3GPP TSG RAN WG1 #109-e R1-220XXXX

e-Meeting, May 9th – 20th, 2022

Source: CMCC

Title: Summary on email discussion of TR skeleton for Rel-18 SI on evolution of NR duplex operation

Agenda item: 9.3

Document for: Discussion & Decision

# 1 Introduction

This document captures the RAN1#109-e email discussion [109-e-R18-Duplex-01] for the TR skeleton for the study item “Study on evolution of NR duplex operation” with SID in RP-220633. Companies are invited to enter their comments on the TR skeleton below.

# 2 Draft TR skeleton

A draft TR skeleton has been provided by the rapporteur in R1-2205187 (it can also be found in the draft folder ‘Inbox/drafts/9.3/draftSkeleton’) and presented in an online (GTW) session in RAN1#109e. The structure of the draft TR skeleton is inspired by TR 36.828.

# 3 Discussion

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| **Company** | **Comments** |
| QC | **Comment #1**: The description of section 6.1 should be updated to include the feasibility aspects of SBFD to reflect the SID description.   |  | | --- | | 6.1 SBFD feasibility and schemes Editor’s note: This section captures the general aspects of SBFD feasibility and schemes except the inter-gNB and inter-UE CLI handling schemes, which are captured in a separate section. |   **Comment #2**: Similar to the structure of section 6 of SBFD, Section 8 should have one more item on “Dynamic TDD schemes and feasibility”. This is needed to make sure we are aligned to the SID. Other schemes for dynamic TDD such as subband half-duplex (SBHD) as discussed in our tdoc R1-2205032 could be captured in that section.   |  | | --- | | The detailed objectives are as follows:   * Identify applicable and relevant deployment scenarios (RAN1). * Develop evaluation methodology for duplex enhancement (RAN1). * Study the subband non-overlapping full duplex and potential enhancements on dynamic/flexible TDD (RAN1, RAN4). * Identify possible schemes and evaluate their feasibility and performances (RAN1). |   **Comment #3**  For section 7 and section 9, we think that FR1 and FR2 evaluation methodology and performance analysis should be captured independently in two different sections.  **Comment #4**  For section 6.2 and 8.1 on cross-link interference, it should be clarified how to handle the common and SBFD specific enhancement or dynamic-TDD specific enhancements.  **Comment #5**  It is preferred to have separate and dedicated section for new channel models of BS-BS channel model and UE-UE. And additional section capturing the model of the different components of self-interference and inter-SB modelling. These models are new to RAN1/RAN4 and should be captured in separate sections.  **Comment #6**  As commented online, there could be link-budget analysis and link-level analysis in addition to SLS. Based on the outcome of RAN1 discussion, these evaluation methods should be added in addition to the SLS. |
| Ericsson | **Comment #1**  In our view, both link and system level evaluations are needed in this study item for SBFD, where link level evaluations are needed to properly study self-interference suppression. For dynamic TDD, we think system level evaluations are sufficient. Based on this, RAN1 should agree on a set of evaluation assumptions for both link and system level. These can be captured in the TR as two separate tables (see, for example, TR 38.808 for the 60 GHz WI). Accordingly, we suggest that Section 7.1 should contain two sub-sections as follows:  7.1 Evaluation Methodologies  7.1.1 Link Level  *Note: includes a table of link-level evaluation assumptions*  7.1.2 System Level  *Note: includes a table of system-level evaluation assumptions*  **Comment #2**  Regarding Qualcomm's Comment #5, we agree that the BS-BS and UE-UE channel models are important, and these can be captured in a table with all other evaluation as we suggest above.  **Comment #3**  We believe the structure of Section 7.2 – 7.x+2 needs adjustment. One of the more important aspects of the SI is to evaluate the performance impact on a legacy network, and this is done through a two-operator evaluation where Operator A deploys SBFD, and Operator B is legacy (static-TDD). This is stated in the SID quite clearly:   * Study the performance of the identified schemes as well as the impact on legacy operation assuming their co-existence in co-channel and adjacent channels (RAN1).   This is in contrast to the RAN4 objective which is about studying feasibility and impact on RF requirements:   * Study the feasibility of and impact on RF requirements considering adjacent-channel co-existence with the legacy operation (RAN4).   Hence, since RAN1 shall evaluate performance in both co-channel (single-operator) and adjacent channel (two-operator) scenarios, we think the structure of the evaluation results in the TR should reflect this objective accurately. Our suggestion is as follows, where different scenarios can be defined under each sub-section.  7.2 Single-Operator Evaluation Results  *Editor's Note: This section captures performance evaluation results for single-operator (co-channel) scenarios.*  7.2.1 Scenario 1  7.2.2 Scenario 2  …  7.3 Two-Operator Evaluation Results  *Editor's Note: This section captures performance evaluation results for two-operator (adjacent channel) coexistence scenarios, i.e., SBFD operator + legacy (static TDD) operator.*  7.3.1 Scenario 1  7.3.2 Scenario 2  …  **Comment #4**  We also agree with Qualcomm’s comment 3 regarding having separate sub-sections for FR1 and FR2 evaluations. |
| OPPO | **Comment #1**: Another way to fulfill the SID task of “Identify possible schemes and evaluate their feasibility and performances (RAN1)” is to put feasibility evaluation in section 7, with separate sub-sections. If the feasibility study is put in section 6,   * The feasibility study should be applicable to individual SBFD scheme, rather than the general SBFD principle. So Qualcomm’s suggestion could be improved to “SBFD schemes and corresponding feasibilities” * The group should discuss whether such feasibility study should include not only SBFD schemes in section 6.1, but also interference handling schemes in section 6.2. Our understanding is to include both.   **Comment #2**: We share the view with Qualcomm that the “scheme and feasibility” apply to dynamic TDD section as well.  **Comment #3:** Regarding to how to capture in TR the common schemes that handles both CLI in full duplex and CLI in dynamic TDD (i.e., Qualcomm’s comment #4), we are less worried for now, and think this is a kind of editorial issue that can be solved by either cross-reference or simple duplication. However, we are more curious on how to handle the RAN1 discussion for such common part (if any) -- keep the discussions parallel in two agenda? or even a more basic question: should the RAN1 discussion pursue to have any common handling between the CLI in full duplex and the CLI in dynamic TDD? We understand this may go beyond the skeleton itself but somehow related.  **Comment #4**: We think it is a bit too early to discuss now where to put what kind of channel model or where to put LLS results. At current stage it is good enough to say the note under sections 7 and 9 as:  *Editor’s note: This section captures the evaluation metrics, description of evaluation methodologies, etc, respectively for SLS and LLS, if any agreed.*  **Comment #5:**  By reading the following SID assignment,   * Study the performance of the identified schemes as well as the impact on legacy operation assuming their co-existence in co-channel and adjacent channels (RAN1).   we had a feel that the co-existence study should not be based on potentially separate scenarios, such as scenario x+1 or x+2. Instead, the fair comparison between w/ legacy operation and w/o legacy operation is better to be based on the same deployment scenario (with different ratios of R18/legacy UE populations). In addition, we think it is a bit too early to exclude the evaluation setup that co-channel co-existence and adjacent-channel coexistence occur together.  Therefore, we prefer to see a skeleton like following, and with scenarios {x+1, x+2} being removed:  *7.x Scenario y: SBFD scenario y*  *Editor’s note: This section captures the evaluation assumptions and performance evaluation results for SBFD scenario y, including the evaluation cases that take into account the impact on legacy operation assuming their co-existence in co-channel and adjacent channels.* |
| Spreadtrum | **Comment #1**: For the new added section 10 ***Feasibility of and impact on RF requirements***, editor’s note only mentioned RAN4 work and input. If coexistence issue can be discussed in this section, RAN1 work should be included as well, as it is in the scope of SID below:   * *Study the performance of the identified schemes as well as the impact on legacy operation assuming their co-existence in co-channel and adjacent channels (RAN1).* |
| Huawei, HiSilicon | **Comment #1:**  On section 7.1 and 9.1, in addition to system-level evaluation, we think both link budget analysis and link-level evaluation should be included. As discussed in our contribution R1-2203156, to evaluate the feasibility and performance of SBFD and dynamic TDD (in response to Ericsson’s comment #1), it is critical to study the CLI handling schemes, which are highly related to the performance of RX receiver, co-site self-interference cancellation, etc. It is difficult to evaluate these aspects in system level simulations due to the difficulty in modelling of realistic channel estimation (potentially impacted by CLI) and interference suppression algorithms. In addition, the link budget analysis on interference (section 2.4 in R1-2203156) is a very useful tool to study the feasibility and performance of SBFD and dynamic TDD. These results can provide some good insights on the potential blocking issues by comparing with the current RAN4 requirement as well as how much interference suppression and/or cancellation is required for each scenario. These are important for concluding the feasibility of SBFD and dynamic TDD.  7.1.1 Link budget analysis  *Note: This section includes the simulation assumptions for link budget analysis*  7.1.2 Link Level evaluations  *Note: This section includes the simulation assumptions for link-level evaluations*  7.1.2 System Level evaluations  *Note: This section includes the simulation assumptions for system-level evaluations*  …  9.1.1 Link budget analysis  *Note: This section includes the simulation assumptions for link budget analysis*  9.1.2 Link Level evaluations  *Note: This section includes the simulation assumptions for link-level evaluations*  9.1.2 System Level evaluations  *Note: This section includes the simulation assumptions for system-level evaluations*  **Comment #2:**  On QC’s comment 1 to include the feasibility aspects of SBFD for section 6.1, we have a different view. The feasibility of SBFD not only depends on the general aspects of SBFD, it is also highly dependent on Section 6.2, i.e. whether the CLI can be properly handled. Hence, one possible way to conclude on the feasibility in separate sub-section under section 7 and section 9.  **Comment #3:**  On section 6.2, we are wondering whether intra-gNB CLI (self-interference) should also be included. |
| TCL | For section 6.1 we share similar views with Qualcomm and OPOO to include “Feasibility” in section 6.1, in order to align section 6.1 with the objectives mentioned in the SID.  For “Inter-gNB and Inter-UE CLI handling” in section 6 and section 8, we are ok with the moderator skeleton, as the solutions of inter-gNB and inter UE CLI handling in SBFD may be different from CLI handling solutions in dynamic TDD. |
| CATT | **Comment #1:**  On section 8, Potential enhancements on dynamic/flexible TDD  8.1 Inter-gNB and inter-UE CLI handling schemes  is listed on the only agenda item  However, in the workplan tdoc [R1-2204302](file:///C:\Users\lishu\Dropbox\documents\3gpp\ran1\ran1_109\tdocs\R1-2204302.zip), the following is listed as two parallel agenda:   * + Study possible schemes for dynamic/flexible TDD   + Study inter-gNB and inter-UE CLI handling schemes   Can you please clarify the intention (if section will include other schemes than CLI handling) ?  **Comment #2:**  There are two sections regarding CLI handling schemes:  6.2 Inter-gNB and inter-UE CLI handling schemes  8.1 Inter-gNB and inter-UE CLI handling schemes  Is the intention here to capture CLI handling schemes for SBFD and for dynamic TDD at their respective section? If yes, how about RAN1 discussion, are we going to conduct CLI discussion in both SBFD and dynamic TDD agenda item? |
| Xiaomi | **Comment#1:**  On chapter 6, we echo with HW’s comments that self-interference should be considered. As self-interference is quite different from inter-gNB and inter-UE CLI, it’s better to use a separate section to capture, i.e. ‘6.3 Self-interference handling scheme’. Accordingly, editor notes under section 6.1 should also be updated to capture self-interference, i.e. ‘*Editor’s note: This section captures the general aspects of SBFD schemes except the inter-gNB ~~and~~ ,inter-UE CLI and self-interference handling schemes, which are captured in a separate section.*’.  **Comment#2:**  Regarding to chapter 7 and chapter 9, we think the current format is good enough. By reading the comments so far, our feeling is that it may be hard to identify all the detail scenarios and methodology for simulation at a very early stage. On the other hand, the current structure is general enough and can be easily extended by adding new sub-sections to cover all the expected/identified scenarios/cases during the evaluation discussion. For example, we can further add sub-section under section 7.2 to capture FR1 and FR2, LLS and SLS, single operator and two operators, etc. To address companies’ concern, maybe we can add a note for each section like: 7.2 Scenario 1: SBFD scenario 1 Editor’s note: This section captures the evaluation assumptions and performance evaluation results for SBFD scenario 1. Sub-section can be added in the future to capture the evaluation cases according to the discussion, e.g. different frequency ranges, methodologies(LLS, SLS)… |
| vivo | **Comment #1:**  About the feasibility study, we agree with HW that it depends on SBFD schemes, CLI and self-interference handling, and also the deployment scenarios. Therefore, we prefer to have a separate section or sub-section after or under section 7 and under or after section 9.  **Comment #2:**  We also think the most important thing for SBFD is self-interference handling, it should be also included in section 6 as separate sub-section.  **Comment #3:**  About handling the common part CLI handling schemes for SBFD and for dynamic TDD, we share OPPO’s views that it can be solved by either cross-reference or simple duplication, and fine to keep it. The discussion can be either in Agenda 9.3.2 or 9.3.3. |
| ZTE | **Comment#1:**  As we commented online, interference models are one of the major issues to be addressed in this SI. Since interference models may require both RAN1 and RAN4 input and may be applied to more than one simulation methods (LLS, SLS), it is better to have a separate section to capture all these interference models.  The gNB-gNB and UE-UE channel models can also be put in a separate section.  **Comment#2:**  Regarding whether to add “schemes for dynamic TDD” in the TR skeleton, we are not sure about what “schemes for dynamic TDD refers to? Do we intend to introduce some new TDD framework? It would be better if companies can first clarify this terminology.  **Comment#3:**  It seems SBFD gNBs with different UL/DL resource patterns are not listed in section 7. Although it may be treated as lower priority, it doesn’t mean this case can not be simulated. |
| New H3C | **Comment#1:**  Regarding section 6.1, we think current editor is fine and this section should include all of proposed SBFD schemes. We can draw conclusions on all of proposed SBFD schemes feasibility in section 10-12.  **Comment#2:**  Regarding sub-bullet of section 7, we think HW’s proposal is a good starting point to further discuss about refine.  **Comment#3:**  We have the similar view with spreadtrum on section 10 should consider the impact on legacy operation in RAN1. |
| MediaTek | 1. As most of the evaluations will use some interference models (most likely provided by RAN4), ***a section on the interference models needs to be added to the skeleton***. 2. In our view, both link-level and system-level simulations will be needed to evaluate the performance and feasibility of SBFD. ***Thus, subsections for LLS and SLS should be added in sections 7.1 and 9.1***. 3. Feasibility: ***Feasibility evaluation need to be added to section 7***. 4. Impact to legacy operation: The impact to legacy operation has two parts:    1. Impact to legacy UEs (e.g., R15 UEs that don’t support CLI measurements). The impact to legacy UEs exist even for the scenarios with a single cell/operator. ***Thus, all the scenarios listed in section 7 need to consider the impact to legacy UEs***.   Impact to legacy operation, i.e., operator with legacy TDD. The impact to legacy operator exists for the scenarios where two cells (of the same operator or different operators) use different SBFD/TDD configurations, e.g., one cell uses SBFD while the other cell uses legacy TDD. |
| NEC | **Comment #1**: SBFD schemes currently being discussed will have not only CLI impact but also may have impact on different UE physical layer procedures (e.g. for CSI-RS reception, TDD signaling). It would be better if we can also have a sub-section indicating the impact/enhancements on physical layer procedures as follows 6.1 SBFD schemes Editor’s note: This section captures the general aspects of SBFD schemes except the inter-gNB and inter-UE CLI handling schemes, which are captured in a separate section. 6.2 Physical Layer Enhancements Editor’s note: This section captures the potential impacts and enhancements to physical layer procedures for different SBFD schemes. 6.2 Inter-gNB and inter-UE CLI handling schemes Editor’s note: This section captures the potential inter-gNB and inter-UE CLI handling schemes for SBFD, some of the schemes may also be applicable for dynamic/flexible TDD.  **Comment #2**  Agree with Qualcomm and Ericsson regarding having separate sub-sections for FR1 and FR2 evaluations.  **Comment #3**  In section 7 for SBFD, both co-channel and adjacent-channel scenarios are considered. However, in section 8 for dynamic TDD, only adjacent-channel scenario is considered. According to the SID objective below, it seems co-channel should also be considered so we suggest adding one subsection in section 8 for co-channel scenario as well   * *Study the performance of the identified schemes as well as the impact on legacy operation assuming their co-existence in co-channel and adjacent channels (RAN1).*  9.x+2 Scenario x+1: Co-channel co-existence scenario *Editor’s note: This section captures the evaluation assumptions and performance evaluation results for scenario of adjacent-channel co-existence between dynamic/flexible TDD operation and legacy operation* |
| Intel | Thanks for the TR skeleton.  A few suggestions from our side:   * We support the suggestions to add *link budget* and *link-level evaluations* in addition to system-level evaluations. * We share some of the views above and propose have a separate sub-section on handling of self-interference for SBFD under Section 6. * A separate section or sub-section (possibly under Sections 6 or 7) on feasiblity of SBFD should be added. * We do not see any issue with capturing inter-gNB and inter-UE CLI handling schemes under both Sections 6 and 8 for SBFD and flexible/dynamic TDD respectively. In the end, if there is no distinction between the two, the sub-sections could be merged or cross-referenced as appropriate, but good to have separate placeholders since we see new CLI components for SBFD compared to dynamic/flexible TDD. |
| Samsung | **Comment 1 (RF feasibility aspects)**  We prefer to document all RF feasibility aspects (for both SBFD and D-TDD) in Section 10 RF feasibility and impact of RF requirements. Sections 6 SBFD and 8 D-TDD are descriptive and followed by their respective performance evaluation sections 7 and 9. We expect that Section 10 will be largely based on RAN4 input, although many findings from the RAN1 co-channel SLS evaluations will also provide input here. For the rapporteurs, this will make handling text input much easier during the lifetime of the SI and also provide a self-contained analysis of the RF aspects.  If needed, we can create separate sub-sections 10.1 RF aspects of SBFD and 10.2 RF aspects of D-TDD.  **Comment 2 (LLS)**  It is too early for us to agree that we create separate sub-sections for LLS and SLS under 7.1 Evaluation methodologies as suggested by some companies. In our view, SLS will be sufficient for D-TDD. For SBFD, we should first agree if LLS are needed in addition to co-/adjacent channel SLS. For purpose of the gNB-side SI performance, we do not see much purpose in conducting LLS. Primary input for RAN1 SLS is the maximum Tx power at which DL transmissions in the SBFD DL SB can be supported while simultaneously receiving UL transmissions in the SBFD UL subband at an acceptable UL sensitivity degradation.  Similar to the views expressed by Oppo (comment #4), it may be sufficient for now to add to Section 7 in the editor’s note: “This section captures the evaluation metrics, description of **SLS and LLS** evaluation methodologies where needed, etc.”.  If we agree that we need LLS in the SBFD evaluation part, then we think that we can follow the proposal made by Ericsson (comment #1).  **Comment 3 (inter-SB CLI modelling)**  We expect the detailed description of the inter-SB CLI modelling for the RAN1 SLS to become quite extensive. This part of the evaluation methodology in Section 7.1 may be best placed in a new Annex A.2.  **Comment 4 (UE-UE and gNB-gNB channel models)**  If we agree to use different BS-BS channel and UE-UE channel models (than R16) for the RAN1 SLS evaluation part, we should place these in new Annex A.1 Channel models with A.1.1 BS-BS and A.1.2 UE-UE.  **Comment 5 (FR1 vs. FR2)**  We have no strong views on creating separate sections for FR1 and FR2 evaluation methodology and performance evaluation as proposed by Qualcomm (comment #3). We will follow the preference of the group. |
| InterDigital | For study on dynamic/flexible TDD, SLS is sufficient. But, LLS should be separately captured for SBFD study under Section 7, where the **LLS** should be conducted based on **different RB gap values** (as guard RBs), ranging from 0-RB gap to X-RB gap, between DL subband and UL subband, which is an essential part of the new SBFD structure which has never been considered in RAN1. Thus, it is obvious that LLS study for SBFD is needed.  Overall, it is important to draw conclusions from the study on how flexible DL/UL subband allocations may affect to the DL/UL performance, as the RB gap is not a fixed configuration (like a guard band) but is a **dynamically varying factor** in practice depending on gNB’s scheduling decisions, presence of CLI, traffic condition, beam/power-domain condition, etc., which all need to be taken into account during the study. |
| Sony | On section 6.2:  6.2 Inter-gNB and inter-UE CLI handling schemes  As pointed out by others, in subband case, there is also gNB self interference. Perhaps instead of restricting the title to only inter-gNb and inter-UE CLI we can simply make it more general and insert sub-sections later on, that is we can just call it:  **6.2 Interference Handling**  **6.2.1 gNB self interference**  **6.2.2 Inter-gNB CLI**  **6.2.3 Inter-UE CLI** |
| Apple | Thanks for the draft skeleton.  The evaluation assumptions shall be based on existing UE and gNB, without any new RF requirements, that is what enhancements (in terms of UL coverage, etc) is achievable, if any, by introducing new signalling but without any new RF requirements. That should be the starting point.  Any possible solutions shall be justified not only in provided uplink enhancement (coverage, etc), but also identifying (under realistic assumptions) the degradation to legacy victim UEs/gNBs.  For LLS, we don’t think RAN1 needs to reinvent the wheel. For any channel (PUSCH as an example), the required SINR to achieve a given BLER for a given code rate (which depends on data rate) is independent of what we discuss here. RAN1 can use the existing “required SINR”s from R17 CovEnh analysis, and Of course “link budget” numbers (not LLS) shall be updated based on self-interference at gNB, inter/intra sub-band CLI, etc. Those added interference numbers have nothing to do with LLS, indeed they come from RAN4 and/or SLS. |
| Nokia, NSB | **Comment #1:**  We are in line with companies proposing to include link-budget, link-level and system-level simulation studies sub-sections as they are all relevant for understanding the feasibility of SBFD. For dynamic TDD, link-level and system-level evaluations sub-sections are sufficient.  **Comment #2:**  The SI states the need of coexistence studies:  - Study the performance of the identified schemes as well as the impact on legacy operation assuming their co-existence in co-channel and adjacent channels (RAN1).  However, it is also mentioned that the Rel-15 and Rel-16 outcome should be used as reference to avoid repetition. Therefore, we would like to mention that the adjacent-channel co-existence studies for dynamic TDD should only be performed if new scenario and/or assumptions are agreed. Otherwise, co-existence studies from previous releases could be re-used.  **Comment #3:**  As mentioned in the SI objectives, the feasibility aspects of SBFD and dynamic TDD should be captured in Sections 6 and 8 respectively. Section 10 can cover detail of RF aspects.  **Comment #4:**  Modelling of the new types of interference in SBFD are key to understand the feasibility of SBFD. Thus, we suggest including a separate section for this.  **Comment #5:**  Agree with Huawei and Xiaomi on highlighting the importance of the self-interference component (intra gNB CLI) on SBFD. Therefore, we suggest having a separate sub-section under Section 6 for the gNB self-interference.  **Comment #6:**  Agree with Qualcomm and others on having separate sub-sections for FR1 and FR2 evaluations for SBFD (Section 7) and dynamic TDD (Section 9).  **Comment #7:**  For the section 7 and 9, instead of having separate sections for each scenario, we prefer to keep this as part of evaluation assumption. Agreed evaluation scenarios during RAN1#109 can be first included as sub-sections of 7.1 or 9.1. We can come back for the scenario part with any agreement on the evaluation assumption. Following is the example of the section structure.  7.1 Evaluation assumption (including scenarios)  7.2 Evaluation results (fine with what Huawei proposed) |
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# References

1. RP-213591, New SI: Study on evolution of NR duplex operation, CMCC
2. RP-220633, Revised SID: Study on evolution of NR duplex operation, CMCC