**3GPP TSG-RAN WG4 Meeting # 98-bis-e R4-210XXXX**

**Electronic Meeting, 12th – 20th April, 2021**

**Agenda item:** 8.11.2 & 8.11.3

**Source:** Moderator (CMCC)

**Title:** Email discussion summary for [98-bis-e][311] NR\_Repeater\_RF

**Document for:** Information

# Introduction

RAN#90e approved a new “New WID on NR Repeaters” with RAN4 as the responsible WG, which includes development of FR1 FDD specifications as well as TDD specifications for FR1 and FR2. The scope of this email discussion focuses on RF core requirements, which is separated by radiated and conducted requirements, the same as the agenda 8.11.2 and 8.11.3 for current meeting.

List of candidate target of email discussion for 1st round and 2nd round

* 1st round: discuss the open issues and strive to minimize the open issues
* 2nd round: according to 1st round discussion, discuss left open issues for 2nd round, and strive to minimize the open issues, and strive to approve WF.

# Topic #1: Conducted requirements

NR repeater conducted related requirements are discussed in this thread, including transmit power related requirements, emission related requirements and the others*.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2107106**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107106.zip) | Huawei | Observation 1: Classes are not required for repeatersObservation 2: NR EVM target <3.5% Observation 3: The current repeater output power assumption of 30dBm seems appropriate for both DL and UL.Observation 4: AGC/ALS is part of installation and does not need to be specified. |
| [**R4-2104612**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104612.zip) | CMCC | Observation 1: in China, DL repeater maximum output power has been classified into three classes with the same method as NR BS and no maximum output power limitation for UL power. Observation 2: It is noted at least for NR repeater, maximum gain is not limited and repeater could achieve much larger gain than 90dB, the assumption in previous repeater spec. And larger DL output power could perform better coverage.Proposal 1: DL repeater output power upper limit is needed based on system-level simulation to guarantee coexistence between repeater and other network nodes, either implicitly or explicitly.Observation 3: For UL repeater, it is reasonable to set the target maximum output power as maximum UE output power. However, the specified maximum output power for repeater should be larger than the target value as the near-far effect could compress gain and reduce practical output power. Proposal 2: UL maximum output power should be larger than any UE power class. Proposal 3: UL maximum output power is suggested to be based on declaration. Observation 4: In high-speed train scenario, much fast ALC adjustment mechanism is required. Further discuss whether current ALC mechanism could be applicable for high-speed train scenario. If not, how to define the ALC requirements.Proposal 4: there are two options for ALC requirements definition option 1: no explicit ALC requirements and only stating ALC would not introduce extra tolerance for UL power control algorithm option 2: defining explicit ALC requirement and taking repeater’s moving speed into account.  |
| [**R4-2104671**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104671.zip) | Ericsson | **Proposal 1: Adopt the following output power accuracy:****Normal conditions**

|  |  |
| --- | --- |
| **Rated output power** | **Limit** |
| P  31 dBm | +2 dB and -2 dB |
| P < 31 dBm | +3 dB and -3 dB |

**Extreme conditions**

|  |  |
| --- | --- |
| **Rated output power** | **Limit** |
| P  31 dBm | +2,5 dB and -2,5 dB |
| P < 31 dBm | +4 dB and -4 dB |

**Proposal 2: The same DL power limits, based on declared deployment scenario should be adopted for repeaters as for BS.****Observation 1: For a local area repeater, the UL TX power would likely not cause any degradations to neighbor networks.****Observation 2: For MR and WA repeaters, a combination of directional antennas and careful location could be used to avoid degradation to neighbors.****Proposal 3: Consider requirements with increasing input power level, and also input power that is beyond the declared maximum input power that verify that output power, and some key unwanted emissions requirements are properly met.** |
| [**R4-2104795**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104795.zip) | CATT | **Observation 1: Repeater’s access link output power capability up to medium area BS’s capability may be sufficient.****Observation 2: Repeater’s backhaul link output power is usually smaller than access link.****Proposal: E-UTRA repeater output power requirement approach can be considered by NR repeater for both FDD and TDD backhaul link and access link. TDD UL/DL pattern for the test can be discussed further.** |
| [**R4-2104988**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104988.zip) | NEC | **Proposal 1: RAN4 do not differentiate DL and UL with separate approaches to set maximum output power limits.****Proposal 2: RAN4 do not limit the UL power not exceeding any UE power class defined in the band.****Proposal 3: RAN4 reuse BS-like approach of constraining the maximum output power****Proposal 4: RAN4 specify dedicated requirements for ALC/AGC** |
| [**R4-2106327**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106327.zip) | Nokia, Nokia Shanghai Bell | ***Proposal 1: Rated carrier output power may be declared by the manufacturers, similar to BS and IAB for conducted requirements. However, it needs to be checked whether the minimum requirements defined for carrier output power of the BS and IAB are still applicable for NR repeaters as well.******Observation 1: Depending on the type and class of the NR repeater, the minimum requirements can be slightly differed.******Proposal 2: For NR repeaters, power control can be done by imposing a maximum power limit in both*** ***gNodeB – Repeater (backhaul) link and Repeater – UE (access) link, as proposed for radiated requirements.******Proposal 3: Having followed the class and type definitions of IAB, some class and type combinations need to have an upper limit for rated carrier output power for NR repeaters. It must be discussed how to handle such a scenario in conducted requirements.*** |
| [**R4-2106350**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106350.zip) | NTT DOCOMO, INC. | **Maximum output power:****Observation 1: LTE FDD repeater does not have the upper limit for output power and the acceptable output power deviations are defined with 31 dBm as boundary.****Observation 2: If RAN4 avoid additional consideration for interference coordination, NR TDD repeater must have upper limit on maximum output power.****Observation 3: The same concept of output power for the Base Station can be applied in DL direction.****Proposal 1: RAN4 applies the output power requirements for NR FDD repeater to both DL and UL, and specifies the maximum output power without upper limit.****Proposal 2: RAN4 specify the maximum output power for NR TDD repeater without upper limit in DL.****Proposal 3: If RAN4 conclude that TDD repeater must have upper output power limit (same with UE power class limit) in UL, the requirements of TDD repeater output power for DL and UL should be considered individually.****EVM:****Observation 4: It is necessary to consider which modulation is ultimately feasible for DL and UL, respectively.****Observation 5: Repeater will be used to cover indoor areas of customers’ homes and it is important to achieve higher modulation scheme.****Proposal 4: RAN4 consider which modulation up to 256QAM is feasible in DL and UL, and define the EVM requirements for the feasible modulation.** |
| [**R4-2104617**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104617.zip) | CMCC | **Observation 1: In previous spec, ACLR cannot be measured for repeater because the adjacent channel emission is lower than thermal noise of the Repeater amplifier chain when assuming repeater only have RF domain amplifier without any digital domain processing.****Observation 2: as digital signal processor and digital FIR filter may be equipped in NR repeater, noise at adjacent channel could be rejected and ACLR could be measurable.****Proposal 1: the same ACLR requirements as NR spec could be used for some repeater, i.e. 45dB for DL and 30dB for UL. It is noted there is some limits for ACLR measuring that the testing signal from signal source such as BS for DL and UE for UL should be transmitted at the lowest and highest carrier in repeater passband.****Proposal 2: all the spurious emissions should be in line with BS spec for WA, MR and LA. But for home class repeater, at least co-location spurious requirements should be deleted.****Proposal 3: the same spectral emission mask as BS could be reused for repeater.** |
| [**R4-2104669**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104669.zip) | Ericsson | **Observation 1: The E-UTRA OOB gain is likely to be sufficient for >1MHz as long as the repeater is not co-located with other equipment.****Observation 2: If co-location of the repeater with other equipment is to be considered, then a more stringent requirement of gain less than around 25 to 30dB should be considered.****Observation 3: The E-UTRA requirement of 60dB gain in the first 1MHz may lead to emissions amplification in some circumstances.****Proposal 1: Include an ACLR-like requirement for repeaters (may be an absolute adjacent channel emissions power)****Proposal 2: Include co-location, co-existence, protection of FDD receiver and “other” spurious emissions requirements****Proposal 3: Consider whether out of band gain co-location requirements are needed** |
| [**R4-2104796**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104796.zip) | CATT | **Proposal 1: ACLR with NR adjacent channel is not defined for NR repeater for both access link and service link.****Observation: ACLR with E-UTRA adjacent channel can be considered to use the following approach,****1) not define the requirement****2) do co-exist simulation to see if the requirement can be relaxed.****Proposal 2: BS operating band unwanted emission requirement can be reused by NR repeater access link for different output power levels.****Observation: NR repeater backhaul link OBUE may consider reusing BS OBUE requirements.****Proposal 3: BS spurious emission requirements can be reused for NR repeater access link.****Observation: NR repeater backhaul link spurious emission requirement needs more discussion.** |
| [**R4-2106328**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106328.zip) | Nokia, Nokia Shanghai Bell | **Observation 1: As ACLR depends on the desired signal power, it may not be measurable if the desired signal power is in the scale of noise power level.****Observation 2: OBUE is an upper bound, which is independent on the signal power level, defined to limit the unwanted emissions in the adjacent bands.****Proposal 1: For NR repeaters, if the signal level is in the scale of noise power level, it is meaningful to use OBUE metric to measure the unwanted emissions in the adjacent channels, instead of ACLR.****Observation 3:In case of NR repeaters that operate in noncontiguous spectrum, CACLR may not be a suitable metric to measure the unwanted emissions in the adjacent band.** **Proposal 2: For NR repeaters that operate in noncontiguous spectrum, OBUE can be used to measure the unwanted emissions in each sub-block gap.****Observation 4: Direct re-use of gNB/IAB OBUE requirements may not be possible as it would result in different level of protection for adjacent channel operation in case no ACLR is defined.** |
| [**R4-2106351**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106351.zip) | NTT DOCOMO, INC. | **OBUE and spurious emission (Receiver spurious emission):****Observation 1: The requirements for receiver spurious emission are specified for BS and IAB and they have the same basic limit.****Observation 2: If the receiver spurious emission requirements for TDD don’t exist, then there is no test requirements for the emission in TDD OFF period.****Proposal 1: RAN4 specify the receiver spurious emission requirements for TDD based on the one for Base Station.****Proposal 2: RAN4 check whether the FDD repeater is assumed to have different antenna connectors between Rx and Tx.****Proposal 3: In RAN4 have concluded there are FDD repeaters having the different antenna connector for Rx and Tx, respectively. Then RAN4 specify the receiver spurious emission requirements for FDD repeater.****Output intermodulation:****Proposal 4: RAN4 consider the requirement for Tx intermodulation for BS as the baseline of requirements for output intermodulation.** |
| [**R4-2104670**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104670.zip) | Ericsson | **Proposal 1: Apply input intermodulation and output intermodulation requirements that are the same as those in the E-UTRA repeater specification.****Proposal 2: Apply an ACRR requirement that is the same as in the E-UTRA repeater specification for all signal types.** * **This protects from amplification of interference in other operators carriers outside of the passband, but not inside the passband.**

**Proposal 4: Apply a TDD switching time requirement****Proposal 5: Apply a TDD OFF power requirement** |
| [**R4-2104797**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104797.zip) | CATT | **Proposal 1: E-UTRA repeater requirement, i.e. 0.01 ppm is reused for both FDD and TDD NR repeater conducted requirement for access link and service link.****Proposal 2: Conducted EVM requirements for NR repeater access link and service link are defined as 6%.****Observation 1: Out of band gain requirement may need co-existence analysis or simulation.****Observation 2: E-UTRA input intermodulation approach can be considered by NR repeater access link and backhaul link with some adjustment of the frequency offset.****Observation 3: BS output intermodulation can be reused for NR repeater intermodulation requirement for access link.****Observation 4: Whether output intermodulation for access link is defined should be discussed.** |
| [**R4-2106329**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106329.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.****Proposal: The usage of repeaters does not cause additional requirements for DL timing or UL timing control.** |
| [**R4-2104615**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104615.zip) | CMCC | **Observation 1: more stringent EVM requirements is suggested for NR repeater to reduce noise.****Observation 2: vector error produced by NR repeater could be less than NR transmitter or LTE repeater.****Proposal 1: to reduce whole link EVM, [5%-6%] EVM is suggested for 64QAM or other lower order modulation scheme for FR1 and FR2****Proposal 2: 256 QAM is also suggested for repeater EVM definition with more stringent EVM than 3.5% to reduce extra interference to wanted signal.****Proposal 3: for both FR1 and FR2, the same ±0.01 ppm frequency error could still apply to NR repeater.** |

## Open issues summary

Agenda 8.11.2

It is noted for Tx related discussion, DL means repeater-UE (access) link and UL means repeater-gNB (backhaul) link while for Rx related discussion, e.g. out of band gain requirements, DL means gNB - repeater (backhaul) link and UL means UE - repeater (access) link.

### Sub-topic 1-1

Output power related conducted requirements for both FDD and TDD*.*

**Issue 1-1-1: whether/how to define AGC/ALC related requirements?**

* Proposals
	+ Option 1: no need to be specified (Huawei)
	+ Option 2: specify dedicated requirements for ALC/AGC (NEC)
	+ Option 3: implicitly specify ALC/AGC requirements, e.g. by verifying current requirements are properly met in some special cases
		- Option 3-1: Consider requirements with increasing input power level, and also input power that is beyond the declared maximum input power that verify that output power, and some key unwanted emissions requirements are properly met (Ericsson)
	+ Option 4: further discussion about the high-speed train scenario (CMCC)
* Recommended WF
	+ TBA

**Issue 1-1-2: DL output power**

* Proposals
	+ Option 1: 30dBm upper limits (Huawei)
	+ Option 2: reuse the same approach and upper limits as BS, i.e. no upper limits for WA, 38dBm and 24dBm upper limits for MR and LA respectively. (Ericsson, NEC)
	+ Option 3: reuse the same approach as BS/IAB, however, further check the upper limits, especially for those classes that don’t have such limits in BS/IAB spec (Nokia, Nokia Shanghai Bell, CMCC).
	+ Option 4: reuse the same approach as E-UTRA repeater for FDD DL and TDD DL, i.e. output power is based on declaration without any power upper limits specification (NTT DOCOMO, CATT)
* Recommended WF
	+ TBA.

**Issue 1-1-3: UL output power**

* Proposals
	+ Option 1: 30dBm upper limits (Huawei)
	+ Option 2: not exceeding existing UE power class
	+ Option 3: exceeding existing UE power class considering gain compression (CMCC, NEC)
	+ Option 4: reuse the same approach as E-UTRA repeater for both FDD UL and TDD UL, i.e. output power is based on declaration without any power upper limits specification (CATT)
	+ Option 5: reuse the same approach as E-UTRA repeater only for FDD UL, i.e. output power is based on declaration without any power upper limits specification (NTT DOCOMO)
	+ Option 6: reuse the same approach as BS/IAB, however, further check the upper limits, especially for those classes that don’t have such limits in BS/IAB spec (Nokia, Nokia Shanghai Bell)
* Recommended WF
	+ TBA.

**Issue 1-1-4: how to avoid performance degradation of other networks?**

* Proposals
	+ Option 1: For MR and WA UL, managed by antenna and deployment scenarios; for LA UL, the degradation could be avoided. (Ericsson)
	+ Option 2: power upper limits for UL TDD repeater (NTT DOCOMO)
* Recommended WF
	+ TBA

**Issue 1-1-5: power tolerance**

* Proposals
	+ Option 1: the same as E-UTRA repeater spec (Ericsson)
	+ Option 2: TBA
* Recommended WF
	+ TBA

### Sub-topic 1-2

Unwanted emission related conducted requirements including ACLR, operating band unwanted emissions and spurious emissions requirements.

**Issue 1-2-1: whether/ how to define ACLR with NR adjacent channel or some equivalent requirements**

* Proposals
	+ Option 1: yes
		- Option 1-1: an ACLR-like requirement for repeaters (may be an absolute adjacent channel emissions power) (Ericsson)
		- Option 1-2: modified OBUE as equivalent requirements for ACLR if the signal level is in the scale of noise power level (Nokia)
		- Option 1-3: modified OBUE as equivalent requirements for CACLR to measure the unwanted emissions in each sub-block gap (Nokia)
	+ Option 2: no ACLR with NR adjacent channel for both access link and service link (CATT)
* Recommended WF
	+ ACLR with NR adjacent channel or some equivalent requirements are required to match the same adjacent channel protection as NR/IAB spec. The equivalent requirements include modified OBUE requirements and absolute adjacent channel emissions power.

**Issue 1-2-2: whether/ how to define ACLR with E-UTRA adjacent channel or some equivalent requirements**

* Proposals
	+ Option 1: co-existence simulation to see if the requirements could be relaxed (CATT)
	+ Option 2: no ACLR with E-UTRA adjacent channel for both access link and service link (CATT)
* Recommended WF
	+ TBA

**Issue 1-2-3: operating unwanted emission requirements**

* Proposals
	+ Option 1: BS requirements can be reused by NR repeater for DL and UL (CATT, CMCC)
	+ Option 2: modified OBUE level to match the same level of adjacent channel protection as the full set of gNB/IAB requirements provides (Nokia)
* Recommended WF
	+ TBA

Spurious related requirements

**Issue 1-2-4: which of following spurious emission categories should be specified for NR repeater**

* Proposals
	+ Option 1: general spurious emission (Ericsson, CMCC)
	+ Option 2: Co-location with other base stations. (Ericsson, CMCC)
	+ Option 3: Co-existence with other systems in the same geographical area. (Ericsson, CMCC)
	+ Option 4: Protection of BS receiver for FDD operating band. (Ericsson, CMCC)
	+ Option 5: regional and regulation related requirements. (Ericsson, CMCC)
	+ Option 6: receiver spurious emission for transmitter OFF period for TDD repeater (NTT DOCOMO)
* Recommended WF
	+ NR repeater spurious emission could include general spurious emission, co- location with other base stations, Co-existence with other systems in the same geographical area, Protection of BS receiver for FDD operating band, regional and regulation related requirements and TDD receiver spurious emission for transmitter OFF period.

**Issue 1-2-5: referring to BS or UE spec for Tx spurious emission requirements?**

* Proposals
	+ Option 1: BS
		- Option 1-1: reuse the same BS requirements only for DL (CATT)
		- Option 1-2: further check whether the same BS requirements could be reused for UL (CATT)
		- Option 1-3: reuse the same BS requirements for both DL and UL (CMCC)
	+ Option 2: TBA
* Recommended WF
	+ The same spurious emission requirements as BS spec still apply to DL repeater. Further check whether it could be reused for UL repeater.

**Issue 1-2-6: Rx spurious emission requirements**

* Proposals
	+ Option 1: (NTT DOCOMO)
		- For TDD: based on BS spec
		- For FDD: specify Rx spurious emission if different antenna connectors are assumed between Rx and Tx
	+ Option 2: TBA
* Recommended WF
	+ Take Rx spurious emission requirements in BS spec as baseline for TDD repeater. Further discussion about FDD repeater.

**Issue 1-2-7: whether unwanted emission requirements are the same for all classes?**

* Proposals
	+ Option 1: distinguished by classes
	+ Option 2: the same for all repeaters
	+ Option 3: at least low power repeater may have more relax requirements whether there are classes classification or not. (CMCC)
* Recommended WF
	+ TBA
		1. Sub-topic 1-3

The requirements except for power and unwanted emission related requirements for both FDD and TDD, including frequency stability, EVM, input intermodulation, output intermodulation, ACRR, out of band gain, TDD switching time, TDD OFF and REFSENSE requirements.

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

**Issue 1-3-1: frequency stability for both TDD and FDD conducted requirements**

* Proposals
	+ Option 1: 0.01ppm (CMCC, CATT)
* Recommended WF
	+ 0.01 ppm for FR1 conducted requirements

**EVM related issues**

**Issue 1-3-2: whether to consider feasible modulation schemes for DL and UL, respectively?**

* Proposals
	+ Option 1: necessary (NTT DOCOMO)
	+ Option 2: TBA
* Recommended WF
	+ TBA

**Issue 1-3-3: EVM aligned with which modulation scheme?**

* Proposals
	+ Option 1: 256QAM (Huawei)
	+ Option 2: 64 QAM and 256 QAM. Two EVM level, one level for modulation order less than or equal to 64QAM and the other level for 256QAM (CMCC)
* Recommended WF
	+ RAN4 consider which modulation up to 256QAM is feasible, and define the EVM requirements for the feasible modulation

**Issue 1-3-4: whether to improve EVM beyond what is required for NR BS/UE spec**

* Proposals
	+ Option 1: yes,
		- <3.5% (Huawei)
		- 6% (CATT)
		- 5%-6% for modulation order less than or equal to 64QAM (CMCC)
	+ Option 2: TBA
* Recommended WF
	+ More stringent EVM requirement compared with NR spec is required to reduce the degradation of system performance.

**Input intermodulation related requirements**

**Issue 1-3-5: input intermodulation requirements**

* Proposals
	+ Option 1: reuse the same approach as E-UTRAN repeater
		- Option 1-1: the same as E-UTRAN repeater (Ericsson)
		- Option 1-2: with some adjustment of the frequency offset for both UL and DL (CATT)
	+ Option 2: TBA
* Recommended WF
	+ Take the same approach of E-UTRAN repeater as baseline including general requirements, co-existence and co-location requirements. Further discussion about whether some adjustment is necessary or not, e.g. frequency offset.

**Output intermodulation related requirements**

**Issue 1-3-6: output intermodulation for DL**

* Proposals
	+ Option 1: the same as E-UTRAN repeater requirement (Ericsson)
	+ Option 2: BS Transmitter intermodulation as the baseline (CATT, NTT DOCOMO)
* Recommended WF
	+ Take BS Transmitter intermodulation requirement as the baseline for DL repeater with 30dB coupling loss assumption when define interfering signal level.

**Issue 1-3-7: whether to define output intermodulation for UL**

* Proposals
	+ Option 1: further discussion (CATT)
	+ Option 2: yes, take BS Transmitter intermodulation requirement as the baseline for UL repeater with 30dB coupling loss assumption when define interfering signal level. (Ericsson, NTT DOCOMO)
* Recommended WF
	+ TBA

**ACRR related requirements**

**Issue 1-3-8: ACRR**

* Proposals
	+ Option 1: Apply an ACRR requirement that is the same as in the E-UTRA repeater specification for all signal types, not just WCDMA (Ericsson)
	+ Option 2: TBA
* Recommended WF
	+ Take E-UTRA repeater specification as the baseline when define ACRR requirement for NR repeater.

**Out of band gain related requirements**

**Issue 1-3-9: whether co-existence simulation is needed to derive out of band gain for NR repeater**

* Proposals
	+ Option 1: yes (CATT)
	+ Option 2: TBA
* Recommended WF
	+ TBA

**Issue 1-3-10: whether to consider out of band co-location requirement for NR repeater**

* Proposals
	+ Option 1: yes
	+ Option 2: no
* Recommended WF
	+ TBA

**Issue 1-3-11: out of band gain requirements**

* Proposals
	+ Option 1: some modification based on E-UTRAN repeater spec (Ericsson)
		- 35-45 dB for >1MHz from the passband if not co-located with other equipment
		- Less than 25-30dB for >1MHz from the passband if co-located with other equipment
		- 60 dB gain is not enough for the first 1MHz
	+ Option 2: TBA
* Recommended WF
	+ Take E-UTRA repeater spec as the baseline when define out of band gain requirements for NR repeater. Further discuss about the modification and whether consider co-location scenarios.

**timing related requirements**

**Issue 1-3-12: whether to define TDD switching requirements, if so how to define these requirements?**

* Proposals
	+ Option 1: necessary (Ericsson)
	+ Option 2: no need for tighter requirements for timing that is already specified for gNB and UE (Nokia)
* Recommended WF
	+ TDD switching requirements is necessary for TDD repeater and the value is FFS.

**Issue 1-3-13: group delay requirements, taking following aspects into consideration**

* Proposals
	+ Option 1: group delay contributes the same way for timing as the propagation delays (Nokia)
	+ Option 2: TBA
* Recommended WF
	+ TBA

**Issue 1-3-14: whether/how to define TDD OFF requirements**

* Proposals
	+ Option 1: necessary (Ericsson)
	+ Option 2: TBA
* Recommended WF
	+ TBA

**Issue 1-3-15: whether to define REFSENSE or equivalent requirements**

* Proposals
	+ Option 1: REFSENSE or NF (CMCC)
	+ Option 2: TBA
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

*One of the two formats, i.e. either example 1 or 2 can be used by moderators.*

**Example 1**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1: Sub topic 1-2:….Others: |

**Example 2**

Sub topic 1-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Issue 1-1-1: whether/how to define AGC/ALC related requirements?** As stated (option 3-1), we believe that AGC/ALC requirements should be captured, but this can be done by meeting other key requirements on output power and emissions with several input power levels.**Issue 1-1-2: DL output power** One issue to discuss further is that the BS power limits are per carrier. When setting limits as in option 1 or 2 we need to agree whether these are per carrier or per passband, and whether “carriers” can easily be defined within the passband**Issue 1-1-3: UL output power**The safest approach from a co-existence viewpoint is to not exceed any UE power class. IAB does not limit UL power, but has explicit power control and also there is an underlying assumption that the IAB is positioned in a planned manner by the operator considering the location of the donor BS and other BS. Also, IAB is not applicable in all bands, in particular FDD bands. First check could be whether there is any objection to limit to the largest UE power class ? (option 2) |
| Huawei | **Issue 1-1-1: The ALC is only needed if the max output power is exceeded otherwise the repeater is fixed gain. In the high speed train scenario how does the repeater know that the signal coming from further away requires higher gain. Clearly the rate of the change of the input signal will effect how quickly the power limiting ALC needs to work but I cant see how the gain could be altered to track the train?****Issue 1-1-2: We are not against different power levels however its not clear that a high power repeater with limited gain is particularly useful. We think the scenarios should be defined (ongoing in [310]) and then appropriate power limits applied to these.****Issue 1-1-3: As with BS we are not against different power levels based on deployment. If the repeater is deployed in a different location to a UE with a directional antennas then possibly it could have higher power with no negative effect on adjacent systems. Sticking to the highest current UE power level is ok of course and safe.** |
| Nokia, Nokia Shanghai Bell | **Issue 1-1-1:** Option 3 is most preferable out of the options.: It is reasonable to indirectly require automatic gain control to take place, when input signal levels increase above an implementation specific level, by requiring to meet both output power and emission requirements when high input power is present.Option 3-1 requires further clarifications on what requirements are in scope.Regarding option 4, Iit is not clear how a moving repeater type of use case appeared in the discussion, this should be clarified first. Before the dynamic cases, we must first agree on the static scenarios. Overall, it is not clear to us if moving repeaters are within the WID scope and this would need to be clarified. Moving repeaters require functionality that is not part of a simple analog RF repeater**Issue 1-1-2:** We prefer option 3. The actual output power capability should be declared by manufacturer. We see that defining an upper limit of 30 dBm for all cases likely limits the performance of repeaters. Then on the other hand meeting emission requirements becomes very difficult when output power is very high. This could be handled either by setting a maximum limit or relying on the manufacturer declarations. **Issue 1-1-3:**We prefer option 6. The actual output power capability should be declared by manufacturer. We see that defining an upper limit of 30 dBm for all cases likely limits the performance of repeaters. Then on the other hand meeting emission requirements becomes very difficult when output power is very high, especially if TDD repeaters are required to meet UE requirements. This could be handled either by setting a maximum limit or relying on the manufacturer declarations. Also possible coexistence and/or interference issues should be considered for TDD repeaters with very high output power, as power control will be available only indirectly by controlling UE output power.**Issue 1-1-4:** This is important question as e.g. for IAB the UL interference was not studied below 3.5 GHz. Same applies dynamic TDD studies in TR 38.828.We have slight preference towards option 2, as for TDD RF repeaters constraining the upper limit of UL power is an easy and simple way of controlling the interference for other networks. Option 1 may not work in all cases, but can help. Overall, there is need to consider whether maximum output power limitations need to be specified for all cases.**Issue 1-1-5:** Tolerances can be considered after class definitions and possible power limits have been decided. |
| QCOM | **Issue 1-1-1: whether/how to define AGC/ALC related requirements?** Option 3: We can verify the any ALC and AGC action by setting requirements at different power conditions. In this way the action of AGC ALC would be implicitly tested.**Issue 1-1-3: UL output power****Option 2 is most consistent with baseline assumptions used to develop NR specs and that is our preference. We are open to discussion if some companies have a strong technical argument to increase the upper limit.** |
| ZTE | **Issue 1-1-1: whether/how to define AGC/ALC related requirements?** This could be tested with other requirements if necessary, in addition, to impose input power higher than maximum input power of repeater might be risky we think.**Issue 1-1-2: DL output power** Fine to go with option 2 and 3;**Issue 1-1-3: UL output power**Fine with option 4, it should be guaranteed that no network performance is degraded.**Issue 1-1-4: how to avoid performance degradation of other networks?**Set the upper output power should be one option for DL without power control, however for uplink, it might need more discussions.**Issue 1-1-5: power tolerance**Fine with option 1 |
| CMCC | **Issue 1-1-1: whether/how to define AGC/ALC related requirements?****For the stationary scenario, option 3 is preferred by verifying output power and emission related requirements.** **For the high-speed train scenario, more study is suggested.** **To Huawei: how the gain could be altered to track the train?****There is a simple modem model equipped in the repeater to decode the DL RSRP/ RSSI and UL RSSI signal. Then repeater knows how to alter its gain based on these UL and DL signals.****To Nokia: Moving repeaters require functionality that is not part of a simple analog RF repeater****When we refer to the WID, there is no explanation about whether to limit repeater only to stationary repeater or not. From my understanding, moving repeater is not excluded. It seems we may need some more clarification about the moving use case. I’ll include this issue in future WF for further discussion.****As for the supporting functionality, only a simple module mode is needed. From our understanding, this simple module mode will also be equipped in other stational repeater, which wouldn’t introduce extra impact on RF requirements.****Issue 1-1-2: DL output power****We prefer option 3.****To Huawei:****From our understanding, the maximum gain of repeater is not limited and higher than 90dB is also achievable, which implies that the higher power repeater would help to extend the coverage. In the poor populated area, repeater could be deployed for coverage considering its low cost. I guess the scenario of wide area repeater is clear as discussed in operator’s contributions. Of cause if other companies also suggest to discuss the applicable scenarios for NR repeater, we are also OK.****Issue 1-1-3: UL output power****We prefer option 3. Repeater may need to compress its gain to guarantee its output power is not larger than allowable maximum output power. If we assume there is a UE located near to the repeater, the repeater have to compress its UL gain to make the output power not larger than the upper limits. If at the same time there is a UE located relatively far from the repeater, repeater could only reuse the same compressed gain to amplify the received UL signal. Therefore the amplified output power is much lower than what we need as repeater can’t amplify with maximum gain. Therefore, UL output power limit should be larger than any UE power class.****Issue 1-1-4: how to avoid performance degradation of other networks?****Option 1 and option 2 are both OK to us.****Issue 1-1-5: power tolerance****It is suggested to study Power tolerance requirements under the conclusion of output power and class definition.** |
| Docomo | **Issue 1-1-2: DL output power** We are OK with Option 2 or Option 3.**Issue 1-1-3: UL output power**We are OK with Option 6. Even if the UL output power of the TDD repeater is capped up to UE power class, it is necessary to take into account that the LTE FDD repeater which is already in operation and having more output power should not be excluded from 3GPP requirements when it is converted to NR **Issue 1-1-4: how to avoid performance degradation of other networks?**We have commented Option 2 as the safety way based on WID. Considering the use case, if there are needs to use TDD repeater with UL power exceeding UE power classes, we are open to not defining the upper limit. |
| CATT | **Issue 1-1-1: whether/how to define AGC/ALC related requirements?** Option 3 is used in E-TRUA repeater, it can also be reused. The declared maximum input power in option 3-1 needs more clarification. How to define and test it can be further discussed.**Issue 1-1-2: DL output power** Generally, we think we may need to discuss if we use “UL” and “DL” to diferentiate the links. This issue is reated to the calss definition. Currently, we think E-UTRA approach can be reused. But also can accept the other approach if the deployment scenario analysis is clear.**Issue 1-1-3: UL output power**The same comment as 1-1-2.**Issue 1-1-4: how to avoid performance degradation of other networks?**Support to set power limits.**Issue 1-1-5: power tolerance**We also proposed option 1 in last meeting, but would like to understand the relationship to the the output power level. |
| Commscope | **Issue 1-1-1: whether/how to define AGC/ALC related requirements?** CommScope agree to proposal option 3-1**Issue 1-1-2: DL output power** It is CommScope’s position that defining maximum power limits for the DL or UL is not needed. Repeaters are typically produced with varying power levels, and appropriate power levels are selected dependent upon the specific network environment in which it is deployed. Power levels can be adjusted as needed to ensure coexistence. Thus, CommScope agrees with option 4 (reuse same approach as for LTE…)**Issue 1-1-3: UL output power**CommScope agree to proposal option 4 (see issue 1-1-3)**Issue 1-1-4: how to avoid performance degradation of other networks?**CommScope agree to proposal option 2.**Issue 1-1-5: power tolerance**CommScope agree to proposal option 1 using same tolerances as E-UTRA repeater specification. |
| NEC | **Issue 1-1-1: Upper limits for AGC/ALC gain may be needed, but option 1 or 3 is ok if it is covered by other requirements.****Issue 1-1-2: We prefer option 2 or 3.****Issue 1-1-3: We prefer option 6.** |

Sub topic 1-2

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| **Company** | **Comments** |
| Ericsson | **Issue 1-2-1: whether/ how to define ACLR with NR adjacent channel or some equivalent requirements**We think there is not much difference between the option 1 sub-options; in principle set absolute requirements that are equivalent to ACLR. One question to discuss is whether “modified OBUE” means that the requirement is not over the whole adjacent channel but instead with a narrower measurement bandwidth, like OBUE. We are open to either if the requirement ends up equivalent to ACLR. (Option 1)**Issue 1-2-2: whether/ how to define ACLR with E-UTRA adjacent channel or some equivalent requirements**We do not see a need for co-existence simulations; absolute requirement levels could be set to give equivalent emissions levels to a UE or BS with typical power conforming to the ACLR.Option 3: Set absolute requirements based on achieving same emissions power as an assumed UE/BS meeting ACLR requirements with a reference power.**Issue 1-2-3: operating unwanted emission requirements**We are OK with modified OBUE to provide the same protection as ACLR (option 2). It needs to be obvious though that also the regulatory requirements are met. It is OK to take BS regulatory requirements, but it should be double checked whether there are regulatory issues when taking BS requirements for UL, in particular for FDD.**Issue 1-2-5: referring to BS or UE spec for Tx spurious emission requirements?**It should be checked whether there are any regulatory issues using BS requirements for UL transmissions, in particular for FDD.Option 1-4: BS requirements are default. Check if any regulatory issues concerning UL.**Issue 1-2-7: whether unwanted emission requirements are the same for all classes?**Option 1: The BS requirements are currently differentiated between BS classes |
| Huawei | **Issue 1-2-1: If the OBUE requirements are equivalent to the ALCR then no need to specify both. Possibly ALCR is not needed in current repaetrer specs as te power level is only ~30dBm and so the absolute and relative requirements are similar. If the repeater were using a higher power level the ACLR requirement might be needed.****Issue 1-2-2: In DL the ACLR is such that the ACS of the UE dominates hence the effect of wanted –ACS is what drives the adjacent channel interference, reducing ALCR will likely impact this, I’m not sure we need to do co-existence to observe this. What’s more interesting is if introducing higher wanted power effects the co-existence.****Issue 1-2-3: option 2 is ok to be considered (although option 1 is probably ok and easier to implement)****Issue 1-2-4: WF ok****Issue 1-2-5: The regulatory SE requirements which SE are based on are almost the same for BS and UE so I am not sure it makes much difference. FR2 UE Se requirements are slightly different to allow for exceptions for a LO but overall the emission are similar total power. The repeater probably will be same architecture in both directions (no LO) so the BS requirements should be ok.****Issue 1-2-6: Unlike a TDD BS the receiver and Tx are on at the same time, so really the total emissions should meet the regulatory limits, this is similar to FDD BS so for FR1 these limits should be considered. For OTA no separate Rx emission are necessary as they cannot be distinguished from Tx.****Issue 1-2-7: Depends on the decisions for output power, OBURE for BS are different for different power levels (although the step is below the current repeater power levels). If we introduce higher power then we may need similar steps to avoid the requirement becming to strict.** |
| Nokia, Nokia Shanghai Bell | **Issue 1-2-1:** The recommended WF looks reasonable quite reasonable, but are both absolute ACLR and OBUE required, as both are similar absolute metrics?**Issue 1-2-2:** Before embarking on simulation campaign, it would be good to justify why E-UTRA adjacent channel protection would require different requirements compared to NR adjacent channel.**Issue 1-2-3:** We prefer option 2. Option 1 has the issue that the repeater would generate more interference as requirements are relaxed for adjacent channels protection thus not providing similar level of adjacent channel rotection as IAB and gNB**Issue 1-2-4**: All proposed transmitter requirements appear. Receiver spurious emissions require further consideration.**Issue 1-2-7:** Option 1: RF requirements for BS and IAB are organized based on class definitions. We believe, a similar approach would be needed to organize the RF requirements (meaning for unwanted emission requirements as well) for repeaters as well. |
| QCOM | **Issue 1-2-1: whether/ how to define ACLR with NR adjacent channel or some equivalent requirements**The proposed WF is agreeable**Issue 1-2-3: operating unwanted emission requirements**Either option is fine with us..**Issue 1-2-5: referring to BS or UE spec for Tx spurious emission requirements?**We are OK with the proposed WF |
| ZTE | **Issue 1-2-7: whether unwanted emission requirements are the same for all classes?**Option 1, the same approach as current BS. |
| CMCC | **Issue 1-2-1: whether/ how to define ACLR with NR adjacent channel or some equivalent requirements**Recommended WF is OK to us.**Issue 1-2-2: whether/ how to define ACLR with E-UTRA adjacent channel or some equivalent requirements**Prefer option 3, proposed by Ericsson.**Issue 1-2-3: operating unwanted emission requirements**If RAN4 conclude to not define ACLR requirements, then option 2 is preferred as equivalent requirements as ACLR.**Issue 1-2-4: which of following spurious emission categories should be specified for NR repeater**Recommended WF is OK to us.**Issue 1-2-5: referring to BS or UE spec for Tx spurious emission requirements?**Option 3 is preferred. The main divergence is whether to reuse BS or UE spec. According to Chinese regulations if the output power of device is larger than some limits, then this kind of device would be regarded as network node and have to follow corresponding regulations including power and emission requirements. therefore, repeater is regarded as network node and then refer to BS spec.**Issue 1-2-6: Rx spurious emission requirements**Recommended WF is OK to us.**Issue 1-2-7: whether unwanted emission requirements are the same for all classes?**Option 3 is preferred. At least for home class with very low output power, it’s challenging to meet the same stringent requirement as WA, MR or even LA. |
| Docomo | **Issue 1-2-1: whether/ how to define ACLR with NR adjacent channel or some equivalent requirements**We are OK with recommended WF.**Issue 1-2-4: which of following spurious emission categories should be specified for NR repeater**We are fine with recommended WF.**Issue 1-2-5: referring to BS or UE spec for Tx spurious emission requirements?**We are fine with recommended WF.**Issue 1-2-6: Rx spurious emission requirements**We have similar view with Huawei. Regarding FDD repeater, it may not be necessary. Depending on the implementation, if frequency-sharing antennas are considered for both access-link and backhaul-link, both will be in the ON state, so the Tx spurious emission requirements may just apply and Rx spurious emission requirements may not be necessary. |
| CATT | **Issue 1-2-1: whether/ how to define ACLR with NR adjacent channel or some equivalent requirements**Sorry for our vague wording. We were proposing no relative ACLR requirements. For absolute ACLR, more analysis is needed.**Issue 1-2-2: whether/ how to define ACLR with E-UTRA adjacent channel or some equivalent requirements**If technical analysis is valid for the requirements, we’re ok with reasonable requirements.**Issue 1-2-3: operating unwanted emission requirements**We proposed for access link as option 1 and for backhaul link, there may need some double check.**Issue 1-2-4: which of following spurious emission categories should be specified for NR repeater**Still ok with the proposal for access link, but may need more discussion for backhaul link.**Issue 1-2-5: referring to BS or UE spec for Tx spurious emission requirements?**We generally ok with the WF. Maybe we should rewording the WF, it’s difficult to understand “DL repeater”. **Issue 1-2-6: Rx spurious emission requirements**FFS.**Issue 1-2-7: whether unwanted emission requirements are the same for all classes?**According to different power levels or power classes if there’s a class definition. |
| Commscope | **Issue 1-2-1: whether/ how to define ACLR with NR adjacent channel or some equivalent requirements**We agree with option 2 since OBUEn and EVM requirements sufficiently cover ACLR needs.**Issue 1-2-2: whether/ how to define ACLR with E-UTRA adjacent channel or some equivalent requirements**We agree with option 2 since OBUE requirements sufficiently cover ACLR needs.**Issue 1-2-3: operating unwanted emission requirements**We agree with option 1.**Issue 1-2-4: which of following spurious emission categories should be specified for NR repeater**We agree with option 1 to option 5.**Issue 1-2-5: referring to BS or UE spec for Tx spurious emission requirements?**We agree with option 1-3 (reuse the same BS requirements for both DL and UL**Issue 1-2-6: Rx spurious emission requirements**It is our position that TX spurious emission specification is sufficient since repeater are transmitting in both directions (uplink + downlink).**Issue 1-2-7: whether unwanted emission requirements are the same for all classes?**We agree with option 2 as for LTE repeater standard. |
| NEC | **Issue 1-2-1: Recommended WF is fine.****Issue 1-2-3: Option 2 is fine.****Issue 1-2-4: Recommended WF is fine.****Issue 1-2-5: Recommended WF is fine.** |

Sub topic 1-3

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| **Company** | **Comments** |
| Ericsson | Sub-topic 1.3: **Issue 1-3-3: EVM aligned with which modulation scheme?****Issue 1-3-4: whether to improve EVM beyond what is required for NR BS/UE spec**The need for EVM may differ depending on the repeater deployment scenario. If the repeater is near to the edge of coverage, then it may be that SNR limits the modulation order. Such repeaters should not be burdened by needing to meet low EVM. On the other hand, for the train carriage to outside scenario mentioned by CMCC, low EVM may be very relevant. So at least some kind of requirement differentiation is needed.Unlike a BS or UE, EVM conformance testing represents a larger proportion of the test load for repeaters. Another possibility is to skip a 3GPP minimum requirement for EVM (hence reduce conformance testing) and leave it for repeater vendors to differentiate in product specs/tests.Option 2: More than on EVM levelOption 3: Do not define EVM requirement for repeater**Issue 1-3-5: input intermodulation requirements**We agree with the WF**Issue 1-3-6: output intermodulation for DL**We are OK to take the BS approach (option 2) or with option 1**Issue 1-3-9: whether co-existence simulation is needed to derive out of band gain for NR repeater**The requirement can be defined based on an assumption on coupling loss to and power of another transmitter. Power is rather difficult to guess for another system but assuming the same power as a BS seems reasonable.Option 2: Base on assumed MCL to another transmitter with the same output power as a BS**Issue 1-3-10: whether to consider out of band co-location requirement for NR repeater**Yes, but the requirements should be optional (in the same way as BS co-location requirements)Option 1a: Yes, but optional**Issue 1-3-11: out of band gain requirements**The E-UTRA repeater spec does not fully protect the first 1MHz**Issue 1-3-13: group delay requirements, taking following aspects into consideration**Agree with Nokia. Also, we think that introducing requirements could risk of constrainingimplementations. Some implementations may include some digital processing and potentially separation between parts of the repeater. A small minimum group delay requirement may constrain such implementations. On the other hand, a large requirement might not be useful for some integrated analogue only repeaters. We do not see a need for a minimum requirement; the guard period needs to be set adequately for the group delay.Option 2: No need to define a requirement**Issue 1-3-15: whether to define REFSENSE or equivalent requirements**Although some repeaters may detect SSB and decode other repeaters, we should not force all repeaters to do so. It is not obvious how to test REFSENSE; the BS and UE tests rely on an FRC, feedback etc. |
| Commscope | Sub-topic 1.3: **Issue 1-3-1: frequency stability for both TDD and FDD conducted requirements**We agree with the recommended WF.**Issue 1-3-2: whether to consider feasible modulation schemes for DL and UL, respectively?**It is CommScope’s position to follow using the limits from BS**Issue 1-3-3: EVM aligned with which modulation scheme?**We agree with the recommended WF**Issue 1-3-4: whether to improve EVM beyond what is required for NR BS/UE spec**Our recommendation is to use same limits as for BS (assuming low probability that both BS and repeater will operate at the limit).**Issue 1-3-5: input intermodulation requirements**We agree with the recommended WF**Issue 1-3-6: output intermodulation for DL**We agree with the recommended WF**Issue 1-3-7: whether to define output intermodulation for UL**We agree with the option 2 **Issue 1-3-8: ACRR**We agree with the recommended WF**Issue 1-3-9: whether co-existence simulation is needed to derive out of band gain for NR repeater**We see the difficulty to define minimum coupling losses to any radio transmitters. However, we propose to follow the LTE standard, focusing on the donor coupling loss. The LTE requirements provide good practice to avoid out of band amplification.**Issue 1-3-10: whether to consider out of band co-location requirement for NR repeater**See comment issue 1-3-9**Issue 1-3-11: out of band gain requirements**We agree with the recommended WF**Issue 1-3-12: whether to define TDD switching requirements, if so how to define these requirements?**TDD may need more requirements than FDD, so we agree with the recommended WF to further discuss any additional requirements. Many of the switching requirements may be able to be replaced with a EVM measurement on test waveform with a minimum guard period, with the peak EVM measured at the beginning and end of the TX/RX periods. Any transmit off requirements should recognize that in some cases the repeater is directly coupled to the base station**Issue 1-3-13: group delay requirements, taking following aspects into consideration**Delay requirements shouldn’t be part of the standard (following LTE standard).**Issue 1-3-14: whether/how to define TDD OFF requirements**We think TDD off requirements are not needed as part of a repeater standard. |

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| Huawei | **Issue 1-3-1:** WF ok**Issue 1-3-2/3/4:** These seem linked, if 256QAM is optional then we can have different requirements based on repeater capability. Higher value is ok if only 64QAM supported.**Issue 1-3-5:** WF is ok**Issue 1-3-6:** WF ok**Issue 1-3-7:**  Seems IMD needed for both directions (option 2)**Issue 1-3-8:** WF ok**Issue 1-3-9:** If the output power (and expected gain) is higher than the existing repeater assumptions then we need to assess the effect of out of band gain. As these things are statistical in nature not sure how it can be done without co-existence?**Issue 1-3-10:** Not sure of the scenario where a repeater is co-located with BS, but we can specify of course. Co-location are optional requirements anyway.**Issue 1-3-11:** As we are discussing higher output power and potentially higher expected gain from the repeater then out of band gain assumptions may need to be updated.**Issue 1-3-12:** Also discussed in [310] on-off mask is necessary**Issue 1-3-13:** Also discussed in [310] group delay maximum can be incorporated in the on=off mask we think.**Issue 1-3-14:** Similar to 1-3-12, we think its necessary**Issue 1-3-15:** The repeater sensitivity is really only important in terms of the noise floor it amplifies, to maintain the OBUE requirements (and implied ACLR) the wanted signal is ~45dBc above the received noise floor, if the signal is larger than that then the output noise is just the input noise amplified. The sensitivity/NF will be related to the minimum input signal the repeater can operate with (and meet EVM, emissions requirements etc), currently this is not a requirement for repeaters. Maybe NF is a good way to address this or maybe min input level  |
| Nokia, Nokia Shanghai Bell | **Issue 1-3-3:** The repeater will not be aware which MCS is being used during operation, therefore different requirements for 64QAM and 256QAM would imply different repeater implementations and related manufacturer declaration**Issue 1-3-4:** For LTE FDD repeaters more stringent EVM was not specified. Imposing a more stringent requirement for repeater is contradictory with the fact that repeater does not have similar means to use digital signal processing methods to control signal quality. Additionally, there may be use cases like rural coverage extension where high MCS is not achievable. Therefore, it does not seem reasonable to mandate stricter requirements for all repeaters.**Issue 1-3-8:** This is related to the ACRR and configurable passband discussion in thread [310] and might be useful to consider together.**Issue 1-3-9:** It may be possible to derive the requirement analytically considering some baseline exists in E-UTRA repeater specification.**Issue 1-3-12 and 1-3-13:** Based on GtW discussion on Tuesday morning, switching time requirements can also cover group delay. When the detailed switching time is discussed the UE switching times specified in TS 38.211 section 4.2.3 need to be taken into account. Repeater does not need to switch faster than UE.**Issue 1-3-15**: Repeaters are not mandated to have demodulation capabilities so reference sensitivity is not recommended to be defined. |
| QCOM | **Issue 1-3-1:** we are ok with the WF**Issue 1-3-3:** we are ok with the WF**Issue 1-3-5:** we are ok with the WF**Issue 1-3-6:** we are ok with the WF**Issue 1-3-8:** we are ok with the WF**Issue 1-3-11:** As we are discussing higher output power and potentially higher expected gain from the repeater then out of band gain assumptions may need to be updated.**Issue 1-3-12:** This discussion should occur in thread 310**Issue 1-3-13:** This discussion should occur in thread 310 |
| ZTE | **Issue 1-3-1: frequency stability for both TDD and FDD conducted requirements**Fine with recommended WF, it’s relative requirement with respect to the input signal/The frequency deviation of the output signal with respect to the input signal shall be no more than ±0,01 PPM.**Issue 1-3-2: whether to consider feasible modulation schemes for DL and UL, respectively?**Necessary.**Issue 1-3-3: EVM aligned with which modulation scheme?**This depends on repeater EVM performance, if EVM contributed is too higher, then 256QAM performance gain would be dismissed, therefore more discussion might be needed.**Issue 1-3-4: whether to improve EVM beyond what is required for NR BS/UE spec**More feasibility study are needed to improve EVM performance. **Issue 1-3-5: input intermodulation requirements**Fine with recommended WF.**Issue 1-3-6: output intermodulation for DL**Fine with BS approach**Issue 1-3-9: whether co-existence simulation is needed to derive out of band gain for NR repeater**Out of band gain should be derived based on MCL we think.**Issue 1-3-10: whether to consider out of band co-location requirement for NR repeater**Yes, **Issue 1-3-11: out of band gain requirements**Fine with recommended WF.**Issue 1-3-12: whether to define TDD switching requirements, if so how to define these requirements?**It’s fine to define on/off mask as TDD switching requirements.**Issue 1-3-13: group delay requirements, taking following aspects into consideration**At least some analysis on its group delay might be needed.**Issue 1-3-15: whether to define REFSENSE or equivalent requirements**Don’t see the necessity to define REFSENS for repeater. |
| CMCC | **Issue 1-3-1: frequency stability for both TDD and FDD conducted requirements****Recommended WF is OK to us****Issue 1-3-2: whether to consider feasible modulation schemes for DL and UL, respectively?****Yes, at least for FR2****Issue 1-3-3: EVM aligned with which modulation scheme?****Option 3. As for some cases 256 QAM would be the major modulation scheme while for the other repeaters, they may only amplify highest 64QAM. If we only define one set of EVM, it could be either too stringent or too relax.****Issue 1-3-4: whether to improve EVM beyond what is required for NR BS/UE spec****Recommended WF is OK to us****Issue 1-3-5: input intermodulation requirements****Recommended WF is OK to us****Issue 1-3-6: output intermodulation for DL****Recommended WF is OK to us****Issue 1-3-7: whether to define output intermodulation for UL****Option 1. In BS spec 30 dB is used as minimum coupling loss, which may not applicable for UL anymore.****Issue 1-3-8: ACRR****Recommended WF is OK to us****Issue 1-3-10: whether to consider out of band co-location requirement for NR repeater****More discussion about the scenario****Issue 1-3-11: out of band gain requirements****Recommended WF is OK to us****Issue 1-3-12 and 1-3-13 are suggested to be moved to email thread [310]****Issue 1-3-14: whether/how to define TDD OFF requirements****Option 1****Issue 1-3-15: whether to define REFSENSE or equivalent requirements****REFSENSE or NF or input level are all OK to us** |
| Docomo | **Issue 1-3-3: EVM aligned with which modulation scheme?**We are OK with recommended WF.**Issue 1-3-6: output intermodulation for DL**We are OK with recommended WF.**Issue 1-3-12: whether to define TDD switching requirements, if so how to define these requirements?**We are OK with recommended WF.**Issue 1-3-14: whether/how to define TDD OFF requirements**We are OK with Option 1. |
| CATT | **Issue 1-3-1: frequency stability for both TDD and FDD conducted requirements****Support the WF****Issue 1-3-2: whether to consider feasible modulation schemes for DL and UL, respectively?****Not sure about it. Actually the EVM/SNR for different modulation is same. i.e. if 6% for 64QAM, also 6% for QPSK. I think this may depends on if the modulation scheme is based on declaration. If can be declared, then can be tested. But as we provided in our paper, the output signal quality is decided by the combination of input signal and the repeater Tx path, so not sure if this declaration is valid.****Issue 1-3-3: EVM aligned with which modulation scheme?****Not sure about 256QAM. See the comments above.****Issue 1-3-4: whether to improve EVM beyond what is required for NR BS/UE spec****We support 6%, would also ok with further discussion on different modulation.****Issue 1-3-5: input intermodulation requirements****Ok with WF.****Issue 1-3-6: output intermodulation for DL****Ok with WF.****Issue 1-3-7: whether to define output intermodulation for UL****FFS.****Issue 1-3-8: ACRR****Should the BW be considered? As a starting point or reference may be better.****Issue 1-3-9: whether co-existence simulation is needed to derive out of band gain for NR repeater****We’re not proposing co-existence simulation, just provided the background for E-UTRA repeater requirements. Can accept any reasonable technical analysis input.****Issue 1-3-10: whether to consider out of band co-location requirement for NR repeater****Yes.****Issue 1-3-11: out of band gain requirements****The same comment as 1-3-8, larger BW may need to be considered.****Issue 1-3-12: whether to define TDD switching requirements, if so how to define these requirements?****If it can be verified together with synchronization with TDD UL/DL pattern? More consideration is needed on how to verify it. The output signal of the signal generator already has transient period, so the output of repeater performance is not purely the repeater’s contribution.****Issue 1-3-13: group delay requirements, taking following aspects into consideration****No requirements.****Issue 1-3-14: whether/how to define TDD OFF requirements****May also be verified together with synchronization with TDD UL/DL pattern as Issue 1-3-12.****Issue 1-3-15: whether to define REFSENSE or equivalent requirements****No REFSENS.** |
| NEC | **Issue 1-3-1: Recommended WF is fine.****Issue 1-3-2: Option 1. Feasible modulation schemes without repeater are different for DL and UL. We should consider the feasible modulation schemes for DL and UL, respectively.****Issue 1-3-3: Recommended WF is fine.** **Issue 1-3-4: Agree with Nokia. We do not prefer to mandate stricter requirements for all repeaters.****Issue 1-3-8: Recommended WF is fine.** |

### 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

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic #1-1 power related conducted requirements** |
| **Issue 1-1-1:****whether/how to define AGC/ALC related requirements?** | *9 companies support not to explicitly define ALC and AGC requirements at least for the stationary repeater. As for how to verify ALC/AGC actions needs further study. the following tentative agreements are suggested.****Tentative agreements:**** No dedicated ALC/AGC requirements are needed at least for the stationary repeater.
	+ FFS on how to verify ALC/AGC actions. One candidate approach is to verify other key requirements e.g. power and emissions related requirements with several input power levels. Then the ALC/AGC would be implicitly tested.
	+ FFS about ACL/AGC requirements for moving repeater.

***Recommendations for 2nd round:**** Whether to include moving repeater scenario in the scope? For example, the repeater would be deployed in the high-speed train scenario for inside coverage considering the high propagation loss of the carriage.
* More discussion about the tentative agreement listed above. Hope they could be agreed after second round discussion.
 |
| **Issue 1-1-2: DL output power**  | *4 companies support option 3; 3 company support option 2 and 3; 1 company doesn’t object different levels and suggest to wait for the conclusion of class definition; 1 company prefer option 4; 1 company thinks all the options are acceptable and suggest to discuss how to name the different links using “UL/DL” or other concept at first?****Tentative agreements:***Wait for the conclusion of NR repeater classes definition. Once it is agreed to define different classes, appropriate power upper limits could be applied to.***Recommendations for 2nd round:****Do we use the “UL/DL” to differentiate the links or other concept e.g. “access link/ backhaul link” ?* |
| **Issue 1-1-3: UL output power**  | *3 company support option 6; 2 companies support option 2; 2 company support option 4; 1company support option 2 and option 3 if strong technical argument is proposed; 1 company support option 3; 1 company support all the options.* *In addition to consider avoiding network performance degradation from the point of UL co-existence, some other aspects are suggested including the existing LTE FDD repeater conversion into NR repeater and the near-far effect, which means repeater could only use the same compressed gain to amplify signal from UE far away from repeater because repeater have to compress its gain to guarantee amplified signal from nearby UE is not larger than the maximum value and then the output power could be lower.****Recommendations for 2nd round:****Companies are encouraged to provide strong technical arguments about the output power upper limits e.g. some specified value or only based on declaration.* |
| **Issue 1-1-4: how to avoid performance degradation of other networks?** | 4 company slightly prefer output power upper limits; 1 company prefer this power limits only for DL. 1 company thinks both are OK.***Considering this issue has already been taken into consideration in output power limits discussion. It is not recommended for second round discussion.*** |
| **Issue 1-1-5: power tolerance** | *3 company prefer option 1; 2 company prefer to wait for the conclusion of class definition and power limits definition.****Tentative agreements:***Wait for the conclusion of NR repeater classes definition and output power limits definition. ***Recommendations for 2nd round:****Just wait for the conclusion of classes definition and power limits.* |

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|  | **Status summary**  |
| **Sub-topic #1-2 emission related conducted requirements** |
| **Issue 1-2-1, 1-2-2 and 1-2-3 are merged** **ACLR and equivalent requirement** | ***ACLR with adjacent NR channel****1 company suggests existing OBUE and EVM requirements sufficiently cover ACLR requirements. 1 company opposes to define relative ACLR and needs analysis for absolute ACLR. Except for these 2 companies, all the other companies (7) support to define ACLR or equivalent requirements to provide the same requirements as BS/IAB spec.* *As for setting relative ACLR requirement or equivalent requirement, 1 company suggest to set relative ACLR requirements if the output power is much higher than ~30dBm while others prefer to support equivalent requirement.**Another issue is how to define the equivalent requirement. Absolute ACLR requirements and OBUE are proposed in the original open issues. According to the 1st round discussion it seems that the absolute ACLR requirements and OBUE are the similar absolute metrics and both are using narrower adjacent channel bandwidth instead of the whole adjacent channel BW. Therefore it seems there is no need to define two sets of requirement, further study how to define this requirement and then decide which one is preferred.****ACLR with adjacent E-UTRA channel****As for relative ACLR with adjacent E-UTRA channel, 2 companies don’t suggest to do the simulation; 1 company query the motivation of the co-existence study. According to the 1st discussion, it seems no simulation is required. Instead, technical analysis have higher priority.****Candidate options:**** *FFS on Relative ACLR or some equivalent requirements with adjacent NR channel to match the same adjacent channel protection as NR/IAB spec. The equivalent requirements include modified OBUE requirements and absolute adjacent channel emissions power.*
	+ *FFS on whether existing BS OBUE and EVM requirements could sufficiently cover ACLR requirements or not?*
	+ *FFS on how to set either absolute ACLR or modified OBUE or both of these two requirements as equivalent requirements. These two requirements are similar absolute metrics with narrower adjacent channel instead of the whole channel BW.*
* *FFS on ACLR with adjacent E-UTRA requirements. It is suggested to embark on technical analysis instead of simulation at first.*
	+ *FFS on absolute requirements based on achieving same emissions power as an assumed UE/BS meeting ACLR requirements with a reference power.*

***Recommendations for 2nd round:**** *Whether the existing BS OBUE and EVM requirements sufficiently cover ACLR requirements or not?*
* *Whether define the same ACLR or equivalent requirements for both DL(access link) and UL(backhaul link)*
 |
| **Issue 1-2-4, 1-2-5 and 1-2-6 are merged** **Spurious emission related requirements** | *One question is proposed about further checking whether there are any regulatory issues using BS requirements for UL transmission, especially for FDD.**All the companies agree with the WF for spurious emission. For UL, further check whether there are any regulatory issues using BS requirements for UL transmission, especially for FDD.****Tentative agreements:**** *The same spurious emission requirements as BS spec still apply to DL(access link). Further check whether it could be reused for UL repeater, especially for FDD.*
* *NR repeater spurious emission could include general spurious emission, co- location with other base stations, Co-existence with other systems in the same geographical area, Protection of BS receiver for FDD operating band, regional and regulation related requirements.*
* *Only Tx spurious emission is sufficient and Rx spurious emission is not necessary.*

***Recommendations for 2nd round:****Further check whether the same spurious emission requirements could be reused for repeater UL(backhaul), especially for FDD.**More discussion about the tentative agreement listed above. Hope they could be agreed after second round discussion.* |
| **Issue 1-2-7****whether unwanted emission requirements are the same for all classes** | *This issue is suggested to be considered after the conclusion of class definition and output power.* |

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|  | **Status summary**  |
| **Sub-topic #1-3 other conducted requirements** |
| **Issue 1-3-1****Frequency error for FR1 conducted requirements** | *All the 7 companies agree with the WF.****Tentative agreement:**** *The frequency deviation of the output signal with respect to the input signal shall be no more than ±0.01 PPM for FR1 conducted requirements.*

***Recommendations for 2nd round:**** *further discussion is not needed*
 |
| **Issue 1-3-2, 1-3-3 and 1-3-4 are merged** **EVM requirements** | *Companies’ comments are various and it seems hard to reach a consensus. Some new views are proposed including:** *more than one EVM could be required as modulation is dependent on various deployment scenarios*
* *more EVM level implies modulation scheme should be based on declaration*

***candidate options:**** *FFS on whether define EVM limits or based on manufacture’s declaration.*
	+ *FFS on which modulation up to 256QAM is feasible*
	+ *FFS to differentiate different modulation scheme for DL and UL respectively*
	+ *FFS on only one EVM level or more than one EVM. If multiple EVM level are agreed, the modulation scheme is based on declaration or not?*
	+ *FFS on whether to define more stringent requirements than current spec or not*

***Recommendations for 2nd round:**** *only one EVM level or more than one EVM?*
* *Which modulation scheme?*
* *Whether to differentiate DL and UL modulation scheme respectively*
 |
| **Issue 1-3-5****Input IMD** | *All 7 companies support the WF.****Tentative agreements:****Take the same approach of E-UTRAN repeater as baseline including general requirements, co-existence and co-location requirements. Further discussion about whether some adjustment is necessary or not, e.g. frequency offset.****Recommendations for 2nd round:****Further discussion about whether some adjustment is necessary or not, e.g. frequency offset.**More discussion about the tentative agreement listed above. Hope they could be agreed after second round discussion.* |
| **Issue 1-3-6 and 1-3-7 are merged****output IMD** | *All 8 companies support the WF about output IMD for DL (access link).* *As for UL, 3 companies suggest to reuse the same requirements as DL but 1 company suggests FFS.****Tentative agreements:****Take BS Transmitter intermodulation requirement as the baseline for DL (access link) with 30dB coupling loss assumption when define interfering signal level.**FFS on output intermodulation for UL (backhaul)****Recommendations for 2nd round:****Further discuss whether the same BS Transmitter intermodulation could be applied to UL (backhaul link).**More discussion about the tentative agreement listed above. Hope they could be agreed after second round discussion.* |
| **Issue 1-3-8 ACRR** | *Five companies support the WF. 1 company suggest to merge this discussion with configurable passband discussion in thread [310]. 1 company suggest to take BW into consideration.****Tentative agreements:****Take E-UTRA repeater specification as the baseline when define ACRR requirement for NR repeater.** *FFS on whether consider the adjacent channel within the passband*

***Recommendations for 2nd round:****Further discuss whether consider the adjacent channel within the passband, which is ongoing in email thread [310]. Therefore, it is suggested to focus on the discussion in [310] not in this email thread.**More discussion about the tentative agreement listed above. Hope they could be agreed after second round discussion.* |
| **Issue 1-3-9, 1-3-10 and 1-3-11 are merged****Out of band gain** | *All the views are various among companies and it’s hard to reach a consensus.* *for whether to define the co-location requirements, some companies suggest to define it as optional requirements.**for the issue whether to do co-existence study, some companies suggest to do the simulation considering the statistical feature in nature while others suggest that reasonable technical analysis is sufficient as how E-UTRA repeater spec has done. Of cause, the assumption is suggested to be updated because NR repeater is expected to have higher output power and gain.**As for how to define out of band gain, the key is to define the minimum coupling losses and outpower power of other nodes. Some companies suggest to focus on the donor coupling loss. 1 company suggestion is based on assumed MCL to another transmitter with the same output power as a BS. 1 company comments that larger BW may need to be considered.****Candidate options:****FFS on out of band gain.** *FFS on whether take E-UTRA repeater spec as the baseline when define out of band gain requirements for NR repeater.*
	+ *FFS on whether to update assumption because higher output power is assumed for NR repeater*
* *FFS on co-location scenario. Which kind of requirement is preferred? No requirements, optional requirements or mandatory requirements?*
* *FFS on the necessity of co-existence simulation. Simulation or only technical analysis?*
* *FFS on the coupling loss and power of another transmitter, taking following aspects into consideration*
	+ *The donor coupling loss*
	+ *Base on assumed MCL to another transmitter with the same output power as a BS*

***Recommendations for 2nd round:****Further discuss based on above candidate options.* |
| **Issue 1-3-12, 1-3-13****Timing related requirements** | *These timing related requirements are suggested to be removed to email thread [310].* |
| **Issue 1-3-14****TDD OFF requirements** | *3 company thinks these requirements are necessary and maybe verified with synchronization or switching time requirements. 1 company thinks TDD off requirements are not needed;****Recommendations for 2nd round:****Further discuss about whether TDD OFF requirements are necessary or not.* |
| **Issue 1-3-15****REFSENSE or equivalent requirements** | *3 company query the necessity of such requirements. 2 company suggest NF or min input power. 1 company have concern on how to test REFSENSE because BS and UE tests relay on FRC, feedback etc.****Recommendations for 2nd round:****Further discuss about whether REFSENSE or equivalent requirements are necessary or not.* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | WF on RF requirements for NR repeater | CMCC |

### 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)

# Topic #2: Radiated requirements

NR repeater radiated related requirements are discussed in this thread, including transmit power related requirements, emission requirements and the others*.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2104613**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104613.zip) | CMCC | **Observation 1: For FR2, 3GPP only define maximum output power upper limits requirements for UE. For BS, power requirements are declared by manufacturer with specified tolerance for normal and extreme condition.****Proposal 1: For DL repeater the same approach as BS spec could be reused that the output power requirements are based on declaration with some specified tolerance requirements.****Proposal 2: minimum peak EIRP for UL repeater should be larger than UE spec, taking the near-far effect into consideration.****Proposal 3: The same UL maximum output power in terms of EIRP are suggested since they are derived from regulatory requirements.****Proposal 4: DL coexistence study has high priority to give guidance for maximum output power requirements while UL coexistence study has relatively lower priority.****Observation 2: considering much complex antenna array could be equipped on FR2 repeater, the beam correspondence capability may be required to make repeater use the same DL Rx antenna as UL Tx antenna. Otherwise, tolerance is not negligible when calculating UL output power.**  |
| [**R4-2104674**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104674.zip) | Ericsson | **Proposal 1: The TRP accuracy requirement for a repeater should be the same as for BS.****Proposal 2: DL TRP output power can be declared with no restriction on power.****Proposal 3: For UL power consider an approach similar to IAB*** **Wide area class with no restriction on power**
* **Local area class with power restricted to 31dBm**

**Proposal 4: Consider requirements that ensure that with changing input power level, and also input power level that leads to gain limitation, EVM and some key unwanted emissions requirements are properly met.** |
| [**R4-2104798**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104798.zip) | CATT | **Observation 1: FR1 radiated output power can be discussed after the conclusion of NR type discussion.****Observation 2: FR2 NR repeater BS FR2 power approach can be considered by NR repeater for both access link and service link. Whether there’s difference for the two links needs more discussion.****Observation 3: ALC requirement may be needed to guarantee the output signal quality, how to define it FFS.** |
| [**R4-2106330**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106330.zip) | Nokia, Nokia Shanghai Bell | ***Proposal 1: For FR2 NR repeaters both rated beam EIRP level and rated carrier TRP output power, during ON period, need to be considered.******Proposal 2: Rated beam EIRP level and rated carrier TRP output power may be declared by the manufacturers, similar to BS and IAB. However, it needs to be checked whether the minimum requirements defined for rated beam EIRP level and rated carrier TRP output power of the BS and IAB are still applicable for NR repeaters as well.******Observation 1: Depending on the type and class of the NR repeater, the minimum requirements can be slightly differed.******Proposal 3: For NR repeaters, power control can be done by imposing a maximum power limit in both*** ***gNodeB – Repeater (backhaul) link and Repeater – UE (access) link.******Proposal 4: If the class and type definitions of the IAB is followed for NR repeaters, some class and type combinations do not define an upper limit of the rated carrier TRP output power. This is not an issue for IABs as there exists a method to control the output power. For NR repeaters, it must be discussed how to handle such a scenario.******Observation 2: Automatic gain controlling may not need to be specified for repeater; the same functionality could be obtained by using an implementation specific approach. AGC in only needed in context of limiting maximum output power and unwanted emissions with high-power input signal.******Observation 3: The dynamic ranges of the NR repeater access and backhaul links could vary depending on the deployment scenario.******Proposal 5: Dynamic range of the NR repeater backhaul and access links must be defined based on the class and type of the repeaters.*** |
| [**R4-2106352**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106352.zip) | NTT DOCOMO, INC. | **Maximum output power:****Observation 1: Base Station and IAB for FR2 don’t have upper limit on the output power and they are based on declaration.****Proposal 1: RAN4 specify the maximum output power for FR2 repeater based on declaration without upper limit in DL.****EVM:****Observation 2: It is necessary to consider which modulation is ultimately feasible for DL and UL, respectively.****Observation 3: Repeater will be used to cover indoor areas of customers’ homes and it is important to achieve higher modulation scheme.****Proposal 2: RAN4 consider which modulation up to 256QAM and 64QAM is feasible in DL and UL, respectively, and define the EVM requirements for the feasible modulation.** |
| [**R4-2104618**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104618.zip) | CMCC | **Observation 1: if fixed gain and pattern is assumed for FR2 repeater, the directional requirement is not based on manufacturer’s declaration any more but based on the fixed assumption.****Proposal 1: for FR2 repeater, output intermodulation requirement is not suggested and input intermodulation could follow the same requirements as FR2 BS receiver requirements.** **Observation 2: for FR2 ACLR, extra evaluation may be needed to verify whether the increased repeaters could produce extra adjacent interference to other networks.****Proposal 2: FR2 repeater should follow BS spec for spurious requirement by defining general requirements and additional OTA requirements for protection of Earth Exploration Satellite Service** |
| [**R4-2104672**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104672.zip) | Ericsson | **Observation 1: In the DL, the ACLR requirement drives the amount of BS emissions in the adjacent channel. If only the OBUE requirement is present, emissions are increased by around 7dB.****Observation 2: To provide the same amount of DL adjacent channel protection as a BS or IAB, a repeater must comply to at least the absolute BS ACLR requirement (with adjustment if the maximum power is >31dBm).****Observation 3: The general spurious emissions for a repeater should be the same as those for a BS/UE (including category A/B and protection of ESS)** |
| [**R4-2104799**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104799.zip) | CATT | **Proposal 1: FR2 BS relative ACLR can be considered to be reused by NR FR2 repeater for both access link and backhaul link.****Observation: FR2 Absolute ACLR needs more discussion with some input of the mmWave repeater implementation architecture and noise floor analysis.****Proposal 2: FR2 BS operating band unwanted emission requirement can be reused by FR2 NR repeater for both access link and backhaul link.****Proposal 3: FR2 BS spurious emission requirements can be reused for FR2 NR repeater access link.** |
| [**R4-2106331**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106331.zip) | Nokia, Nokia Shanghai Bell | ***Observation 1: As ACLR depends on the desired signal power, it may not be measurable if the desired signal power is in the scale of noise power level.******Observation 2: OBUE is an upper bound, which is independent on the signal power level, defined to limit the unwanted emissions in the adjacent bands.******Proposal 1: For NR repeaters, if the signal level is in the scale of noise power level, it is meaningful to use OBUE metric to measure the unwanted emissions in the adjacent channels, instead of ACLR.******Observation 3In case of NR repeaters that operate in noncontiguous spectrum, CACLR may not be a suitable metric to measure the unwanted emissions in the adjacent band.*** ***Proposal 2: For NR repeaters that operate in noncontiguous spectrum, OBUE can be used to measure the unwanted emissions in each sub-block gap.******Observation 4: Direct re-use of gNB/IAB OBUE requirements may not be possible as it would result in different level of protection for adjacent channel operation in case no ACLR is defined.*** |
| [**R4-2106353**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106353.zip) | NTT DOCOMO, INC. | **OBUE and spurious emission (Receiver spurious emission):****Observation 1: If the receiver spurious emission requirements for TDD don’t exist, then there is no test requirements for the emission in TDD OFF period.****Proposal 1: RAN4 specify the receiver spurious emission requirements for TDD based on the one for Base Station.****Tx/output intermodulation and input intermodulation requirements:****Proposal 2: RAN4 doesn’t specify the output intermodulation requirements for FR2 NR repeater.****Proposal 3: RAN4 consider the input intermodulation requirements based on the receiver intermodulation requirements for FR2 Base Station.** |
| [**R4-2104675**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104675.zip) | Ericsson | **Proposal 1: No need for TX intermodulation requirements for FR2****Proposal 2: In place of receiver requirements, a requirement on out of passband gain should be defined. This should be based on the UE blocking requirement level within the band and the BS out of band blocking levels for out of band.****Proposal 3: A requirement on input intermodulation should be created, with levels based on the BS RX intermodulation requirement.****Observation 1: There may be implications of not specifying requirements relating to frequencies that apply to another operator but are within the passband.** |
| [**R4-2104800**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104800.zip) | CATT | **Proposal 1: E-UTRA repeater requirement, i.e. 0.01 ppm is reused for both access link and backhaul link.****Proposal 2: EVM requirements for FR2 NR repeater are defined as 6% for both access link and backhaul link.****Observation 1: Out of band gain requirement may need co-existence analysis or simulation.****Observation 2: Input intermodulation may not be needed for backhaul link.****Observation 3: Output intermodulation may not be needed for both backhaul link and access link.** |
| [**R4-2106332**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106332.zip) | Nokia, Nokia Shanghai Bell | ***Observation 1: In case of FR2, having two distant-units (backhaul and access units) with frequency conversion happened in each unit, could introduce frequency error in NR repeaters.******Proposal 1: While defining the frequency error values for NR repeaters in FR2, the frequency error that could result in frequency conversion should be considered. Additionally, the hardware complexity and cost required to achieve a lower frequency error must be discussed.*****Proposal 2: Keep frequency error requirement in square brackets until more complete understanding on system performance impact and implementation feasibility has been achieved.** |

## Open issues summary

Agenda 8.11.3

FR1 radiated requirements are listed here just because some companies show their views for FR1 OTA requirements, which doesn’t imply we finally approve to define radiated requirements for FR1. To differentiate FR1 and FR2 discussion it seems reasonable to separate all the requirements by FR1 and FR2. However, this will duplicate the numbers of issues, making it very complex to reply this summary. Therefore, in topic #2 all the issues apply for both FR1 and FR2 without specific statement. Otherwise, the applicable frequency range would be emphasized if they are only applicable for either FR1 or FR2.

It is noted for Tx related discussion, DL means repeater-UE (access) link and UL means repeater-gNB (backhaul) link while for Rx related discussion, e.g. out of band gain requirements, DL means gNB - repeater (backhaul) link and UL means UE - repeater (access) link.

### Sub-topic 2-1

**Issue 2-1-1: whether to define radiated requirements for FR1?**

* Proposals
	+ Option 1: yes
	+ Option 2: no
* Recommended WF
	+ TBA

### Sub-topic 2-2

Output power related radiated requirements for both FR1 and FR2.

**Issue 2-2-1: how to define output power requirement (TRP) for FR1?**

* Proposals
	+ Option 1: further check whether the same minimum requirements as BS/IAB still apply to FR1 repeater. further discuss about whether define upper limits for all classes (Nokia)
	+ Option 2: TBA
* Recommended WF
	+ It is suggested to discuss FR1 radiated output power after the conclusion of NR class and types discussion.

**Issue 2-2-2: whether to define both the rated beam EIRP level and rated carrier TRP output power for FR2?**

* Proposals
	+ Option 1: yes, both EIRP and TRP (Nokia)
	+ Option 2: TBA
* Recommended WF
	+ Both rated beam EIRP level and rated carrier TRP output power, during ON period, need to be considered for FR2 NR repeater

**Issue 2-2-3: DL output power requirement (TRP) for FR2**

* Proposals
	+ Option 1: output power based on declaration without upper limit in DL for FR2. (NTT DOCOMO, Ericsson, CATT, Nokia, CMCC)
* Recommended WF
	+ RAN4 specify the maximum output power for FR2 repeater based on declaration without upper limit in DL.

**Issue 2-2-4: DL TRP accuracy**

* Proposals
	+ Option 1: the same as BS for DL (Ericsson, CMCC)
	+ Option 2: TBA
* Recommended WF
	+ The TRP accuracy requirement for FR2 DL repeater should be the same as BS spec

**Issue 2-2-5: UL output power requirements (TRP) for FR2?**

* Proposals
	+ Option 1: the same approach as IAB. Wide area class with no restriction on power; Local area class with power restricted to 31dBm. (Ericsson)
	+ Option 2: the same approach as NR BS, i.e. output power based on declaration without upper limit for FR2. (CATT)
	+ Option 3: higher than UE spec considering gain compression. (CMCC)
* Recommended WF
	+ TBA

**Issue 2-2-6: whether/how to define ALC/AGC requirement**

* Proposals
	+ Option 1: dedicated requirements
	+ Option 2: no ALC/AGC requirements
	+ Option 3: implicitly specify ALC/AGC requirements, e.g. by verifying current requirements are properly met in some special cases
* Recommended WF
	+ TBA

**Issue 2-2-7: how to define ALC/AGC requirement either implicitly or explicitly, taking following aspects into consideration**

* Proposals
	+ Option 1: Consider requirements that ensure that with changing input power level, and also input power level that leads to gain limitation, and some key unwanted emissions requirements are properly met. (Ericsson)
	+ Option 2: ALC requirements may be needed to guarantee the output signal quality (CATT)
	+ Option 3: AGC may not be needed, the same functionality could be obtained by using an implementation specific approach. AGC in only needed in context of limiting maximum output power and unwanted emissions with high-power input signal. (Nokia)
	+ Option 4: the beam correspondence capability may be required to make repeater use the same DL Rx antenna as UL Tx antenna. otherwise, tolerance is not negligible when calculating UL output power. (CMCC)
* Recommended WF
	+ TBA

**Issue 2-2-8: whether/how to define dynamic range of NR repeater DL and UL**

* Proposals
	+ Option 1: yes
		- Option 1-1: based on the class and types of repeaters. (Nokia)
	+ Option 2: TBA
* Recommended WF
	+ TBA

### Sub-topic 2-3

Unwanted emission related radiated requirements including ACLR, operating band unwanted emissions and spurious emissions requirements.

It is noted all the issues are applicable for both FR1 and FR2 if no specific statement. Otherwise, the applicable FR would be emphasized if it is only for either FR1 or FR2.

**Issue 2-3-1: whether/how to define relative ACLR for FR2 UL and DL**

* Proposals
	+ Option 1: yes
		- Option 1-1: reuse BS relative ACLR (CATT)
		- Option 1-2: based on system level evaluation (CMCC)
	+ Option 2: TBA
* Recommended WF
	+ TBA

**Issue 2-3-2: whether/how to define absolute ACLR for FR2 UL and DL**

* Proposals
	+ Option 1: yes
		- Option 1-1: at least comply to absolute BS ACLR requirements (with adjustment if the maximum power is >31dBm) for DL to provide the same amount of DL adjacent channel protection as BS and IAB (Ericsson)
		- Option 1-2: more discussion with some input of implementation architecture and NF (CATT)
* Recommended WF
	+ ACLR or some equivalent requirements are required to match the same adjacent channel protection as NR/IAB spec. the equivalent requirements include modified operating band unwanted emission and absolute ACLR for FR2 repeater.

**Issue 2-3-3: operating band unwanted emission requirement for UL and DL**

* Proposals
	+ Option 1: for FR2 the same as BS(CATT)
	+ Option 2: updated OBUE as equivalent requirements for ACLR (Nokia)
	+ Option 3: updated OBUE as equivalent requirements for CACLR to measure the unwanted emissions in each sub-block gap (Nokia)
* Recommended WF
	+ TBA

Spurious related requirements

**Issue 2-3-4: Tx spurious emission requirements for FR2**

* Proposals
	+ Option 1: the same as those for BS could be reused for both DL and UL including category A/B and protection of ESS (Ericsson, CMCC)
	+ Option 2: the same as those for BS could be reused for DL repeater (CATT)
* Recommended WF
	+ At least for DL, the same spurious emissions requirements as BS could be reused for NR repeater including category A/B and protection of ESS

**Issue 2-3-5: Rx spurious emission requirements for FR2**

* Proposals
	+ Option 1: receiver spurious emission requirements based on the one for BS (NTT DOCOMO)
* Recommended WF
	+ Define receiver spurious emission requirements for FR2 repeater.

### Sub-topic 2-4

The requirements except for power and unwanted emission related requirements for both FR1 and FR2, including frequency stability, out of passband gain, EVM, input intermodulation and output intermodulation.

It is noted all the issues are applicable for FR2.

**Issue 2-4-1: frequency stability for FR2**

* Proposals
	+ Option 1: 0.01ppm for both DL and UL (CMCC, CATT)
	+ Option 2: keep 0.01ppm in square brackets until more complete understanding on system performance impact and implementation feasibility (Nokia)
* Recommended WF
	+ [0.01ppm] for FR2 both DL and UL

**Issue 2-4-2: out of passband gain for FR2, taking following aspects into consideration**

* Proposals
	+ Option 1: based on FR2 UE blocking requirement level within the band and the BS out of band blocking level for out of and (Ericsson)
	+ Option 2: based on co-existence analysis and simulations (CATT)
* Recommended WF
	+ TBA

**FR2 EVM related requirements**

**Issue 2-4-3: whether to consider feasible modulation schemes for DL and UL, respectively?**

* Proposals
	+ Option 1: necessary (NTT DOCOMO)
	+ Option 2: TBA
* Recommended WF
	+ TBA

**Issue 2-4-4: EVM aligned with which modulation scheme, 256 QAM or 64 QAM?**

* Proposals
	+ Option 1: feasible modulations up to 256 QAM for DL and 64 QAM for UL respectively (NTT DOCOMO)
	+ Option 2: TBA
* Recommended WF
	+ RAN4 consider which modulation up to 256QAM and 64QAM is feasible in DL and UL, respectively, and define the EVM requirements for the feasible modulation.

**Issue 2-4-5: EVM requirements**

* Proposals
	+ Option 1: 6% for both DL and UL(CATT)
	+ Option 2: TBA
* Recommended WF
	+ More stringent EVM requirement compared with NR spec is required to reduce the degradation of system performance.

**Issue 2-4-6: input intermodulation for FR2**

* Proposals
	+ Option 1: based on FR2 BS receiver intermodulation (NTT DOCOMO, Ericsson, CMCC)
	+ Option 2: may not be needed for backhaul link and further discussion for access link because BS requirements can’t be reused (CATT)
* Recommended WF
	+ TBA

**Issue 2-4-7: output intermodulation for FR2**

* Proposals
	+ Option 1: not needed for both DL and UL (NTT DOCOMO, Ericsson, CATT, CMCC)
	+ Option 2: TBA
* Recommended WF
	+ RAN4 doesn’t specify the output intermodulation requirements for FR2 NR repeater

**Issue 2-4-8: requirements relating to frequencies that belonging to other operators but are within the passband**

* Proposals
	+ Option 1: there may be implication of not specifying such requirements (Ericsson)
	+ Option 2: TBA
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

**Example 1**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1: Sub topic 1-2:….Others: |

**Example 2**

Sub topic 2-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Option 2. Our preference is not to include OTA requirements. The scope of the WI is repeaters without active beamforming and it is not expected that repeaters with many active TX and no connectors would be used for FR1. The conformance work for OTA will be somewhat complex as there are no reference test procedures from BS or UE, and the assessments will differ between FR1 and FR2. So we think there is little gain from FR1 OTA, and effort should be focused on FR2 OTA conformance.  |
| Huawei | As there is no active beam forming OTA requirements are less important but as we have worked on the BS test chambers etc if they are thought t be necessary its ok. As we have discussed before isolation between antennas is an important parameter which cannot be tested for a conducted system and needs to be measured on installation. If this can be included and hence the installation is simplified with built in antennas then it’s a good reason to have OTA requirements. |
| Nokia, Nokia Shanghai Bell | Radiated requirement definition for FR1 would increase the workload significantly. Also WID states that for FDD testing is conducted. Given the fixed beam assumption in the work, radiated requirements seem to provide limited benefits in FR1. |
| QCOM | Option 2 |
| ZTE | Option 2. don’t see the strong motivation to have OTA testing for FR1 repeater. |
| CMCC | Option 2 |
| CATT | Option 2. |
| Commscope | Option 1. The upper part of the FR1 spectrum is suitable for repeater solutions with integrated (fixed beam) antennas. Hence, conducted measurements would not be possible without considerable effort and radiated requirement would be the straight-forward approach.  |
| NEC | Option 2 |

Sub topic 2-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Issue 2-2-2: whether to define both the rated beam EIRP level and rated carrier TRP output power for FR2?** Since the repeater does not perform beamforming, we do not see a need for an EIRP requirement. It is not like a BS where there is a requirement on accurately steering a beam in a number of directions. We can discuss if some requirement is needed for regulatory considerations.Option 2: TRP only.**Issue 2-2-6: whether/how to define ALC/AGC requirement** As with FR1, we believe that ALC/AGC can be tested by demonstrating compliance to output power and some other key requirements with several input power levels. Option 3.**Issue 2-2-7: how to define ALC/AGC requirement either implicitly or explicitly, taking following aspects into consideration**We do not see the need for option 4 as there is no active beamforming**Issue 2-2-8: whether/how to define dynamic range of NR repeater DL and UL** This could be met with the requirements described in 2-2-7. Option 2: Meet implicitly as described in 2.2.7 option 1 |
| Huawei | **Issue 2-2-1:** WF ok**Issue 2-2-2:** As the repeater does not have dynamic beam forming as the gain is fixed then probably EIRP and TRP are not necessary. It tempting to say only EIRP is sufficient but it would require the gain to be known, measuring gain and then EIRP is effectively the same as TRP so Maybe TRP alone is ok.**Issue 2-2-3:** As we didn’t need any upper limits for BS its probably safe to agree with WF**Issue 2-2-4:** WF ok**Issue 2-2-5:** I think we need to see some gain budgets to see if higher UL power is needed, using existing UE max makes things simpler. With fixed max gain the output power capability really just places the zone where the repeater is best deployed, high UL output power implied BS to repeater loss is high, hence with fixed repeater gain DL input and hence DL output is low. The links should be considered together when we look at the deployment scenarios.**Issue 2-2-6:** Currently the AGC requirement is part of the installation procedure to prevent oscillation, as previously discussed its not clear this is needed for OAT repeater (although possible an additional OTA RF req/test might be). Foe ALC the output power limit should be sufficient but if we wish to introduce a reaction time element that should be further discussed.**Issue 2-2-7:** Option 1 seems a good starting point. Option 4 implies active beam forming, our understanding is beam was fixed.**Issue 2-2-8:** I think this is linked to the min signal level and or the refesen as discussed in 1-3-15, base don the use case the repeater may need a min power (or dynamic range) requirement, however this might be based on its gain which is not specified and may vary depending on implementation, as such its not clear what a min level might be ? |
| Nokia, Nokia Shanghai Bell | **Issue 2-2-2, 2-2-3 and 2-2-4:** We agree with proposed WF**Issue 2-2-5**: Same approach as IAB-MT is a good starting point for UL, i.e. maximum output power is declared. Maximum power limit can be further considered in case there are concerns of interference issues, though in FR2 they should not be as severe as in FR1.**Issue 2-2-6:** We prefer option 3, e.g. maximum output power and emissions could be required to be met when high input power is present.**Issue 2-2-7:** We prefer option 3, which is also aligned with option 1. It is unclear at the moment how beam correspondence is applicable if the beams are fixed.**Issue 2-2-8:** Dynamic range here refers to defining or declaring a class specific upper bound for output power and requiring the AGC to limit the increase of power above this value. |
| QCOM | **Issue 2-2-1: how to define output power requirement (TRP) for FR1?** **We are ok with the WF****Issue 2-2-2: whether to define both the rated beam EIRP level and rated carrier TRP output power for FR2?** **The WF is OK****Issue 2-2-3: DL output power requirement (TRP) for FR2****WF is ok****Issue 2-2-4: DL TRP accuracy** **WF is ok****Issue 2-2-6: whether/how to define ALC/AGC requirement** **Option 3** |
| ZTE | **Issue 2-2-1: how to define output power requirement (TRP) for FR1?** Fine with recommended WF.**Issue 2-2-2: whether to define both the rated beam EIRP level and rated carrier TRP output power for FR2?** Further discussion might be needed, if EIRP level could be reflected in other requirement ,like repeater gain, it might be also okay.**Issue 2-2-3: DL output power requirement (TRP) for FR2**Fine with recommended WF.**Issue 2-2-4: DL TRP accuracy** Fine with recommended WF.**Issue 2-2-5: UL output power requirements (TRP) for FR2?**Option 1 might be not correct, since for FR2 IAB-MT, there are no upper power limit defined in TS 38.174.**Issue 2-2-6: whether/how to define ALC/AGC requirement** No strong opinions, maybe option 3 is fine for us. |
| CMCC | **Issue 2-2-1: how to define output power requirement (TRP) for FR1?****WF is OK****Issue 2-2-2: whether to define both the rated beam EIRP level and rated carrier TRP output power for FR2?** **WF is OK****Issue 2-2-3: DL output power requirement (TRP) for FR2****WF is OK****Issue 2-2-4: DL TRP accuracy****WF is OK****Issue 2-2-5: UL output power requirements (TRP) for FR2?****Option 3, the same reason as FR1 repeater****Issue 2-2-6: whether/how to define ALC/AGC requirement****Option 3 is preferred****Issue 2-2-7: how to define ALC/AGC requirement either implicitly or explicitly, taking following aspects into consideration****Option 4****Issue 2-2-8: whether/how to define dynamic range of NR repeater DL and UL** **May be not needed.** |
| Docomo | **Issue 2-2-2: whether to define both the rated beam EIRP level and rated carrier TRP output power for FR2?**We are OK with recommended WF.**Issue 2-2-3: DL output power requirement (TRP) for FR2**We are OK with recommended WF. |
| CATT | **Issue 2-2-1: how to define output power requirement (TRP) for FR1?** **Ok with the WF.****Issue 2-2-2: whether to define both the rated beam EIRP level and rated carrier TRP output power for FR2?** **Ok with WF.****Issue 2-2-3: DL output power requirement (TRP) for FR2****Ok with WF.****Issue 2-2-4: DL TRP accuracy** **Ok, is not sure if more discussion is needed about the test because repeater can’t generate signal and there could be signal generator accuracy contribution?****Issue 2-2-5: UL output power requirements (TRP) for FR2?****Option 1 is for FR1? Currently think option 2 is ok, as it’s based on declaration.****Issue 2-2-6: whether/how to define ALC/AGC requirement** **We think it may be needed, would like to see more analysis.****Issue 2-2-7: how to define ALC/AGC requirement either implicitly or explicitly, taking following aspects into consideration****Support to study more on these arguments.****Issue 2-2-8: whether/how to define dynamic range of NR repeater DL and UL** **Not sure on this. Need more clarification on the concept here.** |
| CommScope | **Issue 2-2-5: UL output power requirements (TRP) for FR2?**For a repeater the UL output power requirements shall be in alignment with the DL requirements. In our opinion **option 2** is correct, i.e. the output power shall be based on declaration without upper limit for FR2.**Issue 2-2-6: whether/how to define ALC/AGC requirement**For a repeater the ALC/AGC functionality is mandatory to guarantee proper operation but it shall not be task of the standard to define the exact functionality but rather ensure correct radiation under ALC/AGC conditions. Hence, our opinion is **option 3**: implicitly specify ALC/AGC requirements**Issue 2-2-7: how to define ALC/AGC requirement either implicitly or explicitly, taking following aspects into consideration**Our opinion is that only **option 1** should be considered (same argumentation as for Issue 2-2-6) |

Sub topic 2-3

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Issue 2-3-1: whether/how to define relative ACLR for FR2 UL and DL**We think that an absolute emissions requirement dimensioned so that the emissions are the same as a BS/UE with a reference power level is OK; no relative requirement needed. Recommended WF is OK for us.**Issue 2-3-3: operating band unwanted emission requirement for UL and DL**We agree with options 2 & 3 |
| Huawei | **Issue 2-3-1/2:** The problem with relative emissions is if the input signal is low then the ALCR cannot be recovered hence they are only valid over a certain power range, of course absolute requirement have the opposite problem they become to difficult if the power level is 2 high. If the power level is limited then maybe absolute alone (as in current FR1 repeaters) is sufficient but if we are increasing power then a combination of relative and absolute may be necessary.**Issue 2-3-3:** OBUE requirements have some regulatory aspects to them so can we update to match ACLR, also ACLR varies with power level (relative or abs). Not against options 2&3 but need to see more details.**Issue 2-3-4:** WF ok**Issue 2-3-5:** As Rx is on at same time as the Tx it’s not possible to separate UL Rx emissions from DL TX emissions and vica-verca, hence specific Rx emsison not necessary. |
| Nokia, Nokia Shanghai Bell | **Issue 2-3-1:** relative ACLR is not a good metric for repeater emissions as limited input ACLR may impact the output ACLR, in some cases making it impossible to meet the ACLR requirements.**Issue 2-3-2 and 2-3-3:** Absolute ACLR should be considered together with OBUE. As both are absolute emission requirements, it may be that both are not needed. Our preference is to define an OBUE requirement which guarantees the same level of adjacent channel protection as IAB specification.**Issue 2-3-4:** We agree with option 1**Issue 2-3-5:** It is still unclear to us whether Rx spurious emission requirement is necessary, given that in real operation there may be high power UL transmission during the period when Rx spurious requirement would need to be met. |
| ZTE | **Issue 2-3-2: whether/how to define absolute ACLR for FR2 UL and DL**Might be okay for Recommended WF |
| CMCC | **Issue 2-3-1: whether/how to define relative ACLR for FR2 UL and DL**Option 2**Issue 2-3-2: whether/how to define absolute ACLR for FR2 UL and DL**Recommended WF is OK**Issue 2-3-3: operating band unwanted emission requirement for UL and DL**If RAN4 conclude no ACLR requirements, then the modified OBUE could be reused to provide the same protection.**Issue 2-3-4: Tx spurious emission requirements for FR2**WF is OK**Issue 2-3-5: Rx spurious emission requirements for FR2**WF is OK |
| Docomo | **Issue 2-3-5: Rx spurious emission requirements for FR2**As commented by Huawei, if the Rx spurious emission testing for FR2 OTA is not feasible, then these requirements cannot be defined. If RAN4 agree the testability is not realistic, then we are OK not to define Rx spurious emission requirements. |
| CATT | **Issue 2-3-1: whether/how to define relative ACLR for FR2 UL and DL****Issue 2-3-2: whether/how to define absolute ACLR for FR2 UL and DL****Issue 2-3-3: operating band unwanted emission requirement for UL and DL****Can be discussed together if any modified OBUE, absolute ACLR is ok. Also not sure if relative ACLR can be omitted when the output power is high.****Issue 2-3-4: Tx spurious emission requirements for FR2****Ok with WF.****Issue 2-3-5: Rx spurious emission requirements for FR2****FFS.** |
| CommScope | **Issue 2-3-1: whether/how to define relative ACLR for FR2 UL and DL**We propose to omit ACLR for NR repeater standard, following the LTE repeater standard. We think that OBUE requirements and EVM performance sufficiently cover ACLR needs.**Issue 2-3-2: whether/how to define absolute ACLR for FR2 UL and DL**We propose to omit ACLR for NR repeater standard, following the LTE repeater standard. We think that OBUE requirements and EVM performance sufficiently cover ACLR needs.**Issue 2-3-3: operating band unwanted emission requirement for UL and DL**We agree with **option 2**.**Issue 2-3-4: Tx spurious emission requirements for FR2**We agree with **option 1**. |

Sub topic 2-4

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Issue 2-4-1: frequency stability for FR2**We are OK with the recommended WF**Issue 2-4-5: EVM requirements** Different deployments may need different levels of EVM. In some cases, the repeater may not experience extremely high SNR and then there is no point to design for high EVM. In other cases, high EVM is relevant. Two EVM requirement levels could be defined. Alternatively, since EVM conformance testing is a more significant fraction of total conformance testing for repeaters and a one size fits all requirement may not work EVM could be left out of 3GPP conformance and left for manufacturer specification for repeaters.**Issue 2-4-8: requirements relating to frequencies that belonging to other operators but are within the passband**If other operators have carriers within the passband, there is the risk that the repeater amplifies nearby interference sources for those carriers and causes interference if the neighbour operators BS or UE are in the same direction as the repeater. More comments welcome on this topic and whether/how it could be solved. |
| Huawei | **Issue 2-4-1:** WF ok**Issue 2-4-2:** need to consider further, starting point is deployment scenarios and expected repeater gain etc.**Issue 2-4-3/4/5:** As with FR1 its probably ok to have the repeater capability declared in some way and have different EVM requirements based on the highest capability.**Issue 2-4-6/7:** Need to look at the potential issue for FR2 and if these are necessary.**Issue 2-4-8:** Should other operators channels be within the passband? The passband is defined as having possible separate bands. For example if max modulation capability is declared and your system uses only 64QAM but the repeater amplified another operator’s 256QAM signal you will significantly affect the other system. AS you have no control of other operator’s capabilities it implies that repeater cannot have such declared capabilities. |
| Nokia, Nokia Shanghai Bell | **Issue 2-4-1:** We prefer option 2 as for FR2 it is likely necessary to downconvert signal to lower frequency when it is routed between the antenna arrays. Therefore, the two frequency conversions may make it infeasible to meet the 0.01ppm frequency error.**Issue 2-4-3:** 256QAM is not specified for UL**Issue 2-4-4:** Repeater is not aware which MCS the signal it is forwarding is using. Therefore, having different EVM requirements implies two different repeaters. We support to idea to allow building repeaters which support up to 64 QAM and also repeaters which support up to 256QAM.**Issue 2-4-5:** Some repeaters may be deployed in places where high SNR is not feasible. Therefore further discussion is needed whether it is reasonable to mandate more stringent EVM requirement for all repeaters.**Issue 2-4-8:** Option 1: We agree with the observation. This is related to the discussion on ACRR and configurable passband in [310]. As it may be impossible to control the passband beyond what the repeater is initially configured when it is built and deployed additional requirements beyond regular emission requirements are challenging to define. |
| QCOM | **Issue 2-4-1: frequency stability for FR2****Ok with WF****Issue 2-4-4: EVM aligned with which modulation scheme, 256 QAM or 64 QAM?****OK with WF****Issue 2-4-5: EVM requirements** OK with WF |
| ZTE | **Issue 2-4-1: frequency stability for FR2**Fine with recommended WF**Issue 2-4-3: whether to consider feasible modulation schemes for DL and UL, respectively?**Option 1 **Issue 2-4-4: EVM aligned with which modulation scheme, 256 QAM or 64 QAM?**Fine with recommended WF.**Issue 2-4-6: input intermodulation for FR2**Fine with option 1**Issue 2-4-7: output intermodulation for FR2**No need to define that requirement |
| CMCC | **Issue 2-4-1: frequency stability for FR2****WF is OK****Issue 2-4-2: out of passband gain for FR2, taking following aspects into consideration****Option 2 is preferred****Issue 2-4-3: whether to consider feasible modulation schemes for DL and UL, respectively?****Option 1 as the highest modulation scheme for DL and UL are different.****Issue 2-4-4: EVM aligned with which modulation scheme, 256 QAM or 64 QAM?****WF is OK****Issue 2-4-5: EVM requirements****WF is OK****Issue 2-4-6: input intermodulation for FR2****Option 1 is preferred****Issue 2-4-7: output intermodulation for FR2****WF is OK****Issue 2-4-8: requirements relating to frequencies that belonging to other operators but are within the passband** **I guess this issue has been discussed in email thread [310] and Ericsson propose a very good question and further study is needed to check whether repeater could reject adjacent emission within passband or not.**  |
| Docomo | **Issue 2-4-1: frequency stability for FR2**We are OK with recommended WF.**Issue 2-4-3: whether to consider feasible modulation schemes for DL and UL, respectively? / Issue 2-4-4: EVM aligned with which modulation scheme, 256 QAM or 64 QAM?**We are OK with recommended WF. Taking the Nokia’s comment into consideration is needed, when defining the EVM requirements. |
| CATT | **Issue 2-4-1: frequency stability for FR2****Ok with WF****Issue 2-4-2: out of passband gain for FR2, taking following aspects into consideration****We’re not proposing co-existence analysis and are happy to see any reasonable analysis.****Issue 2-4-3: whether to consider feasible modulation schemes for DL and UL, respectively?****The same comment as conducted.****Issue 2-4-4: EVM aligned with which modulation scheme, 256 QAM or 64 QAM?****Don’t think 256QAM is needed for FR2 repeater. 64 QAM need more analysis.****Issue 2-4-5: EVM requirements** **Ok with WF.****Issue 2-4-6: input intermodulation for FR2****FFS.****Issue 2-4-7: output intermodulation for FR2****Ok with WF.****Issue 2-4-8: requirements relating to frequencies that belonging to other operators but are within the passband****FFS, currently thinks may not needed.** |
| CommScope | **Issue 2-4-1: frequency stability for FR2**We are OK with the recommended WF**Issue 2-4-4: EVM aligned with which modulation scheme, 256 QAM or 64 QAM?**We are OK with the recommended WF**Issue 2-4-5: EVM requirements**In our opinion the BS EVM requirements shall be considered for repeaters (like it has been done for the LTE standard). For an OTA test setup, it must be ensured that the SNR of the received signal and the path loss after the coverage antenna do not negatively influence the EVM contribution of the repeater. **Issue 2-4-6: input intermodulation for FR2**We agree with **option 1**.**Issue 2-4-7: output intermodulation for FR2**We are OK with the recommended WF |

### 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

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic #2-1 FR1 radiated requirements or not?** |
| **Issue 2-1-1****whether to define radiated requirements for FR1?** | *This issue could be removed to email thread [310]* |

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic #2-2 power related radiated requirements** |
| **Issue 2-2-1****how to define output power requirement (TRP) for FR1** | ***Tentative agreements:****It is suggested to discuss FR1 radiated output power after the conclusion of whether to define radiated requirements for FR1.* |
| **Issue 2-2-2, 2-2-3 and 2-2-4 are merged** **DL power** | *5 companies suggest to include both rated beam EIRP level and rated carrier TRP output power, during ON period.**2 companies only support TRP requirements as repeater does not perform beamforming.**1 company prefer further study and if EIRP level could be reflected in other requirements, like repeater gain, it might be also okay.**All the 7 companies suggest to specify the maximum output power for FR2 repeater based on declaration without upper limit in DL.**All the 6 companies suggest that the TRP accuracy requirement for FR2 DL repeater should be the same as BS spec. and 1 company propose that it is not sure if more discussion is needed about the test because repeater can’t generate signal and there could be signal generator accuracy contribution.****Tentative agreements:**** *At least define TRP requirements for FR2 repeater. Further check whether define EIRP requirements*
* *output power for FR2 repeater is based on declaration without upper limit in DL*
* *TRP accuracy requirement for FR2 DL repeater should be the same as BS spec*
	+ *FFS on conformance test.*

***Recommendations for 2nd round:****Further discuss about whether to define EIRP requirements.**More discussion about the tentative agreement listed above. Hope they could be agreed after second round discussion.* |
| **Issue 2-2-5****UL output power (TRP)** | *3 companies suggest output power shall be based on declaration without upper limit for FR2. 1 company suggest to consider the gain budgets at first to see if higher UL power is needed.****Tentative agreements:****UL output power shall be based on declaration without upper limit for FR2****Recommendations for 2nd round:****More discussion about the tentative agreement listed above. Hope they could be agreed after second round discussion.* |
| **Issue 2-2-6 and 2-2-7 are merged****ALC requirements** | *1 further discussion as it is not clear whether it is needed for OTA**7 companies suggest to implicitly specify ALC/AGC requirements. AGC is only needed in context of limiting maximum output power and unwanted emissions with high-power input signal that leads to gain limits. 2 company suggest further study.****Tentative agreements:****Further study about whether to implicitly specify ALC/AGC requirements. AGC may be only needed in context of limiting maximum output power and unwanted emissions with high-power input signal that leads to gain limits.****Recommendations for 2nd round:****More discussion about the tentative agreement listed above. Hope they could be agreed after second round discussion.* |
| **Issue 2-2-8****Dynamic range** | *Nokia has explained the concept of “dynamic range” that dynamic range here refers to defining or declaring a class specific upper bound for output power and requiring the AGC to limit the increase of power above this value. From this point of view,* ***it’s suggested not to discuss this issue any more and focus on AGC/ALC requirements.*** |

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|  | **Status summary**  |
| **Sub-topic #2-3 emission related radiated requirements** |
| **Issue 2-3-1, 2-3-2 and 2-3-3 are merged** **relative ACLR, Absolute ACLR and OBUE** | *It seems all the companies support the WF****Tentative agreements:****ACLR or some equivalent requirements are required to match the same adjacent channel protection as NR/IAB spec. the equivalent requirements include modified operating band unwanted emission and absolute ACLR for FR2 repeater.****Recommendations for 2nd round:****Further discuss about the details of these requirements.**More discussion about the tentative agreement listed above. Hope they could be agreed after second round discussion.* |
| **Issue 2-3-4****Tx spurious emission** | *All the 5 companies suggest to agree the WF.****Tentative agreements:****At least for DL, the same spurious emissions requirements as BS could be reused for NR repeater including category A/B and protection of ESS.****Recommendations for 2nd round:****Further discuss about these requirements could still apply to UL.**More discussion about the tentative agreement listed above. Hope they could be agreed after second round discussion.* |
| **Issue 2-3-5****Rx spurious emission** | *It seems all the companies agree that Rx spurious emission is not necessary as Rx is on at same time as the Tx it’s not possible to separate Rx emissions from TX emissions.****Tentative agreements:****Rx spurious emission is not necessary for FR2 repeater.****Recommendations for 2nd round:****More discussion about the tentative agreement listed above. Hope they could be agreed after second round discussion.* |

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|  | **Status summary**  |
| **Sub-topic #2-4 other radiated requirements** |
| **Issue 2-4-1****Frequency stability** | *All 10 companies support the WF****Tentative agreements:****The frequency deviation of the output signal with respect to the input signal shall be no more than [±0,01] PPM for FR2.****Recommendations for 2nd round:****More discussion about the tentative agreement listed above. Hope they could be agreed after second round discussion.* |
| **Issue 2-4-2****out of passband gain** | *Further study is suggested since most companies doesn’t present their comments.* *Maybe start the discussion from deployment scenarios and expected repeater gain etc.**FFS on whether only reasonable analysis is sufficient or extra simulation is also required.* |
| **Issue 2-4-3, 2-4-4 and 2-4-5 are merged****EVM** | *The discussion seems the same as FR1 in issue 1-3-2, 1-3-3, 1-3-4.****Tentative agreements:**** *FFS on whether define EVM limits or based on manufacture’s declaration.*
	+ *FFS on which modulation up to 256QAM is feasible*
	+ *FFS to differentiate different modulation scheme for DL and UL respectively*
	+ *FFS on only one EVM level or more than one EVM. If multiple EVM level are agreed, the modulation scheme is based on declaration or not?*
	+ *FFS on whether to define more stringent requirements than current spec or not*

***Recommendations for 2nd round:****Further discuss about above open issues.* |
| **Issue 2-4-6****Input IMD** | *It seems most companies needs further study about input IMD requirements.****Recommendations for 2nd round:**** *FFS on input IMD*
	+ *Further check whether this requirement could be based on FR2 BS receiver intermodulation*
	+ *further check whether this is potential issue for FR2*
 |
| **Issue 2-4-7****Output IMD** | *It seems most companies needs further study about output IMD requirements.****Recommendations for 2nd round:**** *FFS on output IMD*
	+ *further check whether this is potential issue for FR2*
 |
| **Issue 2-4-8****Requirements in the passband** | *This issue is related to the discussion on ACRR and configurable passband in email thread [310]. It is suggested to focus this discussion in [310].****Recommendations for 2nd round:****Further study is suggested on whether/ how to avoid interference to other operators deployed with the adjacent channel within the passband.* |

### 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)

*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 … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-2107106 | Discussion on RF parameters to be specified | Huawei |  |  |
| R4-2104612 | Discussion on transmitter power related conducted requirements | CMCC |  |  |
| R4-2104671 | Conducted TX power requirements for repeaters | Ericsson |  |  |
| R4-2104795 | Discussion on NR repeater conducted output power | CATT |  |  |
| R4-2104988 | Discussion on NR repeater FR1 maximum output power and ALC/AGC | NEC |  |  |
| R4-2106327 | Conducted power related requirements consideration for NR-Repeaters | Nokia, Nokia Shanghai Bell |  |  |
| R4-2106350 | Views on transmitted power related requirements for FR1 NR repeater | NTT DOCOMO, INC. |  |  |
| R4-2104617 | Discussion on emission related conducted requirements | CMCC |  |  |
| R4-2104669 | Conducted unwanted emissions requirements for repeaters | Ericsson |  |  |
| R4-2104796 | Discussion on NR repeater conducted emission requirement | CATT |  |  |
| R4-2106328 | Conductive emission requirement consideration for NR-Repeaters | Nokia, Nokia Shanghai Bell |  |  |
| R4-2106351 | Views on emission requirements for FR1 NR repeater | NTT DOCOMO, INC. |  |  |
| R4-2104615 | Discussion on signal quality related requirements for NR repeater | CMCC |  | *Moved from agenda 8.11.1.4* |
| R4-2104670 | NR repeaters conducted other requirements | Ericsson |  |  |
| R4-2104797 | Discussion on NR repeater conducted other requirements | CATT |  |  |
| R4-2106329 | Repeater timing | Nokia, Nokia Shanghai Bell |  |  |
| R4-2104613 | Discussion on transmitter power related FR2 radiated requirements | CMCC |  |  |
| R4-2104674 | Radiated TX power for repeaters | Ericsson |  |  |
| R4-2104798 | Discussion on power requirement for FR2 NR repeater | CATT |  |  |
| R4-2106330 | Radiated power related requirements consideration for NR-Repeaters | Nokia, Nokia Shanghai Bell |  |  |
| R4-2106352 | Views on transmitted power related requirements for FR2 NR repeater | NTT DOCOMO, INC. |  |  |
| R4-2104618 | Discussion on transmitter emission related radiated requirements | CMCC |  |  |
| R4-2104672 | Radiated emissions requirements | Ericsson |  |  |
| R4-2104799 | Discussion on emission requirements for FR2 NR repeater | CATT |  |  |
| R4-2106331 | Radiated emission requirement consideration for NR-Repeaters | Nokia, Nokia Shanghai Bell |  |  |
| R4-2106353 | Views on emission requirements for FR2 NR repeater | NTT DOCOMO, INC. |  |  |
| R4-2104675 | Other radiated repeater requirements | Ericsson |  |  |
| R4-2104800 | Discussion on other requirements for FR2 NR repeater | CATT |  |  |
| R4-2106332 | Frequency error considerations for FR2 NR-Repeaters | Nokia, Nokia Shanghai Bell |  |  |

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