-e][308] NR\_Repeater\_General

**Document for:** Information

# Introduction

This email thread is discussing several issues regarding the introduction of repeaters for NR in both FR1 and FR2. The main topics for discussion are listed below:

* 1st round:
	+ System parameters
	+ Definition of repeater classes and types
	+ UL/DL switching requirement for TDD
	+ Handling of the conformance specs
	+ Specification Skeleton
* 2nd round: TBA

# Topic #1: System Parameters

*Several system parameters are discussed in this section*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2111915 | CATT | **Proposal 1: The name of the links between repeater and BS/UE follow E-UTRA repeater specification that downlink and uplink are used. The requirements are defined for downlink and uplink.****Proposal 2: There are separate clauses in the repeater’s spec for channel raster and sync raster which refer BS and UE specification.** |
| R4-2113665 | Nokia | **Proposal 1: For repeater type 1-C, the implementation options used for BS type 1-C (to define the multi-band requirement) could be used.****Proposal 2: It makes sense to specify the requirements assuming that the same implementation option is used for the access and backhaul sides of a repeater.****Observation 1: The agreed pass band definition does not clearly state whether each of those individual pass bands belong to the same operating band or not. As a result, one could think the individual pass bands would locate in the same or different operating bands.****Proposal 3: When the pass bands are located in different operating bands, the requirement defined for each operating band could be used for the respective pass band. That is, if the requirements for each operating band are different, then that of the pass band would also be different.**If a repeater could have more than one pass band, it would be essential to define some parameters to characterize the repeater pass bands. For example, similar to the sub-block gap $W\_{gap}$ in contiguous and non-contiguous carrier aggregation.**Proposal 4: Additional parameters would need to be defined to characterize multiple pass bands of a repeater.****Proposal 5: It would be good to consider whether requirements need to differ in cases where a repeater has two pass bands which are located either within two different operating bands or within the same band.** |

## Open issues summary

### Sub-topic 1-1

Definition/naming for UE to repeater link and repeater to BS link

**Issue 1-1: Naming of links between repeater/BS and UE/repeater**

* Proposals
	+ Option 1: The name of the links between repeater and BS/UE follow E-UTRA repeater specification that downlink and uplink are used. The requirements are defined for downlink and uplink.
	+ Option 2: Other proposals
* Recommended WF
	+ Option 1

If option 2 is preferred then please also present an alternative proposal to be considered.

### Sub-topic 1-2

Need for channel raster/sync raster in repeater specs

*Open issues and candidate options before e-meeting:*

**Issue 1-2: Channel and sync raster**

* Proposals
	+ Option 1: Both channel raster and sync raster should be included in the repeater specifications
	+ Option 2: Only channel raster is needed in the repeater specifications
	+ Option 3: Neither is needed in the repeater specifications
* Recommended WF
	+ Option 1

If other options are preferred, please state the arguments for the chosen option

### Sub-topic 1-3

Multi-band requirements for type 1-C

*Open issues and candidate options before e-meeting:*

**Issue 1-3: Multi-band requirements for type 1-C**

* Proposals
	+ Option 1: Proposal 1: For repeater type 1-C, the implementation options used for BS type 1-C (to define the multi-band requirement) could be used.
	+ Option 2: Other options
* Recommended WF
	+ Option 1

If other options are preferred, please state the arguments for the chosen option

### Sub-topic 1-4

Assumptions on repeater implementation for requirements definition

*Open issues and candidate options before e-meeting:*

**Issue 1-4: Implementation assumptions for repeaters**

* Proposals
	+ Option 1: specify the requirements assuming that the same implementation option is used for the access and backhaul sides of a repeater.
	+ Option 2: Specify the requirements assuming different implementations for access and backhaul are possible
	+ Option 3: Other options
* Recommended WF
	+ Option 1

If other options are preferred, please state the arguments for the chosen option

### Sub-topic 1-5

Requirements for repeaters with pass bands in different operating bands

*Open issues and candidate options before e-meeting:*

**Issue 1-5: Requirements with pass bands in different bands**

* Proposals
	+ Option 1: The requirement defined for each operating band could be used for the respective pass band. That is, if the requirements for each operating band are different, then that of the pass band would also be different
	+ Option 2: Other options
* Recommended WF
	+ Option 1

If other options are preferred, please state the arguments for the chosen option

### Sub-topic 1-6

Parameters to characterize multiple pass bands

*Open issues and candidate options before e-meeting:*

**Issue 1-6: Parameters for multiple pass bands repeaters**

* Proposals
	+ Option 1: Additional parameters would need to be defined to characterize multiple pass bands of a repeater (e.g. gap between passbands)
	+ Option 2: Nothing is needed, just independent requirements for each pass band
* Recommended WF
	+ Option 1

If Option 1 is preferred, please also propose other possible parameters. If Option 2 is preferred, please state the arguments

### Sub-topic 1-7

Requirements for repeaters with multiple pass bands

*Open issues and candidate options before e-meeting:*

**Issue 1-7: Requirements with multiple pass bands**

* Proposals
	+ Option 1: Requirements need to differ in cases where a repeater has two pass bands which are located either within two different operating bands or within the same band.
	+ Option 2: Requirements can be the same
* Recommended WF
	+ Option 1

Please state your preference and arguments.

## Companies views’ collection for 1st round

### Open issues

Sub topic 1-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We are fine with using the terms DL and UL. Note that there are 4 groups of requirements; DL TX, UL TX, DL RX (i.e. Input intermodulation), Ul RX (i.e. input intermodulation) |
| CATT | Support the recommended WF. |
| Huawei | The names of the links are ok, but we are concerned that this will be confused with the “sides” of the repeater which we have agreed can have different classes. For example if the “UE side” of the repeater were indoor local area and the “BS side” were outdoor wide area, then the UL transmitter would be wide area and the uplink receiver would be local area. The existing repeaters do not have this complication as they have no classes. |
| Nokia, Nokia Shanghai Bell | We are ok with the WF. |
| AT&T | We support the WF. |
| CMCC | WF is preferred. The concept of “DL/UL” combined with “Tx/Rx requirements” could clearly describe links among BS, repeater and UE. |
| Samsung  | Fine to follow LTE approach  |
| Qualcomm | We are ok with the WF |

Sub topic 1-2

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| **Company** | **Comments** |
| Ericsson | We do not see it as essential to include references to channel and sync raster; designers of repeaters that read SSB will presumably check the UE/BS specs anyhow and will need to check other specs too (e.g. RRC). We don’t have any objection to including either or both though (as references to the BS spec) |
| CATT | Support option 1 but as said in our paper, just referring BS spec may be ok. |
| Huawei | Can’t see why channel and sync rater is necessary, the repeater has a passband and amplifies what is inside the passband. Don’t really agree the channel information is needed. If this is clear and the BS/UE are referenced for information then maybe ok but we don’t really see the need. |
| Nokia, Nokia Shanghai Bell | It is fine to refer to other specifications for raster information though we think that rasters are not essential for repeaters operating on the basis of passbands rather than specific channel bandwidths. |
| AT&T | We support option 3 which is inline with the agreed WF in R4-2108626. |
| CMCC | Option 1 is preferred. Channel raster and syn-raster are necessary for certain repeaters equipped with digital processor. It would be clear if including both channel raster and syn-raster in repeater spec. of cause, some notes may be needed to clarify that raster related requirement is only optional for certain repeaters not mandatory for all repeaters. |
| Samsung  | Agree with the point that we can study further on how to refer to BS/UE spec on sync and channel raster according to WF.  |
| Qualcomm | Option 1 |
| Pivotal | We actually prefer Option 3, and agree with Ericsson, Huawei and Nokia in that the channel and sync raster are neither essential nor necessary. |

Sub topic 1-3

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Option 1 is OK; this was thought through for the BS. |
| Huawei | Option 1 use the BS method is ok |
| Nokia, Nokia Shanghai Bell | We support option 1. |
| AT&T | We support the WF. |
| CMCC | Option 1. For WA, it is possibility that all connectors are multi-band connectors. For home class, in most cases, all connectors are single-band connectors to reduce cost and complexity. Therefore, the same implementation options for BS 1-C could be used. |
| Samsung  | Fine with the WF |
| Qualcomm | Ok with the WF |

Sub topic 1-4

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Either option is feasible. Apart from the need to make two declarations we would like to clarify is there actually any increase in complexity if option 2 would be adopted? (It would add implementation flexibility) |
| Huawei | Related to our comment on sub-topic 1-1 we seem to be using the language “access side” and “backhaul side” which is ok but we should perhaps clarify some definitions.On this sub-topic, it seems having different classes on each side is a feasible deployment scenario so option 2 |
| Nokia, Nokia Shanghai Bell | In the related Tdoc it is clear that the discussion is about whether single-band, multi-band or mix of single and multi-band connectors are used. As repeater by definition sends forward what it receives, it is safe to assume similar approach is used in both access and backhaul sides of the repeater. |
| AT&T | We agree with Ericsson that we should consider implementation flexibility for access vs. backhaul. |
| CMCC | Option 1. We could assume the same implementation option for DL and UL sides of repeater since repeater may use the same antenna device for DL and UL. |
| Samsung  | The “implementation option” in option 1 is confusing. Maybe the proponent can refine the proposal to specific aspect. But from the angle of repeater class of each links, we agree that it could be different according to deployment scenario. To support this flexibility should be allowed.  |
| Qualcomm | Option 1 |

Sub topic 1-5

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| **Company** | **Comments** |
| Ericsson | Agree |
| Huawei | Option 1 makes sense |
| Nokia, Nokia Shanghai Bell | We support the WF. |
| AT&T | We support the WF. |
| CMCC | Option 1. It’s better to define RF requirements for each pass band corresponding to the operating band |
| Samsung  | Fine with the WF |
| Qualcomm | Ok with the WF |

Sub topic 1-6

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | There is a need to define a sub-block gap in the same manner as a multi-carrier BS. Requirements such as CACLR, ACS etc. should apply within sub-block gaps as appropriate. |
| Huawei | If additional requirements are needed then we should specify them – but no need to agree the principle of specifying parameters. So ok with option 1 but we don’t need to formally agree this just agree the parameters as they are proposed. |
| Nokia, Nokia Shanghai Bell | We support the WF. For CACLR definition NR BS specification use the Wgap parameter and channel bandwidth to define how CACLR applies in the sub-block gap. For repeaters this may need to be adapted to work based on passband bandwidth instead of channel bandwidth. |
| CMCC | Option 1. Candidate parameters include Inter RF Bandwidth gap size (Wgap), ΔfOBUE, f\_offset, Δf, f\_offsetmax , Δfmax, BWChannel of BS |
| Samsung  | Passband definition agreed in last meeting which states that “A repeater can have one or several pass bands.” Hence this requirement with in multiple passband gap should be discussed under corresponding agenda.  |
| Qualcomm | Additional parameters will most likely be needed. Ok with the proposed WF |

Sub topic 1-7

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| **Company** | **Comments** |
| Ericsson | Exceptions for spurious emissions and OOB blocking requirements for one band are needed within other bands transmitter/received from the same multi-band connector (in the same way as the BS spec) |
| Huawei | Seems reasonable – option 1 is ok |
| Nokia, Nokia Shanghai Bell | We support the WF. |
| AT&T | We support the WF. |
| CMCC | Option 1 with some modification that Requirements may need to differ in cases where a repeater has two pass bands which are located either within two different operating bands or within the same band. This is based on whether the RF requirements for each operating band are the same or not. If RF requirements are the same for different operating bands, requirements for pass band are the same even when they are located into different operating bands. |
| Samsung  | Fine with the WF to clarify the scenario to be considered for requirement discussion  |
| Qualcomm | Ok with the WF |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing 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.*

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| --- | --- |
|  | **Status summary**  |
| **Sub-topic #1-1** | Companies agree to use the terms DL/UL to refer to the links between repeater and UE/BS. Downlink and Uplink will be used in the specifications for the requirements.*Tentative agreements: Use Downlink and Uplink in the specifications for each link**Candidate options:**Recommendations for 2nd round: Capture the above agreement in a WF* |
| **Sub-topic #1-2** | There is no consensus on this topic, some companies think it is necessary to have the information regarding channel and SSB raster. Some companies think this is not necessary but might be fine to reference this information from the BS or UE specs.*Tentative agreements: Include references to the BS or UE specs on the channel and sync rasters**Recommendations for 2nd round: Discuss further the tentative agreement in the 2nd round and try to reach some agreement* |
| **Sub-topic #1-3** | All companies who commented agreed with Option 1.*Tentative agreements:* For repeater type 1-C, the implementation options used for BS type 1-C (to define the multi-band requirement) could be used.*Recommendations for 2nd round: Capture above agreement in a WF* |
| **Sub-topic #1-4** | There is no consensus yet on this topic, discussion should continue in the 2nd round to try to clarify the proposal. Multiple companies expressed the need to enable implementation flexibility.*Tentative agreements: Allow different classes for each link**Recommendations for 2nd round: Further discuss above agreement and implementation assumptions to see if any further agreement can be reached.* |
| **Sub-topic #1-5** | All companies that commented agree with Option 1.*Tentative agreements: The requirement defined for each operating band could be used for the respective pass band. That is, if the requirements for each operating band are different, then that of the pass band would also be different**Recommendations for 2nd round: Capture above agreement in a WF* |
| **Sub-topic #1-6** | Companies agree that more parameters are needed to be specified, the actual parameters need to be discussed*Tentative agreements: Additional requirements are needed for repeaters supporting multiple pass bands.Exact parameters are FFS, possible list to be discussed is:*Inter RF Bandwidth gap size (Wgap), ΔfOBUE, f\_offset, Δf, f\_offsetmax , Δfmax, BWChannel of BS*Recommendations for 2nd round: Capture above general framework agreement and continue to discuss the actual list of requirements to see if some agreement can be reached.* |
| **Sub-topic #1-7** | Most companies agree with Option 1.*Tentative agreements:* Requirements need to differ in cases where a repeater has two pass bands which are located either within two different operating bands or within the same band. FFS exactly which requirements*Recommendations for 2nd round: Capture above agreement in a WF and further discuss which requirements could be affected.* |

### CRs/TPs

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

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **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)

Continue the discussion on the above topics and try to capture the agreements in a WF. Please see at the bottom for the WF document.

# Topic #2: Repeater Class/Type

The discussion on the definition of the repeater classes and types has been ongoing for a few meetings. In the previous meeting the following agreements were reached:

* At least 2 DL classes for FR1
* Introduce FR2 classes if requirements are different between classes, otherwise not
* Introduce at least 2 UL classes for FR1
* For FR2, either introduce 2 UL classes or limit the repeater power to the maximum UE power class
* Tentative agreement to decouple DL and UL TX classes. Further check if RX requirements might differ between classes
* Introduce types 1-C and 2-O. Further discuss 1-H/O.

In this meeting there are several proposals on which classes to define.

The discussion should be concluded in this meeting such that discussion on the actual requirements can conclude on time for the WI to be finalized as scheduled.

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2111916**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2111916.zip) | CATT | **Proposal 1: The FR1 DL output power levels corresponding to NR BS WA, MR and LA can be defined. The home class can also be considered if the requirements can be discussed and concluded.****Proposal 2: FR1 UL output power levels corresponding to NR BS MR and LA can be defined.****Proposal 3: Revisit the last meeting’s agreement for FR2 UL class and agree that no class is defined for both FR2 DL and UL.****Proposal 4: Power class is used to differentiate the output power levels and emission requirements. No repeater class definition exists in the spec.****Proposal 5: Type 1-H and type 1-O are not defined for NR repeater in R17, they can be defined in future release if there’s demand from market.** |
| [**R4-2112197**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112197.zip) | CMCC | **Proposal 1: FR2 repeater DL classes are still necessary because there is differentiation in DL related requirements among scenarios. For example, absolute ACLR requirements are different among classes.****Observation 1: 90dB maximum gain assumption is reasonable for WA scenario. The received signal at UE after repeater is below the maximum receiving power and also UL receive power is larger than sensitivity with output power less than max output power.****Proposal 2: for both FR1 and FR2 NR repeater, classification is suggested the same as NR BS spec to support WA, MR and LA repeater DL access link with the same deployment scenarios for each class. The same criteria and exactly the same parameter of NR BS classification will be applied for repeater DL access link with modification of how to describe the minimum distance or the coupling loss.****Proposal 3: for FR1 repeater, home class is also suggested characterized by the requirements as E-UTRA spec.** **Proposal 4: it is suggested to define two classes for UL backhaul link, one of which is LA-like scenario with maximum output power less than any UE power class and the other is MR-like scenario without any upper limits for FR1 and FR2.**** Medium Range repeater UL backhaul are characterised by requirements derived from Micro Cell and/or Macro Cell scenarios.**** Local Area repeater UL backhaul are characterised by requirements derived from Pico Cell and /or Micro Cell scenarios.****Observation 1: the potential interference issue introduced by repeater with higher output power than any UE class may be resolved by smart repeater by some intelligent mechanism.** |
| [**R4-2112764**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112764.zip) | NTT DOCOMO, INC. | **Observation 1: The class definition for FR2 UL was based on the idea of unplanned/planned.****Observation 2: Some countries and/or regions where the regulation does not allow the output power of PC1, it might not be able to use the NR repeater unplanned which has the same output power with PC1.****Proposal 1: RAN4 introduce additional class for FR2 UL, which shall not exceed the output power of any UE Power Classes i.e. not to exceed 23dBm.****Proposal 2: RAN4 adopt following idea on how to define UL class:*** **Planned (WA): The output power has no limit.**
* **Semi-unplanned (MR): The output power shall not exceed UE Power Class 1.**
* **Fully-unplanned (LA): The output power shall not exceed any UE Power Classes (23dBm).**
 |
| [**R4-2113204**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113204.zip) | ZTE Corporation | **Observation 1: Many stakeholders are eager to enhance outdoor coverage with low costs, but the utilization of repeater may impact the network from multiple aspects.****Proposal 1: Introduce Medium Range class for both FR1/FR2 repeater, and specify the maximum output power limits. The specific value may need further evaluation.** |
| [**R4-2113363**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113363.zip) | Ericsson | **Proposal 1: BS class definitions (Macro, Micro, Pico) are applied for repeaters****Proposal 2: Discuss whether to omit the statement about minimum distance from repeater class definitions.****Proposal 3: Create LA, MR, WA repeater classes.****Proposal 4: Either limit the repeater output power to the maximum UE power class or create 2 UL repeater classes similar to the IAB classes.** |
| [**R4-2113666**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113666.zip) | Nokia, Nokia Shanghai Bell | Error! Reference source not found.* *Option 1: WA and LA  WA deployment to serve MR requirements*
* *Option 2: WA and LA  WA to serve for MR requirements*
* *Option 3: WA and MR  MR deployment to serve LA requirements*

Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.***Table 1: Possible classes for access and backhaul links for FR1 and FR2***

|  |  |  |
| --- | --- | --- |
| ***Frequency range*** | ***Access link (DL)*** | ***Backhaul link (UL)*** |
| ***FR1*** | ***WA, LA*** | ***WA, LA*** |
| ***FR2*** | ***WA, LA*** | ***WA, LA*** |

Error! Reference source not found. |
| [**R4-2114229**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114229.zip) | Huawei | For repeater type 1-C, UE side classes are defined as indicated below:- Wide Area repeaters on the UE side are characterised by requirements derived from Macro Cell scenarios with a repeater to UE minimum coupling loss equal to 70 dB.- Local Area repeaters on the UE side are characterised by requirements derived from Pico Cell scenarios with a repeater to UE minimum coupling loss equal to 45 dB.For repeater type 1-C, BS side classes are defined as indicated below:- Wide Area repeaters on the BS side are characterised by requirements derived from Macro Cell and/or Micro Cell scenarios.- Local Area repeaters on the BS side are characterised by requirements derived from Pico Cell and /or Micro Cell scenarios.We also have discussed the necessity for a 1-H repeater class and do not think it is required. |
| [**R4-2114481**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114481.zip) | Qualcomm Incorporated | **Proposal 1: RAN4 should develop WA, LA, and home repeater class FR1 specs.****Proposal 2: RAN4 should include repeater requirements for FR2-2****Proposal 3: We should consider indoor hotspot, dense urban, urban micro, urban macro, rural, and factory hall deployments in developing repeater classes.** |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1

General repeater classes definition*:*

It has not yet been agree how to characterize the different repeater classes or whether just maximum output power is enough*:*

**Issue 2-1: Repeater class characterization**

* Proposals
	+ Option 1: Power class is used to differentiate the output power levels and emission requirements. No repeater class definition exists in the spec.
	+ Option 2: Deployment scenario is used to differentiate repeater classes
	+ Option 3: Similar to BS power classes(based on MCL)
	+ Option 4: Other definition/differentiation for classes
* Recommended WF
	+ TBA

Please state your preference and arguments for the choice

GTW Aug 18 WF agreement: Option 2, the detailed definition from BS specification can be considered as starting points.

### Sub-topic 2-2

*Repeater class for FR1 DL(access link)*

**Issue 2-2: Classes for FR1 DL**

* Proposals
	+ Option 1: Introduce WA, MR, LA
	+ Option 2: Introduce WA, MR, LA and home class
	+ Option 3: WA and LA
	+ Option 4: WA, LA and home class
* Recommended WF
	+ Option 2

Option 2 is the most comprehensive. If other option is preferred, please state arguments why some classes are not needed.

GTW Aug 18 Agreement: Introduce WA, MR and LA classes. Further checking the need of home class during requirements introduction phase.

### Sub-topic 2-3

*Repeater class for FR2 DL(access link)*

**Issue 2-3: Classes for FR2 DL**

* Proposals
	+ Option 1: Introduce WA, MR and LA
	+ Option 2: WA and LA
	+ Option 3: no class defined
* Recommended WF
	+ Option 1

Option 1 is the most comprehensive. If other option is preferred, please state arguments why some classes are not needed.

GTW Aug 18 Agreement: Option 1 as baseline pending on further checking whether there is difference among classes from RF requirements aspect.

### Sub-topic 2-4

*Repeater class for FR1 UL(backhaul link)*

**Issue 2-4: Classes for FR1 UL**

* Proposals
	+ Option 1: 2 classes: LA like with maximum output power less than any UE and MR like without upper limit
	+ Option 2: 2 output power classes: upper limit same as UE(e.g. LA) and one without upper limit that is well planned by operator (e.g. WA)
	+ Option 3: Other option
* Recommended WF
	+ Option 2

Option 2 seems to cover most needs. If another option is preferred, please state arguments and proposal for power limits

GTW Aug 18 Agreement: Introduce two classes, one with power limitation and another one without power limitation.

For the class with power limitation: the exact power limitation can be further discussed

* Option 1: With fixed values
* Option 2: With maximum value over the supported classes as per band basis
* Other options not precluded

### Sub-topic 2-5

 *Repeater class for FR2 UL(backhaul link)*

**Issue 2-5: Classes for FR2 UL**

* Proposals
	+ Option 1: 2 classes: WA and LA
	+ Option 2: No class defined
	+ Option 3: 2 classes: LA and MR
	+ Option 4: 3 classes: Planned(WA)- no power limit, Semi-unplanned (MR) – upper limit same as UE PC 1 and Fully-unplanned(LA) – output power same as UE PC3/5
* Recommended WF
	+ Option 4

Option 4 is proposed, if other options are better then please state the arguments and what would be the requirement differentiator

GTW Aug 18 Agreement: Introduce two classes, one with power limitation and another one without power limitation. These can be checked whether there are difference among classes from requirement aspect.

Further discuss the power limitation value for the class with power limitation:

* Option 1: EIRP and TRP specified for PC1 in UE specification 101-2.

Other options not excluded

### Sub-topic 2-6

*Handling of FR2-2*

**Issue 2-6: Repeaters for FR2-2**

* Proposals
	+ Option 1: RAN4 should include repeater requirements for FR2-2
	+ Option 2: RAN4 should not included repeater requirements for FR2-2 in the current WI, it can be discussed in the future
* Recommended WF
	+ TBA

Please state your preference or aguments

### Sub-topic 2-7

*If FR2-2 will be included, what classes should be introduced for FR2-2*

**Issue 2-7: Classes for FR2-2**

* Proposals
	+ Option 1: Maintain the same classes as FR2
	+ Option 2: consider indoor hotspot, dense urban, urban micro, urban macro, rural, and factory hall
	+ Option 3: Further discuss in the next meeting how these
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We have some preference for option 2. The reason is that the downlink power limits for BS have been derived based on the corresponding deployment scenarios. Stating that the requirements are power classes would imply that the power class can be deployed in any deployment scenario. This is true for UEs (which can roam between different scenarios), but for BS the power limits are linked to scenarios. For the BS specs, we do not believe that the classes are based on MCL; rather the other way around the requirements are based on deployment scenarios and MCL is recorded as one of the parameters of the scenario.The definition of the deployment scenarios is, we believe sufficiently flexible for describing repeater deployments. |
| CATT | Option 1 is from our company. We still think it’s reasonable. Power class or power level can be used to differentiate the requirements. There’s no repeater class for UTRA and E-UTRA repeater and we’re not confident on how to define the repeater classes. Inventing repeater class in NR may bring some misleading. The deployment consideration for repeater is different with BS/IAB, such as tunnel. There’s another reason that BS/IAB usually transmit the declared maximum output power which is related to deployment scenarios. But repeater’s output power is decided by the input signal and gain, even maximum gain is used, when the input signal is 10 dB lower, the output power will also be 10 dB lower thus the coverage is smaller. |
| Huawei | BS does not have power class, the power limit is imposed on BS (along with other requirements) based on the declared class. So option 3 is not strictly correct. As repeaters are deployed then option 2 seems sensible, the class should be based on the deployment scenario (MCL may be an important part of this deployment scenario of course) |
| Nokia, Nokia Shanghai Bell | We think option 2 (deployment scenario) should be the baseline and on top of that option 3 (MCL / distance) can be used to characterize the deployment scenario.  |
| AT&T | Option 2. |
| CMCC | For DL, option 3 is preferred. For UL, two levels of output power are suggested. The first level with output power less than any UE power class. For the second level, there is no output power upper limits and output power is allowed to be larger than any UE power class. Repeater could declare their output power if it’s larger than any UE power class. |
| Samsung  | We agree this is a complicated issue which is time consuming to be decided. Option 2 seems easier way to deliver the necessary message on how to category repeater especially for the case which is not easy to be quantified in general way. |
| Docomo | Option 2. |
| ZTE | Option 2 seems to be more reasonable.  |

Sub topic 2-2

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| **Company** | **Comments** |
| Ericsson | We think that the 3 existing classes can be defined to give flexibility (option 1). Regarding option 2; our understanding is that the power limit is an upper limit, not a target (actual power supported is declared) and there would be no other requirement differences for a “home” scenario. So a “home” deployment could be served by repeaters declared with lower power than the maximum limit for an LA class and conforming to LA requirements.Regarding option 3; if this would be adopted it would imply that either medium range is not supported, or there is no need for a power limit for medium range. In our view, if there would be a strong desire to limit to two classes then MR and LA may be more appropriate to avoid that repeaters with unlimited DL power are inadvertently deployed in medium range scenarios. |
| CATT | We’re ok with the power levels for WA, MR, LA and home class (if it can be agreed). Whether the power levels are defined for repeater class or power class depends on the discussion for 2-1. |
| Huawei | Class generally refers to both Tx and Rx this is DL access, so the Tx, output power is not the only limit effected by the class. It’s not clear that so many classes are really justified for a repeater as the deployment is somewhat limited by its function. Home requirements are set to avoid interference to adjacent cell outside building where they are deployed, it’s not clear this is an suitable objective for a repeater as its just amplifying existing signals. But option 1 is probably ok |
| Nokia, Nokia Shanghai Bell | We think option 3, WA and LA, would be sufficient, but we would be also ok with option 1 which adds MR. As maximum output power is declared and the difference in requirements is not clear, we do not see the necessity of having a separate home class. |
| AT&T | We prefer Option 1. |
| CMCC | Option 2 is preferred. Home class is very important in our realistic network deployment for small coverage. For such repeaters, more relaxation requirement is suggested considering its low cost and small size. |
| Docomo | We prefer Option 1. Follow the agreement in GTW session. |
| ZTE | Option 1 but the power limits of WA may still need to be discussed. |

Sub topic 2-3

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| **Company** | **Comments** |
| Ericsson | We are OK for option 1, or in case there would be no difference in the requirements option 3. If the only difference in requirements is the absolute ACLR level then option 1 is not any more complex than option 2 but is clear that all of the scenarios can be supported. |
| CATT | Currently we still slightly prefer option 3. As FR2 power may be declared so not sure if power class can be defined. But if ACLR can’t be defined, there may be no requirements need to be differentiated, then no class or even power class may be ok for FR2. |
| Nokia, Nokia Shanghai Bell | Our preference is option 2 but we would be also ok with option 1 if that gets the clear majority support. |
| AT&T | We prefer Option 1. |
| CMCC | Option 1. There’re some differences of DL related requirements among different scenarios. for example, absolute ACLR requirement. Therefore, the same definition as BS spec is recommended. |
| Docomo | We prefer Option 1. Follow the agreement in GTW session. |
| ZTE | There is a precondition which all devices operating under the FR2 network have the beam forming capability, but repeater does not. Introduction of WA class without upper limits might be reckless. Due to the particularity of FR2, we believe that some interference and coexistence assessments are necessary. |

Sub topic 2-4

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| **Company** | **Comments** |
| Ericsson | We are OK for option 1 and option 2. Note that option 2 is effectively taking the responsibility for ensuring co-existence in the UL from 3GPP and into the hands of the deploying operator (3GPP specs would not guarantee co-existence), but this is already the practice for IAB and using directional antennas + avoiding co-located equipment is achievable for FR2 and FR1 AAS. |
| CATT | Prefer option 1. From power levels perspective, both option 1 and option 2 may be ok. But from how the requirements are differentiated, we support option 1 to reuse the possible BS requirements for the corresponding output power levels. For option 2, some clarification is needed on how to define the requirements for different power levels. |
| Huawei | For BS FR2 has no power limits, the receiver requirement antennas gain declaration varies between classes which changes the receiver requirements a bit. But may not affect the repeater requirements. It’s not clear why we need classes if the requirements are all the same, but we think class should be based on deployment scenario so if 3 deployment scenarios can be defined then option 1 is ok. |
| Nokia, Nokia Shanghai Bell | We support the WF of option 2. |
| AT&T | We support the WF. |
| CMCC | Option 3: no UL scenario related classes definition and only differentiate RF requirements by two levels of output power. One output power less than any UE power class and the second level with output power larger than any UE power class.After careful internal discussion, we suggest option 3 as above. output power larger than any UE power class is mainly used to resolve following two issues which exist in our realistic E-UTRA repeater deployment scenario or even GSM repeater deployment scenario.1. If repeater receives two signals with different input power, one relatively strong level and the other relatively weak level due to different modulation scheme/ location. The repeater would determine its amplification gain based on the larger input signal to avoid output power larger than allowed power. If the amplification gain is less than the target maximum gain then the output power of weak signal would be even less and the coverage for such UEs could be shrunk. If the allowed maximum output power would be larger than target UE power class, this issue could be settled or at least mitigated.
2. If repeater amplifies more than one input signals at the same time, the output power at repeater could be the sum of these two signals. In cases when the output power for these two signals are both 23dBm, then the output power of repeater should be 26dBm. But if we only assume the maximum allowed output power of repeater is 23dBm, the repeater can’t amplify these two signals as they want. From this point of view, the maximum allowed output power of repeater should equal to the sum of all UEs’ target output power that are serviced by repeater at the same time.

Above issues imply UL output power of repeater should be equal to or larger than the target value. In most cases the target value equals to the maximum UE power class assuming repeater is deployed at the cell edge for UL. The output power of repeater equals to target value only when repeater service one UE. But when repeater serves two or even more UEs at the same time, the output power of repeater in UL should be larger than the target value.For option 2, it seems the UL output power is related to planned or unplanned scenario. However this is misunderstanding of why repeater’s output power should be larger than UE power class. even in unplanned scenario, repeater’s output power could be larger than any UE power class as long as repeater services two or more UEs at the same time in DL. |

Sub topic 2-5

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| **Company** | **Comments** |
| Ericsson | Either no class, but maximum UL power limit, or 2 classes with a limit on one class (like IAB) or option 4 are all fine. Same comment as FR1; the class with no upper limit is not guaranteeing co-existence in the 3GPP specifications but instead relies on intelligent deployment taking into account other operator BS. |
| CATT | Currently support option 2 if no requirements will be differentiated. The problem for option 4 is that UE EIRP requirement is very different with BS, for example spherical coverage, not sure the benefit of option 4. |
| Huawei | The power limits make sense to be based on existing UE limits if we don’t want to do more co-existence work. But the deployment is not that of a UE, as such the class should be based on that |
| Nokia, Nokia Shanghai Bell | Option 1: In previous meeting it was already agreed to use PC1 power upper limit for one class and another one without power limits. As the maximum output power is declared having this class definition does not preclude implementing repeaters with lower maximum output power if required by country-specific regulations. |
| CMCC | Option 2. The same reason as sub topic 2-5. Repeater’s output power may need to be larger than any UE power class as long as it services two or more UEs at the same time in DL no matter repeater is planned or unplanned. |
| Docomo | We are fine with Option 1. Since the maximum output power is declaration basis and it is allowed to declare lower output power than that of PC1 level as maximum, there are no concern on country-specific regulation. Follow the agreement in GTW session.  |
| ZTE | Option 3. There is a precondition which all devices operating under the FR2 network have the beam forming capability, but repeater does not. Introduction of WA class without upper limits might be reckless. Due to the particularity of FR2, we believe that introduce MR with upper limits first could be taken as baseline. |

Sub topic 2-6

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| **Company** | **Comments** |
| Ericsson | We are not against covering FR2-2 in principle. However, procedurally there is not yet an FR2-2 spec, and we should not create a dependency between WI so for this reason the WI should not agree to include the results of another Rel-17 WI. |
| CATT | Support option 2, BS requirements for FR2-2 is not decided yet. And we don’t think FR2-2 is urgent for repeater. |
| Huawei | We should follows process and wait to cover FR2-2 for repeater (option 2) |
| Nokia, Nokia Shanghai Bell | We support option 2, this is also plenary decision and not for RAN4 to decide. |
| AT&T | We support option 2. The addition of FR2-2 frequency range needs to be approved by RAN Plenary as part of the normal WID approval process. |
| CMCC | Option 2. Wait for the completeness of FR2-2 related RF requirements. |
| Samsung  | RAN4 agreed to take existing Rel-16 bands for repeater as basis. Even if the RAN-P agree to update scope to bring new bands to be added in Rel-17 in this WI it’s believed that it may not be possible to complete all related work on time.  |
| Docomo | Option 2. It should be made decision in plenary. |
| Qualcomm | We think developing the repeater spec along with FR2-2 would be management so we would prefer Option 1 |

Sub topic 2-7

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| **Company** | **Comments** |
| Ericsson | See comment about about FR2-2. There has not yet been any discussion on BS and UE classes for this FR. Presumably at least the DL classes could be the same, but as of now making an agreement would be risking to diverge from the approach used for BS. |
| CATT | Depends on the agreement for 2-6. We think FR2-2 discussion can be postponed to future release. |
| Huawei | Clearly the outcome of sub-topic 2-6 affects this, we don’t think its necessary to discuss at this time. |
| Nokia, Nokia Shanghai Bell | This discussion can be postponed until after there is an outcome on sub-topic 2-6. |
| AT&T | No need to discuss at this time until there is an approved WI containing the addition of FR2-2. |
| Qualcomm | Most likely the same classes could be maintained given the flexibility of the FR2 classes but this would also have to be further discussed after the FR2-2 BS classes are clear |

### 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#2-1** | *:**Agreement reached in GTW, see above* |
| **Sub-topic#2-2** | *Agreement reached in GTW, see above* |
| **Sub-topic#2-3** | *Agreement reached in GTW, see above* |
| **Sub-topic#2-4** | *Agreement reached in GTW, see above* |
| **Sub-topic#2-5** | *Agreement reached in GTW, see above* |
| **Sub-topic#2-6** | *Most companies commented that repeaters for FR2-2 should not be discussed for now because even the BS/UE requirements are not yet defined. Also, inclusion of FR2-2 would require some WID clarifications in the plenary.* |
| **Sub-topic#2-7** | *Most companies commented that this discussion could only happen after agreeing to cover FR2-2 and knowing more about the BS/UE requirements for that range. Before clarifying the discussion in sub-topic#2-6, this should not be discussed further.* |

### 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)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

No further discussion in the 2nd round

# Topic #3: TDD Repeater Switching Requirements

This section discusses how to define the switching requirements for TDD repeaters.

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2111917**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2111917.zip) | CATT | **Proposal 1: The TDD repeater requirements can be defined as EVM and OFF power level for both DL and UL.****Proposal 2: The DL OFF power level is measured at the UL transmission period + UE transmit period length \*2. The UL OFF power level is measured at the DL transmission period + BS transmit period length \*2.****Proposal 3: TDD switch timing accuracy is the name of the requirement.****Proposal 4: Dynamic range for the TDD time accuracy requirement is defined, [35] dB range as CCSA TD-LTE is considered.****Proposal 5: Different DL/UL configuration capability can be merged to the TDD time accuracy requirement.****Proposal 6: No group delay requirement is defined for NR TDD repeater.** |
| [**R4-2112196**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112196.zip) | CMCC | **Proposal 1: maximum output power could be tested together with TDD switching requirements****Proposal 2: fig 4 is suggested as the schematic diagram of TDD switching related requirements.** **Proposal 3: two methods for TDD switching related requirements definition are listed as below. TDD switching related requirements include group delay, TDD switching period, power ramp down and power ramp up transition period.*** **Option 1: only list the schematic diagram as in fig4 in the spec without any specific basic limits of TDD switching related requirements.**
* **Option 2: define basic limits for at least one part of TDD switching related requirements including group delay, TDD switching period, power ramp down and power ramp up transition period.**

**Observation 1: before defining TDD requirements, we should find out whether current RF requirements e.g. EVM could already make sure repeater amplify corresponding signal in advance before it receives and terminate its gain amplification after signals passed through repeater without introducing cross link interference.** |
| [**R4-2113207**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113207.zip) | ZTE Corporation | **Proposal 1: Introduce Cell Phase Synchronization Accuracy requirements for TDD repeater, the value could be set to 3µs as the baseline. How to measure this requirement is FFS.**  |
| [**R4-2113362**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113362.zip) | Ericsson | **Proposal 1: Define the switching time requirement in the same manner for both directions****Proposal 2: The switching time requirement is 10us for FR1 and 3us for FR2****Proposal 3: Discuss further whether gain or power level should be the requirement metric for TDD OFF power****Proposal 4: No need to set a requirement or test relating to synchronization of DL and UL switching****Proposal 5: RAN4 should discuss further whether the OFF level should be defined as an absolute power level or a minimum gain****Proposal 6: Define the requirement and test as applicable with a continuously applied stimulus signal. Transition time is the time take to transition between maximum output power and minimum power (or gain).****Proposal 7: Do not create a group delay requirement** |
| [**R4-2113667**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113667.zip) | Nokia, Nokia Shanghai Bell | **Observation 1: Relative timing of UL/DL signals are essentially the same for all UEs at the repeater.****Observation 2: Normal TA control loop for UL timing will have no additional requirements due to usage of repeaters.****Observation 3: Any group delay through the repeater will contribute the same way for timing as the propagation delays over the radio links.****Observation 4: The RX/TX switching times will be larger at the repeater than guaranteed for gNB and the UE with NR TA control loop and related parameters.****Observation 5: The available gap between DL TX and UL TX will be the RX/TX switching gap on the backhaul link reduced by the group delay of the repeater and the ramp-down/-up periods of the DL/UL TX power.****Observation 6: Agreed baseline for repeater switching sufficiently considers both DL and UL TX signals.****Observation 7: As indicated in the baseline switching diagram, the expected range of the guard period between DL and UL TX should be known.****Observation 8: The actual group delay of the repeater implementation should be known for the network planning with repeater deployments as too long group delay limits the applicable deployments and network configurations.****Proposal 1: RAN4 to confirm the diagram in the WF as the basis for the repeater TDD switching requirements so that UL and DL will not be treated independently.****Proposal 2: Open issues related to gain switching, stimulus signal and whether the requirements can be tested with power/EVM measurements, to be discussed in the conformance part.****Proposal 3: There is no need to specify requirement for the group delay.****Proposal 4: Requirements for the repeater TX OFF/ON and ON/OFF times can be based on the base station requirements.** |
| [**R4-2113984**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113984.zip) | Qualcomm CDMA Technologies | **Proposal 1. To further quantify the TDD swtiching requirements, an updated diagram for TDD repeater operation is suggested in Figure 1. The guard period should account for the ramping periods as well as the switching intervals.****Proposal 2. The guard period will depend on the switching delays. RAN4 should discuss further what values of the switching times should be considered.****Proposal 3. Stimulus signal should be adopted to measure the switching gain. More analysis is required to specify switching requirements while keeping in mind the impact of the introduction of this stimulus signal on conformance testing. TE vendors should confirm the feasibility of such test in conducted and radiated setups.****Proposal 4. Group delay requirement should capture the different delay components. To simplify the process, RAN4 can assume that the repeater should switch X seconds after the end of UL/DL transmission and this X should be based on the group delay. RAN4 can further discuss what this value should be.****Proposal 5 RAN4 should continue to discuss conformance-related issues, such as port mapping between Tx and Rx within the repeater, declaration of output power, off power and EVM, and switching time upper limits.** |
| [**R4-2114228**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114228.zip) | Huawei | **Proposal 1:** Use 2 diagrams (similar to figures 2.1-1 and 2.1-2) for the timing accuracy definition**Figure 2.1-1. Downlink Gain ON/OFF Template****Figure 2.1-2. Uplink Gain ON/OFF Template****Proposal 2:** Add definitions for the 2 gain states; Rated gain and zero gain**Rated gain:** forward gain for either UL or DL based on the installed gain setting**Zero gain:** forward gain for either UL or DL in the OFF state**Proposal 3**: Name of the requirement is switching accuracy  |

## Open issues summary

The definition of the switching requirements is still opened, many details are still to be agreed.

### Sub-topic 3-1

*Requirement naming:*

**Issue 3-1: Requirement naming**

* Proposals
	+ Option 1: Name of the requirement is TDD switching accuracy
	+ Option 2: TDD switch timing accuracy
	+ Option 3: Other name
* Recommended WF
	+ Option 1

*If another option is preferred, please provide a concrete proposal*

### Sub-topic 3-2

*Diagram to be used to define the requirement*

**Issue 3-2: Diagram for requirement definition**

* Proposals
	+ Option 1: Fig. 4 in R4-2112196 (all requirements in a single diagram)
	+ Option 2: Use 2 diagrams (similar to figures 2.1-1 and 2.1-2 or Figure 1 in [R4-2111917](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2111917.zip)) for the timing accuracy definition
	+ Option 3: Other
* Recommended WF
	+ Option 1

Option 1 should be clear enough and more compact. If Option 3 is preferred, please provide another proposal

### Sub-topic 3-3

*Requirement for group delay*

*Most companies stated a preference not to define a group delay requirement, however, it is not clear how to define a complete switching time requirement without having a group delay requirement*

**Issue 3-3: Group delay requirement**

* Proposals
	+ Option 1: Define a maximum group delay requirement
	+ Option 2: Do not define a maximum group delay requirement, manufacturer to declare it for the test. Overall switch delay will be group delay + power ramp up/ramp down(discussed in Issue 3-4)
	+ Option 3: Do not define a specific group delay requirement, define an overall switching delay requirement that would comprise both group delay and power ramp up/ramp down(discussed in Issue 3-4)
	+ Option 4: Do not define any group delay, implicitly check in the conformance test that switching happens after entire UL/DL signal is forwarded
	+ Option 5: Other options
* Recommended WF
	+ TBA

Please state your preferred options and arguments for the choice. If Option 5 is sought, please provide alternate proposal.

### Sub-topic 3-4

 *Switching time on/off requirement – power ramp up and ramp down*

**Issue 3-4: Switching time on/off requirement**

* Proposals
	+ Option 1: The switching time requirement is 10us for FR1 and 3us for FR2
	+ Option 2: Other options
* Recommended WF
	+ Option 1

If option 2 is preferred, please provide an alternate proposal

### Sub-topic 3-5

*Definition for rated gain and zero gain*

**Issue 3-5: Rated gain and zero gain definition**

* Proposals
	+ Option 1: Add definitions for the 2 gain states; Rated gain and zero gain:
		- * Rated gain: forward gain for either UL or DL based on the installed gain setting
			* Zero gain: forward gain for either UL or DL in the OFF state
	+ Option 2: Definition is not needed
	+ Option 3: Other definition
* Recommended WF
	+ Option 1

Please provide arguments for the choice and alternative proposal for Option 3.

### Sub-topic 3-6

 *Requirement for Cell Phase Synchronization Accuracy*

**Issue 3-6: Cell Phase Synchronization Accuracy**

* Proposals
	+ Option 1: Introduce Cell Phase Synchronization Accuracy requirements, take 3μs as baseline.
	+ Option 2: Other options
* Recommended WF
	+ Option 1

If option 2 is preferred, please provide an alternate proposal

## Companies views’ collection for 1st round

### Open issues

Sub topic 3-1

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| **Company** | **Comments** |
| Ericsson | The term “accuracy” is a bit inexact; it can refer to power level, positioning etc. How about “TDD transition time” like in the other specs ? |
| CATT | Maybe it could be “TDD switching timing accuracy”? |
| Huawei | This is the same requirement in the existing TDD repeater specification. We see no point in changing the name for the same of it as it could cause confusion. So option 1 is ok |
| Nokia, Nokia Shanghai Bell | We prefer to first agree the actual requirement and the correct name can be chosen later once we know how the requirement exactly looks like. |
| CMCC | Option 1 is preferred since we may need to test other requirements together on top of time accuracy. |
| ZTE | This diagram is more likely an evolution of the timing accuracy in TS 25.116. So Option 2 might be more reasonable. |
| Qualcomm | We are fine to call it TDD switching accuracy as proposed in the WF but we are open also to other proposals. |

Sub topic 3-2

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| **Company** | **Comments** |
| Ericsson | We do not fully follow why the diagram used in the BS/UE specs to depict transition time cannot be used (apart from the fact that on/off power probably needs to be replaced by on/off gain). |
| CATT | We would prefer Figure 1 in [R4-2111917](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2111917.zip) or Figure 1 in R4-213984. Actually, both of them use the idea from CCSA TD-LTE repeater requirements. CCSA and R4-213984 used one diagram. [R4-2111917](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2111917.zip) separated DL and UL. We think both of them can be ok if the requirements and test can be described clearly. There can be some seperated test such as off power, and there can be some combined test such as EVM and power. So theoretically both can works, although separating them may be easier to be understood. |
| Keysight | Clarification question to folks in this discussion. Please help me to understand this requirement.Is this requirement to define time period of DL TX power and UL Tx power (detail seems TBD) ramp up and down timing and verifying time gap (repeater gain off period) between these two (DL TX and UL Tx) is one of intention of this requirementORThis requirement is to verify power ramp up and down (detail seems TBD) of each DL TX burst and UL TX burst as these defined in BS/UE conformance spec. this probably implies DL Tx and UL Tx can be measured independently. |
| Huawei | We think having 2 diagrams is important as the y axis parameters is different. The diagram in 1917 is probably ok (option 2) |
| Nokia, Nokia Shanghai Bell | Similarly as in sub-topic 3-1 we think it is more important to first define the actual requirement and then the explanatory Figure can be polished to final form later.That being said, we have a slight preference towards using the principle of the figure in the agreed WF R4-2108083, which may be need to duplicated to describe both UL -> DL and DL -> UL transmission direction changes, or Fig 4 in R4-2112196. In our view the key aspect is to describe that there is not only a ramp up/down of power but full turnaround of the repeater transmission direction.  |
| CMCC | Option 1. Fig 4 in R4-2112196 is to show timeline of repeater. It takes repeater receiver and transmit as a whole part and group delay is used to show the period from repeater receives the signal to repeater terminate its amplification for each DL or UL direction. Power ramp down, power ramp up and switching period are also illustrated in the diagram to show timeline of repeater. |
| Qualcomm | We are fine with the proposed WF but the most important is to have clear requirements.To Keysight: in our understanding it is the 2nd part of what is written(after OR). The requirement is defined to check that the repeater correctly follows the UL/DL configuration and that it rams power up/down on each interface without too long delay. |
| Keysight | Thank you Qualcomm for answering question. Very helpful.At the same time, by reading contributions and this discussion, requirement is still clear. For which Fig to use, either Opt 1 or 2 are fine however, which part of timing and/or timing relation/duration (in diagram) is concern of this requirement needs to be clearly defined.  |

Sub topic 3-3

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| **Company** | **Comments** |
| Ericsson | We do not see the need to define a group delay requirement; in fact it may constrain implementation in some cases. Also, group delay should not be confused with simultaneous switching. As suggested, the conformance testing will implicitly test that the switching does not cut off DL/UL forwarding or cause oscillations. |
| CATT | We prefer option 4. |
| Huawei | We do not see the need for a group delay requirement, not quite sure what the difference between option 3 and 4 are but checking switching envelope should be sufficient. |
| Nokia, Nokia Shanghai Bell | Our preference is option 3. This would avoid a specific group delay requirement, but verify that the group delay cannot be excessively long. From conformance testing perspective this would not impact the measurement procedure, as we would still verify power is at the correct level at a given time. |
| CMCC | We don’t have strong options on this issue. Option 2 and 3 are both OK for us and we need further check.In conformance part, group delay could be tested by comparing two signals, one is the signal directly from gNB and the other is the signal from repeater output. D-U switching signal is used for testing to show the delay because there is power ramp down when it’s switching from DL to UL and we could test delay only based on power monitor. From this point of view, group delay plus power ramp down/up would be better for testing.  |
| Qualcomm | We would be ok with Option 4 if this implies that a group delay would be somehow known during testing. |

Sub topic 3-4

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We are OK for this. It could be put in [] if companies want time to check further. |
| CATT | We would prefer no requirement for the ON/OFF. |
| Huawei | Its not clear what the OFF gain needs to be, clearly each direction needs to be off before the other direction is on to prevent oscillation, So if we have specified the on periods its not clear an on/off time is needed it just needs to not oscillate. As this time is 10us in BS spec though it seems reasonable to use the same number which will enable each direction to be tested separately. |
| Nokia, Nokia Shanghai Bell | We agree that the requirement can be based on BS requirements of 3us for FR2 and 10 us for FR1, our understanding is that these values are inclusive of the repeater group delay and would be applicable to be used for option 3 from issue 3-3 |
| CMCC | We need further check |
| Qualcomm | We would be fine for Option 1. It should be clarified whether this includes group delay or is just the power ramp up/down time. |
| Pivotal | Agree with CATT, and prefer no switching time requirement. |

Sub topic 3-5

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We are generally OK with option 1, although instead of “zero gain” it may be better to use the term “minimum gain”. |
| CATT | Support option 2 if there’s no test related to the definitions. |
| Huawei | The definitions relate to the levels in the diagram so are somewhat dependent on the final decision on the diagram. But we should not use definitions in the specification diagram without defining them. |
| Nokia, Nokia Shanghai Bell | We are ok with option 1 but would also like to re-consider the term zero gain as the intention is not the state the gain is 0 dB. |
| CMCC | For option 1 we’re afraid repeater could not always operate with rated gain based on the installed gain setting. In some cases, repeater may reduce it’s gain to guarantee the output power is less than allowed maximum value. In case repeater can’t operate with rated gain how could we test rated gain? |

Sub topic 3-6

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We do not see the need or possibility to make such a requirement for a repeater, since the repeater simply amplifies other signals and does not create signals itself. As long as the BS transmitters meet cell phase sync then there will not be interference. If the repeater does not properly synchronize then it may (i) amplify too long -> but the input signal will have finished in time so no interference or (ii) not start amplifying until too late -> but then it will fail to meet other requirements such as EVM. |
| CATT | We don’t think Cell Phase Synchronization Accuracy is applicable to repeater. Our understanding is that a repeater is a transparent node to amplify the signals so there’s no cell synchronization concept for a repeater. |
| Huawei | The timing accuracy we have been discussing is sufficient, we don’t think this is necessary. |
| Nokia, Nokia Shanghai Bell | Cell phase synchronization is defined in RRM specifications and not directly applicable for repeaters. The DL transmit time of repeater is implicitly set by gNB transmit time, propagation delay from gNB to repeater and repeater group delay. |
| ZTE | In fact, the cell phase synchronization is not only defined in the RRM specifications, but also defined in IAB RF specification such as TS 38.174. Admittedly, repeaters will amplify the other signals simply, and do not generate signals itself. However, the introduction of cell phase synchronization accuracy is for the repeater can maintain good synchronization in the network. Although RAN4#98 meetings have made it clear that the synchronization issues of the repeater will not be discussed, synchronization is not a one-off behavior, it needs to be maintained all the time, and in actual deployment, repeater has various mechanisms to ensure the synchronization. The introduction of cell phase synchronization accuracy is one of the timing requirement and could help repeater maintain synchronization. In addition, since the NR TDD support the TDD configuration feature, any loss of synchronization may cause serious interference during flexible switching between UL and DL. This requirement could ensure that the repeater could stay in sync with all other devices in the network and avoid the potential interference during flexible switching. |
| Qualcomm | WE do not see the need for such a requirement, in fact this might create issues if due to propagation delay the time would have to be larger than 3us. IAB is different because it is an actual base station that has to be synchrounous to all other base stations in the system.  |
| Pivotal | We agree with Ericsson explanation and do not see this as practical requirement. |

### 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#3-1** | *There is no consensus yet on this topic, there are various opinions between TDD switching accuracy, TDD switch timing accuracy and TDD transision time**Recommendations for 2nd round: Further discuss in a WF to see if some agreement can be reached.* |
| **Sub-topic#3-2** | *Companies’ opinions on this topic are different, the differences are in which diagram to use and even if a diagram is needed or can be agreed upon later.**Recommendations for 2nd round: Further discuss in a WF to see if some agreement can be reached.* |
| **Sub-topic#3-3** | *Companies agree not to have an explicit group delay but there is no consensus on whether this should be implicitly captured in the switching time or the UL/DL switch can just be somehow verified in a corresponding test without the need for any requirement.**Tentative agreements: Do not have any explicit group delay requirement.**Recommendations for 2nd round: Capture above agreement. Further discuss whether a group delay would be implicit in a switching time delay or UL/DL switching can be entirely left to testing(between Option 3 and Option 4)* |
| **Sub-topic#3-4** | *There is no consensus on this topic. Most companies seem to agree that re-using 10us for FR1 and 3us for FR2 is feasible for the on/off power.* *Recommendations for 2nd round: Further discuss in a FW if the BS on/off delay can be re-used and what exactly this delay accounts for(e.g, is a total delay including group delay or just on/off power switching delay)* |
| **Sub-topic#3-5** | *Most companies agree some requirement would be needed but further discussion on the details is needed before making any decision.**Recommendations for 2nd round: Continue the discussion on whether minimum gain/zero gain and raged gain should be defined and how* |
| **Sub-topic#3-6** | *Most companies agree that cell phase synchronization is not needed.* *Tentative agreements: Cell phase synchronization will not be defined for repeaters**Recommendations for 2nd round: Continue the discussion to see if the above agreement can be confirmed and if any additional clarifications are needed. Attempt to capture the agreement in a WF.* |

### 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)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

Continue the discussion on the above topics and try to capture the agreements in a WF. Please see at the bottom for the WF document.

# Topic #4: Others

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2112234**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112234.zip) | Qualcomm Incorporated | **Proposal:****Introduce two new specifications for the repeater conformance testing as below:**38.1xx – NR; Repeater conformance testing – Part 1: Conducted conformance testing38.1xx – NR; Repeater conformance testing – Part 2: Radiated conformance testing |
| [**R4-2112187**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112187.zip) | CMCC | The structure of TS 38.106 is outlined in detail below:Draft outline of TS 38.1061 Scope2 References3 Definitions of terms, symbols and abbreviations3.1 Terms3.2 Symbols3.3 Abbreviations4 General4.1 Relationship with other core specifications4.2 Relationship between Minimum Requirements and Test Requirements4.3 Conducted and radiated requirement reference points4.4 Repeater classes4.5 Regional requirements4.6 Applicability of requirements5 Operating bands and channel arrangement5.1 General5.2 Operating bands5.3 Pass band6 Conducted transmitter characteristics6.1 General6.2 Repeater output power6.3 Frequency stability6.4 Out of band gain6.5 Unwanted emissions6.6 Error Vector Magnitude6.7 Input intermodulation6.8 Output intermodulation6.9 Adjacent Channel Rejection Ratio (ACRR) 6. 10 ON/OFF time mask7 Conducted receiver characteristics8 Radiated transmitter characteristics8.1 General8.2 Repeater output power8.3 OTA frequency stability8.4 OTA out of band gain8.5 OTA unwanted emissions8.6 OTA Error Vector Magnitude8.7 OTA input intermodulation8.8 OTA output intermodulation8.9 OTA Adjacent Channel Rejection Ratio (ACRR) 8.10 ON/OFF time mask9 Radiated receiver characteristicsAnnex A (normative): Environmental requirements for the Repeater equipmentAnnex B (informative): Change history |
| [**R4-2112188**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112188.zip) | CMCC | Document containing the formal proposed TS skeleton |
| [**R4-2113668**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113668.zip) | Nokia, Nokia Shanghai Bell | **Observation 1: The frame/slot/symbol timing accuracy should consider the available switching times of UL/DL signals, which need to be taken into account in how the switching time requirement is set.****Observation 2. Repeater synchronization to the received signal enables suitable timing for ramping up/down of the RX/TX chain but the timing of the TX signals are under the control of serving gNB.** **Proposal 1: Possible further discussion on CLI due to high power UL transmissions should take place together with discussion on other associated RF requirements, such as maximum output power and unwanted emissions.** |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 4-1

*Handling of the conformance specifications*

**Issue 4-1: Handling of conformance specs**

* Proposals
	+ Option 1: Introduce two new specifications for the repeater conformance testing as below:
		- * 38.1xx – NR; Repeater conformance testing – Part 1: Conducted conformance testing
			* 38.1xx – NR; Repeater conformance testing – Part 2: Radiated conformance testing
	+ Option 2: Other options
* Recommended WF
	+ Option 1

If option 2 is preferred, please provide an alternate proposal

### Sub-topic 4-2

*TS 38.106 skeleton*

**Issue 2-2: Specification skeleton**

* Recommended WF
	+ As proposed in R4-2112187

Please provide any comments on the proposed skeleton and whether any addition/changes are needed

### Sub-topic 4-3

*Repeaters and handling of CLI*

**Issue 4-3: Repeaters and CLI**

* Proposals
	+ Option 1: Possible further discussion on CLI due to high power UL transmissions should take place together with discussion on other associated RF requirements, such as maximum output power and unwanted emissions.
	+ Option 2: No need to consider CLI during the current work
* Recommended WF
	+ Option 1

If option 2 is preferred, please provide argument why this is not needed

## Companies views’ collection for 1st round

### Open issues

Sub topic 4-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Option 1 is OK. |
| CATT | Support option 1. The spec may be -1 and -2. |
| Huawei | Option 1 is ok |
| Nokia, Nokia Shanghai Bell | We agree with option 1 |
| AT&T | We support the WF. |
| CMCC | Option 1 is preferred. |
| Qualcomm | Support the WF |

Sub topic 4-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We do not see a need for a section on “relationship to other core specifications” as it is not really clear what content there would need to be. We do not see a need for sections on receiver characteristics at present |
| CATT | Generally the skeleton is good except that some of the clauses may need to be updated according to the agreement, for example ON/OFF mask, ACRR, TDD switching timing requirements, etc. |
| Huawei | Clause 5 title operating band and channel arrangement should perhaps just be operating bands or maybe more general frequency bands? But it does not cover channel arrangements so this is misleading.6.10/8.10 we are still discussing the name of this requirements in sub-topic 3.1Transmitter and receiver requirements should not really be distinguished. Maybe we will have a NF type requirement but it will be formulated as a system (RF in/RF out) requirement as many of the other are (input intermodulation for example) so all RF requirements ca just go in the same section (conducted or radiated) |
| Nokia, Nokia Shanghai Bell | This is a good starting point for the skeleton but as of now no receiver requirements have been identified and therefore proposed clause 7 and 9 are not needed. |
| CMCC | Channel raster and sync raster related requirements may be also necessary based on above discussion and we could update the skeleton after the conclusion of related discussion. |

Sub topic 4-3

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | It is indeed true that high power UL transmissions could cause co-existence issues, but this is not a cross link interference question (the link is still the uplink). For the IAB specification, the solution is that the 3GPP spec does not guarantee co-existence and the operator needs to do so. Whatever the solution for repeaters, we think that this is an UL only question and not CLI. CLI is an independent topic that is not related to repeaters. |
| CATT  | Support option 2. In our understanding, CLI is a big topic which cann’t be solved easily only in the RF repeater topic. And as Ericsson said, it’s not related directly to repeater but to the whole network deployment. |
| Huawei | As transmission are appropriate for the link and we have no dynamic TDD it seems CLI is not the appropriate investigation. |
| CMCC | Option 2. As we stated in UL output power related sub-topics, the output power of repeater would not be excessive larger than UE power class. in most cases repeater’s output power could be less than 10dB larger than any UE power class. |
| Samsung  | RAN4 agreed that no RAN4 requirement impact due to dynamic TDD in Rel-17 repeater. According to this the consequent scenario of CLI is not in the scope as well.  |
| Qualcomm | Option 2. CLI is not covered by this work. We are open to see more analysis that there will be issues with the deployments if this is not addressed. |

### 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** |
| R4-2112188 | 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#4-1** | *Companies agree with the proposed introduction of 2 new specs for conformance.**Tentative agreements: Introduce two new specifications for the repeater conformance testing as below:**• 38.1xx – NR; Repeater conformance testing – Part 1: Conducted conformance testing**• 38.1xx – NR; Repeater conformance testing – Part 2: Radiated conformance testing**Recommendations for 2nd round: Capture above agreement in the chairman minutes. No further discussion needed* |
| **Sub-topic#4-2** | *There are several comments on the spec skeleton, editor should take those into account and share an updated skeleton**Recommendations for 2nd round:Update the skeleton and see if it can be approved* |
| **Sub-topic#4-3** | *Companies that commented agreed that CLI should not be in the scope.**Tentative agreements: CLI will not be considered in the current WI**Recommendations for 2nd round: Capture above agreement in the chairman minutes, no need for further discussion.* |

### 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)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on System Parameters for Repeaters | Nokia | Capture agreements and further discussion for Topic #1 |
| WF on TDD Repeater Switching Requirements | Qualcomm Incorporated | Caputre agreements and further discussion for Topic#3 |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
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Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)