**3GPP TSG-RAN WG4 Meeting # 104-e R4-22XXXXX**

**Electronic Meeting, 15– 26 August 2022**

**Agenda item:** 11.3

**Source:** Moderator (Samsung)

**Title:** Email discussion summary for [104-e][315] FS\_NR\_duplex\_evo

**Document for:** Information

# Introduction

This thread is on Rel-18 SI for Study on evolution of NR duplex operation. As this is the first meeting for RAN4 discussion, according to guideline from RAN4 leadership in R4-2114691, work plan should be discussed and concluded as a basis for organizing discussion. Besides discussion and clarification on RAN4 work scope, there are contributions submitted for RF feasibility with respect to co-channel self-interference, co-existence study on adjacent channel and regulatory aspect, which will be discussed under each topic. Meanwhile, the reply LS on interference modelling requested by RAN1 shall be discussed in this thread.

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

* 1st round: comment collected for each topic and conclude on work plan if possible
* 2nd round: WF and reply LS to be discussed according to 1st round discussion

It is appreciated that the delegates for this topic put their contact information in the table below.

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
|  |  |  |

Note:

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

# Topic #1: Work plan

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2212487 | Samsung, CMCC | Work plan from rapporteur companies according to SID approved in RP-221352.  |
| R4-2212492 | Huawei, HiSilicon | **Observation 1**: the main tasks for RAN4 are feasibility study, the impact to RF requirements and considerations on the regulatory aspects on the concerned deployment cases. |
| R4-2212485 | Samsung | **Observation 1**: for gNB co-channel self-interference case, the RF impact on gNB perspective can be discussed further with the items/scenario in RAN1 LS as starting point. **Observation 2**: for UE-to-UE co-channel inter-subband CLI, further discussion is needed dependent on SBFD subband configuration. **Observation 3**: For gNB-to-gNB inter-cell co-channel inter-subband CLI, the gNB location will have impact on IC capability requested to ensure gNB co-channel co-existence.**Observation 4**: for adjacent channel co-existence, whether enhancement is needed for gNB capable of SBFD operation needs further study. **Observation 5**: the candidate method for CLI handling may have impact on feasibility and RF impact which needs further study dependent on RAN1 further conclusion.  |

## Open issues summary

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

### Sub-topic 1-1

*Sub-topic description:*

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

**Issue 1-1: Work plan**

* Proposals: work plan with scope on RF discussion for SI is provided in R4-2212487 for endorsement
* Recommended WF
	+ Companies’ view, comment and/or clarification on work plan are encouraged.
	+ If current version is not agreeable please elaborate specifically on how to update.

## Companies views’ collection for 1st round

### Open issues

Sub topic 1-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

### CRs/TPs comments collection

*NA*

## Summary for 1st round

### Open issues

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

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

### 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: Feasiblity study and RF impact

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

## Companies’ contributions summary

### Reply LS on interference modelling for SBFD operation

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2211709 | CATT | **Observation 1: RAN1 would like to know BS/UE SBFD RF performance/capabilities and how to model them in the system simulation for several SBFD scenarios.****Observation 2: RAN4 can have the assumption in Table 1 for the input of SBFD discussion.****Proposal 1: RAN4 need to analyse if the Rx blocking issue is a problem for the intra-subband interference types.****Proposal 2: For gNB self-interference, inter-band CLI and adjacent channel CLI, at least the following two issues should be analysed in RAN4.**1. **Victim Rx path is not blocked by the aggressor Tx band power.**
2. **Victim Rx band noise due to the aggressor Tx leakage.**

**Proposal 3: The reply to RAN1 can be step-by-step, the first step can be a preliminary model for calibration purpose. The exact model and the performance can be replied later.****Observation 3: The RAN4 conclusions for blocking issue would be two possible directions: 1) The blocking issue is severe to make SBFD not feasible. 2) The blocking issue can be solved with xdB (**$x\geq 0$**) SNR degradation to victim Rx band.****Proposal 4: For the blocking issue, RAN4 can reply the two possible conclusion directions to RAN1 to arrange the further simulation work.****Observation 4: For residual Tx leakage issue, RAN4 may need more time to discuss the performance and the simulation model than the blocking issue.****Proposal 5: ACIR model in TR 36.942 can be a reference model for RAN1 simulation calibration purpose.** |
| R4-2211562 | Qualcomm CDMA Technologies | **Proposal 1: Agree within RAN4 to utilize RAN1 RSI metric when studying the feasibility of SBFD deployment. RSI represents the ratio between gNB Tx power on an DL RB *m* and the gNB residual self-interference on a single receiver chain at UL RB *n* caused by DL transmission on DL RB *m*, which is represented in dB as** $α^{(m,n)}=P\_{Tx}^{m}[dBm]-I\_{SI}^{(m,n)}[dBm]$**.****Proposal 2: RAN4 to agree on the value range of 80-90 dB of spatial isolation via be based on two panels configuration with split of the antenna elements for simultaneous downlink transmission and uplink reception.****Proposal 3: RAN4 to agree on approximating the frequency isolation gNB’s capability with RAN4 gNB ACLR requirements, which equals to 45 dB, 28 dB, and 26 dB for FR1, FR2-1, and FR2-2, respectively.** **Proposal 4: The frequency isolation could be approximated as flat, non-frequency selective profile and its value per-RB is** $ACLR+10×log\_{10} RB\_{DL}$**.****Proposal 5: RAN4 to agree on the value range of 5-10 dB for beam nulling and clutter mitigation for FR1 and FR2 SBFD deployments.** **Proposal 6: RAN4 to agree on the value range of 10-15 dB for residual self-interference cancellation in the digital domain for FR1 and FR2 SBFD deployments.** **Proposal 7: RAN4 to agree on the value range of the aggregate self-interference** **mitigation RSI** $α^{(m,n)}$ **of 140-150 dB (120-140 dB) for FR1 (FR2) as shown in Table 1.** Table 1 Aggregate self-interference mitigation budget

|  |  |
| --- | --- |
|  | Mitigation capability for FR1 (FR2) |
| **Ant. isolation** | 80 dB (80-90 dB) |
| **Freq. isolation (ASLR)** | 45 dB (28 dB) |
| **Tx/Rx beam nulling or beam isolation** | 5~10 dB (5~10 dB) |
| **Digital IC** | 10~15 dB (10 dB) |
| ***RSI*** $α\_{SI}^{(n,m)}$ | 140~150 dB (120-140 dB) |

**Proposal 8: RAN4 to adopt gNB ACLR and ACS requirements to model co-channel inter-gNB CLI.****Proposal 9: For co-site inter-sector inter-gNB CLI, self-interference mitigation capability should be assumed for CLI mitigation in order to ensure successful reception of the UL signals at the victim gNB.****Proposal 10: RAN4 to discuss developing multiple gain-state model with input power dependent noise figure for RAN1 and possibly RAN4.****Proposal 10: RAN4 to reply to RAN LS with the draft LS provided in Section 5 in this contribution.**  |
| R4-2211880 | Apple | ***Proposal 1: For UE-UE co-channel inter-subband CLI modeling of TX unwanted emission, use the in-band emission requirement in 38.101-1 (FR1) and 38.101-2 (FR2).*** ***Proposal 2: For UE-UE co-channel inter-subband CLI modeling of RX selectivity/blocking, use the current maximum input level specified in RAN4 as a threshold:**** ***If inter-subband interference is higher than the threshold, it is assumed it will result large receiver degradation and hence the RX will not correctly decode the data***
* ***For inter-subband interference that is smaller than the threshold, treat the blocker as interference, i.e. consider a dB-to-dB increase of interference due to blocker power***

***Proposal 3: For UE-UE adjacent-channel CLI modeling of TX unwanted emission, use the two ACLR level model shown in Fig. 3.******Proposal 4: For UE-UE adjacent-channel inter-subband CLI modeling of RX selectivity/blocking, use the following model:**** ***If the blocker is higher than -25dBm, it is assumed it will result large receiver degradation and hence the RX will not correctly decode the data***
* ***For the blocker that is smaller than -25dBm, use the ACS values to calculate the resulting interference***

***In addition, consider a 5dB SNR degradation due to receiver gain backoff***  |
| R4-2212117 | Kumu Networks | In this paper, we presented a joint RF cancellation and beam-nulling approach for self-interference mitigation in SBFD systems. We evaluated our approach through simulations showing >100dB isolation achievable with minimal impact on beamforming gains and the number of RF cancellers scaling linearly with the number of antennas in the system. The simulations incorporate different antenna configurations and channel multipath effects and found the proposed solution to be robust to both. We have also demonstrated the efficacy of this system with a smaller scale hardware prototype using Kumu Networks’ RF cancellation chip. |
| R4-2212160 | MediaTek (Chengdu) Inc. | Proposal 1: For co-channel Aspect 1, indicate to RAN1 that it is feasible to model UE Tx emissions per RB by modelling the minimum required IBE requirements specified in 38.101-1 and 38.101-2.Proposal 2: For co-channel Aspect 2, indicate to RAN1 that there are no UE in-channel selectivity minimum requirements today, so concrete assumptions about existing UE performance cannot be made. However, the ICI and power imbalance aspects should be considered in any co-channel Rx modelling by RAN1.Proposal 3: For adjacent channel Aspect 1, indicate to RAN1 that:* for adjacent channel UE Tx emissions, the UE SEM is applicable as a per-RB/sub-band measure for UEs at maximum output power. At lower output power levels, it is not possible to make concrete assumptions about relative leakage on per-RB/sub-band level, but ACLR dictates the maximum allowed average leakage across the channel.
* ACLR is only appropriate for modelling “average” emission impacts across the ACLR measurement bandwidth of the channel. It should not be assumed that the average ACLR would accurately model UE emission behaviour if averaged per-RB/sub-band. Also indicate that ACLR inherently includes a guardband.

Proposal 4: For adjacent channel aspect 2, indicate to RAN1 that:* there are no per-RB/sub-band related requirements defined, so one cannot make concrete assumptions on existing UE selectivity performance on a per-RB/sub-band level
* ACS can only be used to identify statistical average impact across a channel
 |
| [R4-2212312](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212312.zip) | CMCC | **Observation 1: Target SI cancelation ratio should be 148dB for WA, 128dB for MR and 111dB for LA.** **Observation 2: per PRB basis RSI is more preferred to facilitate RAN1’ simulation and scheme design.****Observation 3: it seems more reasonable to show one SI value range to reflect overall SI suppression capability. If necessary, we could add some examples of separate estimates for different means under the overall value range assumption.****Observation 4: for gNB without sub-band filter for SI cancellation, RSI could be simplified as frequency flat at least for FR1. But for gNB with sub-band filter, the attenuation mask is not flat unless defining larger transition guard band.****Observation 5: it’s feasible to consider Tx leakage and Rx selectivity as described in RAN1’s LS for inter-sub band CLI. Besides, blocking issue should also be carefully studied for co-site scenario.****Proposal 1: it’s suggested to further check whether legacy ACLR limit of gNB is also applicable for inter-sub band case or not.****Observation 7: for inter sub-band CLI, the main differences between co-site inter sector and inter site scenarios include following two aspects:*** **Antenna isolation of co-site inter-sector is near-field antenna characteristics but for inter-site, antenna isolation is far-field antenna characteristics.**
* **For co-site scenario, digital interference cancellation could be utilized. But for inter-site scenario, there is no possibility for such digital interference cancellation.**

**Proposal 2: It’s better to reuse legacy IBE requirements for evaluation.****Observation 8: two options are listed to avoid UE-UE inter-sub band interference based on the assumption that legacy UE could also work in SBFD network.*** **Option 1: RAN4 collect minimum requirements from UE vendors that could reflect all legacy UE’s Rx selectivity for inter-sub band case and reply it to RAN1 for their simulation and scheme design.**
* **Option 2: RAN4 send the LS to RAN1 and ask RAN1 design schemes to avoid UE-UE inter-sub band interference with 0dB Rx inter-sub band selectivity requirements**
 |
| R4-2212486 | Samsung | The UL reception SINR formula for gNB with SBFD operation is summarized as below:$$SINR\_{gNB}=\frac{wanted signal from UE-PL+Antenna gain(including BF)}{Noise floor+Interference\_{other}+Interference \_{self}}$$Where $Interference\_{self}=P\_{tx}\left(dBm\right)-RSIC(dBc)$And the Interferenceother is interference from surrounding system(s) includes below cases which is applicable for certain scenario* + $Interference\_{co-site\\_\_{co}}=P\_{tx\_{aggressor}}\left(dBm\right)-RSIC\left(dBc\right)$
	+ $Interference\_{inter-site\\_co }=P\_{tx\_{aggressor}}\left(dBm\right)-PL+antenna gain-ASBIR(dBc)$
	+ $Interference\_{co-site\\_adj}=P\_{tx\_{aggressor}}\left(dBm\right)-RSIC(dBc)$
	+ $Interference\_{inter-site\\_adj}=P\_{tx\_{aggressor}}\left(dBm\right)-PL+antenna gain-ACIR(dBc)$
	+ $Interference\_{inter-site co-subband}=P\_{tx\_{aggressor\\_UE}}\left(dBm\right)-PL+antenna gain$

For victim UE DL reception with UE UL interference the SINR formula is summarized as below:$$SINR\_{victim UE}=\frac{wanted signal from BS-PL+Antenna gain(including BF)}{Noise floor+Interference\_{other}}$$Where the Interferenceother is fromvictim UE transmission as below * + $Interference\_{UE-UE\\_co }=P\_{tx\_{aggressor}}\left(dBm\right)-PL+antenna gain-ASBIR(dBc)$
	+ $Interference\_{UE-UE\\_adj}=P\_{tx\_{aggressor}}\left(dBm\right)-PL+antenna gain-ACIR(dBc)$

And the RSIC, ASBIR, and ACIR are provided in table 1, table 2 and table 4 respectively. Table 1: value range of RSIC

|  |  |  |
| --- | --- | --- |
| **Parameter** | **FR1** | **FR2** |
| Spatial isolation  | 70 -80 dBc | 90-120 dBc |
| Frequency isolation | 45 dBc  | 30 dBc |
| Beam nulling /isolation | ~10 dBc |  ~5 dBc |
| Digital IC  | 30-50 dBc | 30 -50 dBc |
| Overall RSIC capability  | 140 – 185 dBc | 145 - 205 dBc |

Table 2: ASBIR (adjacent sub-band interference ratio) candidate for co-channel inter-subband CLI

|  |  |  |
| --- | --- | --- |
| **Frequency range** | **Inter-site gNB-gNB** | **UE-UE** |
| **FR1** | Candidate 1 | 43dBc | 28dBc |
| Candidate 2 | 20+dBc | 20+dB |
| **FR2** | Candidate 1 | 22.5dBc | 16.5dBc |
| Candidate 2 | ~14dBc | ~14dB |

Table 4: ACIR

|  |  |  |
| --- | --- | --- |
| **Frequency range** | **Inter-site gNB-gNB** | **UE-UE** |
| FR1 | 43dBc | 28dBc |
| FR2 | 22.5dBc | 16.5dBc |

 |
| R4-2212492 | Huawei, HiSilicon | **Observation 2**: for self-interference, the RX receiver blocking and reference sensitivity degradation should be evaluated. |
| R4-2212493 | Huawei, HiSilicon | *Moderator summary according to the LS draft*:For BS self-interference cancellation link budget provided as below table with Table 2.1-1 link budget for RSI

|  |  |  |
| --- | --- | --- |
|  Parameters | FR1 Macro | FR2 Macro |
| Tx power (dBm) | 49 | 38 dBm/400M |
| Spatial isolation (dB) | 80 | 85~95 |
| TX beam isolation (dB) | 10 | 10 |
| Blocking level at receiver chain (dBm) | -41 | -63/100M |
| Frequency isolation ACLR (dB) | 45 | 28 |
| RX beam isolation (dB) | 10 | 10 |
| Digital cancellation (dB) | 10 | - |
| Overall suppression (dB) | 145 | 123 |
| REFSENS degradation (dB) | < 1 | < 1 |

Co-channel inter-subband CLI:

|  |  |  |
| --- | --- | --- |
| CLI interference  | Transmitter perspective | Receiver perspective |
| gNB-gNB (co-site and inter-site) | ACLR | In-band blocking  |
|  UE-UE | IBE | 0dB since no subband filter |
| ACLR if subband filter applied | ACS if subband filter assumed |

Adjacent-channel CLI gNB-gNB (co-site and inter-site): TX ACLR and RX ACS can be used in the simulation. Tntenna gain would be different for wanted signal and unwanted signal. Hence separate calculation from ACLR and ACS perspective is more accurate. UE-UE: if we assume the directivity is the same for wanted signal and unwanted signal for UE, the ACIR ratio can be adopted |
| R4-2212599 | Xiaomi | **For gNB self-interference:** **Observation 1: the lowest measured isolation is from configuration IV if the same distance is considered for all the configurations.****Observation 2: 30dB minimum coupling loss (MCL) is assumed for both WCDMA, LTE and NR FR1 for co-side BS when defining transmitter intermodulation requirement.****Observation 3: the in-band emission improved from UE side and current ICS requirement from BS side could be as a reference when deriving the frequency isolation.****For gNB-gNB/ UE-UE co-channel CLI:****Observation 4: the two aspects are very similar to transmitter part and receiver part in Frequency isolation as mentioned above in the gNB self-interference case especially for gNB-gNB co-channel CLI case, thus they could be discussed together.****For gNB-gNB/ UE-UE adjacent-channel CLI:****Observation 5: the two aspects for gNB-gNB/ UE-UE adjacent-channel CLI could be reflected by ACIR，the granularity shall be for FFS.** |
| R4-2212619 | Ericsson | **Proposal 1:****For UE specific parameters, RAN4 should use the existing UE RF specification and extrapolate the needed parameters for system level studies.** **Proposal 2:****For system level and co-existence studies, it is proposed to use the existing requirements and the corresponding existing reference carrier bandwidth granularity.****Proposal 3:****For link level, interference cancellation and evaluation studies, RAN4 should consider finer needed granularity when transmitter and receiver models are being developed.****Proposal 4:****RAN4 should develop realistic models for transmitter and receiver impairments for further evaluation of SBFD.** **Proposal 5:****BS characteristics based on a BS just meeting gNB minimum RF requirements should be used as a base-line for SBFD feasibility studies. From this, modelling of improved performance can be considered if needed.****Proposal 6:****RAN4 should consider the models and means to achieve the required suppression separately for each BS class.** **Proposal 7:****RAN4 should develop realistic models for high antenna isolations and define how isolation based on different evaluation need should be specified.****Proposal 8:****Multi-carrier behaviour of gNB should be considered when evaluating DL and UL RF impairments and cancellation schemes.****Proposal 9:****Energy efficiency of gNB should be considered when evaluating SBFD and cancellation schemes.**The annex proposes a reply LS to RAN1 based on the initial state of RAN4 discussions.**Proposal 10:****RAN4 should send the draft LS response in this paper as the first stage of providing answers to questions stated in the LS on interference modelling for duplex evaluation.**  |
| R4-2212802 | vivo | **Proposal 1: For the interference study in RAN4, these in-channel and adjacent channel RF metrics in Table 1 can be used as the baseline for full duplex.****Proposal 2: RAN4 provide a single range for RAN1 considering the overall self-interference suppression capability for BS.****Observation 1: For wide area BS, the self-interference suppression value is estimated as 112 dB according to current BS dynamic range. （assuming DL 40M+UL 20M+DL 40M configuration）****Proposal 3: For subband transmission at gNB side, discuss whether BS ACLR can apply for adjacent subband.****Proposal 4: RAN4 to discuss the guard bands between adjacent subbands for full duplex.****Proposal 5: Reuse BS ICS at the receiver side for gNB-gNB co-channel inter-subband CLI.****Proposal 6. Use UE IBE as a starting point at Tx side for UE-UE co-channel inter-subband CLI.** |
| R4-2212848 | Nokia, Nokia Shanghai Bell | ***Observation 1: Different implementations in terms of output power, MIMO and beamforming capabilities need to be considered in feasibility evaluation.******Observation 2: SBFD cannot be operated without changes to RF architecture and as such SBFD needs new physical implementations and cannot be software upgraded to existing and deployed base stations.******Observation 3: SBFD operation using shared antenna for Tx and Rx does not appear to be feasible.******Observation 4: Impact of reflections from clutter needs further work.******Observation 5: gNB RF architecture based on separate Tx and Rx antennas results in**** ***Inferior performance in case total antenna area is kept equal***
* ***Significant increase in cost, size and weight in case antenna area is increased to avoid performance loss***
* ***Permanent loss of reciprocity even if antenna area is increased***

***Observation 6: SBFD results in increased power consumption compared to static or dynamic TDD******Observation 7: Analog interference cancellation in the circuit board does not appear feasible at least in case multiple antenna elements are used, which is the case in nearly all commercial base stations.******Observation 8: Dynamic range and linearity of Rx front-end needs to be taken into account in addition to direct Tx ACLR contribution when analysing feasibility of SBFD operation.******Observation 9: More than 100 dB of isolation from Tx antenna(s) to individual Rx antenna is required to avoid desensitization of the receiver in a typical FR1 macro scenario.******Observation 10: Required antenna-to-antenna isolation scales dB-to-dB with transmit output power and sensitivity.******Observation 11: Impacts from blockers and IIP2 need to be further analyzed.******Observation 12: In case no degradation of UE performance is desired for SBFD use cases, the physical separation (> 200 m) or coupling loss (>90 dB) between aggressor UE and victim UE need to be very large.*** ***Observation 13: If worst case UE ACLR performance is considered, ACLR contribution to the in-band noise at the receive input seem to be the strongest contribution compared with IMD3 contributions.*** ***Observation 14: The unwanted emissions at the gNB are currently modelled with the adjacent channel power leakage (ACLR). An extension of the ACLR for adjacent sub-bands in the same carrier, namely the inter-subband leakage ratio (ISLR), can be used to model the unwanted emissions for SBFD gNBs. This assumes there is suffiency frequency separation between 2 sub-bands of opposite link direction.******Observation 15: The new inter-subband selectivity (ISS) defines the gNB receiver selectivity with finer frequency granurality as compared to existing gNB adjacent channel selectivity requirements.******Observation 16: For modelling the co-channel inter-subband CLI, the inter-subband interference ratio (ISIR) is proposed. The ISIR resembles the existing ACIR requirement but it is defined with finer granurality.******Observation 17: For adjacent channel inter-subband CLI, the existing BS ACIR requirements can be extended for SBFD simulations. Finer frequency granurality in the ACIR assumptions could be needed.*** ***Observation 18: The current UE in-band emission model can be applied for modelling the UE unwanted emissions on SBFD.******Observation 19: No ICS requirements are defined for the UE. Existing UE ACS requirements could be applied with finer frequency granurality.******Observation 20: For adjacent channel inter-subband CLI, the existing UE ACIR requirements can be extended for SBFD simulations. Finer frequency granurality in the ACIR requirements could be needed.*** ***Observation 21: For FR1 UMa simulations, SBFD is shown to provide a >2x improvement in the UL coverage/5%-ile UE UL throughput performance as compared to static TDD, if assuming a ratio of self-interference (RSI) of at least 148 dB or more (45 dB ACLR + 80 dB analog suppression + scaling factor).*** ***Observation 22: For FR1 UMa simulations, UL spectral efficiency of SBFD is generally worse than with static TDD (60%-16% worse depending on the RSI) since half the amount of transmit and receive antennas is used for SBFD.*** ***Proposal 1: Sufficiently large gain under realistic assumptions should be observed from SBFD as compared to fixed and dynamic TDD to justify the complexity of introducing support for SBFD.*** ***Proposal 2: Regarding gNB self-interference modelling for system level simulations, principles for the model for UE in-band emissions (IBE) in TS 38.101-1, Section 6.4.2.3 can be used as a starting point for modelling the frequency-separation dependency of the gNB self-interference between an aggressor and victim RB/SC.******Proposal 3: With respect to question 1-3 from the RAN1 LS R1-2205543 on ‘Whether it is possible to simplify the RSI as frequency flat model, and under which condition(s) the dependency of the RSI on frequency can be ignored?’:**** ***a fixed value of*** $α\_{SI}^{\left(m,n\right)}$ ***can be assumed (for any (m,n) RB pair) if there is sufficient separation or guard band between UL and DL subbands/RBs such that the UL RB are placed only on the ‘flat region’ of the DL emission mask.***
	+ ***Under the additional assumption of fixed gNB transmit power density (i.e. gNB transmit power varies depending on number of allocated RBs), the accumulated interference from all DL RBs towards a victim UL RB n can be simplified as follows:***
		- $dBm(I\_{SI}^{\left(n\right)})=dBm(\sum\_{m\in DL subband}^{}I\_{SI}^{\left(m,n\right)})=P\_{tx}^{RB}-dB\left(α\_{SI}\right)+dB(M)$ ***wherein,***
			* $P\_{tx}^{RB}$ ***is the transmit power per RB***
			* $M$ ***is the total number of allocated DL RBs at a given time***
		- ***Note: This model is conditioned on sufficient (analog) isolation between Tx-Rx such that the receiver still operates in linear region. If not the case, intermodulation products will be dominant which may introduce some frequency dependent components making the presented model not valid***

***Proposal 4: For the modelling of intra-site inter-subband inter-sector interference, reuse the same model as for self-interference but replacing*** $α\_{SI}^{\left(m,n\right)}$ ***with a new parameter*** $γ\_{A\rightarrow B}^{\left(m,n\right)}$ ***expressing the overall isolation between Tx and Rx across co-located sectors A and B, including spatial isolation, beamforming, etc.**** ***Considering that the major sources of inter-sector interference are due to the radiation via sidelobes and back lobes of the gNB antenna,*** $γ\_{A\rightarrow B}^{\left(m,n\right)}$ ***can be assumed to be higher or at least equal to*** $α\_{SI}^{\left(m,n\right)}$***.***

***Proposal 5: Use the answers provided in this section (section 7) in the reply LS to RAN1.*** |
| [R4-2213690](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2213690.zip) | ZTE Corporation | *Moderator summary according to LS draft:*RSI analysis has been provided for FR1 and FR2 gNB respective. And the <1dB de-sensitivity should be met at least dependent on BS implementation to enable SBFD operation. For co-channel CLI case, two options provided from transmitter perspective. And only flat ACS model provided for receiver perspective. For adjacent channel CLI case, two options provided from transmitter perspective. And only flat ACS model provided for receiver perspective.It’s suggested to focus on sub-band or carrier level granularity without further study on interference model in finer granularity to facilitate discussion.  |
| R4-2213692 | ZTE Corporation | **Observation 1:** for FR1 full duplex BS, the following approach could be used to handle the self-interference:1. Antenna isolation from transmitter to receiver;
2. Sub-band filtering of transmitter to further reject the leakage into the receiver;
3. ACLR of transmitter which is mainly determined by the PA performance and digital filtering implemented for DL;
4. Sub-band filtering of receiver to reject the power from the transmitter;
5. ACS of receiver to reject the power from the transmitter by digital filtering;
6. Digital interference cancellation at receiver;
7. RF interference cancellation;

**Observation 2:** for FR2 full duplex BS, the following approach could be used to handle the self-interference:1. Antenna isolation from transmitter to receiver;
2. ACLR of transmitter which is mainly determined by the PA performance and digital filtering implemented for DL;
3. ACS of receiver to reject the power from the transmitter by digital filtering;
4. Digital interference cancellation at receiver;
5. RF interference cancellation;

**Observation 3**: it seems feasible to support the full duplex operation for Medium range BS.**Proposal 1** : for FR1 full duplex BS, to consider the self interference mitigation approaches as mentioned in table 2.2.1-1 to different BS class supporting the full duplex operation and its detailed value could be further studied.**Proposal 2**: for FR1 full duplex BS, to check the feasibility from both refesens degradation and LNA blocking perspective.**Observation 4**: it seems feasible to support the full duplex operation for Wide area BS with only the antenna isolation considered.**Proposal 3** : for FR2 full duplex BS, to consider the self interference mitigation approaches as mentioned in table 2.2.2-1 with the removal of sub-band filtering to different BS class supporting the full duplex operation and its detailed value could be further studied.**Proposal 4**: for FR2 full duplex BS, to check the feasibility from both refesens degradation and LNA blocking perspective. |

### Adjacent channel co-existence study

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2211561 | Qualcomm CDMA Technologies | **Proposal 1: For FR1, support UMa with 500m ISD and InH as baseline deployment scenario for subband non-overlapping full duplex evaluation. Consider Uma with large percentile of UEs indoor to investigate extreme inter-UE CLI.****Proposal 2: For FR2, support UMa with 200m ISD for FR2-1 and InH for FR2-1 as baseline deployment scenarios for subband non-overlapping full duplex evaluation.** **Proposal 3: For FR1, support UMi as optional deployment scenarios.** **Proposal 4: For FR2, support UMi with 100m ISD for FR2-1, InH for FR2-2 and IAB as optional deployment scenarios.** **Proposal 5: In SBFD deployments, inter-gNB and inter-UE CLI results from the leakage to adjacent subband.****Proposal 6: For co-located gNBs, the current RAN4 30 dB isolation is not sufficient to address the inter-gNB CLI. For current ACLR and ACS RAN4 requirements, inter-gNB isolation in the ballpark of 80 dB is required for feasible SBFD deployments.** **Proposal 7: For co-site inter-sector inter-gNB CLI, self-interference mitigation capability should be assumed for CLI mitigation in order to ensure successful reception of the UL signals at the victim gNB.****Proposal 8: Inter-gNB coupling loss can be evaluated utilizing existing gNB-UE channel models in TR 38.802/38.901 with the proper adjustments on deployment and antenna parameters to mimic a gNB-gNB scenario.** **Proposal 9: gNB ACLR requirements provide a measure of Tx leakage on the adjacent channel. As a starting point for FR1 and FR2-1, 45 dB and 28 dB ACLR, respectively, as defined in RAN4 specs may be used.****Proposal 10: gNB ACS requirements provide a measure of Rx selectivity on the adjacent band, which can be assumed valid for inter-subband selectivity. As a starting point for FR1 and FR2-1-, 46 dB and 24 dB ACS, respectively, as defined in RAN4 specs may be used.****Proposal 11: For inter-site inter-sector inter-gNB CLI, RAN4 to adopt gNB ACLR and ACS requirements (i.e., Adjacent channel interference ratio per subband).****Proposal 12: Agree on the simulation parameters provided in Table 1 for RAN4 coexistence work**  |
| R4-2211710 | CATT | **Observation 1: The four adjacent channel interference scenarios for SBFD were simulated in dynamic TDD. The difference for SBFD is that one of the aggressor and victim is changed to sub-band.****Proposal 1: RAN4 should discuss and decide if co-existence simulation should be conducted for SBFD adjacent channel co-existence.****Proposal 2: Some typical sub-band parameters assumption, such as RB number, guard band, filter, etc, should be discussed and decided for RAN4 further discussion.****Observation 2: The co-located BS-BS interference analysis for SBFD is the same with dynamic TDD, i.e. if blocking requirement for gNB is not changed, aggressor Tx power will block victim Rx path.****Proposal 3: RAN4 should decide if co-located scenario should be supported or if BS blocking requirement can be more stringent for SBFD SI.** |
| R4-2212161 | MediaTek (Chengdu) Inc. | Regarding system level simulation (SLS) activities for the Duplex Enhancements SI, RAN4 to recommend to RAN#97-e that, due to the likely overlap, co-channel and adjacent channel system level analysis for this specific SI should be carried out purely by RAN1, with RAN4 providing relevant modelling information, as requested in [2].Failing that, we would propose to hold off further SLS development in RAN4 until further clarification at RAN#97-e. |
| R4-2212313 | CMCC | **Observation 1: legacy ACLR/ACS limits will lead to performance degradation for macro gNB- macro gNB scenario for both FR1 and FR2. But as long as care is taken with some solutions, in other scenarios, legacy ACLR and ACS limits may still apply.****Observation 2: legacy ACLR/ACS limits still apply for UE-UE CLI scenario for FR2. For FR1, legacy ACLR/ACS limits still applies for most scenarios except for macro->indoor, for which scenario, as long as care is taken with some solutions, legacy ACLR and ACS limits may also apply.****Proposal 1: 4GHz and 30GHz are suggested as example frequency for FR1 and FR2 respectively.****Proposal 2: Deployment scenarios for adjacent channel evaluation are as below for FR1.*** **urban macro and indoor as the baseline**
	+ **We can only focus on the scenario that legacy limits not applicable as verified in R16 CLI to reduce workload.**
* **dense urban scenario with 1 layer (micro) or 2-layer (macro + micro) scenarios are optional, if companies contribute to them, final simulation results should also be considered.**

**Proposal 3: Deployment scenario for adjacent channel evaluation are as below for FR2*** **urban macro, indoor and urban micro all as the baseline**
	+ **We can only focus on the scenario that legacy limits not applicable as verified in R16 CLI to reduce workload.**

**Proposal 4: we should at first model ACLR equivalent emission mask for legacy TDD carrier to help calculate received sub-band interference at adjacent SBFD carrier.****Observation 3: some options to model ACLR equivalent emission mask among adjacent channel for legacy TDD.*** **Option 1: frequency flat among adjacent channel**
* **Option 2: reuse OBUE spectrum model but scaling the limit so that total emission power among adjacent channel equal to ACLR value.**

**Proposal 5: we should define ACLR1, ACLR2 and even higher order ACLR model for SBFD network to help evaluate interference.****Observation 4: simulation assumption for FR1 is listed in table 3.** |
| R4-2212494 | Huawei, HiSilicon | ***Observation 1: Refer to the conclusion in TR 38.828, no/limited performance degradation can be observed under Indoor scenarios.******Proposal 1: For Rel-18 duplex co-existence evaluation:**** ***Macro scenario shall be treated as high priority for both FR1 and FR2;***
* ***RAN4 Rel-16 CLI study’s conclusion can be reused for indoor scenario. Thus such scenario shall be treated as low priority for both FR1 and FR2.***

***Proposal 2: Consider the following scenarios for Rel-18 duplex co-existence evaluation:***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| FR | ScenarioNo. | Deployment Scenario(Aggressor -> Victim) | Aggressor baseline (adjacent channel) | Aggressor(adjacent channel) | Victim |
| 1 | 1 | Urban Macro → Macro | 100MHz NR TDD DL | 100MHz NR SBFD1:4 UL:DL | 100MHz NR TDD DL |
| 2 | 100MHz NR TDD UL | 100MHz NR SBFD1:4 UL:DL | 100MHz NR TDD UL |
| 3 | 100MHz NR SBFD1:4 UL:DL | 100MHz NR TDD DL | 100MHz NR SBFD1:4 UL:DL |
| 4 | 100MHz NR SBFD1:4 UL:DL | 100MHz NR TDD UL | 100MHz NR SBFD1:4 UL:DL |
| 2 | 5 | UrbanMacro → Macro | 200MHz NR TDD DL | 200MHz NR SBFD1:4 UL:DL | 200MHz NR TDD DL |
| 6 | 200MHz NR TDD UL | 200MHz NR SBFD1:4 UL:DL | 200MHz NR TDD UL |
| 7 | 200MHz NR SBFD1:4 UL:DL | 200MHz NR TDD DL | 200MHz NR SBFD1:4 UL:DL |
| 8 | 200MHz NR SBFD1:4 UL:DL | 200MHz NR TDD UL | 200MHz NR SBFD1:4 UL:DL |

***Proposal 3: The 100% grid shift shall be applied for evaluation, while 0% grid shift doesn’t need to be considered.**** ***Further discuss on whether to consider other grid shift value.***

***Proposal 4: Consider two types of UE distribution for the co-existence evaluation regarding Macro scenario:**** ***Option 1 (Basic option since this is reuse of TR 38.828):***
	+ ***Random and uniform UE dropping. 20% outdoor in cars: 30km/h and 80% indoor in houses: 3km/h.***
* ***Option 2:***
	+ ***Step 1: Randomly drop a cluster within a macro cell geographical area considering the minimum distance between macro TRP to cluster centre, e.g., 100m , where the size of each cluster is 120 x 50 (m);***
	+ ***Step 2: 80% UEs are randomly and uniformly dropped within the cluster, and 20% UEs are randomly and uniformly dropped outside the cluster.***

***Proposal 5: On the BS antenna configuration assumption for legacy TDD operation:**** ***For FR2, reuse the BS antenna configuration in TR 38.828 clause 5.2.2.5;***
* ***For FR1, discuss on how to choose between the following two types of BS antenna configuration:***
* ***Alt. 1: The BS antenna modelling captured in TR 38.828 clause 5.2.1.5;***
* ***Alt. 2: The BS antenna modelling extension defined in TR 38.803 clause 5.2.3.2.4.***

***Proposal 6: Further discuss on how to determine the SBFD BS antenna configuration between following two options:**** ***Option 1: The total number of antenna elements of the antenna array for SBFD is the same as the total number of antenna elements of the antenna array for legacy TDD.***
* ***Option 2: The total number of antenna elements of the antenna array for SBFD is two times of the total number of antenna elements of the antenna array for legacy TDD.***

***Proposal 7: Adopt [49 dBm] for FR1 and [38 dBm] for FR2 BS Tx power assumption.******Proposal 8: Reuse the FR1/FR2 BS noise figure assumption in TR 38.828 for legacy TDD BS, further discuss on the value of this parameter for SBFD BS.*** |
| R4-2212621 | Ericsson | **Proposal 1:****Estimate UE performance based on existing UE RF requirements and if needed extrapolated for system level studies.****Proposal 2:****RAN4 to use FR1 UE transmit requirements discussed in this section for system level studies and LS response to RAN1****Proposal 3:****RAN4 to use UE SEM requirement of -25 dBm or ACLR 30dB for LS response to RAN1.****Observation 1:** **The -25 dBm / MHz or ACLR can be pessimistic and thus UE vendors to provide more detailed analysis for possibly lower value if needed.****Proposal 4:****RAN4 to use UE blocking requirements discussed in this section for system level studies and LS response to RAN1.****Proposal 5:****RAN4 to use UE ACS requirements discussed in this section for system level studies and LS response to RAN1.****Observation 2:****There is a need to further discuss FR2 system parameters for SBFD study.****Proposal 6:****RAN4 to use BS ACLR and operating band unwanted emission as baseline and extrapolate the requirements taking into account the additional guard between DL transmission of the aggressor and UL reception of the victim and different aggressor / RX sub-band bandwidths for adjacent channel system studies discussed in this section.** **Proposal 7:****RAN4 to use BS receiver blocking as baseline for adjacent channel system studies discussed in this section. Further work is needed to establish acceptable interferer levels that will not cause noise floor degradation in the receiver.****Observation 3:****Additional receiver aspects such as receiver linearity can influence the interference for adjacent channel studies and should be considered depending on the interfere level and deployment.****Observation 4:** **Measurements of physical passive antennas for different set ups indicate isolation level of 40-50 dB for co-located antennas.**  |
| [R4-2212697](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104-e/Docs/R4-2212697.zip) | Samsung | **Proposal 1**: The RAN4 shall conduct co-ex study as the co-ex study will be the discussion basis for RAN4 to:* Determine the supporting co-ex scenarios for SBFD operation;
* Check the adjacent channel interference with existing ACIR (ACLR/ACS) requirements in SBFD operation;
* Check the feasibility of new ACIR (ACLR/ACS) requirements for new SBFD-capable gNBs.

**Observation 1**: The adjacent channel co-existence study can focus on the timeslot(s) where the aggressor SBFD having its subband UL and DL operating simultaneously while the victim legacy TDD system is in its DL timeslot(s). The rest timeslot(s) are legacy TDD co-existence cases, and the adjacent channel interference (ACI) of those cases were solved by legacy ACLR and ACS of each frequency range already.**Proposal 2**: Proposed to consider both SBFD Subband configuration#1 with {DUD} pattern, which means one SBFD slot consists of one UL subband at the center of the channel bandwidth and two DL subbands at two sides of the channel bandwidth, and SBFD Subband configuration#2 with {DU} pattern, which means one SBFD slot consists of one UL subband at one side of the channel bandwidth and one DL subband at the other side of the channel bandwidth, in RAN4 co-ex study. These two configurations are shown in figure below: 1. (b)

Fig.2 SBFD subband configurations: (a) #1 {DUD}, (b) #2 {DU}**Observation 2**: The results from TR 38.828 reflects the cross-link adjacent channel interference impact focused on the FR1 and FR2 Macro-Macro case for BS-BS interference link, and FR1 Macro-Indoor case for UE-UE interference link. And RAN1 agreements also shows they will focus on Macro cases as starting point.**Proposal 3**: Considering Observation 1 and 2, we propose RAN4 to consider the following scenarios in Table 2 as the starting point for SBFD co-ex study with legacy TDD system.Table 2. SBFD adjacent channel co-existence scenarios (starting point)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| FR | ScenarioNo. | Deployment Scenario(Aggressor -> Victim) | Aggressor baseline | Aggressor | Victim |
| 1 | 1 | Macro -> Macro | NR, 100MHz, DL ACI | NR, 100MHz SBFD1 | NR, 100MHz, DL |
| 2 | Macro -> Macro | SBFD Intra-system | NR, 100MHz, DL | NR, 100MHz SBFD1 |
| 3 | Macro -> Indoor | NR, 100MHz, DL ACI | NR, 100MHz SBFD1 | NR, 100MHz, DL |
| 4 | Macro -> Indoor | SBFD Intra-system | NR, 100MHz, DL | NR, 100MHz SBFD1 |
| 2 | 5 | Macro -> Macro | NR, 200MHz, DL ACI | NR, 200MHz, SBFD2 | NR, 200MHz, DL |
| 6 | Macro -> Macro | SBFD Intra-system | NR, 200MHz, DL | NR, 200MHz, SBFD2 |
| Note 1: For FR1, consider subband config#1 with {DUD}: 40MHz DL + 20MHz UL + 40MHz DL and subband config#2 with {DU}: 80MHz DL + 20MHz UL.Note 2: For FR2, consider subband config#1 with {DUD}: 50MHz DL + 50MHz UL + 100MHz DL and subband config#2 with {DU}: 150MHz DL + 50MHz UL. |

**Proposal 4**: Propose to adopt the system characteristics, deployment parameters and other assumptions from TR 38.828 as the starting point for SBFD co-ex study. But the assumptions should be updated accordingly to fulfill the SBFD co-ex purpose.**Proposal 5**: Our understanding is that the SBFD BS could 1) utilize half of its original panel for DL and UL each, or 2) the SBFD BS could implement an extra panel with same number of elements for subband UL receiving so that the subband DL Tx will utilize same elements as legacy TDD BS. Thus, it is proposed for the meeting to consider two options for SBFD BS antenna and TRP power:* Option 1: Utilize half of its original panel for SBFD UL and DL each. In this case, the TRP and elements number for DL and UL in SBFD BS will be half of the TDD BS configuration.
* Option 2: Utilize an extra panel for subband UL operation. In this case, the TRP and element number for DL and UL in SBFD BS will be the same as TDD BS configuration.

**Proposal 6**: Propose to consider two options of SBFD BS power and elements based on what was assumed TR 38.828, while the victim legacy TDD BS assumption stays the same. The detailed proposed changes for SBFD BS can be found in the highlighted part of above tables.

|  |  |  |
| --- | --- | --- |
|  | FR1 Macro Urban | FR2 Macro Urban |
| BS antenna configurations | For Legacy TDD:(Mg,Ng,M,N,P)=(1,1,8,8,2) (dH,dV)=(0.5,0.8)λFor SBFD:Option 1: (Mg,Ng,M,N,P)=(1,1,4,8,2) (dH,dV)=(0.5,0.8)λOption 2: (Mg,Ng,M,N,P)=(1,1,8,8,2) (dH,dV)=(0.5,0.8)λ | For 30 GHz legacy TDD: (1, 1, 8, 16, 2) For SBFD: Option 1 (1, 1, 8, 8, 2)Option 2 (1, 1, 8, 16, 2) |
| BS Tx power | For Legacy TDD:49 dBmFor SBFD:Option 1: 46 dBmOption 2: 49 dBm | For legacy TDD:43dBmFor SBFD:Option 1: 40 dBmOption 2: 43 dBm |

**Proposal 7**: Propose to align the mechanical down-tilt angles assumptions for BS. And it is proposed to use 6 degrees for the Macro BS for FR1 and FR2 as provided in TR 38.803.**Proposal 8**: Propose to use the following as the general uplink power control model for SBFD co-existence study.

|  |
| --- |
| For downlink scenario, no power control scheme is applied.For uplink scenario, TPC model specified in Section 9.1 TR 36.942 [9] is applied with following parameters.- CLx-ile = –SNR\_target + UE\_maxpower – ThermalNoise – BS\_NoiseFigure + 10\*log10(BW) - γ = 1Where, SNR\_target for FR1 and FR2 are 15 dB. |

**Proposal 9**: For FR1, it is proposed to adopt ACLR1 as 30 dBc and ACLR2 as 43 dBc for FR1 UE.**Proposal 10**: Propose to adopt the following steps, modified from TR 38.828 and other general legacy RAN4 coex study report, as the simulation steps for SBFD coex study.

|  |
| --- |
| 1. Aggressor and victim network are generated.- UEs are distributed randomly across the network.2. UE associations: UEs are associated to base station based on coupling loss.- Associations are made assuming a single element at both UE and BS.3. Once association is done, round robin scheduling is used. BF weights are adjusted to point to the LOS direction between BS-UE. This is done for both victim and aggressor networks.4. When legacy TDD system is victim, follow steps 4a:4a. Throughput is computed considering ACI from another static TDD system as baseline aggressor:- $Thput\_{baseline}\left[bpshz\right]=f\left(SINR\_{ICI+ACI\\_baseline}\right)=f\left(\frac{S}{N+I\_{ICI}+I\_{ACI\\_baseline}}\right)$, where $I\_{ICI}$ is the inter-cell interference and $I\_{ACI\\_baseline}$ is the adjacent channel interference from the baseline aggressor.When SBFD system is victim, follow steps 4b:4b. Throughput is computed in the victim system without considering ACI as below:- $Thput\_{baseline}\left[bpshz\right]=f\left(SINR\_{ICI}\right)=f\left(\frac{S}{N+I\_{ICI}}\right)$, where $I\_{ICI}$ is the inter-cell interference.5. Throughput is computed considering ACI below:- $Thput\_{ACI}\left[bpshz\right]=f\left(SINR\_{ICI+ACI}\right)=f\left(\frac{S}{N+I\_{ICI}+I\_{ACI}}\right)$, where $I\_{ACI}$ is the adjacent channel interference. |

**Proposal 11**: It is proposed to follow the TR 38.828’s evaluation criteria to check the 50% and 5% throughput loss compared to the baseline scenario as described in table 2 (Proposal 3).**Proposal 12**: In the above step 4b and 5, when SBFD is victim system, it is proposed to use {N = noise floor + 1dB} for the SBFD system to simulate the self-interference impact as a simplified method to evaluate its SINR/throughput.**Observation 3**: The CLI SINR and Throughput distribution of our simulation platform seems quite aligned with the results in TR 38.828.**Observation 4**: Our initial results shows the existing ACIR (ACLR/ACS) provides sufficient interference reduction in adjacent band legacy TDD. The performance degradation is below the evaluation criteria proposed in Proposal 11.  |
| R4-2212801 | vivo | **Observation 1. For the gNB-gNB adjacent channel CLI co-existence, the interference from legacy BS can follow current ACLR/ACS model.****Observation 2: For SBFD channel, the adjacent channel leakage depends on the SBFD configuration.****Observation 3. The interference due to ACS is also dependent on the SBFD configuration.****Proposal 1: RAN4 decides SBFD configuration in the adjacent channel co-existence study.****Observation 4: For gNB supporting SBFD configuration (e.g. DL+UL+DL), if it transmits at DL subbands with its maximum power, the PSD for total DL transmission could boost.** **Proposal 2: RAN4 to discuss the power assumption at DL subbands for gNB supporting SBFD configuration.****Proposal 3: For UE-UE adjacent channel CLI, RAN4 can discuss how to apply ACLR/ACS to the subband level.** |
| R4-2212847 | Nokia, Nokia Shanghai Bell | ***Proposal 1: Sufficiently large gain under realistic assumptions should be observed from SBFD as compared to fixed and dynamic TDD to justify the complexity of introducing support for SBFD.*** ***Observation 1: Both gNB-to-gNB and UE-to-UE adjacent channel CLI are present in SBFD operation.******Observation 2: From a co-existence perspective, differences between SBFD and dynamic TDD operation are minor during non-aligned slots.******Observation 3: Due to the dynamics in dynamic TDD, it is expected that there are less mis-aligned slots when dynamic TDD is used as compared to SBFD.******Proposal 2: Unless there are meaningful differences in the deployment scenarios and/or used parameters, the conclusions done for dynamic TDD in TR 38.828 apply also for SBFD operation.*** |
| R4-2213691 | ZTE Corporation | **Proposal 1**: to study the following three coexistence scenario in the adjacent channel:1. Full duplex BS coexisting with full duplex BS in the adjacent channel;
2. Full duplex BS coexisting with legacy TDD DL in the adjacent channel;
3. Full duplex BS coexisting with legacy TDD UL in the adjacent channel;

**Proposal 2:** to further checked the feasibility of following coexistence scenarios highlighted in orange in Table 2.2-1 and Table 2.2-2. **Proposal 3:** to further study the coexistence scenario in Table 2.3-1 and Table 2.3-2 to investigate the impacts on full duplex BS. **Proposal 4:** to usethe simulation assumption in TR 38.828 as baseline for full duplex coexistence study and further discuss the antenna pattern and related power for FR1 BS and FR2 BS due to the separate Tx and Rx antenna array assumption. |

### Co-channel RF feasibility study

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2212146 | Intel Corporation | **Proposal 1**: Since the CLI interference is large enough to potentially degrade the BS Rx SNIR, we propose to perform link-level simulations which will more precisely capture the adjacent channel leakage due to RF front-end non-linearities. **Proposal 2**: We propose RAN4 to conduct further study into feasible levels of Tx-Rx antenna isolation.**Proposal 3**: For the Full Duplex simulation effort, we would propose to agree on a PA model that includes a realistic DPD component |
| R4-2211711 | CATT | **Proposal 1: The SBFD discussion for FR1 and FR2 should be separated.****Proposal 2: SBFD discussion doesn’t impact current non-SBFD BS RF requirements, such as blocking requirements, etc. Whether SBFD BS defines new requirements depends on the further discussion in SBFD study.****Proposal 3: The following two capabilities should be discussed together for SBFD gNB self-interference Rx blocking issue.*** **SBFD BS Rx blocking capability at Tx subband**
* **Self-interference cancellation capability at Tx subband**

**Proposal 4: The SIC capability at Tx sub-band is divided to the following three domains for further discussion.*** **Propagation domain SIC capability at Tx sub-band**
* **Analog domain SIC capability at Tx sub-band**
* **[Digital domain SIC capability at Tx sub-band]**

**How to reply RAN1 such as total capability or separate capability can have some flexibility.****Observation 1: SIC capability for Rx blocking issue may mainly rely on the propagation and analog domain techniques.****Proposal 5: RAN4 should decide if BS Tx SB filter should be used for the Tx leakage performance evaluation.****Observation 2: Some techniques based on the known Tx signal may not work well for SIC at Rx SB.****Proposal 6: The SIC capability at Rx sub-band is divided to the following three domains for further discussion.*** **Propagation domain SIC capability at Rx sub-band**
* **Analog domain SIC capability at Rx sub-band**
* **Digital domain SIC capability at Rx sub-band**

**How to reply RAN1 such as total capability or separate capability can have some flexibility.****Proposal 7: The Rx blocking analysis assumption for inter-subband CLI, such as layout model, gNB parameters, UE parameters, etc, should be decided before the further discussion.****Proposal 8: The analysis assumption for gNB and UE subband Tx leakage performance should be discussed and decided, such as implementation architecture.****Proposal 9: The Rx blocking analysis assumption for intra-subband CLI, such as layout model, gNB parameters, UE parameters, etc, should be decided before the further discussion.** |
| R4-2211790 | CEWiT | Not available  |
| R4-2212620 | Ericsson | **Observation 1:****It is not necessary to perform link level simulations using separate models for DPD and PA.****Proposal 1:****Adopt a net effect model that captures the essential behaviours of a realistic DPD and PA combination with compliance to the base station ACLR requirements.** **Proposal 2:****Adopt a simple crest factor processing model, e.g., hard clipping + bandpass filtering, that captures the essential behaviours of a BS design to increase transmit power. This requires input from RAN4.****Observation 2:****There are several receiver imperfections which in combination with high power level in DL sub-band can highly affect the SBFD receiver.****Proposal 3:****Receiver impairments should be modelled and considered for SBFD link level and self-interference studies.****Proposal 4:** **3GPP existing BS receiver requirements should be used as base-line and if needed extrapolated to derive models for link level and self-interference and feasibility studies.** **Proposal 5:****The 6 dB sensitivity degradation of existing BS receiver requirements is too high considering UL coverage enhancement as one key benefit of SBFD. The analysis should consider 0.1 dB and 1 dB degradation instead.****Proposal 6:****The BS receiver non-linearities and selectivity that can reasonably be achieved should be modelled and investigated when evaluating SBFD and its feasibility.****Proposal 7:****The receiver reciprocal mixing of phase noise should be modelled and investigated when evaluating SBFD and its feasibility.****Observation 3: Simple physical separation cannot provide enough isolations between RX and TX with reasonable separation distances. A maximum isolation of ~40 dB seems possible with reasonable separation of ~4** **λ**.**Observation 4: EBG structure in combination with physical separation provides 60-65 dB of isolations but over limited bandwidth.****Observation 5:** **Dielectric absorber slabs in combination with physical separation provide isolation around 65 dB but is not a recommended solution for SBFD antennas due to passive intermodulation (PIM) and environmental variation aspects.****Observation 6:** **Choke structure in combination with physical separation provide isolation around 60-70 dB but is bandwidth limited.****Observation 7:** **Combination of different structures can provide reasonable isolation of 65 dB over large enough bandwidth.****Observation 8:** **SBFD antenna performance highly depends on polarization and desired bandwidth and complexity of combined structures. In addition, the achievable isolation can degrade up to 10-15 dB depending on the beam forming over steering range of the antennas.** **Proposal 8:****For link level assessment of SBFD, proper modelling of advanced antennas as well as modelling of beamforming impact on isolation should be considered.****Observation 9:** **SBFD inter-gNB antenna isolation performance highly depends site installation and achievable isolation can vary significantly depending on the beam forming over steering range of the antennas.** **Proposal 9:****For link level and system level assessment of SBFD for both co-channel and adjacent channel CLI, proper modelling of inter-gNB isolation as well as modelling of beamforming impact on isolation should be considered.****Observation 10:** **Measurements of physical passive antennas for different set ups indicate isolation level of 40-50 dB for co-located antennas.** **Proposal 11:****It is proposed to adopt the antenna parameters in this document for far field antenna pattern modelling during the SBFD studies.** |

## Open issues summary

 RAN1 evaluation may be pending on RAN4 input on interference modelling for SBFD operation. To avoid potential impact on RAN1 progress due to lack of proper model, it’s suggested to prioritize the discussion on reply LS to RAN1 during this meeting. And input from companies will be merged under sub-topic 2-1 for all reply LS related discussion. And the remaining sub-topics on co-channel feasibility, adjacent channel co-existence and RF impact discussion will not handle related issues which already have been included in sub-topic 2-1 to avoid overlapping/redundant discussion. But the conclusion in sub-topic 2-1 would be considered as applicable for other sub-topics. Furthermore, even if tentative agreement concluded to be delivered RAN1, it's not precluded further discussion in RAN4.

### Sub-topic 2-1: reply LS on interference modelling for SBFD operation

LS from RAN1 in R4-2211510 is to request RAN4 to provide interference modeling for SLS on SBFD operation with three aspects as:

* Self-interference modelling for gNB capable of SBFD operation
* Co-channel inter-subband CLI modelling on gNB-gNB and UE-UE
* Adjacent-channel CLI modelling on gNB-gNB and UE-UE

Under sub-topic 2-1 it aims to collect view and invite discussion according to proposals provided from companies’ input for each aspect.

#### Issue 2-1-1: baseline in SBFD operation

* Proposal to gNB
	+ Option 1: If found feasible, SBFD operation requires new/enhanced implementation for gNB capable of SBFD and cannot be software upgraded to existing BS
	+ Option 2: SIC model is based on gNB implementation with existing BS RF requirement for gNB capable of SBFD
	+ Option 3: No impact on requirement applied to existing gNB or gNB not capable of SBFD operation.
* Proposal to UE
	+ Option 1: Estimate UE performance based on existing UE RF requirements and if needed extrapolated for system level studies
	+ Option 2: Large physical separation or coupling loss between UEs is needed
	+ Option 3: TBA
* Criteria on gNB UL receiver sensitivity degradation due to self-interference:
	+ Option 1: minus 1dB degradation
	+ Option 2: minus 0.1dB degradation
	+ Option 3: required total RSIC for gNB SBFD operation is dependent on gNB output power and sensitivity level
* Recommended WF
	+ TBA

#### Issue 2-1-2: Self-interference modelling for gNB capable SBFD operation

* Proposal from company according to factors requested by RAN1 for FR1 and FR2-1(Question 1-2).

Table 2-1-1: Summary table for FR1

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Factors  | R4-2211562 | R4-2212493 | R4-2212486 | R4-2212620 | R4-2212848 | R4-2213690 | R4-2212117 |
| Spatial isolation  | 80 dB Separated panel  | 80dB | 70 -80 dBSeparated panel | 65dB in large enough BW | 100+ dB needed for Macro, feasibility FFS ,  | 50dB | >70dB |
| Frequency isolation | 45 dB | 45 | 45 dB | - | 45dBWith guard band | 45dB | 45dB |
| Beam nulling /isolation | 5~10 dB | TX beam:10dBRX beam:10dB | ~10 dB | - | FFS | - | +3dB on top of beamforming isolation |
| Digital IC  | 10~15 dB  | 10db | 30-50 dB | - | FFS | 30 |  |
| Overall RSIC | 140~150 dB as capable | 145dB  | 140 – 185 dB as capable  | - | 100+ dB needed for Macro | 95dB | >100dB |

Table 2-1-2: Summary table for FR2-1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameter | R4-2211562 | R4-2212493 | R4-2212486 | R4-2212848 | R4-2213690 |
| Spatial isolation  | 80-90 dBSeparated panel | 85~95 | 90-120 dBSeparated panel | Shared antenna is not feasible | 96dB |
| Frequency isolation | 28 dB | 28dB | 30 dB | 22.5dB | 28dB |
| Beam nulling /isolation | 5~10 dB | TX beam:10dBRX beam:10dB |  ~5 dB | FFS |  |
| Digital IC  | 10 dB | - | 30 -50 dB | FFS |  |
| Overall RSIC  | 120-140 dB | 123dB | 145 - 205 dB | - | 124dB |

Companies are requested to comment on the following:

* For spatial isolation, how the spatial isolation is defined ?
	+ Element to element
	+ Sub-array to sub-array
	+ Panel to sub-array
	+ Panel to Panel
* For spatial isolation, what are the assumptions on antenna size, spacing of TX and RX, methods used for isolation (isolation, chokes etc.)
* For spatial isolation, is the quotation for boresight or some other beam steering direction ? Any dependency on beam steering directions ?
* For frequency isolation, whether the proposed value could be improved upon with an architecture that exceeds minimum requirements (i.e., given value is a baseline)
* For beam nulling, whether the suppression is for far field scatterers or in the near field
* For beam nulling, impact to far field gain, sidelobes etc.
* For digital IC, assumptions on the signal to be cancelled (which transmitter impairments are cancelled), and implications for multi-carrier transmitters.
* Also there is a need to consider receiver interference suppression
* Proposal on granularity on frequency domain and question on frequency flat model possibility (Question 1-1/3/5):
	+ Option 1: RSI can be modelled as frequency flat and scaling to subband level
	+ Option 2: RSI can be modelled as almost frequency flat and scaling to RB level
	+ Option 3: Frequency flat model can be assumed with possible guard band reserved between subband pending on implementation
	+ Option 4: A frequency flat model can be used, as long as sufficient guard band is assumed between DL and UL sub-bands.
* Proposal on RSI dependency on Blocking and AGC（Question 1-4）
	+ Option 1: The in-band blocking is suggested to applied as starting point to ensure the receiver of UL sub-band is not blocked due to DL sub-band transmission
	+ Option 2: AGC may be applied to adjust the receiver gain to avoid ADC saturation while impact on sensitivity. However, it seems infeasible to model this in SLS.
	+ Option 3: Further study is needed on the impact, sufficient margins are need to be accommodated for environmental conditions, process and manufacturing tolerances, implementation considerations, interference environment and practical deployments.
	+ Option 4: TBA
* Proposal on dependency on gNB antenna and beam related (Question 1-5)
	+ Option 1: gNB antenna architecture has impact on RSI mode as to achieve high spatial isolation, separate antenna panels between TX and RX chain is requested.
	+ Option 2: TX/RX beam pair can further contribute on RSI pending on implementation.
	+ Option 3: Yes, the RSI will have dependency at least on the listed factors, but further details will need to be studied in RAN4.
* Recommended WF
	+ TBA

#### Issue 2-1-3: co-channel inter-subband gNB-gNB CLI modelling

* Proposal on feasibility and how to model co-site gNB-gNB CLI modelling
	+ Option 1: For co-site gNB-gNB CLI modelling, the RSI range level proposed for self-interference cancellation shall be mandatory supported
	+ Option 2: the same as inter-site gNB-gNB CLI modelling
	+ Option 3: similar modelling as for self-interference but using new parameter expressing the overall isolation between Rx and Rx between co-located sectors. Assumption is same time-frequency operation between sectors. Digital interference suppression is not feasible.
* Proposal on feasibility and how to model inter-site gNB-gNB CLI modelling considering unwanted emission and receiver selectivity
	+ Option 1: UE IBE requirement based model on TX and ICS requirement based model on RX
	+ Option 2: gNB ACLR based model on TX and ICS requirements based model on RX
	+ Option 3: gNB ACLR based model on TX and In-band blocking requirements based model on RX
	+ Option 4: (1/2-step) flat ACLR based model for TX and flat ACS based model with possible consideration on antenna isolation and subband filter pending on implementation
	+ Option 5: Models are valid only if receiver RF front-end operates in linear region.
	+ Option 6: Same Transmitter leakage and receiver impairment model as used for investigating gNB self-interference, but antenna isolation is replaced with inter-site isolation.
* Recommended WF
	+ TBA

#### Issue 2-1-4: co-channel inter-subband UE-UE CLI model

* Proposal on feasibility and how to model UE-UE CLI modelling considering unwanted emission and receiver selectivity
	+ Option 1: UE IBE requirement based model on TX and gNB ICS requirement based model on RX
	+ Option 2: UE ACLR based model on TX and UE ACS requirements based model on RX pending on sub-band configuration
	+ Option 3: UE IBE requirement based model and estimation on RX model for UE with no ICS capability as figure from R4-2212562.(R4-2212160/R4-2212493 also assume 0 ICS from UE RX side)

SNR (dB)

REFSENS + 45 dB

REFSENS + 35 dB

REFSENS

44

DL power in all RBs (dBm)

34

SNR Regime for high DL power

Figure 3.2-1: DL SNR in a receiver of a UE without in-channel selectivity

-1

* + Option 4: UE IBE requirement based model and UE ACS requirement based model on RX
	+ Option 5: UE IBE requirement based model and UE maximum input level as threshold on RX
		- If inter-subband interference is higher than the threshold, it is assumed it will result large receiver degradation and hence the RX will not correctly decode the data
		- For inter-subband interference that is smaller than the threshold, treat the blocker as interference, i.e. consider a dB-to-dB increase of interference due to blocker power
* Recommended WF
	+ TBA

#### Issue 2-1-5: adjacent-channel gNB-gNB CLI model

* Proposal on feasibility and how to model co-site gNB-gNB adjacent channel CLI modelling
	+ Option 1: For co-site gNB-gNB CLI modelling, the RSI range level proposed for self-interference cancellation shall be assumed. (except that antenna isolation is replaced with inter-gNB isolation).
		- Option 1a: As for option 1, but in case TX or RX improvements above the minimum performance to meet 3GPP requirements is considered for gNB self-interference mitigation, for adjacent channel the other operator gNB performance shall be assumed to be the minimum to meet 3GPP, not improved.
	+ Option 2: the same as inter-site gNB-gNB CLI modelling
	+ Option 3: TBA
* Proposal on feasibility and how to model inter-site gNB-gNB CLI modelling considering unwanted emission and receiver selectivity
	+ Option 1: gNB ACLR based model on TX and gNB ACS requirements based model on RX
		- Option 1-1: Apply the same ACIR model as Rel-16 CLI modelling
		- Option 1-2: Antenna gain would be different for wanted signal and unwanted signal. Hence separate calculation from ACLR and ACS perspective is more accurate.
	+ Option 2: TBA
* Recommended WF
	+ TBA

#### Issue 2-1-6: adjacent-channel UE-UE CLI model

* Proposal on feasibility and how to model UE-UE CLI modelling considering unwanted emission and receiver selectivity
	+ Option 1: UE ACLR based model on TX and UE ACS based model on RX which is the same ACIR model as Rel-16 CLI study
	+ Option 2: UE ACLR model with 2step size(FR1 example: ACLR1/2=28/33dB) on TX and UE ACS based model on RX if blocker is smaller than maximum input level of UE
* Recommended WF
	+ TBA

### Sub-topic 2-2: Adjacent channel co-existence study

*The sub-topic is target to summary and collect view on adjacent channel co-existence study regarding three aspects on:*

* *Necessity on SLS simulation in RAN4(Issue 2-2-1)*
* *Scenario for adjacent channel co-existence study in RAN4(Issue 2-2-2~2-2-6)*
* *Detail assumptions based on CLI and legacy study(remaining issues)*

**Issue 2-2-1: Necessity on SLS in RAN4**

* Proposals
	+ Option 1: The RAN4 shall conduct co-ex study as the study results will be the discussion basis for RAN4 to:

- Determine the supporting co-ex scenarios for SBFD operation;

- Check the adjacent channel interference with existing ACIR (ACLR/ACS) requirements in SBFD operation;

- Check the feasibility of new ACIR (ACLR/ACS) requirements for new SBFD-capable gNBs.

* + Option 2: Discuss the differences on deployment scenario and/or parameter between SBFD operation and Rel-16 CLI to decide whether additional SLS needed or not.( R4-2211710/R4-2212847)
	+ Option 3: Adjacent channel SLS can be covered in RAN1(R4-2212161)
* Recommended WF
	+ TBA

**Issue 2-2-2: FR1 SBFD scenarios for co-ex study**

* Proposals
	+ Option 1: UMa and InH as baseline scenarios for SBFD operation.
	+ Option 2: UMi as optional deployment scenario.
	+ Option 3: UMa as high priority, Indoor as low priority.
* Recommended WF
	+ Agree on Urban Macro as FR1 baseline scenario, further discuss the rest scenarios.

**Issue 2-2-3: FR2-1 SBFD scenarios for co-ex study**

* Proposals
	+ Option 1: UMa and InH as baseline scenarios for SBFD operation. UMi and IAB as optional.
	+ Option 2: Urban macro (UMa), Indoor and Urban micro (UMi) as baseline.
	+ Option 3: Urban macro (UMa) as baseline. Indoor as low priority.
	+ Option 4: Urban macro (UMa) as starting point.
* Recommended WF
	+ Agree on Urban Macro as FR2 baseline scenario, further discuss the rest scenarios.

**Issue 2-2-4: Frequencies for co-ex study**

* Proposals
	+ Option 1: FR1: 4GHz as exemplary frequency, FR2: 30GHz as exemplary frequency.
	+ Option 2: FR1: 3.5GHz as exemplary frequency; FR2: 30GHz as exemplary frequency.
	+ Option 3: FR2-2 as optional.
* Recommended WF
	+ Further discuss the above options

**Issue 2-2-5: Aggressor and victim combinations with aggressor baseline for co-ex study**

* Proposals

**NR TDD DL as victim**

* + Option 1-1: Aggressor baseline: NR TDD DL in adjacent channel; Aggressor: SBFD in adjacent channel.
	+ Option 1-2: TBA

**NR TDD UL as victim**

* + Option 2-1: Aggressor baseline: NR TDD UL in adjacent channel; Aggressor: SBFD in adjacent channel.
	+ Option 2-2: Do not consider NR TDD UL as victim in SBFD co-ex study.

**SBFD as victim**

* + Option 3-1: Aggressor baseline: SBFD in adjacent channel; Aggressor: NR TDD UL.
	+ Option 3-2: Aggressor baseline: SBFD in adjacent channel; Aggressor: NR TDD DL.
	+ Option 3-3: Aggressor baseline: SBFD intra-system; Aggressor: NR TDD DL.
* Recommended WF
	+ Further discuss the above options in different cases.

**Issue 2-2-6: SBFD sub-band configurations in co-ex study**

* Proposals
	+ Option 1: Proposed to consider both SBFD Subband configuration#1 with {DUD} pattern, which means one SBFD slot consists of one UL subband at the center of the channel bandwidth and two DL subbands at two sides of the channel bandwidth, and SBFD Subband configuration#2 with {DU} pattern, which means one SBFD slot consists of one UL subband at one side of the channel bandwidth and one DL subband at the other side of the channel bandwidth, in RAN4 co-ex study. These two configurations are shown in figure below:

 

(a) (b)

Fig.2 SBFD subband configurations: (a) #1 {DUD}, (b) #2 {DU}

* + Option 2: RAN4 decides SBFD configuration in the adjacent channel co-existence study.
* Recommended WF
	+ Agree on Option 1.

**Issue 2-2-7: Inter-site distance (ISD)**

* Proposals
	+ Option 1: FR1 UMa with 500m ISD, FR2 UMa with 200m, Indoor Hotspot with 20m (Same as TR 38.828)
	+ Option 2-1: FR2 UMi with 100m ISD
	+ Option 2-2: FR2: 3 clusters randomly dropped in Macro cell on edges, with ISD not specified (TR 38.828)



* Recommended WF
	+ Agree on Option 1 and try to converge Option 2-1 and 2-2.

**Issue 2-2-8: Path-loss model**

* Proposals
	+ Option 1: Use the path-loss models specified in TR 38.828 as baseline. [Moderator notes: as highlighted in tables below.]

Table 5.2.1.1.1-1: Single operator layout for urban macro in FR1 (4 GHz)

|  |  |
| --- | --- |
| Layout | Single layer with 19 hexagonal cell with wrap around |
| Inter-BS distance | 500 m |
| Carrier frequency | 4 GHz |
| Path-loss model | - Macro(Aggressor) → Macro(Victim) - Macro-to-UE: UMa see TR 38.803 [5] - Macro-to-Macro: UMa (h\_UE = 25 m) see TR 38.803 [5] - UE-to-UE: Outdoor UE – Outdoor UE see TR 36.828 [6] + penetration loss see TR 38.803 [5] |
| BS Tx power | 49 dBm |
| UE Tx power | 23 dBm |
| BS antenna configurations | (Mg,Ng,M,N,P)=(1,1,8,8,2) (dH,dV)=(0.5,0.8)λNote 1,2 |
| BS antenna height | 25 m |
| BS antenna element gain + connector loss | 5 dBi (assuming antenna 1.8dB loss) |
| BS receiver noise figure | 5 dB |
| UE antenna configuration | Omni |
| UE antenna height | hUT=3(nfl-1)+1.5nfl for outdoor UEs: 1nfl for indoor UEs: nfl~uniform(1,Nfl) where Nfl = 1 |
| UE antenna gain | 0 dBi |
| UE receiver noise figure | 9 dB |
| Multi operators layout | uncoordinated operation (100% Grid Shift) |
| Note 1: Mg = number of antenna panels in elevation, Ng – number of antenna panels in azimuth, M = number of antenna elements/subarrays in elevation, N= number of antenna elements/subarrays in azimuth, P = number of polarizations.Note 2: TX power is specified per polarization, a single polarization may be simulated under the assumption of polarization match. |

Table 5.2.1.1.2-1: Single operator layout for Indoor scenarios in FR1 (4 GHz)

|  |  |
| --- | --- |
| Layouts | 1. Indoor-to-Indoor : 6 BSs per 120 m x 50 mcid:image001.png@01D3E3E6.8A8631F02. Indoor-to-Macro : the number of Indoor per macro cell (drop randomly) = 1 |
| Inter-BS distance | Indoor-to-Indoor: 20 m |
| The minimum distance between Macro to Indoor: [35] m |
| Minimum BS-UE (2D) distance | Indoor-to-Indoor: 0 m |
| Minimum UE-UE (2D) distance | Indoor-to-Indoor: 1 m ~ 3 m |
| Carrier frequency | 4G Hz |
| BS TX power | 24 dBm |
| UE TX power | 23 dBm |
| Path-loss model | - Indoor (Aggressor) → Macro (Victim): - BS-to-BS: InH-office + penetration loss see TR 38.803 [5] - BS-to-UE: InH-office + penetration loss see TR 38.803 [5] - UE-to-UE: Outdoor UE – Outdoor UE  + penetration loss see TR 38.803 [5], TR 36.828 [6]- Indoor (Aggressor) → Indoor (Victim) - BS-to-BS: InH-office see TR 38.803 [5] - BS-to-UE: InH-office see TR 38.803 [5] - UE-to-UE: InH-office see TR 38.803 [5] |
| BS antenna | FR1 BS antenna element pattern for Indoor scenario from subclause 5.2.1.5.1 / ceiling |
| BS antenna height: | 3 m |
| UE antenna | Omni |
| UE antenna height | 1.5 m |
| Antenna gain of UE | 0 dBi |
| Cell selection criteria | Cell selection is based on RSRP |
| BS receiver noise figure | 5 dB |
| UE receiver noise figure | 9 dB |
| UE power control | Power control as defined in Section 5.2.3.4 |
| Multi operators layout | uncoordinated operation (100% Grid Shift) |

5.2.2.1.1 Urban macro

Table 5.2.2.1.1-1: Single operator layout for urban macro in FR2 (30 GHz)

|  |  |
| --- | --- |
| Network layout | hexagonal grid, 19 macro sites, 3 sectors per site with wrap around |
| Inter-site distance | 200 m |
| BS antenna height | 25 m |
| Path-loss model | - Macro (Aggressor) – Macro (Victim) - Macro-to-Macro: UMa (h\_UE = 25 m) see TR 38.803 [5] - Macro-to-UE(V): Uma + penetration loss see TR 38.803 [5] - UE-to-UE: UMi (h\_BS=1.5 m ~ 22.5 m)  + penetration loss see TR 38.803 [5] |
| Shadowing correlation | Between cells: 1.0Between sites: 0.5 |
| Multi operators layout | uncoordinated operation (100% Grid Shift) |

5.2.2.1.2 Dense urban

Table 5.2.2.1.2-1: Single operator layout for Dense urban in FR2 (30 GHz)

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Remark |
| Network layout | Fixed cluster circle within a macro cell. | note1 |
| Number of micro BSs per macro cell | 3 | 3 cluster circles are in a macro cell. 1 cluster circle has 1 micro BS. |
| Radius of UE dropping within a micro cell | < 28.9 m |  |
| BS antenna height | 10 m |   |
| Channel model | Micro (A) – Micro (V) see TR 38.803 [5] - Micro-to-Micro: UMi  (h\_UE=10 m) - Micro-to-Micro UE:  UMi + penetration loss - Micro (UE)-to-Micro (UE): UMi (h\_BS=1.5 m ~ 22.5 m)  + penetration loss between UEs |  |
| Shadowing correlation | Between cite: 0.5 |  |
| Multi operator layout | Cluster circle is coordinated |  Note 2 |
| Minimum distance between micro BSs in different operator | 10 m |  |
| Note 1: Micro BS is randomly dropped on an edge of the cluster circle. All UEs communicate with micro BS, i.e. macro cell is only used for determining position of micro BS. As a layout of macro cell, hexagonal grid, 19 macro sites, 3 sectors per site model with wrap around with ISD = 200 m is assumed.Note 2: Macro cell is collocated. Micro BS itself is randomly dropped. |

5.2.2.1.3 Indoor

Table 5.2.2.1.3-1: Single operator layout for Indoor scenarios in FR2 (30 GHz)

|  |  |  |
| --- | --- | --- |
| Parameters | Values | Remark |
| Network layout | Indoor-to-Indoor : Total 12 BSs (operator A: 6 BSs & operator B: 6 BSs) 120 m x 50 mcid:image002.png@01D4D8DE.1325CA10Indoor-to-macro: Indoors are placed at different locations |  |
| Inter-site distance | Indoor – Indoor = 20 m |  |
| The minimum distance between Macro to Indoor: [35] m |  |
| BS antenna height | 3 m | ceiling |
| Path-loss model | Indoor(Aggressor) → Indoor(Victim) - BS-to-BS: InH-office see TR 38.803 [5] - BS-to-UE: InH-office see TR 38.803 [5] - UE-to-UE: InH-office see TR 38.803 [5]Indoor (Agressor) → Macro (Victim) - BS-to-BS: InH-office (h\_UE = 3 m) + penetration loss see TR 38.803 [5] - BS-to-UE: InH-office (h\_UE = 3 m) + penetration loss see TR 38.803 [5] - UE-to-UE: InH-office (h\_BS = 1.5 m) + penetration loss see TR 38.803 [5] |  |
| Shadowing correlation | N/A |  |
| Multi operators layout for indoor | Uncoordinated operation (100%) |  |

* + Option 2: Inter-gNB coupling loss can be evaluated utilizing existing gNB-UE channel models in TR 38.802/38.901 with the proper adjustments on deployment and antenna parameters to mimic a gNB-gNB scenario. (Channel model: TR 38.901, Inter-UE: TR 38.901, Inter-gNB: 38.901)
* Recommended WF
	+ Further discuss the above options.

**Issue 2-2-9: Grid shift considerations:**

* Proposals
	+ Option 1: The 100% grid shift shall be applied for evaluation, while 0% grid shift doesn’t need to be considered
	+ TBA
* Recommended WF
	+ Agree on Option 1.

**Issue 2-2-10: UE distribution in macro scenario:**

* Proposals
	+ Option 1: Re-use assumptions in TR 38.828. [Moderator note: as highlighted in table below]

Table 5.2.1.3-1: UE distribution for FR1

|  |  |
| --- | --- |
| Scenarios | UE distribution |
| **Indoor-to-Indoor** | Indoor -> Indoor = 1 user per Transmission Reception Point; 100% indoor |
| **Macro-to-Indoor** | Indoor <-> macro = 1 user per Transmission Reception Point; Indoor has 100% indoor UE. Macro victim has 50% indoor UE and 50% outdoor.Indoor <-> macro = Aggressor: 1 user per Transmission Reception Point, 100% indoor. Victim: 1 user per Transmission Reception Point, 100% outdoor |
| **Urban Macro****(Macro-to-Macro)** | 20% indoor and 80% outdoor |

5.2.2.3.1 Urban Macro (Macro-to-Macro)

**Table 5.2.2.3.1-1: UE distribution for Urban Macro case in FR2**

|  |  |  |
| --- | --- | --- |
| **UE location** | **Outdoor/indoor** | Outdoor and indoor |
| **Indoor UE ratio** | 0% |
| **LOS/NLOS** | LOS and NLOS |
| **UE antenna height** | 1.5 m ≦ hUT ≦ 22.5 m |
| **UE distribution (horizontal)** | Uniform |
| **Minimum BS - UE distance (2D)** | 35 m |

5.2.2.3.2 Dense Urban (Micro-to-Micro)

**Table 5.2.2.3.2-1: UE distribution for Dense Urban case in FR2**

|  |  |  |
| --- | --- | --- |
| **UE location** | **Outdoor/indoor** | Outdoor and indoor |
| **Indoor UE ratio** | 80 % |
| **50% low loss, 50% high loss** | Low/high Penetration loss ratio |
| **LOS/NLOS** | LOS and NLOS |
| **UE antenna height** | Same as 3D-UMi in TR 36.873 [8] |
| **UE distribution (horizontal)** | Uniform |
| **Minimum BS - UE distance (2D)** | 3m |

5.2.2.3.3 Indoor-to-Indoor and Indoor-to-Macro

**Table 5.2.2.3.3-1: UE distribution for Indoor cases in FR2**

|  |  |
| --- | --- |
| **Scenarios** | **UE distribution** |
| Indoor-to-Indoor | Indoor -> Indoor = 1 user per Transmission Reception Point; 100% indoor |
| Macro-to-Indoor | Indoor <-> macro = Aggressor: 1 user per Transmission Reception Point, 100% indoor. Victim: 1 user per Transmission Reception Point, 100% outdoor |

* + Option 2: 80% outdoor, 20% indoor for UMa and Indoor hotspot.
	+ Option 3-1: Random and uniform UE dropping. 20% outdoor in cars: 30km/h and 80% indoor in houses: 3km/h.
	+ Option 3-2: Adopt following steps for UE dropping:
	+ Step 1: Randomly drop a cluster within a macro cell geographical area considering the minimum distance between macro TRP to cluster centre, e.g., 100m , where the size of each cluster is 120 x 50 (m);
	+ Step 2: 80% UEs are randomly and uniformly dropped within the cluster, and 20% UEs are randomly and uniformly dropped outside the cluster.
* Recommended WF
	+ Further discuss the above options.

**Issue 2-2-11: Noise figures:**

* Proposals
	+ Option 1: Re-use TR 38.828 assumptions -- FR1 BS: 5dB, UE: 9dB; FR2 BS: BS: 10dB, UE: 10dB.
	+ Option 2: BS 7dB, UE 13dB for FR1 and FR2.
* Recommended WF
	+ Further discuss the above options.

**Issue 2-2-12: BS antenna and TRP considerations**

* Proposals
	+ Option 1: Re-use TR 38.828 for legacy TDD BS, and consider two options for SBFD BS antenna and TRP power:
	+ Option 1-1: Utilize half of its original panel for SBFD UL and DL each. In this case, the TRP and elements number for DL and UL in SBFD BS will be half of the TDD BS configuration.
	+ Option 1-2: Utilize an extra panel for subband UL operation. In this case, the TRP and element number for DL and UL in SBFD BS will be the same as TDD BS configuration.

|  |  |  |
| --- | --- | --- |
|  | FR1 Macro Urban | FR2 Macro Urban |
| BS antenna configurations | For Legacy TDD:(Mg,Ng,M,N,P)=(1,1,8,8,2) (dH,dV)=(0.5,0.8)λFor SBFD:Option 1: (Mg,Ng,M,N,P)=(1,1,4,8,2) (dH,dV)=(0.5,0.8)λOption 2: (Mg,Ng,M,N,P)=(1,1,8,8,2) (dH,dV)=(0.5,0.8)λ | For 30 GHz legacy TDD: (1, 1, 8, 16, 2) For SBFD: Option 1 (1, 1, 8, 8, 2)Option 2 (1, 1, 8, 16, 2) |
| BS Tx power | For Legacy TDD:49 dBmFor SBFD:Option 1: 46 dBmOption 2: 49 dBm | For legacy TDD:43dBmFor SBFD:Option 1: 40 dBmOption 2: 43 dBm |

* + Option 2: RAN4 to further discuss the antenna pattern and related power for FR1 BS and FR2 BS due to the separate Tx and Rx antenna array assumption.
	+ Option 3: Adopt [49 dBm] for FR1 and [38 dBm] for FR2 BS Tx power assumption.
	+ Option 4: Parameters proposed for the specific scenarios in table below.

|  |  |
| --- | --- |
| Parameter | **Deployment scenarios** |
| **UMa deployment** | **Indoor Hotspot (Indoor office C in TR 38.808)** |
| BS antenna pattern | (M, N, P)=(8, 16, 2), with upper half panel for DL TX, bottom half for UL RX |
| BS Tx power | FR1: 45dBm, FR2: BS: 40 dBm/80 MHz. EIRP should not exceed 73 dBm Note: For system BW larger than above, Tx power scales up accordingly. |  FR1: BS: 31 dBmFR2: 23 dBm per 80 MHz. EIRP should not exceed 58 dBmNote: For system BW larger than above, Tx power scales up accordingly. |

* + Option 5: Use extended array antenna model defined in TR 38.803, Table 5.2.3.2.4-2. The sub-array is essential to be able to provide TX/RX isolation required for SBFD. For FR1 parameters in TR 38.803, Table 5.2.3.2.4-3 is suitable are starting point. Parameters for FR2 is also provided in our contribution.
* Recommended WF
	+ Further discuss the above options.

**Issue 2-2-13: UE antenna and Tx power**

* Proposals
	+ Option 1: Re-use TR 38.828 assumptions:
* FR1 max Tx 23dBm, min Tx -40 dBm with 0dBi omni directional antenna.
* FR2 max Tx 13.4dBm (peak eirp 22.4dBm), min Tx -40dBm, with antenna configuration in below table.
* Table 5.2.2.5.4-1: FR2 UE antenna element pattern

|  |  |
| --- | --- |
| Parameter | Values |
| Antenna element vertical radiation pattern (dB) |  |
| Antenna element horizontal radiation pattern (dB) |  |
| Combining method for 3D antenna element pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 3 dBi (assuming 5dBi directivity and 2dB loss) |
| BS antenna configuration  | (Mg, Ng, M, N, P) = (1, 1, 2, 2, 2)Note 1,2 |
| (dv, dh) | (0.5λ, 0.5λ) |
| UE orientation | Random orientation in the azimuth domain: uniformly distributed between -90 and 90 degrees Note 3Fixed elevation: 90 degrees |
| Note 1: Mg = number of antenna panels in elevation, Ng – number of antenna panels in azimuth, M = number of antenna elements/subarrays in elevation, N= number of antenna elements/subarrays in azimuth, P = number of polarizations.Note 2: TX power is specified per polarization, a single polarization may be simulated under the assumption of polarization match.Note3: This is done to emulate two panels: the configuration is equivalent to 2 panels with 180 shift in horizontal orientation and UE orientation uniformly distributed in the azimuth domain between -180 and 180 degrees.Note 4: A 90 degree element beamwidth was assumed for simulations, even though the physically correct beamwidth would be 130 degrees. The difference in assumption does not substantially impact the simulation |

* + Option 2: FR1 max Tx 23dBm; FR2 max Tx 23dBm (peak eirp 43dBm) with (M, N, P)=(1, 4, 2), 2 panels antennas and element gain as 1.5 dBi.
* Recommended WF
	+ Further discuss the above options.

**Issue 2-2-14: BS mechanical down-tilt angles**

* Proposals
	+ Option 1: Propose to align the mechanical down-tilt angles assumptions for BS. And it is proposed to use 6 degrees for the Macro BS for FR1 and FR2 as provided in TR 38.803.
	+ Option 2: Not specified for UMa, 90-deg (point to ground) for indoor.
* Recommended WF
	+ Agreed on Option 1 and 2.

**Issue 2-2-15: Uplink power control model**

* Proposals
	+ Option 1: Propose to use the following as the general uplink power control model for SBFD co-existence study.

|  |
| --- |
| For downlink scenario, no power control scheme is applied.For uplink scenario, TPC model specified in Section 9.1 TR 36.942 [9] is applied with following parameters.- CLx-ile = –SNR\_target + UE\_maxpower – ThermalNoise – BS\_NoiseFigure + 10\*log10(BW) - γ = 1Where, SNR\_target for FR1 and FR2 are 15 dB. |

* + Option 2: TBA.
* Recommended WF
	+ Agree on Option 1.

**Issue 2-2-16: UE ACLR considerations**

* Proposals
	+ Option 1: For FR1, it is proposed to adopt ACLR1 as 30 dBc and ACLR2 as 43 dBc for FR1 UE.
	+ Option 2-1: We should at first model ACLR equivalent emission mask for legacy TDD carrier to help calculate received sub-band interference at adjacent SBFD carrier.
	+ Option 2-2: We should define ACLR1, ACLR2 and even higher order ACLR model for SBFD network to help evaluate interference.
* Recommended WF
	+ Further discuss the above options.

**Issue 2-2-17: BS ACLR/ACS considerations**

* Proposals
	+ Option 1: Re-use TR 38.828 assumptions -- ACLR/ACS for FR1 BS: 45/46 dBc, FR2 BS: 28/23.5 dBc.
	+ Option 2: TBA
* Recommended WF
	+ Agree on Option 1.

**Issue 2-2-18: SBFD self-interference consideration in SLS**

* Proposals
	+ Option 1: Proposed to use {N = noise floor + 1dB} for the SBFD system to simulate the self-interference impact as a simplified method to evaluate its SINR/throughput.
	+ Option 2: Apply Total Isolation = Spatial Isolation + NLIC + ACLR = 135 dB for intra-gNB CLI link, where Spatial Isolation plus NLIC = 90dB and Flat ACLR = 45dBc/20MHz.
* Recommended WF
	+ Further discuss the above options.

**Issue 1-19: Co-ex study steps**

* Proposals
	+ Option 1: Propose to adopt the following steps, modified from TR 38.828 and other general legacy RAN4 coex study report, as the simulation steps for SBFD coex study.

|  |
| --- |
| 1. Aggressor and victim network are generated.- UEs are distributed randomly across the network.2. UE associations: UEs are associated to base station based on coupling loss.- Associations are made assuming a single element at both UE and BS.3. Once association is done, round robin scheduling is used. BF weights are adjusted to point to the LOS direction between BS-UE. This is done for both victim and aggressor networks.4. When legacy TDD system is victim, follow steps 4a:4a. Throughput is computed considering ACI from another static TDD system as baseline aggressor:- $Thput\_{baseline}\left[bpshz\right]=f\left(SINR\_{ICI+ACI\\_baseline}\right)=f\left(\frac{S}{N+I\_{ICI}+I\_{ACI\\_baseline}}\right)$, where $I\_{ICI}$ is the inter-cell interference and $I\_{ACI\\_baseline}$ is the adjacent channel interference from the baseline aggressor.When SBFD system is victim, follow steps 4b:4b. Throughput is computed in the victim system without considering ACI as below:- $Thput\_{baseline}\left[bpshz\right]=f\left(SINR\_{ICI}\right)=f\left(\frac{S}{N+I\_{ICI}}\right)$, where $I\_{ICI}$ is the inter-cell interference.5. Throughput is computed considering ACI below:- $Thput\_{ACI}\left[bpshz\right]=f\left(SINR\_{ICI+ACI}\right)=f\left(\frac{S}{N+I\_{ICI}+I\_{ACI}}\right)$, where $I\_{ACI}$ is the adjacent channel interference. |

* + Option 2: TBA
* Recommended WF
	+ Agree on Option 1.

**Issue 1-19: Evaluation metrics**

* Proposals
	+ Option 1: It is proposed to follow the TR 38.828’s evaluation criteria to check the 50% and 5% throughput loss compared to the baseline scenario defined.
	+ Option 2: TBA.
* Recommended WF
	+ Agree on Option 1.

**Issue 1-20: Other assumptions**

* Proposals
	+ Option 1: Propose to adopt the system characteristics, deployment parameters and other assumptions from TR 38.828 as the starting point for SBFD co-ex study. But the assumptions should be updated accordingly to fulfill the SBFD co-ex purpose.
	+ Option 2: TBA.
* Recommended WF
	+ Agree on Option 1 as a general starting basis for those SLS assumptions that were not discussed.

### Sub-topic 2-3: co-channel feasibility study

*Sub-topic description: this sub-topic focuses on the issues not covered in sub-topic 2-1 and 2-2.*

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

**Issue 2-2: Candidates for simulation on co-channel self-interference**

* FFS on below options
	+ Option 1: Link level assessment for co-channel adjacent subband interference
	+ Option 2: Discussion on alignment on PA model with realistic DPD component
	+ Option 3: Discussion on crest factor processing model condition on whether power increased assumed for gNB DL subband TX
	+ Option 4: Discussion on Receiver impairment/non-linearity factors can be modelled
	+ Option 5: TBA
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1-1: issue 2-1-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

 ……

Sub topic 2-2: issue 2-2-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

### CRs/TPs comments collection

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

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

## Summary for 1st round

### Open issues

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

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

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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

# Topic #3: Regulatory survey

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2211881 | Apple | Observation 1: The focus of RAN4 task of summarizing the regulatory aspects is to find out if there is any regulation that limits such simultaneous TX and RX by a gNB on TDD spectrum. Proposal 1: If needed, consider using direct liaison with regulatory bodies to obtain relevant regulatory info/clarification.  |
| R4-2212314 | CMCC | **Regulatory information from China:**Observation 1: In China, spectrum is allocated with clearly stating it for TDD or FDD operation. There is no SBFD regulatory requirements in China now.Observation 2: MIIT mainly cares interference between different operators. Necessary interference coordination mechanism and solutions may be proposed by MIIT to avoid interference before any SBFD deployment. |
| R4-2212495 | Huawei, HiSilicon | **Observation based on 3GPP specification and Europe regulatory:**Observation 1: for TDD multiple operators’ networks, it requires synchronized operation for using the same or adjacent operation band.Observation 2: It already possible today to use different TDD frame structure for isolated deployment, e.g. isolated indoor factory, as long as obligation to avoid interference is guaranteed.Observation 3: for single operator’s TDD network, there may be no limitation on the frame structure and it is up to operator’s choice. |
| R4-2212580 | Samsung R&D Institute UK | **Observation based on Europe regulatory:** Observation 1: The evolution of NR duplex operation would bring changes to the frame structures of legacy TDD operation and consequently may affect TDD synchronisation. Observation 2: Several frame structures for TDD MFCN networks have been recommended by ECC to facilitate synchronisation in the frequency band 3400-3800 MHz.at boarder areas. However, unsychronised or semi-synchronised operation of TDD MFCN networks are not precluded with certain requirements and/or procedures of cross-boarder coordination between administrations. |
| R4-2212655 | Ericsson | **Survey on regulatory from Europe, North America, China and Japan:**Observation 1: For a chosen TDD pattern, sub-band full duplex operation would increase the UL transmission in the network, increasing the level of UL interferences.Observation 2: Regulators made coexistence studies assuming a certain DL/UL ratio. Any change in that ratio might have some impacts on the corresponding studies’ conclusion.Observation 3: To authorize SBFD deployment, Regulators might want to re-evaluate existing coexistence studies done for TDD bands, releasing a new regulation.Observation 4: For some 5G bands, Regulators have considered unsynchronized (or semi-synchronized) TDD operation between adjacent operators by introducing more stringent parametersObservation 5: More stringent Regulatory requirements might impact BS feasibility, final cost, size and weight, especially if SBFD DL is considered during “legacy” UL slots. |
| R4-2212849 | Nokia, Nokia Shanghai Bell | **Observation based on Europe regulatory**Proposal 1: focus the study on regulatory aspects for deploying the identified duplex enhancements to the TDD unpaired spectrum in the 3400-3800 MHz frequency range. Observation 1: In many CEPT countries, the same frame format is effectively mandated both indoor and outdoor in the 3400-3800 MHz frequency band.Observation 2: In other regions, synchronization in the 3400-3800 MHz frequency band is not mandated but highly recommended.Proposal 2: Approve TP to the TR 38.585 |

## Open issues summary

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

### Sub-topic 3

*Sub-topic description:*

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

**Issue 3-1: Survey on regulatory aspects**

* Summary according to input for this meeting
	+ Summary on CEPT countries
		- Regulators made coexistence studies assuming a certain DL/UL ratio for IMT TDD band 3.4-3.8GHz band in Europe. The evolution of NR duplex operation would bring changes to the frame structures of legacy TDD operation and consequently may affect TDD synchronisation.(R4-2212580/R4-2212655/R4-2212849)。
		- In many CEPT countries, the same frame format is effectively mandated both indoor and outdoor in the 3400-3800 MHz frequency band.(R4-2212849)
		- Several frame structures for TDD MFCN networks have been recommended by ECC to facilitate synchronisation in the frequency band 3400-3800 MHz at boarder areas. However, unsynchronised or semi-synchronised operation of TDD MFCN networks are not precluded with certain requirements and/or procedures of cross-border coordination between administrations. (R4-2212580)
		- It already possible today to use different TDD frame structure for isolated deployment.(R4-2212495)
	+ Summary on North America(R4-2212655):
		- No TDD pattern has been mandated in US, nor in Canada, but operators are encouraged to coordinate their network deployment and make sure they don’t interfere with each other.
		- Unsynchronized operation is allowed, more stringent regulation parameters have not been specified for such case but, again, operators would have to work their differences to avoid any claim to FCC/ISED.
	+ Summary on China (R4-2212314/R4-2212655):
		- In China, spectrum is allocated with clearly stating it for TDD or FDD operation. there is no SBFD regulatory requirements in China until now.
		- MIIT mainly cares interference between different operators. Necessary interference coordination mechanism and solutions may be proposed by MIIT to avoid interference before any SBFD deployment.
	+ Summary on Japan (R4-2212655):
		- No TDD pattern has been mandated in Japan but operators are required to coordinate their network deployment to avoid interference.
		- Operators are allowed to use unsynchronized operation as far as there is no interference with the adjacent network(s), e.g. for indoor usage.
* Recommended WF
	+ Please comment if any different understanding regarding regulatory aspect for each region/country on SBFD operation

**Issue 3-2: Proposal to study on regulatory aspect**

* Proposals
	+ Option 1: discuss the necessity to consider direct liaison with regulatory bodies to obtain relevant regulatory info/clarification.(R4-2211881)
	+ Option 2: focus the study on regulatory aspects for deploying the identified duplex enhancements to the TDD unpaired spectrum in the 3400-3800 MHz frequency range.(R4-2212849)
	+ Option 3: clarify further the difference between SBFD and CLI operation in view of regulatory from interference perspective
* Recommended WF
	+ Please comment to each option

## Companies views’ collection for 1st round

### Open issues

Sub topic 3-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

Sub topic 3-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

### CRs/TPs comments collection

*For this Rel-18 SI, suggest to focus on open issues discussion in the first meeting and postpone the approval on TP according to work plan.*

## Summary for 1st round

### Open issues

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

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

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |  |
| --- | --- | --- | --- |
| **New Tdoc number** | **Title** | **Source** | **Comments** |
|  | WF on … | YYY |  |
|  | LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |  |

**Existing tdocs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-2211561 |  | Impact of SBFD on RF requirements for co-existence in adjacent channel | Qualcomm CDMA Technologies | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-2211562 |  | Impact of SBFD on RF requirements for self-interference and CLI | Qualcomm CDMA Technologies |  |  |
| R4-2211709 |  | Discussion of the reply LS to RAN1 on interference modelling for duplex evolution | CATT |  |  |
| R4-2211710 |  | Preliminary discussion of the adjacent channel co-existence for SBFD | CATT |  |  |
| R4-2211711 |  | Preliminary discussion on the self-interference and CLI for SBFD | CATT |  |  |
| R4-2211790 |  | Discussion on RF requirements for subband full duplexing | CEWiT |  | Not available |
| R4-2211880 |  | On UE-UE CLI modeling | Apple |  |  |
| R4-2211881 |  | On regulatory aspects of evolution of NR duplex operation | Apple |  |  |
| R4-2212117 |  | Discussion on RF requirement for Massive MIMO Antenna for subband non-overlapping full duplex | Kumu Networks |  |  |
| R4-2212146 |  | Views on RF Analysis for Full Duplex | Intel Corporation |  |  |
| R4-2212160 |  | Duplex enhancements UE-UE CLI modelling | MediaTek (Chengdu) Inc. |  |  |
| R4-2212161 |  | Clarifying RAN4 work scope for duplex enhancements | MediaTek (Chengdu) Inc. |  |  |
| R4-2212312 |  | self interference and CLI study of SBFD | CMCC |  |  |
| R4-2212313 |  | adjacent channel interference analysis for SBFD | CMCC |  |  |
| R4-2212314 |  | SBFD regulatory requirements in China | CMCC |  |  |
| R4-2212485 |  | Initial observations on RF impact due to NR duplex evolution | Samsung |  |  |
| R4-2212486 |  | Discussion on interference modelling for duplex evolution | Samsung |  |  |
| R4-2212487 |  | Workplan on NR duplex evolution for RAN4 | Samsung,CMCC |  |  |
| R4-2212492 |  | On evolution of NR duplex operation | Huawei, HiSilicon |  |  |
| R4-2212493 |  | Reply LS on interference modelling for duplex evolution | Huawei, HiSilicon |  |  |
| R4-2212494 |  | Discussion on the assumptions for co-existence evaluation of Rel-18 duplex evolution | Huawei, HiSilicon |  |  |
| R4-2212495 |  | On regulatory aspects | Huawei, HiSilicon |  |  |
| R4-2212580 |  | Discussion on regulatory aspect of NR duplex evolution | Samsung R&D Institute UK |  |  |
| R4-2212599 |  | Discussion on interference modelling for duplex evolution | Xiaomi |  |  |
| R4-2212619 |  | General considerations for the duplexng enhancements RAN4 work and draft reply LS to RAN1 | Ericsson |  |  |
| R4-2212620 |  | Co-channel gNB self interference analysis | Ericsson |  |  |
| R4-2212621 |  | Co-existence considerations for SBFD | Ericsson |  |  |
| R4-2212655 |  | Sub-Band Full Duplex - Regulatory aspects | Ericsson |  |  |
| R4-2212697 |  | Scenarios, assumptions and analysis for SBFD coex study | Samsung |  |  |
| R4-2212801 |  | Discussion on co-existence in adjacent channel for full duplex | vivo |  |  |
| R4-2212802 |  | Discussion on self-interference and CLI for full duplex | vivo |  |  |
| R4-2212847 |  | Adjacent channel coexistence in Sub Band non-overlapping Full Duplex operation | Nokia, Nokia Shanghai Bell |  |  |
| R4-2212848 |  | Self-interference and CLI in Sub Band non-overlapping Full Duplex | Nokia, Nokia Shanghai Bell |  |  |
| R4-2212849 |  | Regulatory considerations on sub-band full duplex operation | Nokia, Nokia Shanghai Bell |  |  |
| R4-2213690 |  | Discussion on reply LS for full duplex BS | ZTE Corporation |  |  |
| R4-2213691 |  | Discussion on full duplex coexistence in adjacent channel scenario | ZTE Corporation |  |  |
| R4-2213692 |  | Discussion on self-interference and CLI for full duplex BS | ZTE Corporation |  |  |

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** | **Revised to** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-22xxxxx |  | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-22xxxxx |  | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-22xxxxx |  | 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