**3GPP TSG-RAN WG4 Meeting #111 R4-2410108**

**Fukuoka City, Fukuoka, Japan, 20th – 24th May, 2024**

**Agenda item:** 10.12.3

**Source:** Moderator (Samsung)

**Title:** Topic summary for [111][313] NR\_duplex\_evo

**Document for:** Information

# Introduction

In RAN#102, the work item on evolution of NR duplex operation (SBFD) has been approved [RP-234035], with WID further revised in the follow-up RAN plenary [RP-240789]. According to the objectives in WID, RAN1 is tasked to specify the mechanisms to support SBFD, including semi-static indication of time/frequency location, random access in SBFD symbols, and other transmission, reception and measurement behavior and procedures for SBFD aware UE. Furthermore, the enhancement for CLI handing, including gNB-to-gNB and UE-to-UE CLI handling, will also be specified in RAN1. Accordingly, from RAN4 perspective, it is tasked to “Specify BS RF requirements for SBFD operation at gNB [RAN4]”.

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

|  |
| --- |
| * 1. Evolution of NR duplex operation: Sub-band full duplex (SBFD) [NR\_duplex\_evo]
		1. General aspects (including RAN4 aspects for SBFD system parameters) [NR\_duplex\_evo-Core]
		2. BS RF requirements [NR\_duplex\_evo-Core]
			1. Modification of existing requirements for FR1 and FR2-1 [NR\_duplex\_evo-Core]
			2. Potentially new requirements for SBFD operation for FR1 and FR2-1 [NR\_duplex\_evo-Core]
		3. Moderator summary and conclusions [NR\_duplex\_evo]
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*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

# Topic #1: General aspects (including RAN4 aspects for SBFD system parameters)

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407153 | Charter | Observation 1: The study in [1] shows that adjacent-channel interference between two adjacent carriers degrades throughput performance due to SBFD operation adjacent to a second legacy TDD operator and can create severe gNb-to-gNb as well UE-to-UE interference. Proposal 1: We propose to add in the TR (SBFD Technical Report) a statement that says “In most regions SBFD operation can work safely side by side with legacy TDD. However, in some special regions like the in USA, SBFD is expected to create severe degradation to legacy TDD operating in CBRS band. The reason for this special case is that TDD operation like for example, the USA CBRS band, is limited to low gNb power micro-cells, and the adjacent bands namely, AMBIT, and C-band can use 30 dB higher power Macro-cells. In these special regions SBFD should be expected to coexist fairly with legacy TDD.” This comment can be added to section 12.2.1 in TR 38.858 and/or section 11.Proposal 2: We propose to add in the TS 38.104 s similar statement as well. |
| R4-2407554 | CATT | Observation 1: Only two sub-band patterns, DUD and DU, are supported by the R19 SBFD feature.Proposal 1: Add the clarification in the specification that SBFD operation is only defined for FR1 TDD bands and FR2-1 bands.Proposal 2: It should be clarified which UE implementation performance should be considered for guard band discussion.Proposal 3: The following handling approach can be considered.1. Add clarification that only DUD and DU pattern are allowed for the sub-band configuration.2. Not define sub-band BW and the guard band size in specification. The RB number in the test is based on the declaration.  |
| R4-2408127 | vivo | Proposal 1: Introduce duplex mode ‘SBFD’ and reflect in the gNB spec.Proposal 2: It is suggested to only consider DUD and DU for gNB SBFD and UL subband occupies 20% BS channel bandwidth and capture the table for gNB SBFD configurations in TS 38.104.Table 1. BS SBFD configurations in FR1 and FR2-1

|  |  |
| --- | --- |
| SBFD configuration | *BS channel bandwidth* (MHz) |
| 25 | 25 | 50 | 50 | 100 | 100 | 200 | 200 | … |
| DL Subband 1 | 10 | 20 | 20 | 40 | 40 | 80 | 80 | 160 | … |
| UL Subband | 5 | 5 | 10 | 10 | 20 | 20 | 40 | 40 | … |
| DL subband 2 | 10 | N/A | 20 | N/A | 40 | N/A | 80 | N/A | … |

Proposal 3: The NRB configuration for DL or UL subbands can still follow the transmission bandwidth configuration in TS 38.104.Observation 1：For FR1 WA BS, the required RSIC is hard to achieve according to the feasibility study for gNB self-interference.Observation 2: Reserving some minimum guard band can reduce the difficulty to achieve the required RSIC, at least for FR1 wide area BS. |
| R4-2408225 | CMCC | Proposal 1: for RF spec structure of SBFD requirements, it’s better to create new sub-clauses in TS 38.104 which capture all new and existing RF requirements that applies for SBFD. Proposal 2: it’s suggested to specify all TDD bands for SBFD operation.Proposal 3: it’s better to specify limited number of subband size for each channel bandwidth with corresponding guardband. 100MHz and 60MHz are suggested as typical channel bandwidth to support SBFD. |
| R4-2408398 | Qualcomm Germany | Proposal 1: To enhance the readability of the spec, it is preferable to have standalone sub-clauses in TS 38.104 for SBFD-specific existing or new gNB RF requirements. The implementation and structure of such approach can follow at a later stage in the WI phase. Proposal 2: RAN4 to not study band specific SBFD operation since TDD defined bands in TS 38.104 can be target bands for SBFD operation. Proposal 3: RAN4 to include the following text in Clause 5.2 in TS 38.104: subband full duplex can be applied to TDD bands given in Table 5.2-1.Proposal 4: RAN4 to discuss simulation framework, main scenarios and assumptions, and procedures required to determine the simulation effort required to progress discussions on Rx blocking requirements for an SBFD-capable gNB. Proposal 5: RAN4 to further study the if given subband configurations will be specified in the core spec or will be based on manufacturer declaration and its implications on the minimum guardband specification between SBFD and non-SBFD symbols/ slots. Proposal 6: RAN4 to align if the subband bandwidth should be aligned with the supported channel bandwidths for FR1 and FR2-1. |
| R4-2409373 | Ericsson | Observation 1 To evaluate the blocking power level from other BSs, further system level simulations are required.Observation 2 Wide guardband can consume valuable bandwidth. When the bandwidth is low, after excluding the guard band, the remaining PRBs for both DL and UL sub-bands may become insufficient. Such a situation is not practical in real-world deployments.Observation 3 To further protect robustness of SBFD operation, further requirements and testing could be defined based on sectorized test setup.Proposal 1 The desired scenarios are Scenario 1, 3, 5, 6, 9, and the desired case is Case 3.Proposal 2 In the further simulation work in WI, absolute power level of interference from adjacent channel should be collected from the simulation results to derive in-band blocking levels.Proposal 3 The following simulation procedure should be considered to derive the SBFD BS in-band blocking requirements: 1) Setup a coexistence scenario based on scenarios down selected from the SI. 2) Focus on Case 3, to evaluate the blocking requirement of UL SBFD. 3) Remove from the SBFD network the internal co-channel interference. 4) Evaluate the CDF of the wideband power received in the receiver of UL SBFD, from the adjacent channel. 5) Find the 99% tile of the UL SBFD wideband received power CDF to define the blocking requirement in each of the down-selected scenariosProposal 4 SBFD configurations shall be captured in Rel-19 RAN4 specification and restricted to a limited set.Proposal 5 Identify the configurations that are impractical due to excessive guardband width, e.g., rule out narrower bandwidth 5 MHz, 10 MHz, 15 MHz, etc., and focus on higher bandwidth, e.g., 50 MHz, 100 MHz, etc.Proposal 6 For FR1, use 30 kHz as the SCS for SBFD slots. For FR2-1, use 120 kHz as the SCS for SBFD slots.Proposal 7 Limit the number of SBFD configurations to five for FR1, and three for FR2-1. |
| R4-2409412 | Nokia | Proposal 1: For FR1, RAN4 to prioritize SBFD requirements for BS carrier bandwidths of 100 MHz.Proposal 2: For FR1 SBFD requirements, the size of the UL subband is aligned with the transmission bandwidth configurations specified in TS 38.104. That is 51 RBs for a 20 MHz channel and 30 kHz SCS.Proposal 3: For FR1 SBFD requirements, from base station perspective, the following assumptions for guardbands and UL and DL subbands can be used as starting point:a. For FR1 DUD configuration in 100 MHz channel and 30 kHz SCS: < ND, NU, NG > = <106, 51, 5>b. For FR1 DU or UD configuration in 100 MHz channel and 30 kHz SCS: < ND, NU, NG > = <217, 51, 5Proposal 4: For FR2 SBFD requirements, from base station perspective, the following assumptions for guardbands and UL and DL subbands can be used as starting point:a. For FR2 DUD configuration in 100 MHz channel and 120 kHz SCS: < ND, NU, NG > = <25, 14, 1>b. For FR2 DUD configuration in 200 MHz channel and 120 kHz SCS: < ND, NU, NG > = <52, 26, 1>Proposal 5: The value of guardbands, DL and UL subbands are not fixed in the specifications. RAN4 may agree one or more ‘typical’ values for which requirements are defined, while the gNB should still have the possibility to operate with a different (e.g. larger) guardband and UL and DL subband sizes. |
| R4-2409623 | ZTE Corporation, Sanechips | Proposal 1: postpone the decision for Issue 2-1-1 until RAN4 reached the consensus on full sets of RF requirements of SBFD BS. Proposal 2: RAN4 continue the technical analysis for feasibility study of FR1 WA SBFD BS in Rel-19 and focus on RF requirements for other BS class; Proposal 3: the conformance testing are still needed for both SBFD and non-SBFD slots even though RF requirement might be same. Proposal 4: RAN4 don’t need to mention any feasible BS implementation and RAN4 only need to ensure the reasonable performance regardless from coexistence performance or its link performance within the serving cells.Proposal 5: SBFD BS is supposed to be supported in all FR1 TDD bands and FR2-1 TDD bands. Proposal 6: the guard band size between sub-band is up to the implementation or vendor’s declaration; Proposal 7: RAN4 need to discuss the typical sub-band configuration for conformance testing and it should cover all potential BS carrier bandwidth. This should be part of core requirement instead of test models/configurations of conformance testing.Proposal 8: RAN4 could derive the interference signal power level of in-band blocking requirement by system level simulation with 99.99% statistical CDF curve of blocking levels from aggressor system in DL direction and no CLI coordination among different carriers. Proposal 9: RAN4 define the requirement for outside of wanted carrier based on no CLI coordination as baseline. |
| R4-2409763 | Samsung | Observation 1: RAN1 agree to introduce the cell-specific configuration of frequency locations of SBFD subbands, and accordingly RB-level granularity is supported for semi-static indication of SBFD subband frequency location. Observation 2: For determine the limitation/restriction of the size of subband and guardband, the BS SBFD implementations including the possibility of adding UL subband RF filter, analog filter prior to the ADC or other RF and digital domain techniques related to subband bandwidth shall be considered. Proposal 1: The following limitation/restriction of the size of subband and guardband shall be considered as baseline: * Subband (including both UL/DL subband):
	+ Granularity: 1 RB
	+ Possible Subband size (expressed in RBs): {Xmin, Xmin+1,..., Xmax}
		- Xmin = 1
		- Xmax = NRB (i.e., Transmission bandwidth configuration)
* Guardband:
	+ Granularity: 1 RB
	+ Possible guardband size (expressed in RBs): {0, 1, 2, ..., Ymax}
		- Where Ymax is the maximum allowed number of RBs for guardband
			* FFS the value of Ymax

Proposal 2: A new 5.3 clause with suffix B is added to capture the BS channel bandwidth for SBFD (including Transmission bandwidth configuration, guardband and subband configuration for SBFD), with the following text proposal to be considered as baseline skeleton for triggering discussion: =================== Start of Text Proposal ===================5.3B BS channel bandwidth for SBFD5.3B.1 General<To be added, for the definition of channel bandwidth, transmission bandwidth configuration, uplink and downlink subbands and guardband within one NR channel for SBFD operation>5.3B.2 Transmission bandwidth configuration for SBFD<To be added>5.3B.3 Guardband andSubband configuration for SBFD<To be added>=================== End of Text Proposal =================== |

## Open issues summary

### Sub-topic 1-1: General issues for SBFD operation

#### Issue 1-1-1: SBFD as band specific or general feature to all TDD bands

* [Moderator] Treat SBFD as a band specific feature or a general feature to all TDD bands
	+ Option 1 (CMCC/QC/CATT/ZTE): General feature to all TDD bands
		- Option 1a (CATT/QC): SBFD Add the clarification in the specification that SBFD operation is defined for FR1 TDD bands and FR2-1 bands:
			* “subband full duplex can be applied to TDD bands given in Table 5.2-1.” (example given by QC)
	+ Option 2 (vivo/Nokia): Band specific feature
		- Option 2a (vivo): Introduce duplex mode ‘SBFD’ and reflect in the gNB spec.
		- Option 2b (Nokia): Focus on defining the BS RF requirements for SBFD-capable BS in n104 band.
* Moderator Recommendation:
	+ Option 1, and the exact clarification as proposed in Option 1a can be further discussed in this meeting.
* Offline:
	+ SBFD is a feature which can potentially be utilized for all TDD band, under the following considerations:
		- Option 1: Declaration based method
			* The band supported for SBFD shall be declaration based
			* The channel bandwidth supported for SBFD shall be declaration based
				+ The supported channel bandwidth can be impacted by the subband/guard band size discussion
		- Option 2: General principle but with consideration(s) for a specific band
			* General principle: The channel bandwidth shall be larger than X MHz
				+ FFS the value of X

X can be different for high and middle TDD bands

* + - * + For a specific band, the following further restriction(s) can be considered:

Certain restriction can be provided by operator(s) for certain band

Other restrictions are not precluded.

#### Issue 1-1-2: BS classes to support SBFD operation

* [Moderator] Continue to discuss BS classes to support SBFD operation
	+ Proposal 1 (ZTE): RAN4 continue the technical analysis for feasibility study of FR1 WA SBFD BS in Rel-19 and focus on RF requirements for other BS class;
	+ Proposal 2 (CMCC): Define WA, MR, LA gNB requirement for SBFD with same priority
	+ Proposal 3 (Huawei): Not to consider precluding or deprioritizing WA BS type from future discussion on SBFD.
* Moderator Recommendation:
	+ Discussion on Proposal 1 firstly, but seems it is more like a RAN-P level proposal to restrict WI scope. Seems Proposal 2/3 is the target we can follow and the focus should be on particular requirement if no clear priority given by RAN-P.

#### Issue 1-1-3: Applicability of SBFD and non-SBFD requirements

* [Moderator] Applicability of SBFD and non-SBFD requirements is already agreed in SI, with the following conclusion captured in TR:

|  |
| --- |
| For SBFD-capable BS, the existing RF requirements shall be applied in the OFDM symbols/slots others than SBFD symbols/slots and RF requirement impacts in the SBFD symbols/slots will be further clarified in details in the following sections.Some requirements might need to be tested in both SBFD and non-SBFD slots even when the requirement is the same. The reason would be if it could be expected that the BS operating condition may differ between SBFD and non-SBFD slots. Whether to apply a test in both SBFD and non-SBFD slots should be discussed on a requirement by requirement basis in the conformance part of a WI. |

while the focus is on the requirement needs to be verified in both SBFD and non-SBFD slots/symbols even though RF requirement might be the same:

* + Proposal 1 (ZTE): the conformance testing are still needed for both SBFD and non-SBFD slots even though RF requirement might be same.
* Moderator Recommendation:
	+ Discussion on Proposal 1. In some requirement, the testing is not needed for non-SBFD slots/symbols.
* Offline:
	+ The conformance testing is needed for both SBFD and non-SBFD slots/symbols even though RF requirement might be same.

#### Issue 1-1-4: Applicability of SBFD requirements to different feasible BS implementations

* [Moderator] The applicability of SBFD requirements to different feasible BS implementations:
	+ Proposal 1 (ZTE): RAN4 don’t need to mention any feasible BS implementation and RAN4 only need to ensure the reasonable performance regardless from coexistence performance or its link performance within the serving cells.
* Moderator Recommendation:
	+ Discussion on Proposal 1. In the last meeting, the proposal of considering different feasible BS implementation is not intended to mention any feasible BS implementations, but propose the requirement should be defined by considering all possible ones.

#### Issue 1-1-5: Region limitation for subband full duplex

* [Moderator]: Region limitation for subband full duplex is proposed to be added in TR firstly.
	+ Proposal 1 (Charter): We propose to add in the TR (SBFD Technical Report) a statement as below, which can be added to section 12.2.1 in TR 38.858 and/or section 11:
		- “In most regions SBFD operation can work safely side by side with legacy TDD. However, in some special regions like the in USA, SBFD is expected to create severe degradation to legacy TDD operating in CBRS band. The reason for this special case is that TDD operation like for example, the USA CBRS band, is limited to low gNb power micro-cells, and the adjacent bands namely, AMBIT, and C-band can use 30 dB higher power Macro-cells. In these special regions SBFD should be expected to coexist fairly with legacy TDD.”
	+ Proposal 2 (Charter): We propose to add in the TS 38.104 s similar statement as well.
* Moderator Recommendation:
	+ Discussion on Proposal 1/2 firstly.

#### Issue 1-1-6: CLI handling impact on RF requirement

* [Moderator]: The CLI handling impact on RF requirement is discussed.
	+ Proposal 1 (ZTE): RAN4 define the requirement for outside of wanted carrier based on no CLI coordination as baseline.
* Moderator Recommendation:
	+ Discussion on Proposal 1 firstly.
* Offline:
	+ The CLI handling impact on RF requirement:
		- Option 1: RAN4 define RF requirements for the frequency outside of wanted carrier based on no CLI handling as baseline.
		- Option 2: FFS CLI handling impact on RF requirements

### Sub-topic 1-2: Restriction for SBFD subband and guard band

#### Issue 1-2-1: UE implementation performance considered for guard band size

* [Moderator] Even though the UE RF requirement objective is not included in WID, it is proposed that RAN4 to clarify which UE implementation performance should be considered for guard band:
	+ Proposal 1 (CATT): It should be clarified which UE implementation performance should be considered for guard band discussion.
* Moderator Recommendation:
	+ Discuss on Proposal 1, if needed, the group shall discuss how to list the relevant UE implementation performance for guard band size discussion.

#### Issue 1-2-2: How to handle guard band and subband configurations in specification

* [Moderator] How to handle guard band and subband sizes in the specification:
	+ Proposal 1 (CATT/vivo): Add clarification that only DUD and DU patterns are allowed for the sub-band configuration.
	+ Proposal 2 (Qualcomm): RAN4 to further study the if given subband configurations will be specified in the core spec or will be based on manufacturer declaration and its implications on the minimum guardband specification between SBFD and non-SBFD symbols/ slots.
	+ Proposal 3 (Nokia): The value of guardbands, DL and UL subbands are not fixed in the specifications. RAN4 may agree one or more ‘typical’ values for which requirements are defined, while the gNB should still have the possibility to operate with a different (e.g. larger) guardband and UL and DL subband sizes.
* [Moderator] Detailed answers/solutions for the questions in Qualcomm’s Proposal 2
	+ Option 1 (CATT): Not define sub-band BW and the guard band size in specification. The RB number in the test is based on the declaration.
	+ Option 2: Allowed subband configurations will be specified in the core spec
		- Proposal 4 (Samsung): A new 5.3 clause with suffix B is added to capture the BS channel bandwidth for SBFD (including Transmission bandwidth configuration, guardband and subband configuration for SBFD), with the following text proposal to be considered as baseline skeleton for triggering discussion:

=================== Start of Text Proposal ===================

5.3B BS channel bandwidth for SBFD

5.3B.1 General

<To be added, for the definition of channel bandwidth, transmission bandwidth configuration, uplink and downlink subbands and guardband within one NR channel for SBFD operation>

5.3B.2 Transmission bandwidth configuration for SBFD

<To be added>

5.3B.3 Guardband and Subband configuration for SBFD

<To be added>

=================== End of Text Proposal ===================

* + - Proposal 5 (vivo): Capture a table as below one:

**Table 1. BS SBFD configurations in FR1 and FR2-1**

|  |  |
| --- | --- |
| **SBFD configuration** | ***BS channel bandwidth* (MHz)** |
| **25** | **25** | **50** | **50** | **100** | **100** | **200** | **200** | **…** |
| DL Subband 1 | 10 | 20 | 20 | 40 | 40 | 80 | 80 | 160 | … |
| UL Subband | 5 | 5 | 10 | 10 | 20 | 20 | 40 | 40 | … |
| DL subband 2 | 10 | N/A | 20 | N/A | 40 | N/A | 80 | N/A | … |

* + Option 2a: Given configurations with certain subband size and corresponding guard band size:
		- Proposal 6 (Ericsson): SBFD configurations shall be captured in Rel-19 RAN4 specification and restricted to a limited set: Limit the number of SBFD configurations to five for FR1, and three for FR2-1.
* Moderator Recommendation:
	+ Discuss on Options/Proposals firstly.
* Offline:
	+ Add clarification that only DUD and DU patterns are allowed for the sub-band configuration.
	+ FFS which channel bandwidth(s) or all channel bandwidths shall be defined for RF requirements
	+ For a certain channel bandwidth which RAN4 agree to introduce RF requirements:
		- FFS RAN4 only define the UL/DL subbands configuration(s) for RF requirements
			* FFS which UL/DL subbands configuration(s) will be defined in RAN4
			* FFS Guard band size is declaration based and can be different for different BS classes
			* FFS the limitation on the maximum guard band
			* FFS possible range for UL/DL subband sizes
		- From RAN4 perspective, FFS restriction or no restriciton to RAN1 definition for UL/DL subband sizes within the transmission configuration for this channel bandwidth, except:
			* 1RB granularity (already introduced in RAN1)
			* ~~FFS possible range for UL/DL subband sizes~~

#### Issue 1-2-3: Restriction on subband size

* [Moderator] Restriction on RB numbers for subbands:
	+ Option 1: No restriction (but with 1RB granularity)
		- Proposal 1 (CATT): Not define sub-band BW in specification, and the RB number in the test is based on the declaration
	+ Option 1a: No restriction with typical value defined (with 1RB granularity)
		- Proposal 2 (Nokia): The value of guardbands, DL and UL subbands are not fixed in the specifications. RAN4 may agree one or more ‘typical’ values for which requirements are defined, while the gNB should still have the possibility to operate with a different (e.g. larger) guardband and UL and DL subband sizes.
			* Proposal 2a (Nokia): For FR1, RAN4 to prioritize SBFD requirements for BS carrier bandwidths of 100 MHz.,
				+ For FR1 DUD configuration in 100 MHz channel and 30 kHz SCS: < ND, NU, NG > = <106, 51, 5>
				+ For FR1 DU or UD configuration in 100 MHz channel and 30 kHz SCS: < ND, NU, NG > = <217, 51, 5>
			* Proposal 2b (Nokia): For FR2-1 for typical value for BS as starting point
				+ For FR2 DUD configuration in 100 MHz channel and 120 kHz SCS: < ND, NU, NG > = <25, 14, 1>
				+ For FR2 DUD configuration in 200 MHz channel and 120 kHz SCS: < ND, NU, NG > = <52, 26, 1>
	+ Option 2: No restriction (but with 1RB granularity, and possible range for subband size)
		- Proposal 3 (Samsung): Possible Subband size (expressed in RBs): {Xmin, Xmin+1,..., Xmax}
			* Xmin = 1
			* Xmax = NRB (i.e., Transmission bandwidth configuration)
	+ Option 3: Restricted number of subband sizes (only under certain channel bandwidths/SCS)
		- Proposal 4 (CMCC/Ericsson/Nokia): restricted by the limited number of channel bandwidth.
			* Proposal 4a (CMCC): 100MHz and 60MHz are suggested as typical channel bandwidth to support SBFD.
			* Proposal 4b (Ericsson): Identify the configurations that are impractical due to excessive guardband width, e.g., rule out narrower bandwidth 5 MHz, 10 MHz, 15 MHz, etc., and focus on higher bandwidth, e.g., 50 MHz, 100 MHz, etc.
			* Proposal 4c (Ericsson): For FR1, use 30 kHz as the SCS for SBFD slots. For FR2-1, use 120 kHz as the SCS for SBFD slots.
		- Proposal 5: restricted by the supported channel bandwidths for FR1 and FR2-1.
			* Proposal 5a (vivo): The NRB configuration for DL or UL subbands can still follow the transmission bandwidth configuration in TS 38.104.
			* Proposal 5b (Nokia): 51 RBs for a 20 MHz channel and 30 kHz SCS.
			* Proposal 5c (ZTE): RAN4 need to discuss the typical sub-band configuration for conformance testing and it should cover all potential BS carrier bandwidth. This should be part of core requirement instead of test models/configurations of conformance testing.
	+ Other restrictions than above Option 1-3 (as additional one, not contradicting to them):
		- Proposal 6 (vivo): UL subband occupies 20% BS channel bandwidth
* Moderator Recommendation:
	+ Discuss on Options/Proposals firstly.

#### Issue 1-2-4: Restriction on guard band size

* [Moderator] Restriction on RB numbers for guard band:
	+ Option 1: No restriction
		- Proposal 1 (CATT): Not define the guard band size in specification, and the RB number in the test is based on the declaration
		- Proposal 1a (ZTE): the guard band size between sub-band is up to the implementation or vendor’s declaration
		- Proposal 2 (Nokia): The value of guardbands, DL and UL subbands are not fixed in the specifications. RAN4 may agree one or more ‘typical’ values for which requirements are defined, while the gNB should still have the possibility to operate with a different (e.g. larger) guardband and UL and DL subband sizes.
			* Proposal 3 (Nokia): 5PRB for for FR1 for typical value for BS as starting point
				+ For FR1 DUD configuration in 100 MHz channel and 30 kHz SCS: < ND, NU, NG > = <106, 51, 5>
				+ For FR1 DU or UD configuration in 100 MHz channel and 30 kHz SCS: < ND, NU, NG > = <217, 51, 5>
			* Proposal 4 (Nokia): 1PRB for FR2-1 for typical value for BS as starting point
				+ For FR2 DUD configuration in 100 MHz channel and 120 kHz SCS: < ND, NU, NG > = <25, 14, 1>
				+ For FR2 DUD configuration in 200 MHz channel and 120 kHz SCS: < ND, NU, NG > = <52, 26, 1>
	+ Option 2: No restriction (but with 1RB granularity, and possible guard band size):
		- Proposal 5 (Samsung): Possible guardband size (expressed in RBs): {0, 1, 2, ..., Ymax}
			* Where Ymax is the maximum allowed number of RBs for guardband
				+ FFS the value of Ymax
	+ Option 3: A restricted set of guard band sizes defined for corresponding subband.
* Moderator Recommendation:
	+ Discuss on Options/Proposals firstly.

### Sub-topic 1-3: System-level simulation

#### Issue 1-3-1: Additional system-level simulation related (except in-band blocking related)

* [Moderator] The proposals related to additional system-level simulation related are given here. It should be noted that the ones related to in-band blocking are discussed in Sub-Topic 3-4.
* Proposals:
	+ Proposal 1 (Nokia): Among the coexistence cases defined in the SBFD coexistence simulations, consider Case 3 to derive the SBFD BS RF requirements.
	+ Proposal 2 (Nokia): Companies to agree on the simulation assumptions to be used for deriving the requirements. The “worst-case” conditions should be assumed as baseline, e.g. grid shift of 0% should be considered.
	+ Proposal 3 (Nokia): Companies to agree on a simulation methodology to derive each of the BS RF requirements. For instance, a requirement for ACS could be determined as the minimum ACS value providing less than 5% degradation on the 5th percentile and/or average throughput.
* Moderator Recommendation:
	+ The question needs to be answered firstly by the group: Except in-band blocking requirement, do we still need additional co-existence simulation? If so, clarify/confirm the purpose(s) of additional simulation.

### Sub-topic 1-4: BS RF specification structure for SBFD requirements

#### Issue 1-4-1: BS RF Specification structure for SBFD requirements

* Options of how to introduce BS RF new requirements for SBFD-capable BS:
	+ Option 1: Creating new sub-clauses in TS 38.104 (similar as UE feature in TS38.101)
	+ Option 2: Embedding the corresponding new RF requirements for SBFD in the corresponding section of TS 38.104 (similar as NB-IoT RF requirement in TS36.104)
* Moderator Recommendation:
	+ RAN4 agree the below principle:
		- How to introduce BS RF new requirements for SBFD-capable BS:
			* Creating new and standalone sub-clauses in TS 38.104 for SBFD-specific existing or new gNB RF requirements
				+ FFS detailed how to implement such approach in the later phase of WI.

# Topic #2: Modification of existing requirements - TX

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

## Companies’ contributions summary

All Tdocs related to the following topics (including Topic#2, and #3) are listed here:

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407526 | CATT | Proposal 1: The PSD scaling assumption for co-existence simulations is still applicable for the SBFD output power requirement.Observation 1: For transmitter intermodulation requirement, co-location coupling loss assumption can’t use 30 dB for SBFD capable gNB.Proposal 2: Transmitter intermodulation co-located requirement is defined based on the CL declaration by the manufacturers, the existing requirements and declared coupling losses are used for the test.Proposal 3: If the TX intermodulation requirement is applicable in SBFD slots/symbols, the receiver should be active.Proposal 4: 1.0 dB degradation is agreed for OTA sensitivity requirement.Observation 2: For receiver IMD requirement, it’s difficult to say the two interfering signal scenario can cover the single interfering signal scenario for both DUD and DU subband configuration.Observation 3: For receiver IMD requirement, single interfering signal scenario may not be equal to IBB scenario.Proposal 5: Whether IMD requirement for single interfering signal scenario is needed FFS. |
| R4-2408223 | CMCC | Proposal 1: it’s suggested to define WA, MR, LA gNB requirement for SBFD with same priority.Proposal 2: for the typical MCL for Tx IMD, at first, we can use the range of spatial isolation from all companies’ input in TR 38.858 for SBFD self-interference analysis and then down-select to final typical value for Tx inter-modulation requirement.Proposal 3: if larger than 30dB MCL is assumed for Tx IMD, the same degradation as legacy in-band blocking could be assumed as baseline i.e. 6dB REFSENSE degradation. and then further check the the feasibility with better SBFD receiver linearity assumption.Proposal 4: further discuss whether the co-location ACLR/ACS or equivalent requirement is needed or not. |
| R4-2408399 | Qualcomm Germany | Proposal 1: RAN4 to clearly define the scope and definition of multi-carrier operation of SBFD-capable BS in Rel-18 WI.Proposal 2: Transmit ON/OFF power requirement is not applicable within SBFD time slot. Additionally, all existing requirement for frequency error, modulation quality (EVM) and time alignment error (TAE) shall also be applied to BS in SBFD symbols/slots.Proposal 3: RAN4 to discuss how scenarios would be defined to derive ACLR requirements for SBFD.Proposal 4: RAN4 to discuss how to capture new co-location coupling loss requirements for SBFD based on the feasibility analysis captured in TR 38.858.Proposal 5: RAN4 to consider self-interference, inter-site interference, and inter-sector interference when defining the OTA reference sensitivity. Proposal 6: RAN4 to derive the IoT level and wanted signal power level within RAN4 adjacent channel coexistence. Proposal 7: RAN4 to discuss which scenarios to be defined to derive the ACS and in-band blocking requirements for SBFD BS. Proposal 8: RAN4 to discuss how to capture the Rx intermodulation requirements in its adjacent channel coexistence work. |
| R4-2409177 | Huawei, HiSilicon | Observation 1: For output power:• Different conducted power and EIRP/TRP declaration for normal DL symbols/slots and SBFD DL symbols/slots should be allowed. The accuracy requirement for conducted power and EIRP/TRP should be the same for normal DL symbols/slots and SBFD DL symbols/slots Observation 2: For output power dynamics:• Existing RE power control dynamic range requirements will be reused• The total dynamic range requirement is applicable for SBFD-capable BS during normal DL symbols/slots• The output power dynamic range will be defined as the ratio of the declared rated output power with all DL sub-band RBs active for SBFD (maximum) and the same single RB power as non-SBFD (minimum) Observation 3: For transmit ON/OFF power and Tx signal quality:• Transmit ON/OFF power requirement is not applicable within SBFD time slot, while all existing requirements for frequency error, EVM and time alignment error should be applied to SBFD symbols/slotsObservation 4: For unwanted emissions:• For OBUE requirement, the RF bandwidth edge from which OBUE is defined is the edge of the carrier (same for both SBFD and non-SBFD symbols/slots)• For transmitter spurious emission requirement, all the existing requirements shall also be applied to SBFD-capable BS in SBFD symbols/slots. The requirement of protection of the BS receiver of own or different BS is not applicable for TDD operationProposal 1: Not to consider precluding or deprioritizing WA BS type from future discussion on SBFD.Proposal 2: Further discuss how to define OBUE requirement for SBFD capable BS in order to ensure feasible co-existence performance for SBFD BSs operating in adjacent frequency. Proposal 3: Based on the Rel-18 SI outcome i.e. ~1dB sensitivity degradation due to self-interference, further discuss whether to consider interference sources other than self-interference for OTA sensitivity. Proposal 4: Further discuss how to define Rx blocking requirement for SBFD capable BS due to the fact that blocker could be DL transmission from other BSs but not only UEs. Whether it can be scenario specific can be further discussed as well. |
| R4-2409374 | Ericsson | Observation 1 It is allowed to have different conducted power and EIRP/TRP declaration for normal DL symbols/slots and SBFD DL symbols/slots.Observation 2 Accuracy requirement for TRP/EIRP and conducted power shall be the same for normal DL symbols/slots and SBFD DL symbols/slots.Observation 3 Reuse the existing RE power control dynamic range requirement for SBFD BS.Observation 4 The total dynamic range requirement is applicable for SBFD-capable BS during normal DL symbols/slots.Observation 5 Define the output power dynamic range requirement for SBFD as the ratio of the declared rated output power with all DL sub-band RBs active for SBFD (maximum) and the same single RB power as non-SBFD (minimum).Observation 6 Transmitter ON/OFF power doesn’t apply to SBFD slot.Observation 7 Reuse the existing requirements for frequency error, EVM and TAE for BS in SBFD symbols/slots.Observation 8 Measurement of average EVM for BS in normal DL symbols/slots and SBFD DL symbols/slots needs FFS.Observation 9 The existing OBW requirement shall be applied for the whole BS channel bandwidth in SBFD symbols/slots instead of DL sub-band.Observation 10 ACLR requirement shall be defined outside of the whole carrier instead of sub-band for SBFD DL symbols/slots and ACLR requirement is still defined as the ratio of sum of TX power within the whole carrier to the adjacent carrier.Observation 11 For OBUE requirement, the RF bandwidth edge from which OBUE is defined is the edge of the carrier (same for both SBFD and non-SBFD symbols/slots).Observation 12 The transmitter spurious emissions requirement is the same for both SBFD and non-SBFD slots.Observation 13 Use the same co-existence and co-location requirements (between bands) for SBFD slots as normal TDD. Conformance to these requirements remains declaration based.Observation 14 For SBFD-capable BS type 1-H, the existing requirement for conducted reference sensitivity level shall also be applied to BS in SBFD symbols, i.e., no sensitivity degradation is allowed.Observation 15 For SBFD-capable BS OTA sensitivity requirement, [0.5~1.0] dB degradation value needs FFS.Observation 16 OTA sensitivity should be defined considering in real life the receiver is further desensitized by other sources of interference including inter-site interference and inter-sector interference.Observation 17 RAN4 requirements should be conservative enough that the SBFD BS can be expected to perform well in real deployments considering inter-site interference and inter-sector interference.Observation 18 Due to the receiver performance is limited by receiver non-linearity, the sensitivity degradation is much greater than just the sum of the sensitivity degradation from each source alone.Observation 19 RX dynamic range requirement is applicable for SBFD-capable BS. IoT level and wanted signal power level need further discussion in the WI phase.Observation 20 For SBFD, the RX blocking requirement is based on signal levels from the DL of other operators BS.Observation 21 The BS co-location requirements can be applied as they are, with a declaration whether the SBFD BS meets the co-location requirements.Observation 22 The OOB blocking requirement is the same in SBFD slots as for normal TDD.Observation 23 The receiver spurious emissions requirement is the same for both SBFD and non-SBFD slots.Observation 24 The receiver spurious emission is only measurable with conducted testing and OTA testing with transmitter deactivated in SBFD slots.Observation 25 Receiver in-channel selectivity requirement is focused on UL sub-band, and the wanted signal and interfering signal levels is FFS in the WI phase.Based on the discussion in the previous sections we propose the following:Proposal 1 Transmitter ON/OFF power should apply to normal slot.Proposal 2 The TX IM requirement should be applied in SBFD slots, in order to demonstrate that the BS will continue to meet all regulation. However, during these tests, the RX sub-band is not expected to receive and may be deactivated during TX IM test.Proposal 3 Study further the DL signal level from other operator BS to assume when defining the SBFD RX blocking requirement.Proposal 4 Investigate whether an additional requirement based on a single input signal placed to cause IM with the RX sub-band provides any additional robustness, and whether such a requirement is anyhow implicitly captured by the SBFD RX blocking requirement. |
| R4-2409410 | Nokia | Observation 1: New complex test model would be needed to support joint measurement of transmitter signal quality for normal DL symbols/slots and SBFD DL symbols/slots.Proposal 1: Focus on defining the BS RF requirements for SBFD-capable BS in n104 band.Proposal 2: Among the coexistence cases defined in the SBFD coexistence simulations, consider Case 3 to derive the SBFD BS RF requirements.Proposal 3: Companies to agree on the simulation assumptions to be used for deriving the requirements. The “worst-case” conditions should be assumed as baseline, e.g. grid shift of 0% should be considered.Proposal 4: Companies to agree on a simulation methodology to derive each of the BS RF requirements. For instance, a requirement for ACS could be determined as the minimum ACS value providing less than 5% degradation on the 5th percentile and/or average throughput.Proposal 5: For BS Rx in-band blocking requirement, further simulations can be conducted to determine the expected blocker levels due to other operators’ BSs during SBFD slots and to define the SBFD RX blocking requirement. Scenarios shall be selected to reflect “worst-case” while still realistic conditions, e.g. 0% grid shift between operators.Proposal 6: Separate transmitter signal quality measurements are preferred for normal DL symbols/slots and SBFD symbols/slots.Proposal 7: Use maximum of 0.5dB for desensitization target value for the OTA sensitivity requirement due to self-interference. |
| R4-2409624 | ZTE Corporation, Sanechips | Proposal 1: for SBFD BS co-location related requirements, propose to follow the existing CLTA assumption captured in TS 38.141-2. Proposal 2: for Tx intermodulation requirement, it’s also up to vendor’s declaration. If BS claim to comply with Tx intermodulation requirement, then ACLR, UEM ,spurious emission and Rx sensitivity degradation should be declared together. Proposal 3: PSD scaling between non-SBFD slots and SBFD slots is up to the implementation. Proposal 4: agree with 1.0dB degradation for SBFD BS REFSENS requirements;Proposal 5: for receiver dynamic requirement, both uplink signals and BS2BS2 CLI signal should be considered for IoT levels.Proposal 6: for the receiver intermodulation requirements, BS2BS CLI should be taken into account for power level for interference signal.Proposal 7: for receiver intermodulation requirements, consider IMD between CW/NBB/general intermodulation interfering signal intermodulate with SBFD DL transmission with some performance degradation on SBFD receiver as shown in Figure 2.2.3-1. |
| R4-2409764 | Samsung | Modification on Existing TX requirement for SBFDObservation 1: For normal DL symbols/slots and SBFD DL symbols/slots, RAN4 in study phase agreed to allow gNB vendor to have different conducted declaration and different EIRP/TRP declaration (for level and direction).Proposal 1: No need to introduce the requirement for the limitation/restriction between TX PSD between For normal DL symbols/slots and SBFD DL symbols/slotsObservation 2: The value of 30 dB coupling assumed between two co-location gNBs for TX intermodulation requirement could be a very pessimistic assumption for SBFD operation, e.g., in FR1 TDD high band etc.Proposal 2: RAN4 confirm that TX IM requirement should be applied in SBFD slots, by selecting one of the following options as a package solution: - Option 1: By following existing co-location test setup, the UL sub-band is not expected to be scheduled for SBFD UL transmission during TX IM test.- Option 2: Revisit 30dB isolation by considering the study in SBFD study phase.Proposal 3: If coexisting with legacy TDD system in adjacent channel, RAN4 shall apply the existing ACLR requirement for SBFD-capable BS in SBFD symbols, and confirm this requirement can already guarantee adjacent-channel co-existence for Rel-19 SBFD operation. Proposal 4: If coexisting with new SBFD system in adjacent channel, RAN4 shall further study the ACLR requirement for SBFD-capable BS in SBFD symbols. Modification on Existing RX requirement for SBFDProposal 5: RAN4 further discuss the following options to derive OTA sensitivity degradation: - Option 1: the degradation value is BS declaration based. - Option 2: a fixed value provided in the specification. Proposal 6: For the assumption for the interference considered in the OTA sensitivity degradation, only self-interference shall be considered. Observation 3: For conducted ACS requirement, RAN4 already agreed to “take the existing wanted signal of ACS requirement by using the existing reference sensitivity level”, which shall not be revisited. Proposal 7: RAN4 shall apply the existing OTA ACS requirement for SBFD-capable BS in SBFD symbols, except taking the OTA sensitivity degradation into account to determine the level of wanted signal and interference signal mean power. Proposal 8: For in-band blocking requirement, the necessity of additional co-existence evaluation shall be studied by considering the new potential gNB-to-gNB CLI handling schemes, including beam nulling, beam pairing and non-transparent UL resource muting. Proposal 9: In the existing dynamic range requirement, RAN4 assume 20dB interference over thermal noise, which is enough to cover the co-channel interference from other base stations. Proposal 10: If RAN4 want to introduce the additional RX intermodulation requirement (a single input signal placed to cause IM with the RX sub-band), the new intermodulation scenario shall be confirmed firstly with evidence showing the proposed scenario exists in practice.  |

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

## Open issues summary

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

### Sub-topic 2-1: BS output power

#### Issue 2-1-1: PSD scaling for normal and SBFD slots/symbols

* [Moderator]: The following agreements are achieved in study item, while companies are discussing the necessity of the limitation/restriction between TX PSD between normal DL symbols/slots and SBFD DL symbols/slots:

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

* + Option 1 (Samsung/ZTE): No need to introduce the requirement for the limitation/restriction between TX PSD between normal DL symbols/slots and SBFD DL symbols/slots, which should be up to implementation.
	+ Option 2 (CATT): PSD of normal and SBFD slots/symbols are same.
* Moderator Recommendation:
	+ Discussion on the PSD scaling first proposal here.

### Sub-topic 2-2: TX intermodulation

#### Issue 2-2-1: TX intermodulation requirement

* [Moderator] The following is agreed in study item:

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| For transmitter intermodulation requirement for SBFD-capable BS, it was concluded that further study is needed on the following aspects in the normative phase:- whether the transmitter intermodulation requirement is applicable in SBFD slots/symbols.- the applicable co-location coupling loss assumption and the applicable receiver degradation for the transmitter intermodulation requirement, if transmitter intermodulation requirement is applicable in SBFD slots/symbols |

And the following agreement achieved in the WF:

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| Issue 2-6-1: Co-location requirement and reference antenna* Way forward:
	+ Continue the discussion on TX IMD requirement for SBFD, based on the existing assumption for co-location reference antenna.
		- The assumption of co-location reference antenna could be revised based on the outcome from BS RF enh. WI.
 |

* Proposals:
	+ Option 1: Revisit 30dB isolation by considering the study in SBFD study phase (related to revisiting the assumption of co-location reference antenna, related to BS RF enh. WI).
		- Proposal 1 (CATT):
			* CL value in TX IMD co-located requirement: based on CL declaration by manufacturers;
			* Requirement: existing requirement apply (6dB REFSENSE degradation);
			* RX link: RX should be active when TX IMD requirement is applicable in SBFD symbols.
		- Proposal 2 (CMCC):
			* CL value in TX IMD co-located requirement: Use the range of spatial isolation from all companies’ input in TR 38.858 for SBFD self-interference analysis and then down-select to final typical value for Tx inter-modulation requirement
			* Requirement: existing requirement apply (6dB REFSENSE degradation).
			* RX link: FFS.
	+ Option 2: Following existing co-location test setup but requirement is declaration-based, and the UL sub-band is not expected to be scheduled for SBFD UL transmission during TX IM test or some degradation is allowed.
		- Proposal 3 (ZTE): for Tx intermodulation requirement, it’s also up to vendor’s declaration. If BS claim to comply with Tx intermodulation requirement, then ACLR, UEM, spurious emission and Rx sensitivity degradation should be declared together.
* Moderator Recommendation:
	+ RAN4 may firstly try to confirm the following bullets is agreeable:
		- The transmitter intermodulation requirement is applicable in SBFD slots/symbols:
			* FFS the applicable co-location coupling loss assumption
			* FFS the necessity to guarantee RX performance, e.g., (1) UL subband is not expected to be scheduled, or (2) certain degradation is allowed for UL subband.

### Sub-topic 2-3: Unwanted emissions

#### Issue 2-3-1: The necessity of Co-location ACLR requirement

* Proposals:
	+ Proposal 1 (CMCC): further discuss whether the co-location ACLR or equivalent requirement is needed or not.
	+ Proposal 2 (Samsung): separate the discussion by considering coexisting with legacy TDD or new SBFD system in the adjacent channel:
		- If coexisting with legacy TDD system in adjacent channel, RAN4 shall apply the existing ACLR requirement for SBFD-capable BS in SBFD symbols, and confirm this requirement can already guarantee adjacent-channel co-existence for Rel-19 SBFD operation.
		- If coexisting with new SBFD system in adjacent channel, RAN4 shall further study the ACLR requirement for SBFD-capable BS in SBFD symbols.
* Moderator Recommendation:
	+ Discussion on the above Proposal 1 and 2, especially for P2 is something we can agree?

#### Issue 2-3-2: OBUE

* [Moderator] The following is agreed in SI for OBUE requirement: “For OBUE requirement, the RF bandwidth edge from which OBUE is defined is the edge of the carrier (same for both SBFD and non-SBFD symbols/slots).”
* Proposals:
	+ Proposal 1 (Huawei): Further discuss how to define OBUE requirement for SBFD capable BS in order to ensure feasible co-existence performance for SBFD BSs operating in adjacent frequency.
* Moderator Recommendation:
	+ Proponent need to provide clarification on P1 firstly.

#### Issue 2-3-3: Transmitter spurious emissions

* [Moderator] The following is agreed in SI for transmitter spurious emissions (co-location with other base stations):

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| - For inter-band co-location and co-existence requirement or SBFD-capable BS, it was agreed not to update on existing inter-band co-location requirements and manufacturer will declare whether support co-location requirements in SBFD symbols/slots. |

* Proposals:
	+ Proposal 1 (ZTE): for SBFD BS co-location related requirements, propose to follow the existing CLTA assumption captured in TS 38.141-2.
* Moderator Recommendation:
	+ Proponent may need to clarify P1 is applied to all co-location requirement or just co-location requirement under transmitter spurious emissions.

### Sub-topic 2-4: Transmitter signal quality

#### Issue 2-4-1: Joint measurement for normal DL symbols/slots and SBFD symbols/slots

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

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

* Observation/Proposal on joint measurement for normal DL symbols/slots and SBFD DL symbols/slots:
	+ Observation 1 (Nokia): New complex test model would be needed to support joint measurement of transmitter signal quality for normal DL symbols/slots and SBFD DL symbols/slots.
	+ Proposal 1 (Nokia): Separate transmitter signal quality measurements are preferred for normal DL symbols/slots and SBFD symbols/slots.
* Moderator Recommendation:
	+ Discussion whether or not P1 can be agreed.

# Topic #3: Modification of existing requirements - RX

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

## Companies’ contributions summary

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

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

## Open issues summary

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

### Sub-topic 3-1: OTA sensitivity

#### Issue 3-1-1: OTA sensitivity degradation

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

### Sub-topic 3-2: Dynamic range

#### Issue 3-2-1: Dynamic range requirement

* Proposals:
	+ Proposal 1 (Qualcomm): RAN4 to derive the IoT level and wanted signal power level within RAN4 adjacent channel coexistence.
	+ Proposal 2 (Samsung): In the existing dynamic range requirement, RAN4 assume 20dB interference over thermal noise, which is enough to cover the co-channel interference from other base stations.
	+ Proposal 3 (ZTE): for receiver dynamic requirement, both uplink signals and BS2BS CLI signal should be considered for IoT levels.
* Moderator Recommendation:
	+ Discussion on the Proposals firstly.

### Sub-topic 3-3: ACS

#### Issue 3-3-1: Co-location ACS requirement

* Proposals:
	+ Proposal 1 (CMCC): Further discuss whether the co-location ACS or equivalent requirement is needed or not.
* Moderator Recommendation:
	+ Discussion on the proposal together with Issue 3-3-1 for co-location ACS.

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

* [Moderator]: For conducted ACS requirement, RAN4 already agreed to “take the existing wanted signal of ACS requirement by using the existing reference sensitivity level”, which shall not be revisited. For OTA ACS requirement, RAN4 agreed that “the OTA sensitivity degradation shall be taken into account to determine the level of wanted signal and interference signal mean power”, and the details are further discussed here
* Proposal on OTA ACS requirement:
	+ Proposal 1 (Samsung): RAN4 shall apply the existing OTA ACS requirement for SBFD-capable BS in SBFD symbols, except taking the OTA sensitivity degradation into account to determine the level of wanted signal and interference signal mean power.
* Moderator Recommendation:
	+ Discussion on the proposal firstly.

### Sub-topic 3-4: In-band blocking

#### Issue 3-4-1: Necessity for additional co-existence study for In-band blocking

* [Moderator] The following is agreed in SI:

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

* Proposals on general considerations if further simulation is to be done:
	+ Proposal 1 (Qualcomm): RAN4 to discuss simulation framework, main scenarios and assumptions, and procedures required to determine the simulation effort required to progress discussions on Rx blocking requirements for an SBFD-capable gNB.
	+ Proposal 2 (Samsung): For in-band blocking requirement, the necessity of additional co-existence evaluation shall be studied by considering the new potential gNB-to-gNB CLI handling schemes, including beam nulling, beam pairing and non-transparent UL resource muting.
	+ Proposal 3 (Ericsson): Study further the DL signal level from other operator BS to assume when defining the SBFD RX blocking requirement.
* Moderator Recommendation:
	+ Discussion on the proposal firstly.

#### Issue 3-4-2: Scenario/Case for additional co-existence study (if agreed)

* Detailed proposal on desired scenario/case to be simulated
	+ Proposal 1 (Ericsson): The desired scenarios are Scenario 1, 3, 5, 6, 9, and the desired case is Case 3.

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| Table 11.1-1 (from TR 38.858): Adjacent channel co-existence scenarios

| Scenario | FR | Aggressor | Victim |
| --- | --- | --- | --- |
| 1 | FR1 | Urban Macro | Urban Macro |
| 2 | FR1 | Urban Hotspot | Urban Hotspot |
| 3 | FR1 | Indoor | Indoor |
| 4 | FR1 | Urban Macro | Micro |
| 5 | FR1 | Micro | Micro |
| 6 | FR2-1 | Urban Macro | Urban Macro |
| 71 | FR2-1 | Urban Hotspot | Urban Hotspot |
| 8 | FR2-1 | Urban Dense | Urban Dense |
| 9 | FR2-1 | Indoor | Indoor |
| Note 1: This scenario has been down-selected. |

Table 11.1-2 (from TR 38.858): Adjacent channel co-existence cases

| Case | Aggressor | Victim | Slot allocationAggressor Victim |
| --- | --- | --- | --- |
| 1 | SBFD | TDD DL |   |
| 2 | SBFD | TDD UL |   |
| 3 | TDD DL | SBFD |   |
| 4 | TDD UL | SBFD |   |
| Note: Case 3 and Case 4 are down-selected for Scenario 4. |

 |

* + Proposal 2 (Nokia): For BS Rx in-band blocking requirement, further simulations can be conducted to determine the expected blocker levels due to other operators’ BSs during SBFD slots and to define the SBFD RX blocking requirement. Scenarios shall be selected to reflect “worst-case” while still realistic conditions, e.g. 0% grid shift between operators.
* Moderator Recommendation:
	+ Discussion on the proposals firstly.

#### Issue 3-4-3: Procedures for additional co-existence study (if agreed)

* Detailed proposal on procedures for additional co-existence study to be simulated
	+ Proposal 1 (Ericsson): The following simulation procedure should be considered to derive the SBFD BS in-band blocking requirements:
		- 1) Setup a coexistence scenario based on scenarios down selected from the SI.
		- 2) Focus on Case 3, to evaluate the blocking requirement of UL SBFD.
		- 3) Remove from the SBFD network the internal co-channel interference.
		- 4) Evaluate the CDF of the wideband power received in the receiver of UL SBFD, from the adjacent channel.
		- 5) Find the 99% tile of the UL SBFD wideband received power CDF to define the blocking requirement in each of the down-selected scenarios
	+ Proposal 2 (Samsung): For in-band blocking requirement, the necessity of additional co-existence evaluation shall be studied by considering the new potential gNB-to-gNB CLI handling schemes, including beam nulling, beam pairing and non-transparent UL resource muting.
	+ Proposal 3 (ZTE): RAN4 could derive the interference signal power level of in-band blocking requirement by system level simulation with 99.99% statistical CDF curve of blocking levels from aggressor system in DL direction and no CLI coordination among different carriers.
* Moderator Recommendation:
	+ Discussion on the proposals firstly.

### Sub-topic 3-5: Receiver intermodulation

#### Issue 3-5-1: Necessity of New RX intermodulation requirement with 1 interfering signal

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

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

* Proposals:
	+ Proposal 1 (ZTE): for the receiver intermodulation requirements, BS2BS CLI should be taken into account for power level for interference signal.
* Moderator Recommendation:
	+ Discussion on Proposal 1 firstly, to see it can be accepted or not.

# Topic #4: Potentially new requirements for SBFD

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

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407527 | CATT | Observation 1: Evaluating the transient time capability that the design can achieve should be based on hardware architecture of the SBFD-capable BS and switching mode between SBFD slots and normal slots, etc.Proposal 1: More discussion is needed to evaluate the transient time performance considering different implementation.Proposal 2: Considering the performances of the potential new SBFD in channel requirements are actually included in the SI performance, it doesn't need to define these new requirements. – In-channel adjacent subband leakage ratio – In-channel adjacent subband selectivity– In-channel adjacent subband blocking |
| R4-2408224 | CMCC | Observation 1: the transient period for SBFD should not be larger than legacy ON-OFF transient period. Besides, the transient period between SBFD reconfiguration should not be larger than the transient period from SBFD to non-SBFD.Observation 2: This sub-band Tx leakage falling into the same carrier can be discussed together with OTA sensitivity requirements. Observation 3: RAN4 should at first identify the assumption of adjacent network performance for sub-band leakage requirement definition, i.e. whether inter-operator using adjacent carrier follow legacy 3GPP requirement or allow enhanced performance. Observation 4: Sub-band selectivity requirements when Tx interference is within the same carrier can be discussed together with OTA sensitivity requirements. If OTA sensitivity will encompass these sub-band interference, sub-band selectivity with Tx interference signal within carrier is not needed.Observation 5: RAN4 should at first identify the assumption of adjacent network performance for sub-band selectivity requirement definition, i.e. whether inter-operator using adjacent carrier follow 3GPP requirement or allow enhanced performance.Proposal 1: both sub-band selectivity and blocking requirements should be defined. |
| R4-2408400 | Qualcomm Germany | Observation 1: The in-channel subband sub-band Tx leakage and selectivity new requirements depend on the self-interference, inter-site and inter-sector interference considerations. Proposal 1: RAN4 to first define scenarios and assumptions required for the definition of the in-channel adjacent subband leakage and selectivity.Proposal 2: RAN4 to define a new requirement for the transmitter transient period between SBFD and non-SBFD slot. As a starting point, RAN4 can start with the feasibility of adopting the Tx transient period requirement for TDD BS. |
| R4-2409178 | Huawei, HiSilicon | Proposal 1: For SBFD-capable BS, define transmitter transient period between non-SBFD slot and SBFD slot.• The transmitter transient period is within the SBFD slot.• Consider 10us as baseline. Proposal 2: For SBFD-capable BS, further discuss how in-channel adjacent sub-band leakage ratio to be defined.Proposal 3: For SBFD-capable BS, further discuss how in-channel adjacent sub-band blocking and selectivity to be defined. |
| R4-2409375 | Ericsson | Observation 1 The same considerations on inter-site interference due to switching occur for SBFD resources when switched between TX/RX as when the whole slot is switched.Proposal 1 Apply the existing TDD switching time and off level requirement to SBFD RBs when they are switched between TX and RX.Proposal 2 Apply the same transient period to transition between non-SBFD slots and SBFD slots as for normal full DL and UL switching.Proposal 3 Define a requirement on TX sub-band ACLR similar to the ACLR requirement and use existing ACLR requirement as baseline.Proposal 4 Define a requirement on RX sub-band ACS similar to the ACS requirement and use existing ACS requirement as baseline. |
| R4-2409411 | Nokia | Observation 1: Depending on the antenna configuration option, a transition time may be needed between normal slot and SBFD slots.Observation 2: The OTA sensitivity requirement does not capture the effects from inter-sector and inter-gNB interference. Observation 3: In-channel adjacent subband leakage ratio, in-channel adjacent subband blocking and in-channel adjacent subband selectivity requirements cannot be guaranteed implicitly by the OTA sensitivity requirement, since the methods used for self-interference cancellation, might not be available for cancelling interference from other sectors and gNBs, especially when considering a multi-vendor deployment.Observation 4: Even though RAN4 has not agreed on a reference implementation for SBFD operation, minimum requirements can still be defined to ensure proper operation considering self-interference, inter-site and inter-gNB interference.Proposal 1: Focus in defining the BS RF requirements for SBFD-capable BS to n104 band.Proposal 2: For introduction of new BS RF requirements for SBFD operation, creating new sub-clauses is proposed. Proposal 3: Use existing transient period requirement as a baseline for transition between normal slot and SBFD slots.Proposal 4: RAN4 to define in-channel adjacent sub-band leakage ratio requirements within SBFD time slots considering inter-sector interference and inter-site interference. Existing ACLR requirements could be used as baseline depending on the ratio between the bandwidths of the DL and the UL subbands.Proposal 5: RAN4 to define in-channel adjacent sub-band selectivity, the exact requirement limits to be discussed. |
| R4-2409625 | ZTE Corporation, Sanechips | Proposal 1: for the co-site inter-sector, in-channel blocking, in-channel selectivity and in-channel sub-band leakage, this could be left up to the vendor declaration without defining any specific power or freq offset of the corresponding requirement.Proposal 2: for the inter-site scenario, propose to further discuss how to handle the BS CLI problem e.g. with RAN4 minimum RF requirement (usually worst assumptions) or with other coordination schemes defined in other WGs. |
| R4-2409765 | Samsung | Observation 1: It is difficult for RAN4 to agree on a reference scheme for self-interference suppression implemented to derive the potential new requirement in-channel adjacent subband leakage ratio.Observation 2: All the gNB-to-gNB CLI handling schemes likely to be introduced in RAN1 (including beam nulling, beam pairing and non-transparent UL resource muting) will greatly mitigate the gNB-to-gNB CLI, and make it be hard to have a criterion for a “proper” interference level or in-channel adjacent subband leakage ratio.Proposal 1: There is no necessity to introduce new requirement for in-channel adjacent subband leakage ratio. Proposal 2: There is no necessity to introduce new requirement for in-channel adjacent subband blocking and adjacent subband selectivity. Proposal 3: For transmitter transient period between SBFD and non-SBFD, the existing TDD BS transmitter transient period, i.e., 10ms for FR1 and 3ms for FR2-1, can be reused for all four cases: (1) Case-A (SBFD to DL): transmitter OFF-to-ON in SBFD UL band and guard band(s) (2) Case-B (SBFD to UL): transmitter ON-to-OFF in SBFD DL band(3) Case-C (DL to SBFD): transmitter ON-to-OFF in SBFD UL band and guard band(s)(4) Case-D (UL to SBFD): transmitter OFF-to-ON in SBFD DL bandProposal 4: For transmitter transient period between different SBFD reconfigurations, RAN4 study the necessity of introducing requirement by considering the following cases: (1) Case-1 (reconfigured to reduce RB(s) for SBFD UL): There exists some RB(s), which are from SBFD UL to SBFD DL during the transition, while other RBs remain either SBFD UL or SBFD DL during the transition. (2) Case-2 (reconfigured to add RB(s) for SBFD UL): There exists some RB(s), which are from SBFD DL to SBFD UL during the transition, while other RBs remain either SBFD UL or SBFD DL during the transition.(3) Case-3 (reconfigured SBFD UL except Case-1 or 2): There exists some RB(s) which are from SBFD UL to SBFD DL and some RB(s) which are from SBFD UL to SBFD DL during the transition, while other RBs either SBFD UL or SBFD DL during the transition. |

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

## Open issues summary

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

### Sub-topic 4-1: In-channel adjacent subband leakage ratio requirements

#### Issue 4-1-1: Necessity of in-channel adjacent subband leakage ratio requirements

* Proposals:
	+ Proposal 1 (Samsung/CATT): no necessity to introduce new requirement for in-channel adjacent subband leakage ratio.
	+ Proposal 2 (CMCC): This sub-band Tx leakage falling into the same carrier can be discussed together with OTA sensitivity requirements.
	+ Proposal 3 (ZTE): for the co-site inter-sector, in-channel blocking, in-channel selectivity and in-channel sub-band leakage, this could be left up to the vendor declaration without defining any specific power or freq offset of the corresponding requirement.
	+ Proposal 4 (Ericsson): Define a requirement on TX sub-band ACLR similar to the ACLR requirement and use existing ACLR requirement as baseline.
	+ Proposal 5 (Nokia): RAN4 to define in-channel adjacent sub-band leakage ratio requirements within SBFD time slots considering inter-sector interference and inter-site interference. Existing ACLR requirements could be used as baseline depending on the ratio between the bandwidths of the DL and the UL subbands.
* Moderator Recommendation:
	+ Discussion on the proposal firstly by considering:
		- How to propose a minimum requirement to consider different interference cancelation implementations and CLI handing schemes?
		- In-channel adjacent subband leakage ratio/selectivity can be guaranteed by OTA sensitivity or not?
		- New alternative is given as Proposal 3, i.e., vendor declaration based method, which can be discussed in this meeting for the 1st time.

#### Issue 4-1-2: The way to derive requirement for in-channel adjacent subband leakage ratio if agreed to be introduced

* Proposals:
	+ Proposal 1 (CMCC): RAN4 should at first identify the assumption of adjacent network performance for sub-band leakage requirement definition, i.e. whether inter-operator using adjacent carrier follow legacy 3GPP requirement or allow enhanced performance.
	+ Proposal 2 (Qualcomm): RAN4 to first define scenarios and assumptions required for the definition of the in-channel adjacent subband leakage and selectivity.
	+ Proposal 3 (ZTE): for the inter-site scenario, propose to further discuss how to handle the BS CLI problem e.g. with RAN4 minimum RF requirement (usually worst assumptions) or with other coordination schemes defined in other WGs.
* Moderator Recommendation:
	+ Discussion on these proposals firstly.

### Sub-topic 4-2: In-channel adjacent subband selectivity/blocking requirements

#### Issue 4-2-1: Necessity of in-channel adjacent subband selectivity requirements

* Proposals:
	+ Proposal 1 (Samsung/CATT): no necessity to introduce new requirement for in-channel adjacent subband selectivity.
	+ Proposal 2 (CMCC): Need to introduce new requirement for in-channel adjacent subband selectivity.
		- Proposal 2a (CMCC): Sub-band selectivity requirements when Tx interference is within the same carrier can be discussed together with OTA sensitivity requirements. If OTA sensitivity will encompass these sub-band interference, sub-band selectivity with Tx interference signal within carrier is not needed.
	+ Proposal 3 (ZTE): for the co-site inter-sector, in-channel blocking, in-channel selectivity and in-channel sub-band leakage, this could be left up to the vendor declaration without defining any specific power or freq offset of the corresponding requirement.
	+ Proposal 4 (Ericsson): Define a requirement on RX sub-band ACS similar to the ACS requirement and use existing ACS requirement as baseline.
	+ Proposal 5 (Nokia): RAN4 to define in-channel adjacent sub-band selectivity, the exact requirement limits to be discussed.
* Moderator Recommendation:
	+ Discussion on the proposal firstly by considering:
		- How to propose a minimum requirement to consider different interference cancelation implementations and CLI handing schemes?
		- In-channel adjacent subband leakage ratio/selectivity can be guaranteed by OTA sensitivity or not?
		- New alternative is given as Proposal 3, i.e., vendor declaration based method, which can be discussed in this meeting for the 1st time.

#### Issue 4-2-2: Necessity of in-channel adjacent subband blocking requirement

* Proposals:
	+ Proposal 1 (Samsung/CATT): no necessity to introduce new requirement for in-channel adjacent subband blocking.
	+ Proposal 2 (CMCC): Need to introduce new requirement for in-channel adjacent subband blocking.
	+ Proposal 3 (ZTE): for the co-site inter-sector, in-channel blocking, in-channel selectivity and in-channel sub-band leakage, this could be left up to the vendor declaration without defining any specific power or freq offset of the corresponding requirement.
* Moderator Recommendation:
	+ Discussion on the proposal firstly by considering:
		- New alternative is given as Proposal 3, i.e., vendor declaration based method, which can be discussed in this meeting for the 1st time.

#### Issue 4-2-3: The way to derive requirements for in-channel adjacent subband selectivity/blocking if agreed to be introduced

* Proposals:
	+ Proposal 1 (CMCC): RAN4 should at first identify the assumption of adjacent network performance for sub-band selectivity requirement definition, i.e. whether inter-operator using adjacent carrier follow 3GPP requirement or allow enhanced performance.
	+ Proposal 3 (ZTE): for the inter-site scenario, propose to further discuss how to handle the BS CLI problem e.g. with RAN4 minimum RF requirement (usually worst assumptions) or with other coordination schemes defined in other WGs.
* Moderator Recommendation:
	+ Discussion on the proposal firstly by considering how to handle BS CLI problem.

### Sub-topic 4-3: Transient period

#### Issue 4-3-1: Requirement for transient period between SBFD and non-SBFD

* General principal proposals:
	+ Proposal 1 (CATT): More discussion is needed to evaluate the transient time performance considering different implementation.
* Transient period length between SBFD and non-SBFD compared to legacy ON-OFF transient period:
	+ Proposal 2 (CMCC): The transient period for SBFD should not be larger than legacy ON-OFF transient period.
	+ Proposal 3 (Samsung/Huawei/Qualcomm/Ericsson/Nokia): For transmitter transient period between SBFD and non-SBFD, the existing TDD BS transmitter transient period, i.e., 10ms for FR1 and 3ms for FR2-1, can be reused for all four cases:
		- Case-A (SBFD to DL): transmitter OFF-to-ON in SBFD UL band and guard band(s)
		- Case-B (SBFD to UL): transmitter ON-to-OFF in SBFD DL band
		- Case-C (DL to SBFD): transmitter ON-to-OFF in SBFD UL band and guard band(s)
		- Case-D (UL to SBFD): transmitter OFF-to-ON in SBFD DL band
* Location of transient period between SBFD and non-SBFD:
	+ Proposal 4 (Huawei): The transmitter transient period is within the SBFD slot.
* Moderator Recommendation:
	+ Based on majority view, the following proposal is recommended to be agreed:
		- Requirement for transient period between SBFD and non-SBFD:
			* The existing TDD BS transmitter transient period, i.e., 10ms for FR1 and 3ms for FR2-1, can be reused for all four cases:
				+ Case-A (SBFD to DL): transmitter OFF-to-ON in SBFD UL band and guard band(s)
				+ Case-B (SBFD to UL): transmitter ON-to-OFF in SBFD DL band
				+ Case-C (DL to SBFD): transmitter ON-to-OFF in SBFD UL band and guard band(s)
				+ Case-D (UL to SBFD): transmitter OFF-to-ON in SBFD DL band
			* Location of transient period between SBFD and non-SBFD:
				+ The transmitter transient period shall be located within the SBFD slot

#### Issue 4-3-2: Requirement for transient period between different SBFD configurations

* General principal proposals:
	+ Proposal 1 (CATT): More discussion is needed to evaluate the transient time performance considering different implementation.
* Proposals on sub-cases for transient period between different SBFD configurations:
	+ Proposal 2 (Samsung): RAN4 study the necessity of introducing requirement by considering the following cases:
		- Case-1 (reconfigured to reduce RB(s) for SBFD UL): There exists some RB(s), which are from SBFD UL to SBFD DL during the transition, while other RBs remain either SBFD UL or SBFD DL during the transition.
		- Case-2 (reconfigured to add RB(s) for SBFD UL): There exists some RB(s), which are from SBFD DL to SBFD UL during the transition, while other RBs remain either SBFD UL or SBFD DL during the transition.
		- Case-3 (reconfigured SBFD UL except Case-1 or 2): There exists some RB(s) which are from SBFD UL to SBFD DL and some RB(s) which are from SBFD UL to SBFD DL during the transition, while other RBs either SBFD UL or SBFD DL during the transition.
* Transient period length between different SBFD config. Compared to the one between SBFD to non-SBFD:
	+ Proposal 3 (CMCC): The transient period between SBFD reconfiguration should not be larger than the transient period from SBFD to non-SBFD
* Moderator Recommendation:
	+ Discussion on above proposals firstly.