**3GPP RAN WG4 Meeting #112 R4-2413408**

Maastricht, Netherlands, 19th – 23rd August, 2024

**Agenda item:** 8.19.4

**Source:** Moderator (Huawei)

**Title:** Topic summary for [112][308] NR\_duplex\_evo\_BSRF

**Document for:** Information

# Introduction

This document is provided for the moderator summary on NR\_duplex\_evo\_BSRF for Rel-19 work item on evolution of NR duplex operation (SBFD), in which the following agenda items are supposed to be covered specifically:

8.19.2.2 Modification of existing Tx requirements for FR1 and FR2-1 [NR\_duplex\_evo-Core]

8.19.2.3 Modification of existing Rx requirements for FR1 and FR2-1 [NR\_duplex\_evo-Core]

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

# Topic #1: Modification of existing requirements - TX

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

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2411080**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411080.zip) | CATT | Proposal 1: No new co-location ACLR requirement is defined in SBFD WI. Observation: For WA BS, if victim BS DESENS is 1dB and CL for co-location BS is 30 dB, RF BPF rejection performance should be larger than 69dB which is a stringent requirement for some RF filters. Proposal 2: The assumption for the victim BS DESENS and CL of co-location BS should be decided to further discuss the new OBUE (or the 2nd ACLR) requirement. |
| [**R4-2411514**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411514.zip) | Qualcomm Germany | Observation 1: Adopting legacy gNB ACLR requirement for the SBFD-capabe gNB is sufficient to ensure feasible coexistence with adjacent channel deployed legacy TDD systems.  Observation 2: When coexisting with SBFD-capable gNB, legacy ACLR requirement might not be sufficient to ensure feasible coexistence. Additionally, RAN4 has only considered ACIR enhancement as a possible solution during the SI phase.  Proposal 1: RAN4 to consider additional ACLR requirement to ensure feasible coexistence with SBFD-capable gNB. As a starting point, urban macro deployments should be considered as that represent the challenging scenario.  Proposal 2: For OBUE, RAN4 to consider similar approach as ACLR (i.e., two different requirements to address coexistence with legacy TDD and SBFD-capable gNBs. |
| [**R4-2411638**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411638.zip) | Samsung | Proposal 1: For conducted output power and radiated transmit power (radiated transmit power and OTA base station output power), the following new sub-clauses with suffix-B shall be adopted to capture the corresponding declaration for SBFD symbol:  - New clause 6.2B, titled as “Base station output power for SBFD” - New clause 9.2B, titled as “Radiated transmit power for SBFD” - New clause 9.3B, titled as “OTA base station output power for SBFD”  Proposal 2: For SBFD-capable BS, RAN4 will not specify the output power limits for different BS classes for non-SBFD symbols.  Proposal 3: To determine one SBFD-capable BS’s class, the existing requirements for output power limits for BS classes shall be used for non-SBFD symbols, no matter what is the power level declared for SBFD symbols.  Proposal 4: RAN4 shall specify the new sub-clauses 6.3.3B (Total power dynamic range for SBFD) and 9.4.3B (OTA total power dynamic range for SBFD) by defining the output power dynamic range requirement for SBFD as the ratio of the declared rated output power with all DL RBs active for SBFD (maximum) and the same single RB power as non-SBFD (minimum). Proposal 5: To implementation the conclusion of “transmit ON/OFF power requirement is not applicable within SBFD time slot”, RAN4 can add Notes in both clause 6.4.1.1 and 9.5.2.1 to avoid OFF power requirement to be applied for SBFD symbols.  Proposal 6: If coexisting with legacy TDD system in adjacent channel, RAN4 shall apply the existing ACLR requirement for SBFD-capable BS in SBFD symbols, and confirm this requirement can already guarantee adjacent-channel co-existence for Rel-19 SBFD operation.  Proposal 7: If coexisting with new SBFD system in adjacent channel, RAN4 shall further study the ACLR requirement for SBFD-capable BS in SBFD symbols.  Proposal 8: For transmitter intermodulation requirement, RAN4 can specify a new sub-clause 6.7B (Transmitter intermodulation for SBFD) and a new sub-clause 9.8B (OTA transmitter intermodulation for SBFD), by simply explain that the existing requirement shall be applied while no receiver requirement is specified for SBFD symbols.  Moderator note: the proposals related to the specification implementation can be discussed in general part firstly. |
| [**R4-2411737**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411737.zip) | CMCC | Proposal 1: it’s suggested to define WA, MR, LA gNB requirement for SBFD with same priority. Proposal 2: If co-location ACLR is defined, then it is necessary to ensure that the receiver of the BS is not blocked, otherwise the note in the spec that the ACLR requirement is not applied to the co-location scenario is needed |
| [**R4-2412723**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412723.zip) | ZTE Corporation, Sanechips | Proposal 1: propose to follow the legacy ACLR requirement for SBFD capable BS without defining any more tightening requirement for SBFD BS.  Proposal 2: propose to follow the legacy OBUE requirement for SBFD capable BS without defining any more tightening requirement for SBFD BS to address the CLI concern in the adjacent channel. |
| [**R4-2412915**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412915.zip) | Ericsson | Observation 1 Reuse the existing RE power control dynamic range requirement for SBFD BS. Observation 2 The total dynamic range requirement is applicable for SBFD-capable BS during normal DL symbols/slots. Observation 3 Define the output power dynamic range requirement for SBFD as the ratio of the declared rated output power with all DL sub-band RBs active for SBFD (maximum) and the same single RB power as non-SBFD (minimum). Observation 4 Transmitter ON/OFF power doesn’t apply to SBFD slot. Observation 5 Reuse the existing requirements for frequency error, EVM and TAE for BS in SBFD symbols/slots. Observation 6 Measurement of average EVM for BS in normal DL symbols/slots and SBFD DL symbols/slots needs FFS.  Based on the discussion in the previous sections we propose the following: Proposal 1 Formulate the total power dynamic range requirement for SBFD slots using equation based on declaration (of rated output power with all DL sub-band RBs active for SBFD), instead of table used for existing total power dynamic range requirement. Proposal 2 Transmitter ON/OFF power should apply to normal slot. Proposal 3 Averaged EVMs for SBFD slots and non-SBFD slots shall be measured separately. Proposal 4 Averaged EVM for SBFD slots shall be calculated only based on the data samples where DLs are allocated within the SBFD slots. The data samples where ULs are allocated within the SBFD slots shall be removed from the calculation of averaged EVM. Proposal 5 RAN4 do not impose tougher ACLR and OBUE requirements beyond the existing ones. |
| [**R4-2413236**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413236.zip) | Nokia | Observation 1: New complex test model would be needed to support joint measurement of transmitter signal quality for normal DL symbols/slots and SBFD DL symbols/slots. |
| [**R4-2413283**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413283.zip) | Huawei, HiSilicon | Proposal 1: it is proposed to specify additional OBUE requirement for SBFD capable BS in order to ensure co-existence performance for SBFD BSs operating in adjacent frequency. Observation 1: 60~ 65 dB MCL can cover most of deployments scenarios for FR1 high frequency band Observation 2: available guard band for different operators’ spectrum cases are different. The Ratio of transition guard/sub frequency band is higher than that of ΔfOBUE, which means it would not impose additional implementation difficulty for taking the advantage of per operator filter. Proposal 2: the additional OBUE requirement should be defined at different frequency offsets from the sub frequency band edge. |

*The moderator can suggest a limited number of papers which could be presented.*

## Open issues summary

*Before f2f meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1: BS output power

#### Issue 1-1-1: Output power limits for BS classes

* [Moderator]: On BS output power the following agreements are achieved in study item,

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| Since configuration (e.g. antenna, power configuration etc) between SBFD and non-SBFD symbols/slots might be different, RAN4 reached the following consensus for the BS RF requirement of BS output power for both conducted and OTA output power:  - It is allowed to have the different conducted declaration for normal DL symbols/slots and SBFD DL symbols/slots.  - It is allowed to have different EIRP/TRP declaration (for level and direction) for normal DL symbols/slots and SBFD DL symbols/slots.  - Accuracy requirement for TRP/EIRP and conducted power shall be the same for normal DL symbols/slots and SBFD DL symbols/slots. |

And the following agreement is achieved in RAN4#111:

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| **Issue 2-1-1: PSD scaling for normal and SBFD slots/symbols**   * Agreement:   + PSD scaling for normal and SBFD slots/symbols:     - No need to introduce the restriction on PSD scaling for normal and SBFD slots/symbols     - Vendors can declare different TX power values for normal and SBFD slots/symbols |

* Proposals:
  + Option 1 (Samsung): the existing output power limits for BS classes are only specified for non-SBFD symbols.
    - Proposal 1 (Samsung): For SBFD-capable BS, RAN4 will not specify the output power limits for different BS classes for non-SBFD symbols.
    - Proposal 2 (Samsung): To determine one SBFD-capable BS’s class, the existing requirements for output power limits for BS classes shall be used for non-SBFD symbols, no matter what is the power level declared for SBFD symbols.
  + Option 2: the existing output power limits for BS classes are specified for both non-SBFD symbols and SBFD symbols
* Moderator Recommendation:
  + Discussion on the options.
* Ad-Hoc discussion:
  + Samsung: In SBFD symbol, only half of the antenna will be used for SBFD. The power will be defined on the normal symbol instead of all.
  + ZTE: For SBFD, we want to make sure only single declaration can be conducted.
  + Samsung: Confirm ZTE question. But we wonder on which symbol the BS type/power can be the basic for declaration.
  + Huawei: We also think one declaration is enough. The current output power limit definition is only for upper limit, which has no ambiguity regarding Samsung concern. The current declaration applies to all symbols.
  + Nokia: One declaration for non-SBFD symbol is enough, but power degradation on SBFD symbol is also needed.

Common understanding (with this no agreement was needed during Adhoc): One BS class declaration is given for one BS implementation for SBFD capable gNB.

### Sub-topic 1-2: Output power dynamics

#### Issue 1-2-1: Total dynamic range

* [Moderator]: On output power dynamics the following agreements are achieved in study item,

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| Regarding the output power dynamic requirement, which mainly consists of RE power control dynamic range requirement and total dynamic range requirement, RAN4 reached the following consensus:  - To reuse the existing RE power control dynamic range requirement for SBFD BS;  - The total dynamic range requirement is applicable for SBFD-capable BS during normal DL symbols/slots, it is agreed to define the output power dynamic range requirement for SBFD as the ratio of the declared rated output power with all DL RBs active for SBFD (maximum) and the same single RB power as non-SBFD (minimum). |

* Proposals:
  + Proposal (Ericsson): Formulate the total power dynamic range requirement for SBFD slots using equation based on declaration (of rated output power with all DL sub-band RBs active for SBFD), instead of table used for existing total power dynamic range requirement.
* Moderator Recommendation:
  + The proposal is line with SI agreement. Discussion whether or not the proposal can be agreed.
* Ad-hoc agreement:
  + Formulate the total power dynamic range requirement for SBFD slots using equation based on declaration (of rated output power with all DL sub-band RBs active for SBFD), instead of table used for existing total power dynamic range requirement

### Sub-topic 1-3: Transmit ON/OFF power

#### Issue 1-3-1: Transmit ON/OFF power

* [Moderator]: On Transmit ON/OFF power the following agreements are achieved in study item,

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| Regarding the transmitter ON/OFF power requirement, RAN4 mainly focus on the ON-OFF time mask and concluded that transmit ON/OFF power requirement is not applicable within SBFD time slot. |

* Proposals:
  + Proposal (Ericsson): Transmitter ON/OFF power should apply to normal slot
* Moderator Recommendation:
  + The proposal is line with SI agreement, however, it does not include the agreements for SBFD time slot. Discussion whether or not the following proposal can be agreed.
    - Transmitter ON/OFF power should apply to normal slot and it is not applicable within SBFD time slot.
* Ad-Hoc discussion:
  + Samsung: In the RAN1 discussion, they use symbol rather than slot.
  + Ericsson: If we change to symbol, how about conformance test?
* Ad-Hoc agreement:
  + Transmitter ON/OFF power should apply to normal symbol and it is not applicable within SBFD symbol.

### Sub-topic 1-4: Unwanted emissions

#### Issue 1-4-1: ACLR and OBUE

* [Moderator] The following agreement is achieved in RAN4#111:

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| Issue 2-3-1: The necessity of Co-location ACLR requirement   * Agreement:   + RAN4 further study the ACLR requirement by applying the existing ACLR requirement for SBFD-capable BS in SBFD symbols/slots     - FFS the applicable deployment scenario where different ACLR requirement could be useful, whether it justify the different ACLR requirement.   Issue 2-3-2: OBUE   * Agreement:   + Further discuss how to define OBUE requirement for SBFD capable BS in order to ensure feasible co-existence performance for SBFD BSs operating in adjacent frequency. |

* Proposals:
  + Proposal 1 (CMCC): If co-location ACLR is defined, then it is necessary to ensure that the receiver of the BS is not blocked, otherwise the note in the spec that the ACLR requirement is not applied to the co-location scenario is needed.
  + Proposal 2 (Samsung/Qualcomm): separate the discussion by considering coexisting with legacy TDD or new SBFD system in the adjacent channel:
    - When coexisting with legacy TDD system in adjacent channel, RAN4 shall apply the existing ACLR requirement for SBFD-capable BS.
    - When coexisting with new SBFD system in adjacent channel, RAN4 to consider additional ACLR and/or OBUE requirement to ensure feasible coexistence with SBFD-capable gNB. As a starting point, urban macro deployments should be considered as that represent the challenging scenario.
  + Proposal 3 (ZTE/Ericsson): follow the legacy ACLR requirement for SBFD capable BS without defining any tougher requirement.
  + Proposal 4 (CATT): No new co-location ACLR requirement is defined in SBFD WI.
  + Proposal 5 (CATT): The assumption for the victim BS DESENS and CL of co-location BS should be decided to further discuss the new OBUE (or the 2nd ACLR) requirement.
  + Proposal 6 (Huawei): to specify additional OBUE requirement for SBFD capable BS in order to ensure co-existence performance for SBFD BSs operating in adjacent frequency.
  + Proposal 7 (Huawei): the additional OBUE requirement should be defined at different frequency offsets from the sub frequency band edge.
* Moderator Recommendation:
  + RAN4 may firstly try to confirm the following bullets is agreeable:
    - When coexisting with legacy TDD system in adjacent channel, RAN4 shall apply the legacy ACLR and OBUE requirement for SBFD-capable BS.
    - For FR1 macro deployments, when coexisting with new SBFD system in adjacent channel, RAN4 to define additional ACLR and/or OBUE requirement to ensure feasible coexistence with SBFD-capable gNB. The assumption for the victim BS DESENS and CL of BS2BS is FFS.
* Ad-Hoc discussion:
  + Huawei: Qualcomm and Samsung proposed co-ex between SBFD capable BSs, We think this is a good starting point.
  + ZTE: The first bullet would be fine. The second one we observe a lot degradation in our simulation. This is also related to in-band blocking issue.
  + Nokia: We don’t see the necessity of defining new requirements. Customer related requirements can be considered when specific deployment happened.
  + CATT: If we discuss this for all of the band this must be difficult. Can we narrow down the discussion scope e.g. which band(s)?
  + CMCC: We can agree with the first bullet. If we want to define ACLR/OBUE, we should make sure that requirement should be reasonable. Legacy requirement can be reused for the co-located case.
  + Samsung: Not sure if it should be limited to only co-located case. Maybe we can pick band n104 firstly for the second sub-bullet. Per-operator filter can be reflected in this way.
  + Ericsson: Such co-ex case has not been studied during SI phase. We would suggest to think more on the working procedure. Pending on BS evo SI can be considered.
  + Huawei: This is also related to co-ex study, which has been covered in the SI. From our perspective, we think for Macro case, such co-ex we proposed is more common in the field. For CATT comment, we think start the discussion with certain band is a good suggestion.
  + QC: For the second bullet, it may need to be considered in future. We need more time to check the feasibility conclusion from proponent.
* Ad-Hoc agreement:
  + When coexisting with legacy TDD system in adjacent channel, RAN4 shall apply the legacy ACLR and OBUE requirement for SBFD-capable BS.

### Sub-topic 1-5: Transmitter signal quality

#### Issue 1-5-1: Joint measurement for normal DL symbols/slots and SBFD symbols/slots

* [Moderator] The following is agreed in SI which ask for more study on joint measurement for normal DL symbols/slots and SBFD symbols/slots:

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| 10.1.2.4 Transmitted signal quality Regarding the transmitter signal quality, RAN4 agreed that all the existing requirement for frequency error, modulation quality (EVM) and time alignment error (TAE) shall also be applied to BS in SBFD symbols/slots.  - Further discuss the joint measurement for normal DL symbols/slots and SBFD DL symbols/slots during WI phase. |

* Observation/Proposal on joint measurement for normal DL symbols/slots and SBFD DL symbols/slots:
  + Observation 1 (Nokia): New complex test model would be needed to support joint measurement of transmitter signal quality for normal DL symbols/slots and SBFD DL symbols/slots.
  + Proposal 1 (Ericsson): Averaged EVMs for SBFD slots and non-SBFD slots shall be measured separately.
  + Proposal 2 (Ericsson): Averaged EVM for SBFD slots shall be calculated only based on the data samples where DLs are allocated within the SBFD slots. The data samples where ULs are allocated within the SBFD slots shall be removed from the calculation of averaged EVM.
* Moderator Recommendation:
  + Discussion whether or not P1 and P2 can be agreed.

# Topic #2: Modification of existing requirements - RX

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

## Companies’ contributions summary

Skipped since all Tdocs are summarized in Topic#2 already.

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2411081**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411081.zip) | CATT | Proposal 1: 1.0 dB degradation is agreed for OTA sensitivity requirement. Proposal 2: FR1 dynamic range can reuse the existing requirements. Proposal 3: FR2 dynamic range can reuse the existing requirements. Proposal 4: The OTA sensitivity degradation should be taken into account for the baseline REFSENS for ACS requirement. Observation1: The simulation shows that the interference from TDD DL to SBFD UL subband for FR1 and FR2-1 are less than the interference signal level in existing in-band blocking requirements. Proposal 5: For FR1 and FR2-1, existing in-band blocking can be reused. |
| [**R4-2411083**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411083.zip) | CATT | simulation results |
| [**R4-2411515**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411515.zip) | Qualcomm Germany | Proposal 1: RAN4 to discuss allowable degradation due to self-interference, inter-site interference, and inter-sector interference when defining the OTA reference sensitivity.  Proposal 2: RAN4 to discuss if the IoT level and wanted signal power level will be derived based on simulation work.  Proposal 3: To derive the in-band requirement for that particular case, it is recommended to consider the 99% percentile point of the received power for SBFD UL as a victim case for each scenario and then get the average point. |
| [**R4-2411639**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411639.zip) | Samsung | Proposal 1: For the assumption for the interference considered in the OTA sensitivity degradation, only self-interference shall be considered.  Proposal 2: In the existing dynamic range requirement, RAN4 assume 20dB interference over thermal noise, which is enough to cover the co-channel interference from other base stations, by considering gNB-to-gNB CLI handling mechanism to be introduced in RAN1.  Observation 1: For conducted ACS requirement, RAN4 already agreed to “take the existing wanted signal of ACS requirement by using the existing reference sensitivity level”, which shall not be revisited.  Observation 2: Based on the distributions of received power levels plotted for Scenario 1, 3, 5, 6, and 9, the adjacent channel gNB DL power level could be the major factor contributing to the total co-channel received power.  Observation 3: The percentage value of grid shifting plays an important role to determine the distributions of adjacent-channel and co-channel gNB DL received power, by translating the distance between interfering gNB and victim gNB into pathloss.  Proposal 3: RAN4 shall align the co-existence simulation results by comparing the distributions of adjacent-channel and co-channel gNB DL received powers, by comparing the simulation assumptions and other details firstly.  Proposal 4: If RAN4 want to introduce the additional RX intermodulation requirement (a single input signal placed to cause IM with the RX sub-band), the new intermodulation scenario shall be confirmed firstly with evidence showing the proposed scenario exists in practice. |
| [**R4-2411723**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411723.zip) | CableLabs, Charter Communications | Proposal 1: the new BS receiver in-band blocking study should be captured in a technical report. We prefer Option 3. Option 1: merge into clause 11 in TR 38.858. Option 2: capture it in a new Rel-19 TR. Option 3: capture it in a new Rel-19 TR, briefly summarize the conclusions in TR 38.858 and cite the Rel-19 TR. Proposal 2: The in-band blocking study should extend to case 2 because both case 2 and case 3 have strong gNB-to-gNB ACI. The results should be captured in clause 11 in TR 38.858. Proposal 3: It is unreasonable to only consider ACI for in-band blocking. Some level of co-channel interference should also be considered. How to consider co-channel interference is FFS. Propose 4: the X% tile of the UL SBFD wideband received power CDF to define the blocking requirement should be X=99. Observation 1: The CDF of the receiver blocking power for scenario 1 (FR1 UMa-to-UMa) case 3 (TDD DL to SBFD UL subband) is provided in Figure 1. 33% of the blocking power is larger than the P2=-25 dBm in the baseline NF model, and 100% of the blocking power is larger than the P2=-15 dBm in the enhanced NF model. Observation 2: The CDF of the receiver blocking power for scenario 5 (FR1 UMi-to-UMi) case 3 (TDD DL to SBFD UL subband) is provided in Figure 2. 35% of the blocking power is larger than the P2=-20 dBm in the NF model. Observation 3: The CDF of the receiver blocking power for scenario 6 (FR2-1 UMa-to-UMa) case 3 (TDD DL to SBFD UL subband) is provided in Figure 3. 99% of the blocking power is larger than the P2=-40 dBm in the NF model. |
| [**R4-2411735**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411735.zip) | CMCC | Proposal 1: If co-location ACS is not defined, the note in the spec that the ACS requirement is not applied to the co-location scenario is needed. Proposal 2: Only collect power level of interference from adjacent channel to derive in-band blocking levels. Proposal 3: the reference point for the power level should be before RX beamforming Proposal 4: 100% grid-shift should be considered |
| [**R4-2412724**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412724.zip) | ZTE Corporation, Sanechips | Proposal 4: agree with 1.0dB degradation for SBFD BS REFSENS requirements; Proposal 5: for receiver dynamic requirement, both uplink signals and BS2BS2 CLI signal should be considered for IoT levels. Proposal 6: for the receiver intermodulation requirements, BS2BS CLI should be taken into account for power level for interference signal. Proposal 7: for receiver intermodulation requirements, consider IMD between CW/NBB/general intermodulation interfering signal intermodulate with SBFD DL transmission with some performance degradation on SBFD receiver as shown in Figure 2.1.3-1. Observation 1: for Scenario 1 FR1 Urban macro scenario, the received power level are much higher than the existing IBB requirement -43dBm which would be quite challenging for SBFD BS to handle the receiver dynamic range together with the REFSENS requirements.  Observation 2: for Scenario 3 FR1 indoor scenario, the received power is still close to the existing requirement and therefore it should be okay to reuse the existing requirements without any feasibility issue or additional blocking issues.  Observation 3: for Scenario 6 FR2 urban macro scenario and Scenario 9 FR2 indoor scenario, the received power is close to the existing requirement and therefore it should be okay to reuse the existing requirements without any feasibility issue or additional blocking issues. |
| [**R4-2412916**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412916.zip) | Ericsson | Observation 1 The higher the TRP of the aggressor network BSs, the higher the needed in-band blocking requirement for the SBFD network. Observation 2 The lower the grid-shift between the two network requirements, the higher the needed in-band blocking requirement for the SBFD network. Observation 3 For urban macro deployments, stricter in-band blocking requirements would be needed for a SBFD network to face the wideband interference received from the DL of adjacent channel deployments. Observation 4 In UMi deployments, with mid-power BSs, the need for more stringent in-band blocking requirements is deployment dependent. Coordinated deployments may not need an update in requirements, but uncoordinated deployments may need it.  Observation 5 In InH deployments, with low-power BSs, the power level of the BSs (24 dBm) is comparable to the maximum power level of the Ues (23 dBm), so that the fact that the BSs are blockers for an SBFD deployment, does not introduce a need for more stringent requrements for this BS class. Observation 6 InH deployments are easier to coordinate, so that certain distance between BSs of different networks can be assumed, and this also facilitates that there is no need for more stringent requirements. Observation 7 For SBFD-capable BS type 1-H, the existing requirement for conducted reference sensitivity level shall also be applied to BS in SBFD symbols, i.e., no sensitivity degradation is allowed. Observation 8 For SBFD-capable BS OTA sensitivity requirement, [0.5~1.0] dB degradation value needs FFS. Observation 9 OTA sensitivity should be defined considering in real life the receiver is further desensitized by other sources of interference including inter-site interference and inter-sector interference. Observation 10 RAN4 requirements should be conservative enough that the SBFD BS can be expected to perform well in real deployments considering inter-site interference and inter-sector interference. Observation 11 Due to the receiver performance is limited by receiver non-linearity, the sensitivity degradation is much greater than just the sum of the sensitivity degradation from each source alone. Observation 12 RX dynamic range requirement is applicable for SBFD-capable BS. IoT level and wanted signal power level need further discussion in the WI phase. Observation 13 For SBFD, the RX blocking requirement is based on signal levels from the DL of other operators BS. Observation 14 The BS co-location requirements can be applied as they are, with a declaration whether the SBFD BS meets the co-location requirements. Observation 15 The OOB blocking requirement is the same in SBFD slots as for normal TDD. Observation 16 The receiver spurious emissions requirement is the same for both SBFD and non-SBFD slots. Observation 17 The receiver spurious emission is only measurable with conducted testing and OTA testing with transmitter deactivated in SBFD slots. Observation 18 Receiver in-channel selectivity requirement is focused on UL sub-band, and the wanted signal and interfering signal levels is FFS in the WI phase.  Based on the discussion in the previous sections we propose the following: Proposal 1 Define in-band blocking interferer signal power to 5 dBm for Wide Area BSs in SBFD networks. Proposal 2 Define in-band blocking interferer signal power to -1.5 dBm for Medium Range BSs in SBFD networks. Proposal 3 Re-use the existing in-band blocking requirement for Local Area BSs in SBFD networks. Proposal 4 Investigate whether an additional requirement based on a single input signal placed to cause IM with the RX sub-band provides any additional robustness, and whether such a requirement is anyhow implicitly captured by the SBFD RX blocking requirement. |
| [**R4-2413235**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413235.zip) | Nokia | Observation 1: The interference components for the in-band blocking calculation do not account for the ACLR and ACS effects. Observation 2: Current BS RF in-band blocking requirements only consider adjacent channel interference.  Observation 3: Whether or not to include the SBFD co-channel interference as part of the in-band blocking derivation depend on whether current definition of the RAN4 in-band blocking requirement is updated or not. Observation 4: For FR1 wide area SBFD BS, the in-band blocking power at the 99th percentile is 1.8 dBm, which is approximately 40 dB higher than the current in-band blocking requirement. Observation 5: For FR1 medium range SBFD BS, the in-band blocking power at the 99th percentile is -7.3 dBm, which is approximately 30 dB higher than the current in-band blocking requirement. Observation 6: For FR1 local area SBFD BS, the in-band blocking power at the 99th percentile is -39.2 dBm, which is on the same order of magnitude than the existing local area FR1 BS. Observation 7: For FR2-1 wide area SBFD BS, the in-band blocking power at the 99th percentile is -38.1 dBm, which is approximately 25 dB higher than the current in-band blocking requirement. Observation 8: For FR2-1 local area SBFD BS, the in-band blocking power at the 99th percentile is -57.8 dBm, which is on the same order of magnitude than the current in-band blocking requirement. Proposal 1: RAN4 should include a clear statement on how the in-band blocking requirements for SBFD BS are derived in order to avoid possible misunderstandings. Proposal 2: Consider only the adjacent channel interference power to determine the in-band blocking power. Proposal 3: To reduce the scope of the simulations, 10% grid-shift is the only considered grid-shift value. Proposal 4: To reduce the scope of the simulations, consider only SBFD antenna configurations and TDD BS transmit power defined as baseline or 1st priority according to TR 38.858 Annex E. Proposal 5: Use the 99th percentile of the in-band blocking power CDF (X = 99) to derive the BS RF requirements. Proposal 6: Re-use the excel spreadsheet from simulator calibration during the study item to collect the in-band blocking power results from different companies. Proposal 7: RAN4 should not consider any effect of the CLI handling mechanisms for the calculation of the in-band blocking power levels. Proposal 8: Use maximum of 0.5dB for desensitization target value for the OTA sensitivity requirement due to self-interference. |
| [**R4-2413284**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413284.zip) | Huawei, HiSilicon | Proposal 1: for OTA reference sensitivity, it is proposed to add 1 dB addition to reference sensitivity due to self-interference. Proposal 2: 20 dB IoT level assumption is reused for dynamic range requirement. Proposal 3: -10~ -15 dBm is considered as the in-band blocking level. |

*The moderator can suggest a limited number of papers which could be presented.*

## Open issues summary

*Before f2f meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1: OTA sensitivity

#### Issue 2-1-1: OTA sensitivity degradation

* [Moderator]: On Reference sensitivity requirements the following agreements are achieved in study item,

|  |
| --- |
| Regarding Reference sensitivity requirement for SBFD-capable BS, due to the self interference caused internally to receiver side, RAN4 reached the following consensus:  - For BS type 1-H if supported: The existing requirement for conducted reference sensitivity level shall also be applied to BS in SBFD symbols, i.e, no sensitivity degradation is allowed.  - Otherwise, OTA sensitivity requirement could be derived based on the following equation:  *-G*  - The candidate value [0.5~1.0]dB degradation and final value will be specified in the WI phase.  - The following aspects need more discussion during a WI phase  - The declaration of maximum TRP for the requirement of OTA sensitivity within SBFD time slot  - If OTA sensitivity should be defined considering all of the scenarios including self-interference, inter-site interference and inter-sector interference. |

* Assumption for the interference considered in the OTA sensitivity degradation:
  + Alt. 1(Qualcomm): RAN4 to discuss allowable degradation due to self-interference, inter-site interference, and inter-sector interference.
  + Alt. 2(Samsung/ZTE/Huawei): Only self-interference considered
  + Alt. 3: Others
* Options:
  + Option 1: the degradation value is BS declaration based.
  + Option 2: a fixed value for degradation provided in the specification.
    - Option 2a (CATT/ZTE/Huawei): 1.0dB degradation
    - Option 2b (Ericsson): [0.5~1.0] dB degradation
    - Option 2c (Nokia): Use maximum of 0.5dB for desensitization target value for the OTA sensitivity requirement due to self-interference.
* Moderator Recommendation:
  + Discussion on the Options/Alts firstly.

### Sub-topic 2-2: Dynamic range

#### Issue 2-2-1: Dynamic range requirement

* [Moderator]: On Dynamic range requirement the following agreements are achieved in study item,

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| --- |
| Regarding the dynamic range requirement, this requirement is still applicable for SBFD-capable BS. The IoT level and wanted signal power level could be further discussed in the WI phase. |

* Proposals:
  + Proposal 1 (Qualcomm): RAN4 to discuss if the IoT level and wanted signal power level will be derived based on simulation work.
  + Proposal 2 (Samsung/Huawei/CATT): The existing dynamic range requirement, RAN4 assume 20dB interference over thermal noise, which is enough to cover the co-channel interference from other base stations.
  + Proposal 3 (ZTE): for receiver dynamic requirement, both uplink signals and BS2BS CLI signal should be considered for IoT levels.
* Moderator Recommendation:
  + Discussion on the proposals.

### Sub-topic 2-3: ACS

#### Issue 2-3-1: ACS requirement

* [Moderator] The following is agreed in SI:

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| --- |
| - ACS requirement and the interference level shall be determined by RAN4 co-existence study, and for the definition of ACS requirement:  - Conducted ACS: Take the existing wanted signal of ACS requirement by using the existing reference sensitivity level.  - OTA ACS: The OTA sensitivity degradation shall be taken into account to determine the level of wanted signal and interference signal mean power. |

* Proposals:
  + Proposal 1 (CMCC): If co-location ACS is not defined, the note in the spec that the ACS requirement is not applied to the co-location scenario is needed.
  + Proposal 2 (CATT): The OTA sensitivity degradation should be taken into account for the baseline REFSENS for ACS requirement.
* Moderator Recommendation:
  + Discussion on the proposals

### Sub-topic 2-4: In-band blocking

#### Issue 2-4-1: in-band blocking

* [Moderator] The following is agreed in SI:

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| --- |
| - In-band blocking requirement and the interference level shall be determined by RAN4 co-existence study, and for the definition of In-band blocking requirement:  - Conducted In-band blocking: Take the existing wanted signal of In-band blocking requirement by using the existing reference sensitivity level.  - OTA In-band blocking: The OTA sensitivity degradation shall be taken into account to determine the level of wanted signal and interference signal mean power.  - For in-band selectivity and blocking, the requirements shall be defined out of the BS channel bandwidth instead of uplink subband bandwidth. |

And per way forward in RAN4#111, companies are encouraged to provide the evaluation results for in-band blocking in this meeting.

* Observations/Proposals:
  + CATT (R4-2411081)
    - The simulation shows that the interference from TDD DL to SBFD UL subband for FR1 and FR2-1 are less than the interference signal level in existing in-band blocking requirements.
    - For FR1 and FR2-1, existing in-band blocking can be reused.
  + Qualcomm (R4-2411515)
    - To derive the in-band requirement for that particular case, it is recommended to consider the 99% percentile point of the received power for SBFD UL as a victim case for each scenario and then get the average point.
    - RAN4 to not consider any CLI handling scheme effects when defining the in-band blocking requirements.
  + Samsung (R4-2411639)
    - Based on the distributions of received power levels plotted for Scenario 1, 3, 5, 6, and 9, the adjacent channel gNB DL power level could be the major factor contributing to the total co-channel received power.
    - The percentage value of grid shifting plays an important role to determine the distributions of adjacent-channel and co-channel gNB DL received power, by translating the distance between interfering gNB and victim gNB into pathloss.
    - RAN4 shall align the co-existence simulation results by comparing the distributions of adjacent-channel and co-channel gNB DL received powers, by comparing the simulation assumptions and other details firstly.
  + CableLabs, Charter Communications (R4-2411723)
    - the new BS receiver in-band blocking study should be captured in a technical report. We prefer Option 3.
      * Option 1: merge into clause 11 in TR 38.858.
      * Option 2: capture it in a new Rel-19 TR.
      * Option 3: capture it in a new Rel-19 TR, briefly summarize the conclusions in TR 38.858 and cite the Rel-19 TR.
    - The in-band blocking study should extend to case 2 because both case 2 and case 3 have strong gNB-to-gNB ACI. The results should be captured in clause 11 in TR 38.858.
    - It is unreasonable to only consider ACI for in-band blocking. Some level of co-channel interference should also be considered. How to consider co-channel interference is FFS.
    - the X% tile of the UL SBFD wideband received power CDF to define the blocking requirement should be X=99.
    - The CDF of the receiver blocking power for scenario 1 (FR1 UMa-to-UMa) case 3 (TDD DL to SBFD UL subband) is provided in Figure 1. 33% of the blocking power is larger than the P2=-25 dBm in the baseline NF model, and 100% of the blocking power is larger than the P2=-15 dBm in the enhanced NF model.
    - The CDF of the receiver blocking power for scenario 5 (FR1 UMi-to-UMi) case 3 (TDD DL to SBFD UL subband) is provided in Figure 2. 35% of the blocking power is larger than the P2=-20 dBm in the NF model.
    - The CDF of the receiver blocking power for scenario 6 (FR2-1 UMa-to-UMa) case 3 (TDD DL to SBFD UL subband) is provided in Figure 3. 99% of the blocking power is larger than the P2=-40 dBm in the NF model.
  + CMCC (R4-2411735)
    - Only collect power level of interference from adjacent channel to derive in-band blocking levels.
    - the reference point for the power level should be before RX beamforming
    - 100% grid-shift should be considered
  + ZTE （R4-2412724）
    - for Scenario 1 FR1 Urban macro scenario, the received power level are much higher than the existing IBB requirement -43dBm which would be quite challenging for SBFD BS to handle the receiver dynamic range together with the REFSENS requirements.
    - for Scenario 3 FR1 indoor scenario, the received power is still close to the existing requirement and therefore it should be okay to reuse the existing requirements without any feasibility issue or additional blocking issues.
    - for Scenario 6 FR2 urban macro scenario and Scenario 9 FR2 indoor scenario, the received power is close to the existing requirement and therefore it should be okay to reuse the existing requirements without any feasibility issue or additional blocking issues.
  + Ericsson（R4-2412916）
    - [Define in-band blocking interferer signal power to 5 dBm for Wide Area BSs in SBFD networks.](#_Toc173767413)
    - [Define in-band blocking interferer signal power to -1.5 dBm for Medium Range BSs in SBFD networks.](#_Toc173767414)
    - [Re-use the existing in-band blocking requirement for Local Area BSs in SBFD networks.](#_Toc173767415)
    - [Investigate whether an additional requirement based on a single input signal placed to cause IM with the RX sub-band provides any additional robustness, and whether such a requirement is anyhow implicitly captured by the SBFD RX blocking requirement.](#_Toc173767416)
  + Nokia（R4-2413235）
    - RAN4 should include a clear statement on how the in-band blocking requirements for SBFD BS are derived in order to avoid possible misunderstandings.
    - Consider only the adjacent channel interference power to determine the in-band blocking power.
    - To reduce the scope of the simulations, 10% grid-shift is the only considered grid-shift value.
    - To reduce the scope of the simulations, consider only SBFD antenna configurations and TDD BS transmit power defined as baseline or 1st priority according to TR 38.858 Annex E.
    - Use the 99th percentile of the in-band blocking power CDF (X = 99) to derive the BS RF requirements.
    - Re-use the excel spreadsheet from simulator calibration during the study item to collect the in-band blocking power results from different companies.
    - RAN4 should not consider any effect of the CLI handling mechanisms for the calculation of the in-band blocking power levels.
  + Huawei（R4-2413284）
    - 60~ 65 dB MCL can cover most of deployments scenarios since the measured cases can represent a certain worse case.
    - -10~ -15 dBm is considered as the in-band blocking level for FR1 Macro BS.
* Moderator Recommendation:
  + RAN4 need to discuss on contributing source for in-band blocking requirement:
    - Option 1: DL co-channel interference and DL adjacent channel interference
    - Option 2: only the DL adjacent channel interference
  + RAN4 need to discuss on how in-band blocking requirement are derived:
    - Option 1: MCL assumption for BS2BS CLI interference
    - Option 2: Co-existence study
    - Option 3: Both
  + For co-existence study, RAN4 need firstly agree on the open parameters for simulation assumption
    - the power level which should be collected from the simulation results to derive in-band blocking levels: power level of interference from adjacent channel only
    - The reference point for the power level which should be before array gain
    - FFS grid-shift values should be considered.
      * Option 1: 10%
      * Option 2: 20%
      * Option 3: 50%
      * Option 4: 100%
    - 99% of the UL SBFD wideband received power CDF to define the blocking requirement
  + RAN4 to not consider any CLI handling scheme effects when defining the in-band blocking requirements
* Ad-Hoc discussion (only for the first two bullets from Moderator Recommendation):
  + For contributing source for in-band blocking requirement:
    - ZTE: Option 2 is agreeable.
    - Huawei: Current in-band blocking is quite different from the legacy one.
    - QC: We share the same view as ZTE.
    - Nokia: In reality there is also other interference. Do we need to introduce co-channel as well?
    - Samsung: Option 2.
    - Huawei: Option 2. Co-channel can be considered for the new requirements.
    - Ericsson: Same view as Huawei.
    - Ericsson: Fine with core requirement. If we change to symbol, how about conformance test?
  + How in-band blocking requirement are derived:
    - Samsung: There is a link between Op1 and Op2. The change on grid shift, the MCL will be changed as well. We are open to both options. For Option 1, the exact value e.g. 30dB should be revisited.
    - ZTE: Option 2 is more reasonable.
    - Ericsson: Option 2 is more straightforward.
    - Huawei: We also need to give option 1 a try, since it will share more lights on the whole picture.
    - Nokia: For the time being, Option 2 is feasible from work load perspective.
    - Samsung: BS is not randomly dropped. Option 2 is adopted, MCL can still be calculated.
    - CATT: MCL calculation can be considered.
    - ZTE: The close BS may not be the only source, so Option 2 is preferable.
    - Cable lab: Agree with ZTE. Interference contributor is random.
    - Ericsson: Option 3 would lead to a difficult way.
* Ad-Hoc agreement:
  + On contributing source for in-band blocking requirement, it is only the DL adjacent channel interference.

### Sub-topic 2-5: Receiver intermodulation

#### Issue 2-5-1: Necessity of New RX intermodulation requirement with 1 interfering signal

* Proposals:
  + Proposal 1 (Ericsson/ZTE): Whether IMD requirement for single interfering signal scenario is needed. Investigate whether such a requirement is implicitly captured by the SBFD RX blocking requirement.
  + Proposal 2 (Samsung): If RAN4 want to introduce the additional RX intermodulation requirement (a single input signal placed to cause IM with the RX sub-band), the new intermodulation scenario shall be confirmed firstly with evidence showing the proposed scenario exists in practice.
* Moderator Recommendation:
  + Discussion on proposals firstly.

#### Issue 3-5-2: Impact on existing RX intermodulation requirement with 2 interfering signal

* Proposals:
  + Proposal 1 (ZTE): for the receiver intermodulation requirements, BS2BS CLI should be taken into account for power level for interference signal.
* Moderator Recommendation:
  + Discussion on proposal firstly.