**3GPP TSG RAN WG1 #110**  **R1-22xxxxx**

**Toulouse, France, August 22nd – 26th, 2022**

**Agenda item:** 9.3.1

**Source:** Moderator (CMCC)

**Title:** Summary# on evaluation on NR duplex evolution

**Document for:** Discussion/decision

# Introduction

The SI Study on evolution of NR duplex operation was approved in RAN plenary #94-e meeting [1], and the SID was revised in RAN plenary #95 e-meeting [2].

In this contribution, we summarized the related issues and proposals based on the contributions submitted in RAN1#110 under the agenda item 9.3.1 [3]-[28].

The following sections are structured as follows. From section 2 to 4, we categorize the key issues raised by contributions into 3 kinds and some sections may cover more than one sub-issue. For each issue/sub-issue, we provide the background and related proposals, the summary of the proposals, and initial proposals/questions suggested by moderator in sub-sections. For each identified proposal/question, one table is provided.

# Issue#1: Deployment scenarios

## Issue#1-1: Scenarios for SBFD

### Submitted proposal

### Summary

**SBFD Deployment Case 1**

Regarding Rural for FR1, 4 companies [Samsung, Nokia, LG, Xiaomi] suggest to deprioritize or not consider Rural scenario as mandatory for Rel-18 NR duplex evolution study phase.

Regarding FR2-2, Qualcomm suggests to consider InH for FR2-2 as optional scenario, 7 companies [Samsung, Nokia, LG, Xiaomi, CATT, New H3C, Intel] suggest to deprioritize or not consider FR2-2 in Rel-18, with the following consideration:

* FR2-2 is defined for unlicensed technique [Xiaomi, LG]
* FR2-2 is not a target scenario in terms of latency, coverage and capacity [CATT, Samsung]
* FR2-2 has uncertain market rollout for the current moment [Nokia]

In addition, Qualcomm proposes to support HetNet with Urban Macro and Indoor as an optional deployment scenario for Deployment case 1 for FR1.

Moderator suggests **Initial proposal 1-1-1 and 1-1-2.**

**SBFD Deployment Case 2**

There was a discussion in RAN1#109-e on the evaluation scenarios and priority for SBFD Deployment Case 2, but no consensus was achieved. In this meeting, companies’ views are still divergent. Several companies [Huawei, Samsung, Xiaomi, Spreadtrum, Docomo] suggest to deprioritize SBFD Deployment Case 2. Two companies [Nokia, Intel] suggest to reuse the scenarios agreed for Deployment Case 1 for Deployment Case 2. ZTE suggests a subset of the scenarios of Deployment case 1 for Deployment case 2. MediaTek suggests that no further prioritization between the deployment cases for SBFD is pursued in RAN1.

Moderator suggests **Initial proposal 1-1-3.**

**SBFD Deployment Case 3**

For SBFD Deployment Case 3-1,

* Samsung suggests not to evaluate Indoor Hotspot/Office, Dense Urban (1-layer) and Urban Macro for as mandatory
* Intel suggests to reuse the scenarios agreed for SBFD Deployment Case 1
* The following scenarios are considered by some companies:
  + Urban Macro [ZTE (FR1), Xiaomi]
  + Dense Urban Macro layer [ZTE (FR2-1), Xiaomi]
  + Dense Urban Micro layer [ZTE(FR2-1)]

Moderator suggests **Initial proposal 1-1-3**.

For SBFD Deployment Case 3-2,

* Ericsson suggests it can be done on a best effort basis.
* The following scenarios are considered by some companies:
  + HetNet with Urban Macro and Indoor office [Huawei (FR1), Nokia, CMCC (FR1)]
  + Dense Urban with 2-layer [ZTE (FR1), Xiaomi, CMCC (FR1)]

Moderator suggests **Initial proposal 1-1-4**.

**SBFD Deployment Case 4**

There are few inputs on the scenarios for SBFD Deployment Case 4, and no company shows strong opinion to support Indoor hotspot and Dense Urban Micro layer.

### 1st Round Proposals

#### ***Initial proposal 1-1-1(Closed):***

For NR duplex evolution evaluation, Rural scenario is not considered in Rel-18.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | We expect Rural CLI is not as challenging as than for Urban. Whatever schemes we come up with to manage CLI in Urban would be sufficient (or more than enough) for Rural. Hence, we agree with the proposal. |
| Intel | We are OK with FL’s proposal. The list of scenarios to simulate is already quite long, and we do not expect the rural scenario to bring any additional insights. |
| Spreadtrum | We agree with the proposal. |
| Ericsson | We support the proposal |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Apple | Support FL’s proposal |
| Samsung | We support FL initial proposal 1-1-1. |
| ZTE | If no operator is interested in Rural scenario, we are ok with this proposal. |
| NEC | Agree |
| CATT | We support the proposal |
| Nokia, NSB | support |
| NTT DOCOMO | We are fine for SLS. If we perform LLS for coverage performance and follow 38.830, it covers Rural scenario and we can consider this aspect. |
| QC | Support |
| LG Electronics | We are fine with FL’s proposal 1-1-1. |
| Moderator | Based on comments, the proposal was updated. |
| Xiaomi | Support |

#### ***Initial proposal 1-1-2(Closed):***

For NR duplex evolution evaluation, FR2-2 is not considered in Rel-18.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Intel | We are Ok with the proposal. Considerig the current workload in the SI, and additional consideration that RAN1 may need to discuss to enable operation in FR2-2, it may be indeed recommended to postpone enabling operation in FR2-2 to a later release or to resume discussion later on along this SI depending on progress. |
| Spreadtrum | We agree with the proposal. |
| Ericsson | We support the proposal |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Apple | Support FL’s proposal |
| Samsung | We support FL initial proposal 1-1-2. |
| NEC | Agree |
| CATT | We support the proposal |
| Nokia, NSB | Support |
| QC | We prefer to have it as optional, interested companies can submit results. |
| LG Electronics | We are fine with FL’s proposal 1-1-2. |
| Moderator | Based on comments, I feel current proposal is still the way forward. Please continue comments here |
| Fujitsu | We support the proposal. |
| Xiaomi | Support |
| InterDigital | Support |

#### ***Initial proposal 1-1-3(Closed):***

For SBFD evaluation from RAN1 perspective, the evaluation assumptions that are specific for Deployment Case 2 and Case 3-1 can be discussed with low priority (i.e., it can be discussed after the evaluation assumptions for Deployment case 1/4/3-2 are determined).

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | Fine with the proposal. |
| Intel | We are generally OK to deprioritze some of the cases, and we believe that Case 4 and 3-2 should be also among them, considering that co-existence study was already performed in other release with similar assumptions RAN1 is taking for this SI, and also considering this type of evaluations have been handled in the past by RAN4 and are in RAN4’s domain of expertise. If we were to prioritize the agreed cases, our preference is as follows: case 1 > case 2/3-1 > case 4> case 3-2. |
| Spreadtrum | Considering the heavy workload of 4 deployment cases, we are OK to deprioritze case 2 and case3-1. |
| Ericsson | We support the proposal. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Apple | Support FL’s proposal |
| Samsung | We support FL initial proposal 1-1-3.  In this meeting, RAN1 makes a progess on details for the agreed cases, 1 and 4. With this, RAN1 will carry out SLS calibration in the future meeting. For case 2 and 3, we see its necessity is not so urgent that we can discuss and reused the details for the agreed case. |
| NEC | We can agree to the proposal to reduce evaluation workload. However, we would like to point out that if we want to evaluate UE-UE interference, then Scenario-2 and 3 are expected to show more serious performance issues as compared to Scenario-1. So, it would be better that we can atleast agree to a general evaluation assumption framework (having much commonality with the evaluation assumptions of Scenario-1 and Scenario-3a) so that concerned companies can at least begin to evaluate these scenarios. |
| CATT | We support the proposal |
| Nokia, NSB | support |
| NTT DOCOMO | We are fine with the proposal. |
| QC | Support |
| LG Electronics | We support FL’s initial proposal 1-1-3. |
| Moderator | Based on comments, I still think the current proposal is the way forward. Please continue comment here, if any |
| Fujitsu | We support the proposal. |
| Xiaomi | Support |
| InterDigital | Share similar view with NEC |

#### ***Initial proposal 1-1-4(Closed):***

For evaluation of SBFD Deployment Case 3-2, consider the following scenarios for FR1:

* HetNet with Urban Macro and Indoor office
  + Urban Macro layer uses legacy static TDD operation, Indoor office layer uses SBFD operation
* (Optional) Dense Urban with 2-layer
  + Dense Urban Macro layer uses legacy static TDD operation, Dense Urban Micro layer uses SBFD operation

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Intel | We are OK with the proposal, even though as indicated above it is our preference to deprioritize this case. |
| Spreadtrum | We agree with this proposal. It is a good way to evaluate SBFD performance in indoor scenario of case 1, and at the same time to make sure indoor office is practicable in the co-existence case in HetNet of case 3-2. |
| Ericsson | We cannot support this proposal in its current form. We need to have all the details about HetNets scenario before we can agree to this proposal. For example, what is the association method to be used including the cell-range extension? Is CoMP scenario deployed? Moreover, we think that the 2-layer scenario must be the same for both dynamic TDD and SBFD. However, Dense Urban with 2-layer has already been studied in the TR 38.828, therefore we think that could be the baseline. ***Initial proposal 1-1-4 (Modified by Ericsson):*** For evaluation of SBFD Deployment Case 3-2, consider the following scenarios for FR1:   * ~~(Optional)~~ Dense Urban with 2-layer   + Dense Urban Macro layer uses legacy static TDD operation, Dense Urban Micro layer uses SBFD operation * (Optional) HetNet with Urban Macro and Indoor office   + Urban Macro layer uses legacy static TDD operation, Indoor office layer uses SBFD operation   + FFS details on HetNets scenario, e.g., cell range extension, CoMP deployment scenario, number of users served by the small cells etc. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | We are supportive of the proposal, just one minor modification to include the indoor factory use case.  For evaluation of SBFD Deployment Case 3-2, consider the following scenarios for FR1:   * HetNet with Urban Macro and Indoor office/factory   + Urban Macro layer uses legacy static TDD operation, Indoor office layer uses SBFD operation * (Optional) Dense Urban with 2-layer   + Dense Urban Macro layer uses legacy static TDD operation, Dense Urban Micro layer uses SBFD operation |
| Apple | We prefer to deprioritize this case |
| Samsung | We support FL initial proposal 1-1-4 in principle.  However, for 2nd round discussions we see need to then discuss for the (optional) Dense Urban 2-layer case if the different layers can or cannot use different SBFD configurations. Since the case 2 is deprioritized (if agreed) all gNB use the same SBFD configuration. |
| NEC | Agree |
| CATT | We support the proposal |
| Nokia, NSB | support |
| NTT DOCOMO | We are fine with the proposal. |
| QC | Generally, okay. However, as summarized by the FL, we prefer to add HetNet as optional feature for case 1 as well.  For evaluation of SBFD Deployment Case 1, consider the following scenarios for FR1:   * (Optional) HetNet with Urban Macro and Indoor office   + Urban Macro layer uses legacy static TDD operation, Indoor office layer uses SBFD operation |
| LG Electronics | We support FL’s initial proposal 1-1-4. |
| Moderator | Based on comments, the proposal was updated.  @Ericsson, regarding the HetNet, CoMP scenario is not considered here. |

### 2nd Round Proposals

#### ***Updated proposal 1-1-1-r1(Open):***

For SLS of NR duplex evolution, Rural scenario is not considered in Rel-18.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | Support |
| Samsung | Support |
| Fujitsu | We support the proposal. |
| CATT | Fine with the proposal. |
| Xiaomi | Support. |
| Spreadtrum | Support |
| Ericsson | We support the proposal |
| New H3C | Support |
| InterDigital | Support |
| QC | Support |
| Huawei, Hisilicon | OK with the proposal. |
| Intel | Support |

#### ***Updated proposal 1-1-4-r1(Open):***

For evaluation of SBFD Deployment Case 3-2, consider the following scenarios for FR1:

* (Optional) HetNet with Urban Macro and Indoor factory
  + Urban Macro layer uses legacy static TDD operation, Indoor office layer uses SBFD operation. All the Indoor gNBs use the same SBFD subband configuration.
  + Note: CoMP deployment is not considered.
* (Optional) Dense Urban with 2-layer
  + Dense Urban Macro layer uses legacy static TDD operation, Dense Urban Micro layer uses SBFD operation. All the Micro gNBs use the same SBFD subband configuration.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CATT | We are fine with the proposal in general but would like to understand the difference between indoor factory and indoor office. At least the current proposal is not consistent with inddor factory in the first bullet and indoor office in the sub-bullet. |
| Spreadtrum | It’s a bit weird that the indoor case for case 1 is indoor office, but for case 3 it is indoor factory. There should be some alignment between those cases. |
| Ericsson | We cannot support this proposal in its current form as we are not sure what a “HetNet with Urban Macro and Indoor Factory” scenario is. Could you please refer to a TR that deploys HetNet scenario as described above? For e.g., Dense Urban with 2-layer is a known scenario in 38.828.  How is a Dense Urban with 2 -layer different from Hetnet with Urban Macro and Indoor office, if cell-range extension settings and CoMP are not considered. Isnt HetNet also 2 layers with urban macro and indoor hotspot? Secondly, in which TR is this indoor factory or indoor scenario described? |
| New H3C | Support |
| QC | Generally, okay with case 3-2.  However, as commented in the first round, we would like to add HetNet as optional feature for case 1 as well.  For evaluation of SBFD Deployment Case 1, consider the following scenarios for FR1:   * (Optional) HetNet with Urban Macro and Indoor office   Urban Macro layer uses legacy static TDD operation, Indoor office layer uses SBFD operation |
| Huawei, Hisilicon | We have concerns on the note for the first bullet. COMP is a powerful tool to combat the interference, especially the indoor TRPs are usually co-located, COMP should not be precoluded. So we suggested delete the note in the first bullet. |
| Intel | We are OK with proposal. |

### 3rd Round Proposals

#### ***Updated proposal 1-1-1-r1(Open):***

For SLS of NR duplex evolution, Rural scenario is not considered in Rel-18.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | No update, seems stable |
|  |  |

#### ***Initial proposal 1-1-2(Open):***

For NR duplex evolution evaluation, FR2-2 is not considered in Rel-18.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | No update, seems stable |
|  |  |

#### ***Initial proposal 1-1-3(Open):***

For SBFD evaluation from RAN1 perspective, the evaluation assumptions that are specific for Deployment Case 2 and Case 3-1 can be discussed with low priority (i.e., it can be discussed after the evaluation assumptions for Deployment case 1/4/3-2 are determined).

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | No update |
|  |  |

#### ***Updated proposal 1-1-4-r2(Open):***

For evaluation of SBFD Deployment Case 3-2, consider the following scenarios for FR1:

* (Optional) HetNet with Urban Macro and Indoor factory
  + Urban Macro layer uses legacy static TDD operation, Indoor office layer uses SBFD operation. All the Indoor gNBs use the same SBFD subband configuration.
  + ~~Note: CoMP deployment is not considered.~~
  + Note: Regarding the Indoor factory layer, reuse the Indoor factory (InF) scenario and relevant channel model in TR38.901.
* (Optional) Dense Urban with 2-layer
  + Dense Urban Macro layer uses legacy static TDD operation, Dense Urban Micro layer uses SBFD operation. All the Micro gNBs use the same SBFD subband configuration.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | In round 1, some companies prefer to also consider indoor factory in additon to indoor office, I think it would be better to select one of indoor office and indoor factory instead of both in order to reduce the simulation workload, so I use Indoor factory in the new proposal.  Regarding indoor factory, the intention is to reuse the Indoor Factory (InF) scenario and relevant channel model in TR38.901. Regarding indoor office, the intention is to reuse the Indoor office scenario and relevant channel model in TR38.901.  The Hetnet here is to simulate the practical factory scenario which is deployed in the macro scenario, there is not a mature topology and channel model that could be directly used. That’s why we are discussing how to construct such a scenario. The intention here is to construct such a scenario based on Urban Macro and Indoor factory (refer to TR38.901).  @QC, we can focus on how to stabilize the Hetnet scenario for deployment case 3-2, then for case 1, we can reuse it as much as possible, if it is decided to include it also for case 1. |
| Ericsson | We cannot agree to a carte blanche HetNet scenario without knowing the details of the HetNet scenario. We have the same opinion regarding Indoor Factory.  Indoor office scenario is available in 38.901 and can be simulated. If companies think that Indoor factory scenario is well-suited for SBFD operation, it must be motivated.  We propose to change it to the following – ***Updated proposal 1-1-4-r2(Open)(Modified by Ericsson):*** For evaluation of SBFD Deployment Case 3-2, consider the following scenario~~s~~ for FR1:   * 2-layer scenario with independent deployment of the layers   + Layer 1: Urban Macro, or Dense Urban Macro layer   + Layer 2: Indoor office or Indoor factory or Dense Urban Micro layer   + Layer 1 uses static TDD operation and Layer 2 uses SBFD/dynamic TDD operation * ~~(Optional) HetNet with Urban Macro and Indoor factory~~   + ~~Urban Macro layer uses legacy static TDD operation, Indoor office layer uses SBFD operation. All the Indoor gNBs use the same SBFD subband configuration.~~   + ~~Note: CoMP deployment is not considered.~~   + Note: Regarding the Indoor factory layer, reuse the Indoor factory (InF) scenario and relevant channel model in TR38.901. * ~~(Optional) Dense Urban with 2-layer~~ * ~~Dense Urban Macro layer uses legacy static TDD operation, Dense Urban Micro layer uses SBFD operation. All the Micro gNBs use the same SBFD subband configuration~~ |
| Intel | We are OK with Ericsson’s updated proposal. |

## Issue#1-2: Scenarios for dynamic/flexible TDD

### Submitted proposal

### Summary

In RAN1#109-e meeting, there was a discussion on deployment Scenarios for dynamic/flexible TDD. Although there is no agreement, most of the companies seem fine with the following proposal except the adjacent-channel coexistence case.

|  |
| --- |
| **Updated proposal 2-1c:**  For evaluation of dynamic/flexible TDD, consider the following scenarios for evaluation:   * FR1   + High priority     - Indoor office with dynamic TDD UL/DL assignment     - HetNet with Urban Macro and Indoor office deployed in the same carrier, and Macro gNBs use DL dominant static TDD UL/DL configuration. Both of the following options can be considered for this scenario.       * Option 1: Indoor gNBs use UL dominant static TDD UL/DL configuration       * Option 2: Indoor gNBs use dynamic TDD UL/DL assignment     - FFS: Adjacent-channel coexistence case between dynamic TDD and legacy TDD       * FFS: detailed scenario for adjacent-channel coexistence case   + Optional:     - Urban Macro with dynamic TDD UL/DL assignment     - Dense Urban with two layers deployed in the same carrier, and Macro gNBs use DL dominant static TDD UL/DL configuration. Both of the following options can be considered for this scenario.       * Option 1: Micro gNBs use UL dominant static TDD UL/DL configuration       * Option 2: Micro gNBs use dynamic TDD UL/DL assignment * FR2-1   + Indoor office with dynamic TDD UL/DL assignment   + Dense Urban Macro layer with dynamic TDD UL/DL assignment |

In RAN#110, the preference on the scenarios for single operator case are summarized as following.

* FR1
  + Indoor office [Huawei, ZTE, vivo, CATT, Nokia, Intel, Dell, CMCC]
  + HetNet with Urban Macro and Indoor office [Huawei, ZTE, Qualcomm, vivo, CATT, Nokia, Xiaomi, CMCC]
  + (Optional) Urban Macro [Huawei (optional), ZTE, Qualcomm, Intel, CMCC]
  + (Optional) Dense Urban with two layers [Huawei (optional), ZTE, Intel (optional), CMCC]
* FR2-1
  + Indoor office [Huawei, ZTE, Qualcomm (optional), Intel, Dell, CMCC]
  + Dense Urban Macro layer [Huawei, ZTE, Intel, CMCC]

Moderator suggests **Initial proposal 1-2-1.**

Regarding the adjacent-channel coexistence case between dynamic TDD and legacy TDD for FR1, few companies have inputs, and companies’ views are still divergent.

* 3 companies [Huawei, Nokia, Dell] suggest to avoid repeating the Rel-16 co-existence study in Rel-18 in RAN1. They think unless significant changes on the parameters/assumptions from the previous Rel-16 adjacent coexistence studies are agreed, the previous conclusions remain valid and there is no need to perform new coexistence studies.
* MediaTek suggests several scenarios including Urban Macro and Indoor office, and vivo suggests HetNet with Urban Macro and Indoor office on adjacent carriers.

In Moderator’s view, companies who support evaluation scenarios for adjacent-channel coexistence case should explain more on the difference (e.g., the detailed simulation assumptions) from the Rel-16 co-existence study.

### 1st Round Proposals

#### ***Initial proposal 1-2-1(Closed):***

For evaluation of dynamic/flexible TDD for the single operator case, consider the following scenarios:

* FR1
  + Indoor office with dynamic TDD UL/DL assignment
  + HetNet with Urban Macro and Indoor office deployed in the same carrier, and Macro gNBs use DL dominant static TDD UL/DL configuration. Both of the following options can be considered for this scenario.
    - Option 1: Indoor gNBs use UL dominant static TDD UL/DL configuration
    - Option 2: Indoor gNBs use dynamic TDD UL/DL assignment
  + (Optional) Urban Macro with dynamic TDD UL/DL assignment
  + (Optional) Dense Urban with two layers deployed in the same carrier, and Macro gNBs use DL dominant static TDD UL/DL configuration. Both of the following options can be considered for this scenario.
    - Option 1: Micro gNBs use UL dominant static TDD UL/DL configuration
    - Option 2: Micro gNBs use dynamic TDD UL/DL assignment
* FR2-1
  + Indoor office with dynamic TDD UL/DL assignment
  + Dense Urban Macro layer with dynamic TDD UL/DL assignment
* For above scenarios, the following is assumed:
  + DL dominant static TDD UL/DL configuration: assume {DDDSU}, where S=[12D:2G:0U]
  + UL dominant static TDD UL/DL configuration: assume {DSUUU}, where S=[12D:2G:0U]
  + dynamic TDD UL/DL assignment: assume {FFFFF}, companies to report the guard symbols assumed in their simulation

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | Fine with the proposal. |
| Intel | For FR-1, while we’re open to considering HetNet scenarios (e.g., UMa + Hotspot) and see their value, we think that Urban macro should form the baseline scenarios, similar to SBFD. |
| Spreadtrum | Support in principle. But for Urban Macro, it was recommended not to be considered in R16 adjacent channel coexistence study. And compared with R18, the simulation assumption of dynamic TDD in R16 is a little optimistic only considering 0% grid shift. We suggest to avoid repetition work and remove Urban Macro in FR1. |
| Ericsson | Support in principle but we think that case 3-2 needs to be aligned between SBFD and dynamic TDD scenarios. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Similar as Intel, we think the following scenario can be removed for FR1 given the challenges of adjacent channel co-existence as identified in 38.828,   * + (Optional) Urban Macro with dynamic TDD UL/DL assignment |
| Samsung | We support FL initial proposal 1-2-1. |
| ZTE | We propose to delete “optional” and keep these scenarios.  In the end, all scenarios are up to companies to choose to simulate. To some extent, all these scenarios are optional. |
| CATT | We support the proposal |
| Nokia, NSB | Support |
| QC | Generally fine. The optional wording should be dropped. It is up to companies to provide results for scenario of interest. |
| LG Electronics | We support FL’s initial proposal 1-2-1. |
| Moderator | The proposal was updated based on comments.  Some companies [Intel] prefer to keep Urban Macro as baseline, some companies [Huawei, Spreadtrum] prefer to delete Urban Macro. I think keep it optional can be compromise.  Regarding whether to delete “optional”, in my view, if a scenario is marked as baseline, we hope more companies can provide the evaluation results for such scenarios [although we cannot enforce companies to provide the results], but for the optional scenarios, it is up to companies to provide or not. |

### 2nd Round Proposals

#### ***Updated proposal 1-2-1-r1(Open):***

For evaluation of dynamic/flexible TDD for the single operator case, consider the following scenarios:

* FR1
  + Indoor office with dynamic TDD UL/DL assignment
  + (Optional) HetNet with Urban Macro and Indoor factory deployed in the same carrier, and Macro gNBs use DL dominant static TDD UL/DL configuration. Both of the following options can be considered for this scenario.
    - Option 1: Indoor gNBs use UL dominant static TDD UL/DL configuration
    - Option 2: Indoor gNBs use dynamic TDD UL/DL assignment
  + (Optional) Urban Macro with dynamic TDD UL/DL assignment
  + (Optional) Dense Urban with two layers deployed in the same carrier, and Macro gNBs use DL dominant static TDD UL/DL configuration. Both of the following options can be considered for this scenario.
    - Option 1: Micro gNBs use UL dominant static TDD UL/DL configuration
    - Option 2: Micro gNBs use dynamic TDD UL/DL assignment
* FR2-1
  + Indoor office with dynamic TDD UL/DL assignment
  + Dense Urban Macro layer with dynamic TDD UL/DL assignment
* For above scenarios, the following is assumed:
  + DL dominant static TDD UL/DL configuration: assume {DDDSU}, where S=[12D:2G:0U]
  + UL dominant static TDD UL/DL configuration: assume {DSUUU}, where S=[12D:2G:0U]
  + dynamic TDD UL/DL assignment: assume {FFFFF}, companies to report the guard symbols assumed in their simulation

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| CATT | Similar question as for proposal 1-1-4-r1, we would like to understand the difference between indoor office and indoor factory. |
| Spreadtrum | We still think Urban Macro is a repetition work, but if other companies are fine with it, optional is OK for us.  About Hetnet, in the initial proposal of last meeting, it was “indoor hotspot”, and than after discussion about “indoor office and indoor factory”, it updated to “indoor office”, but now it changes back to “indoor factory”. Can this repeted work be avoid? |
| Ericsson | We would like to highlight that it could be beneficial to have same scenarios for evaluation of both SBFD and dynamic TDD (without repeating whatever was done before in the Rel-16 CLI RIM study) . If that’s agreeable, we need to harmonize the scenarios here. Similar comments as previous proposal on the Hetnet scenario. |
| New H3C | Support |
| QC | Our first preference for FR1 deployment scenario of dynamic-TDD is Urban Macro and Indoor office and finally HetNet. We can live with the current FL proposal for progress. |
| Huawei, Hisilicon | We have concern to put FR1 HetNet to optional, and it is an important scenario for flexible TDD use case, because this is the most practical case that flexible TDD may work for FR1, and there is practical deployment needs from our perspective. |
| Intel | For FR-1, our preference was to use Urban macro as a baseline scenario, similar to SBFD, but we are also OK with the proposal in the current form. |

### 3rd Round Proposals

#### ***Updated proposal 1-2-1-r1(Open):***

For evaluation of dynamic/flexible TDD for the single operator case, consider the following scenarios:

* FR1
  + Indoor office with dynamic TDD UL/DL assignment
  + (Optional) HetNet with Urban Macro and Indoor factory deployed in the same carrier, and Macro gNBs use DL dominant static TDD UL/DL configuration. Both of the following options can be considered for this scenario.
    - Option 1: Indoor gNBs use UL dominant static TDD UL/DL configuration
    - Option 2: Indoor gNBs use dynamic TDD UL/DL assignment
    - Note: Regarding the Indoor factory layer, reuse the Indoor factory (InF) scenario and relevant channel model in TR38.901.
  + (Optional) Urban Macro with dynamic TDD UL/DL assignment
  + (Optional) Dense Urban with two layers deployed in the same carrier, and Macro gNBs use DL dominant static TDD UL/DL configuration. Both of the following options can be considered for this scenario.
    - Option 1: Micro gNBs use UL dominant static TDD UL/DL configuration
    - Option 2: Micro gNBs use dynamic TDD UL/DL assignment
* FR2-1
  + Indoor office with dynamic TDD UL/DL assignment
  + Dense Urban Macro layer with dynamic TDD UL/DL assignment
* For above scenarios, the following is assumed:
  + DL dominant static TDD UL/DL configuration: assume {DDDSU}, where S=[12D:2G:0U]
  + UL dominant static TDD UL/DL configuration: assume {DSUUU}, where S=[12D:2G:0U]
  + dynamic TDD UL/DL assignment: assume {FFFFF}, companies to report the guard symbols assumed in their simulation

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Hope I clarify the indoor office and indoor factory. Based on comments, I think the current proposal can be a way forward. |
| Ericsson | Our modifications to proposal 1-1-4r2 could be used here with slight changes to incorporate static TDD or dynamic TDD configurations |

## Issue#1-3: Others

### Submitted proposal

# Issue#2: SLS Evaluation Methodology

## Issue#2-1: Interference modelling for SBFD

### Submitted proposal

### Summary

Regarding gNB self-interference modelling in SLS, moderator suggests **Initial proposal 2-1-1** based on the submitted proposals.

Regarding inter-site gNB-gNB co-channel inter-subband CLI modelling in SLS, moderator suggests **Initial proposal 2-1-2** based on the submitted proposals.

Regarding co-site inter-sector co-channel inter-subband CLI modelling in SLS, moderator suggests **Initial proposal 2-1-3** based on the submitted proposals.

Regarding UE-UE co-channel inter-subband CLI modelling in SLS, moderator suggests **Initial proposal 2-1-4** based on the submitted proposals.

Regarding inter-site gNB-gNB adjacent-channel CLI modelling, co-site gNB-gNB adjacent-channel CLI modelling and UE-UE adjacent-channel CLI modelling, they can be discussed later after we make some conclusions for above proposals.

In addition, regarding RSI value the following values are used by companies in their simulations.

* 135 dB [Qualcomm]
  + Spatial isolation plus Digital NLIC = 90 dB, Frequency isolation: 45 dBc/20MHz
* 137 dB [Ericsson]
  + Antenna isolation = 80 dB, Digital cancellation: 15 dB, Inter-subband leakage ratio (ACIR): 42dB
* 120dB [ZTE]
* 110dB [vivo]
  + Spatial isolation = 65 dB, Frequency isolation: 45 dB
* 123dB [LG]
  + ASIR: 43 dB + SIC: 80dB
* Opt 1: 105dB; Opt 2: 130dB [Spreadtrum]
* 128dB (85dB+43dB) or 143 dB (100dB+43dB) [Xiaomi]

### 1st Round Proposals

#### ***Initial proposal 2-1-1(Open):***

*The* *gNB self-interference can be modeled as white Gaussian noise in SLS as follows:*

* *The gNB self-interference across all Rx chains at UL frequency unit can be modeled as*

*where,*

* + *is the number of Rx chains at gNB,*
  + *, ,*
  + *is the power of gNB self-interference on each Rx chain at UL frequency unit ,*
  + *is the DL power transmitted by gNB across all Tx chains at DL frequency unit ,*
  + *is the ratio of self-interference (RSI).*
* *The covariance of gNB self-interference across all Rx chains at UL frequency unit can be modeled as .*

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Intel | For this topic, since during prior RAN1 meeting we have sent an LS to RAN4 inquiring for their help regarding the self-interference modelling, we may prefer to postpone discussion until we receive an answer from them. |
| Spreadtrum | Agree with Intel, but we also suggest to use a simplified interference modeling (ACLR liked) for calibration before feedback from RAN4. |
| Ericsson | We agree with Intel and also Spreadtrum that a simple model is required for modeling self-interference in SLS. |
| New H3C | We hope to simplify this interference modeling. |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-1-1 in principle.  The intention of this proposal seems to treat noise power as actual noise power plus self-interference power when we computing SINR. i.e., the residual self-interference is regarded as noise boosting. |
| Nokia, NSB | We agree with Intel, Spreadtrum and Ericsson that a simpler ACLR-like model could be adopted (e.g. for calibration purposes, if needed), while we wait for the feedback from RAN4. |
| QC | We would like to consider the modeling when interference is frequency flat. In addition to direct leakage, clutter modeling is necessary to reflect real deployment. An FFS on clutter modeling should be added.  Finally, modeling the residual interference as white guassian noise is not accurate and doesn’t consider the OTA channel between the Tx/Rx panels. We suggest companies to consider a different model based on the following:  The residual interference is modeled based on the trasmissted DL Tx signal and considering the inter-panel channel as near filed channel (e.g. single tap with random phase) and scaled by the |
| LG Electronics | We are also on the same page with Intel, Spreadtrum and Ericsson. Regarding the self-interference modling, it is better that RAN1 may postpone this discussion until response from RAN4 is received. Also, a simple model is required for SLS evaluation. |
| Moderator | It is very likely RAN4 will provide the value(s) for RSI, then RAN1 still needs to decide how to use these values in SLS, this is the intention of this proposal. Some companies prefer simple model, maybe these companies can provide some examples for such simple model. To me, it seems current proposal is simple enough (can be assumed frequency flat for simplicity), just as what Samsung explained above. |
| Fujitsu | We agree to use simple model as same as some companies proposed. |
| CATT | We are fine with the proposal. |
| Xiaomi | We agree with Intel, Spreadtrum, Ericsson, Nokia and LGE that repeated work should be avoided between RAN1 and RAN4. |
| Kumu Networks | Proposal on isolation table should consider improvement from RF cancellation and Beam Nulling jointly. For the table, we proposed the beam nulling line items should include isolation from any type of analog cancellation including RF cancellation.  FR 1:  Spatial isolations : 70 dB  Frequency isolations : 45 dB  Beam Nulling + RF cancellation : 30 dB-40 dB  Total RSI > 145 dB  FR 2:  Spatial isolations : 80-90 dB  Frequency isolations : 28 dB  Total RSI > 138 dB  Beam Nulling + RF cancellation : 30 dB-40 dB  Base on our simulation and hardware measurements, the combine effect can give up to 30 dB cancellation. This will also preserve antenna gain from beamforming. With RF cancellation, LNA saturation can be avoided. |
| Ericsson 2 | We think that if companies agree, we can focus on the common understanding that the gNB self-interference is modeled as frequency flat for the SLS. We think that anything else is complex and adds implementation effort in our simulators. For the actual number, although we can wait for the RAN4 response, we could also decide on a ballpark to simulate as Kumu mentioned.  In our view the most straightforward way of defining the amount of interference experienced by a victim node is in terms of a relative metric between the power spectral density (PSD) of the aggressor signal and the PSD of the resulting interference. In general, the interference PSD at the victim node is a combination of that the TX signal of the aggressor leaks into the bandwidth of the victim (roughly ACLR in RAN4 terms) and that the receiver at the victim picks up power outside of the intended bandwidth (roughly ACS in RAN4 terms). This could be extended to both co-channel and adjacent-channel CLI   For example, For SBFD operation, the TX signal leaks into the UL sub-band due to non-linearities in the transmit chain. The interference experienced at the receiver can be modelled as a relative metric between DL and UL sub-bands made up of three components X, Y and Z as indicated in the figure. X corresponds to the isolation including pathloss, antenna gain, beamforming gain and antenna isolation. Y corresponds to the leakage between DL and UL frequencies which includes effects from both transmitter and receiver. For SBFD, in addition to the TX signal leaking into the UL sub-band, the UL receiver will also pick up power from the DL sub-bands that will add to the actual interference experienced at the receiver. Z corresponds to the self-interference cancellation performed at the receiver, if any. In our opinion, these effects can be modelled as a net effective relative PSD metric for system level simulations. |

#### ***Initial proposal 2-1-2(Open):***

*The inter-site gNB-gNB co-channel inter-subband CLI can be modeled as follows in SLS:*

* *Introduce a BS co-channel inter-subband leakage power ratio (ISLR) to represent the co-channel inter-subband leakage power suppression capability at aggressor gNB.*
  + *The BS ISLR, denoted as , can be defined as the ratio of the transmission power centered on an allocated frequency unit in a SBFD carrier to the leakage power centered on a non-allocated frequency unit in the same SBFD carrier.*
* *Introduce a BS co-channel inter-subband selectivity (ISS) to represent the co-channel inter-subband selectivity capability at victim gNB.*
  + *The BS ISS, denoted as , can be defined as the ratio of the receive power centered on a non-allocated frequency unit in a SBFD carrier to the residual power suppressed by receiver selectivity centered on an allocated frequency unit in the same SBFD carrier.*
* *The inter-site gNB-gNB co-channel inter-subband CLI across all Rx chains at UL frequency unit at victim gNB can be modeled as*

*where,*

* *is the first part of inter-site gNB-gNB co-channel inter-subband CLI across all Rx chains at UL frequency unit , caused by power leakage at aggressor gNB,*
  + *is the channel between aggressor gNB and victim gNB at UL frequency unit , the analog beamforming at the aggressor gNB and victim gNB can be taken into account by* ,
  + *is the unwanted emissions across all Tx chains at UL frequency unit at aggressor gNB,*
    - *is the number of Tx chains at aggressor gNB,*
    - *, , is modelled as white Gaussian noise,*
    - *is the leakage power on each Tx chain at UL frequency unit at aggressor gNB,*
    - *is the DL power transmitted across all Tx chains at DL frequency unit at aggressor gNB,*
* *is the second part of inter-site gNB-gNB co-channel inter-subband CLI across all Rx chains at UL frequency unit , caused by receiver selectivity at victim gNB,*
  + *is the channel between aggressor gNB and victim gNB at DL frequency unit , the analog beamforming at the aggressor gNB and victim gNB can be taken into account by* ,
  + *is the digital precoder at DL frequency unit at aggressor gNB, ,*
  + *is the symbol transmitted at DL frequency unit at aggressor gNB.*
* *The covariance of inter-site gNB-gNB co-channel inter-subband CLI across all Rx chains at UL frequency unit can be modeled as*

*where,*

* *,*
  + *is DL transmission power across all Tx chains at DL frequency unit at aggressor gNB.*

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | Are we supposed to get RAN4 input on this? Is the intention here is for RAN4 to define only *βISLR,BS* and *βISS,BS*? |
| Intel | Similarly as prior proposal, we may prefer to postpone discussion until RAN1 receives an answer from RAN4 regading this topic. It may not be proper to agree on a specific model, while RAN1 is expecting input from RAN4. |
| Spreadtrum | Same as proposal 2-1-1. |
| Ericsson | Same as proposal 2-1-1. |
| New H3C | we hope to simplify this interference modeling. |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-1-2 in principle. |
| Nokia, NSB | At least for calibration purposes, a simpler model could be specified while we wait for the feedback from RAN4. |
| QC | We have two major concerns on the proposasl   * The leakage modeling should have directionality of the precoding. It is generated from the IMD (NL of the gNB transmission, e.g. PA) and it can be expressed as . Considering the case for wideband precoding, e.g. in FR2, then the precoder is common across the Tx tones (m) and . In addition, depedniong on the digital precoding and number of streams, the leakage will have some directionality. So, it is not accurate to model as isotropic in spatial domain (i.e. random gauassian noise). * The model should have the frequency flat scenario.   It is important to clarify how H\_CLI is modeled based on earlier RAN1 agreements, e.g. both small scale and large-scale modeling. |
| LG Electronics | We are fine with initial proposal 2-1-2 in principle. But, it seems better that RAN1 waits RAN4 response regarding the modelding for the inter-site gNB-gNB co-channel inter-subband CLI. |
| Fujitsu | Our proposal is the same as proposal 2-1-1. |
| Xiaomi | Same as proposal 2-1-1 and agree with Nokia that a simpler model could be used for simulation before we receive feedback from RAN4. |
| Ericsson 2 | We can use a similar proposal as we proposed in the comments for 2-1-1. |

#### ***Initial proposal 2-1-3(Open):***

*The* *co-site inter-sector co-channel inter-subband CLI can be modeled as white Gaussian noise in SLS as follows:*

* *Similar method for gNB self-interference modelling can be used for co-site inter-sector co-channel inter-subband CLI modelling.*
* *A new parameter, i.e., ratio of co-site inter-sector co-channel inter-subband CLI (RCOSITE), is introduced to represent the co-site inter-sector co-channel inter-subband CLI suppression capability of gNB. The RCOSITE, denoted as , can be defined as the ratio of the total power transmitted by aggressor gNB across all Tx chains on a frequency unit in a SBFD carrier to the residual interference received by victim gNB on a single Rx chain at a different frequency unit in the same SBFD carrier, where the aggressor gNB and the victim gNB are from different sectors of the same site.*
* *The co-site inter-sector co-channel inter-subband CLI across all Rx chains at UL frequency unit at victim gNB can be modeled as*

*where,*

* + *is the number of Rx chains at victim gNB,*
  + *, ,*
  + *is the power of co-site inter-sector co-channel inter-subband CLI on each Rx chain at UL frequency unit at victim gNB,*
  + *is the DL power transmitted by aggressor gNB across all Tx chains at DL frequency unit .*
* *The covariance of co-site inter-sector gNB-gNB co-channel inter-subband CLI across all Rx chains at UL frequency unit can be modeled as .*

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Intel | Same as above. |
| Spreadtrum | Same as proposal 2-1-1. |
| Ericsson | Same as proposal 2-1-1. |
| New H3C | we hope to simplify this interference modeling. |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-1-3 in principle.  The inter-sector interference can be treated as a special case of self-interference with long antenna isolation. So, we are supportive of this proposal. But, the unclear part is the relation between and . Is the intention is to send LS to RAN4 to ask the value range of or reuse/reinterprete ? At least, we believe antenna isolation of inter-sector interterference (where antenna panels with different boresight) may be larger than that of self-interference (where two antenna panels are isolated by few centimeters and their boresight is aligned) |
| Nokia, NSB | Same as proposal 2-1-1 |
| QC | Similar comment to issue 2-1-1 and a simpler model could be adopted. |
| LG Electronics | We are fine with Initial proposal 2-1-3 in principle. But, as same as above, it is better that RAN1 waits a response from RAN4. |
| Fujitsu | Our proposal is the same as proposal 2-1-1. |
| Xiaomi | Same as proposal 2-1-1. |
| Ericsson 2 | For co-sited inter sector too, we can use a similar method as we proposed in 2-1-1. |

#### ***Initial proposal 2-1-4(Open):***

*The UE-UE co-channel inter-subband CLI can be modeled as white Gaussian noise in SLS as follows:*

* *Introduce a UE co-channel inter-subband leakage power ratio (ISLR) to represent the co-channel inter-subband leakage power suppression capability at aggressor UE.*
  + *The UE ISLR, denoted as , can be defined as the ratio of the transmission power centered on an allocated frequency unit in a SBFD carrier to the leakage power centered on a non-allocated frequency unit in the same SBFD carrier.*
* *Introduce a UE co-channel inter-subband selectivity (ISS) to represent the co-channel inter-subband selectivity capability at victim UE.*
  + *The UE ISS, denoted as , can be defined as the ratio of the receive power centered on a non-allocated frequency unit in a SBFD carrier to the residual power suppressed by receiver selectivity centered on an allocated frequency unit in the same SBFD carrier.*
* *Introduce a UE-UE co-channel inter-subband interference ratio (ISIR) to represent both of ISLR and ISS together, which is defined as follows:*
* *The UE-UE co-channel inter-subband CLI across all Rx chains at DL frequency unit at victim UE can be modeled as*

*where,*

* + *is the number of Rx chains at victim UE,*
  + *, ,*
  + *is the power of UE-UE co-channel inter-subband CLI on each Rx chain at DL frequency unit at UE of victim,*
  + *is the coupling loss (linear value) between the aggressor UE and the victim UE,*
  + *is the UL transmission power of aggressor UE across all Tx chains at UL frequency unit .*
* *The covariance of UE-UE co-channel inter-subband CLI across all Rx chains at DL frequency unit can be modeled as .*

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | Same comment on whether this should be defined by RAN4 or is RAN4’s task is only to define *βISLR,UE* and *βISS,UE*? |
| Intel | Same as above. |
| Spreadtrum | Same as proposal 2-1-1. |
| Ericsson | Same as proposal 2-1-1. |
| New H3C | we hope to simplify this interference modeling. |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-1-4 in general. |
| Nokia, NSB | At least for calibration purposes, a simpler model could be specified while we wait for the feedback from RAN4. |
| QC | Don’t support. Similar model to inter-gNB should be adopted to consider both UE-UE channels and spatial aspects. |
| LG Electronics | We are fine with Initial proposal 2-1-3 in principle. |
| Fujitsu | Our proposal is the same as proposal 2-1-1. |
| Xiaomi | Same as proposal 2-1-1. |
| Ericsson 2 | Both gNBs and UEs can use a similar model for CLI as described in the comments for 2-1-1. |

## Issue#2-2: Performance metrics

### Submitted proposal

### Summary

Regarding UPT (user perceived throughput) related performance metrics for FTP model 3 in SLS, moderator suggests **Initial proposal 2-2-1** based on the submitted proposals.

Regarding latency related performance metric for FTP model 3 in SLS, moderator suggests **Initial proposal 2-2-2** based on the submitted proposals.

Regarding RU (Resource utilization) in SLS, moderator suggests **Initial proposal 2-2-3** based on the submitted proposals.

Regarding DL/UL SINR related metrics in SLS, moderator suggests **Initial proposal 2-2-4** based on the submitted proposals.

For calibration, the calculation of DL/UL SINR related metrics are based on the common understanding on the calculation of coupling loss, moderator suggests **Initial proposal 2-2-5 and 2-2-6** for the definition of coupling loss based on the submitted proposals.

For calibration, moderator suggests **Initial proposal 2-2-7** for the detailed calculation method of legacy DL SINR based on the submitted proposals.

Regarding the detailed calculation methods of SBFD DL SINR / legacy UL SINR/ SBFD UL SINR, they can be discussed later.

In addition, three operators propose to introduce an evaluation metric for the additional energy consumption of SBFD at the BS side. **Moderator suggests Initial proposal 2-2-8.**

### 1st Round Proposals

#### ***Initial proposal 2-2-1(Closed):***

For UPT (user perceived throughput) related performance metrics for FTP model 3 in SLS, adopt option 1 of the following definitions.

* Option 1: UPT is defined as the size of an FTP packet divided by the time which starts when the packet is received in the transmit buffer and ends when the last bit of the packet is correctly delivered to the receiver [Refer to TR36.814].
  + Unfinished FTP packets should be incorporated in the UPT calculation. The number of served bits (possibly zero) of an unfinished FTP packet by the end of the simulation is divided by the served time (simulation end time – file arrival time) [Refer to TR36.889].
  + Average-UPT of a user: defined as the average from all UPTs for all FTP packets intended for this user [Refer to TR36.814].
  + Tail-UPT of a user: defined as the worst 5% UPT among all FTP packets intended for this user [Refer to TR36.814].
  + Average-UPT CDF: The CDF of the average UPTs for all users.
  + Tail-UPT CDF: The CDF of the tail UPTs for all users.
  + Mean/5%/50%/95% Average-UPT: The mean/5%/50%/95% value of Average-UPTs for all users.
  + Mean/5%/50%/95% Tail-UPT: The mean/5%/50%/95% value of Tail-UPTs for all users.
* Option 2: UPT of a user is defined as the total size of the packets generated for the user divided by the time which starts when the first packet is received in the transmit buffer and ends when the last bit of the packet is correctly delivered to the receiver if all the packets are finished by the end of the simulation, otherwise ends at the simulation end time.
  + UPT CDF: The CDF of the UPTs for all users.
  + Mean/5%/50%/95% UPT: The mean/5%/50%/95% value of UPTs for all users.
* Option 3: UPT of a user is defined as the total size of the transmitted packets of the user divided by the total packet transmission time.
  + The transmission time of a packet is defined as the time which starts when the packet is received in the transmit buffer and ends when the last bit of the packet is correctly delivered to the receiver if the packet is finished by the end of the simulation, otherwise ends at the simulation end time.
  + UPT CDF: The CDF of the UPTs for all users.
  + Mean/5%/50%/95% UPT: The mean/5%/50%/95% value of UPTs for all users.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Intel | Our preference is to adopt the same definition as use in the past and we are OK with option 1. |
| Spreadtrum | Prefer option 1 and we also suggest to discuss on how to consider the packet that is not correctly delivered. |
| Ericsson | Option 1. |
| New H3C | Option 1 |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We slightly prefer Option 3 but can accept Option 1 for sake of progress if majority view. Option 3 for the agreed FTP3 model has the advantage that it accounts for tx and re-tx behavior of multiple packet arrivals of the agreed FTP3 model in the UE session of the snapshot as corresponds to what was defined in TR36.814. |
| ZTE | We prefere Option1. We are not sure whether Tail-UPT is needed or not. |
| NEC | We prefer to support Option-2. |
| CATT | We support the proposal to adopt Option 1. |
| Nokia, NSB | We have slight preference for Option 2, although we can also support Option 1. |
| QC | Support option #1.  For option 1, it is needed to add a bullet on how the 50% and 95% metric is computed for the UE. |
| LG Electronics | We prefer option 1. |
| Moderator | The proposal was updated |

#### ***Initial proposal 2-2-2(Closed):***

For latency related performance metric for FTP model 3 in SLS, adopt option 1 of the following definitions.

* Packet latency: defined as the time which starts when the packet is received in the transmit buffer and ends when the last bit of the packet is correctly delivered to the receiver if the packet is finished by the end of the simulation, otherwise ends at the simulation end time.
  + Option 1: Calculate the latency for each packet for each UE, and then calculate the average latency for each UE, then generate the CDF for these average latency for each UE
    - UE-Average-Latency: defined as the average packet latency for a UE
    - UE-Average-Latency CDF: The CDF of the UE-Average-Latency for all users.
    - Mean/5%/50%/95% UE-Average-Latency: The mean/5%/50%/95% value of UE-Average-Latency for all users.
  + Option 2: Calculate the latency for each packet for each UE, and then generate CDF of latency for all these packets from all the UEs.
    - Packet-Latency CDF: The CDF of the packet latencies of all the packets from all the UEs.
    - Mean/5%/50%/95% Packet-Latency: The mean/5%/50%/95% value of Packet-Latency of all the packets from all the UEs.
* Note: HARQ re-transmission should be considered for latency evaluation.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | Option 2 provides a better view of UE’s latency as the very poor and very good latencies in each UE is not averaged out like in Option 1. Hence, we prefer Option 2. |
| Intel | We have a slight preference for Option 2, since this may allow to capture the full spectrum of latencies occurring at each UE, while this may not be possible when averaging. Furthermore, for latency sensitive traffic, what matters is the per-packet latency more than a “per UE metric”. Thus, Option 2 is sufficient and requires less simulation time to obtain sufficient data points for packet latency statistics/CDF. |
| Spreadtrum | We prefer option 1. Since specific traffic model is set for one simulation, we think the average performance of a UE is also meaningful. |
| Ericsson | We support the proposal and prefer Option 2. |
| New H3C | We slightly prefer option 1 |
| Huawei, HiSilicon | We have a slight preference to Option 2. |
| Samsung | We support FL initial proposal 2-2-2. Option 2 would not allow to capture the average latency value per UE which is however one of the key performance improvement targets for Duplexing, e.g., to reduced latency when avoiding long DL symbol periods within a TDD UL/DL periodicity. |
| ZTE | Some alignment between proposal 2-2-1 and 2-2-2 is needed, e.g., option1 is applied to both of these two proposals. |
| CATT | We are open to both options and slightly prefer Option 2. |
| Nokia, NSB | We have preference for Option 2, although we can also support Option 1. |
| QC | Option-2 is preferred as option1 masks latency for UE-specific metric (5%, 50% and 95% per UE). |
| LG Electronics | We prefer option 1. |

#### ***Initial proposal 2-2-3(Closed):***

Two types of RU (Resource utilization) are defined for SBFD evaluation.

* Type-1 RU: DL/UL Type-1 RU = Number of RBs per cell used by traffic for the given link direction during observation time / Total number of all the RBs per cell including DL, UL and guard bands over observation time.
* Type-2 RU (Follow TR 36.814): DL/UL Type-2 RU = Number of RBs per cell used by traffic for the given link direction during observation time / Total number of RBs per cell available for traffic for the given link direction over observation time
* Note: In case of MU-MIMO, one RB allocated to N users within a cell is only counted as used once.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | Type 1 RU allows the resource utilisation at least for the DL to be compared with legacy (non-SBFD) case.  If we use a constant subband size, then Type 2 RU is not needed as the DL or UL resource utilisation over the total DL resource or total UL resource can be derived. If the subband is dynamic then we may need Type 2 RU to see if there is a bottleneck due to subband size configuration (i.e. the size of the subband is limiting the DL/UL throughput).  We think both measurements are useful, so we think we can report Type 1 and Type 2 RU. |
| Intel | The type-1 RU definition is slightly preferred, and more proper when comparing SBFD case with the legacy static TDD. |
| Spreadtrum | We suggest to take those two types of RU into account. As we can see the RU for all resource in type1 and get the performance for UL/DL separately in type2. |
| Ericsson | We support the proposal and are ok with both types. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | We prefer the existing RU definition, i.e. Type-2 RU. Given that SBFD and legacy TDD will be compared under the same packet arrival rate, a Type-2 RU definition is sufficient. |
| Samsung | We support FL initial proposal 2-2-3 and slightly prefer to Type-2. |
| NEC | Motivation for Type-1 RU is not exactly clear. If we consider UL traffic then does this mean RU= Number of RBs used by UL traffic/ Total RB count including DL+UL+guard band? What are we achieving from this metric? |
| CATT | We are fine with both RU types. |
| Nokia, NSB | We are fine with both options |
| QC | Type-2 RU slightly preferred. Having both is also fine as either RU metric can be computed from the other one. |
| LG Electronics | We are fine with initial proposal 2-3-3. |
| Moderator | Agreement  Two types of RU (Resource utilization) are defined for SBFD evaluation.   * Type-1 RU: DL/UL Type-1 RU = Number of RBs per cell used by traffic for the given link direction during observation time / Total number of all the RBs per cell including DL, UL and guard bands over observation time. * Type-2 RU (Follow TR 36.814): DL/UL Type-2 RU = Number of RBs per cell used by traffic for the given link direction during observation time / Total number of RBs per cell available for traffic for the given link direction over observation time * Note: In case of MU-MIMO, one RB allocated to N users within a cell is only counted as used once. * Companies are to submit results for both RU definitions * FFS: RU definition for dynamic TDD evaluations |

#### ***Initial proposal 2-2-4(Closed):***

For DL/UL SINR related metrics in SLS, the following metrics are considered.

* Coupling loss: CDF of coupling loss from Tx antenna port 0 of gNB (serving cell) to Rx antenna port 0 of UE
* Legacy DL SINR: CDF of legacy DL wideband pre-processing SINR considering legacy gNB-UE interference only
* SBFD DL SINR: CDF of SBFD DL pre-processing SINR considering legacy gNB-UE interference and UE-UE co-channel inter-subband CLI
* Legacy UL SINR: CDF of legacy UL pre-processing SINR considering legacy UE-gNB interference only
* SBFD UL SINR: CDF of SBFD UL pre-processing SINR considering legacy UE-gNB interference, self-interference, inter-site gNB-gNB co-channel inter-subband CLI and co-site inter-sector co-channel inter-subband CLI

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | Is the Legacy UL/DL SNIR for non SBFD slots or for the case where SBFD is not configured? Otherwise it isn’t clear why we need to exclude interference caused by CLI in calculating SNIR, i.e. legacy UL/DL SNIR will always be higher than SBFD SNIR if we remove the interferences from the calculation. |
| Spreadtrum | We want to clarify is the pre-processing SINR here is a geometry SINR? |
| Ericsson | Same question as Spreadtrum. Not clear to us what pre-processing SINR is. |
| New H3C | Definition of the pre-processing SINR isn’t clear to us. |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We do not support FL initial proposal 2-2-4.  The need and usefulness to report the Tx/p0 – Rx/p0 coupling loss for calibration purposes is not clear to us. We are ok to separately consider Legacy DL/UL wideband pre-processing SINR and SBFD DL/UL SINR for calibration purposes. This distinction will be useful to check potential benefits of CLI handling schemes in each geometry. However, the DL/UL SINR related metrics are only informative in the sense that they show intermediate performance for a specific link. Final conclusions and recommendations can only be drawn from the system-level performance metrics such as UPT or Latency. |
| ZTE | Similar view as Ericsson. |
| NEC | Applicability for legacy DL/UL SINR is not clear to us. Is this metric to be used only for legacy TDD scenarios? If this metric is used in SBFD operation then this does not reflect actual channel condition. |
| CATT | Is the proposal for Case 1 only since it seems that only co-channel inter-subband CLI is considered? |
| Nokia, NSB | Some clarification is needed.  With respect to legacy vs SBFD SINR metric, it’s not clear if the intention of the proposals is to mandate that ‘Legacy DL/UL SINR’ is collected from static TDD simulations, while ‘SBFD DL/UL SINR’ is collected from SBFD simulations; or whether the intention is to collect both metrics from SBFD simulations by excluding some of the interference components for the legacy metric. |
| NTT DOCOMO | We are fine with the proposal. |
| QC | We are fine with the direction. However, for the CL, an average metric across all ports considering the channel across the gNB Tx/Rx ports should be used. |
| NTT DOCOMO | We are fine with the proposal. |
| Moderator | Based on comments, the proposal was updated. |

#### ***Initial proposal 2-2-5(Closed):***

Consider following for the definition of coupling loss ( from Tx antenna port *p* of transmitter *A* to Rx antenna port *u* of receiver *B:*

**If both large scale fading and small scale fading are modelled, the coupling loss from Tx antenna port p of transmitter A to Rx antenna port u of receiver B is defined in formula (1) which is based on formula (B.1-2) in TR 37.910 with differences highlighted in *red.***

Where

* *N* is the number of clusters, *M* is the number of rays per cluster.
* The complex weight vector () is used for virtualization of Tx antenna port *p* of transmitter , and () is used for virtualization of Rx antenna port *u* of receiver .

For NLOS case for *n*=1, …, *N*, and *m*=1, …, *M*.

with the notations , , , , , , , , , being according to equation (7.5-22) and (7.5-28) in TR38.901, and is the Ricean K-factor;

and for LOS case

with the notations , , , , and being according to equation (7.5-29) in TR38.901;

and and are the field patterns of multiple weighted Tx antenna ports {*p*| *p* =1,2,…,*S* } in the direction of the spherical basis vectors, and respectively, and are the field patterns of Rx antenna port *u* in the direction of the spherical basis vectors, and respectively; they are given by

wherein,

* within and , for LOS case, and for NLOS case.
* within and , for LOS case, and for NLOS case.

where *N*T is the number of antenna elements that virtualizes the Tx antenna port *p*, *N*R is the number of antenna elements that virtualizes the Rx antenna port *u*; (*k*=1, …, *N*T) represents a complex weight vector used for virtualization of Tx antenna port *p*, (*l*=1, …, *N*R) represents a complex weight vector used for virtualization of Rx antenna port *u*, *Ftx,k,θ* and *Ftx,k,ϕ* are the *k*th transmit antenna element’s field patterns according to equation (7.1-11) in TR38.901 in the direction of the spherical basis vectors,  and  respectively, *Frx,l,θ* and *Frx,l,ϕ* are the *l*th receive antenna element’s field patterns according to equation (7.1-11) in TR38.901in the direction of the spherical basis vectors,  and  respectively.

**If only large scale fading is modelled, the coupling loss from Tx antenna port *p* of transmitter *A* to Rx antenna port *u* of receiver *B* is defined in formula (2).**

where the calculation of , , , is same as in formula (1).

The coupling loss (CL) from Tx antenna port 0 of gNB to Rx antenna port 0 of UE is expressed as

where,

* The complex weight vector (used for virtualization of one Tx antenna port at gNB ) and (used for virtualization of one Rx antenna port at UE ) are selected by selecting the best beam pair of gNB and UE , based on the criteria of maximizing receive power after beamforming.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We think that the clarification proposed by the FL to 37.910 are helpful, but we do not think that a formal agreement on FL initial proposal 2-2-5 is needed. |
|  |  |
|  |  |

#### ***Initial proposal 2-2-6(Closed):***

Regarding coupling loss from Tx antenna port 0 of gNB to Rx antenna port 0 of UE , it can be expressed as

where,

* The complex weight vector (used for virtualization of one Tx antenna port at gNB ) and (used for virtualization of one Rx antenna port at UE ) are selected by selecting the best beam pair of gNB and UE , based on the criteria of maximizing receive power after beamforming.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | Like we commented for FL initial proposal 2-2-4, the need and usefulness to report the Tx/p0 – Rx/p0 coupling loss for calibration purposes is not clear to us. We therefore do not support the proposal. |
| QC | Similar comment to 2-2-4, the CL ports should be limited on port 0 Tx/Rx . |
| Moderator | Postponed |

#### ***Initial proposal 2-2-7(Closed):***

Regarding the legacy DL wideband pre-processing SINR of UE *B* in severing cell *A*, it can be expressed as

where,

wherein,

* is the total DL transmit power (over the *S* Tx antenna ports) per subcarrier.
* is the antenna port number of gNB and is the Rx antenna port number of UE.
* The complex weight vector (used for virtualization of one Tx antenna port at gNB ) and (used for virtualization of one Rx antenna port at UE ) are selected by selecting the best beam pair of gNB and UE , based on the criteria of maximizing receive power after beamforming.
* The complex weight vector (used for virtualization of one Tx antenna port at gNB ) is randomly selected.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-2-7. |
| ZTE | For legacy simulation, we usually calculate the SINR of port 0 instead of calculate the average value over all these ports. |
| Moderator | The proposal was updated. |

### 2nd Round Proposals

#### ***Offline consensus 2-2-1-r1:***

For UPT (user perceived throughput) related performance metrics for FTP model 3 in SLS, adopt the following option.

* Option 1: UPT is defined as the size of an FTP packet divided by the time which starts when the packet is received in the transmit buffer and ends when the last bit of the packet is correctly delivered to the receiver [Refer to TR36.814].
  + Unfinished FTP packets should be incorporated in the UPT calculation. The number of served bits (possibly zero) of an unfinished FTP packet by the end of the simulation is divided by the served time (simulation end time – file arrival time) [Refer to TR36.889].
  + Consider zero bits for dropped FTP packets.
  + Average-UPT of a user: defined as the average from all UPTs for all FTP packets intended for this user [Refer to TR36.814].
  + Tail-UPT of a user: defined as the worst 5% UPT among all FTP packets intended for this user [Refer to TR36.814].
  + Median-UPT of a user: defined as the 50% UPT among all FTP packets intended for this user.
  + Average-UPT CDF: The CDF of the Average-UPTs for all users.
  + Tail-UPT CDF: The CDF of the Tail-UPTs for all users.
  + Median-UPT CDF: The CDF of the Median-UPTs for all users.
  + Mean/5%/50%/95% Average-UPT: The mean/5%/50%/95% value of Average-UPTs for all users.
  + Mean/5%/50%/95% Tail-UPT: The mean/5%/50%/95% value of Tail-UPTs for all users.
  + Mean/5%/50%/95% Median-UPT: The mean/5%/50%/95% value of Median-UPTs for all users.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
|  |  |
|  |  |
|  |  |

#### ***Updated proposal 2-2-2-r1(Closed):***

For latency related performance metric for FTP model 3 in SLS, option 1 is baseline, it is up to companies to report the latency with option 2.

* Packet latency: defined as the time which starts when the packet is received in the transmit buffer and ends when the last bit of the packet is correctly delivered to the receiver if the packet is finished by the end of the simulation, otherwise ends at the simulation end time.
  + (baseline) Option 1: Calculate the latency for each packet for each UE, and then generate CDF of latency for all these packets from all the UEs.
    - Packet-Latency CDF: The CDF of the packet latencies of all the packets from all the UEs.
    - Mean/5%/50%/95% Packet-Latency: The mean/5%/50%/95% value of Packet-Latency of all the packets from all the UEs.
  + (optional) Option 2: Calculate the latency for each packet for each UE, and then calculate the average latency for each UE, then generate the CDF for these average latency for each UE
    - UE-Average-Latency: defined as the average packet latency for a UE
    - UE-Average-Latency CDF: The CDF of the UE-Average-Latency for all users.
    - Mean/5%/50%/95% UE-Average-Latency: The mean/5%/50%/95% value of UE-Average-Latency for all users.
* Note: HARQ re-transmission should be considered for latency evaluation.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Please note that the unfinished packets have already been considered by the “…ends when the last bit of the packet is correctly delivered to the receiver if the packet is finished by the end of the simulation, otherwise ends at the simulation end time.” |
| Sony | There was a comment on dropped packets by ZTE during the offline session. I think it is good record the percentage of dropped packets rather than assume a latency = end of simulation time – packet arrival time. A packet that is not delivered technically has an infinite latency. |
| Samsung | As we commented in the offline session, the latency for dropped packed is not well-defined so that the latency should be separately counted as the percentage of dropped packets. If we use the definition, the latency depends on simulation run time. More importantly, the average latency is biased to the dropped packet. |
| CATT | We are fine with the proposal. For the latency of dropped packet, we also think latency = end of simulation time – packet arrival time is not proper. |
| Xiaomi | We agree with Samsung. Actually the dropped packet issue is not specific for SBFD. In the legacy SLS simulation, it is also typical to have some packets dropped. From our perspective, it is reasonable to calculate latency only for the packets successfully received. |
| Spreadtrum | We agree with Xiaomi that latency should based on successful delivered bit. And we can further discuss whether successful delivered bit is based on successful packet or part of the successful packet. |
| Ericsson | We can support this proposal in principle. We think that dropped traffic latencies will skew the statistics of the latency and must not be considered. |
| New H3C | We share the similar view with Samsung. |
| QC | Latency for successfully delivered packets. The dropped packets will be captured in UPT. |
| Intel | We are generally OK with the proposal, and agree with Ericsson’s comments that the dropped traffic latencies should not be included in the statistics. |

#### ***Updated proposal 2-2-4-r1(Closed):***

At least for SLS calibration purpose in SBFD deployment case 1, the following DL/UL SINR related metrics can be considered.

* CDF of DL SINR in DL slots: DL SINR is calculated by taking into account legacy gNB-UE interference
* CDF of DL SINR in SBFD slots: DL SINR is calculated by taking into account legacy gNB-UE interference and UE-UE co-channel inter-subband CLI
* CDF of UL SINR in UL slots: UL SINR is calculated by taking into legacy UE-gNB interference
* CDF of UL SINR in SBFD slots: UL SINR is calculated by taking into account legacy UE-gNB interference, self-interference, inter-site gNB-gNB co-channel inter-subband CLI and co-site inter-sector co-channel inter-subband CLI

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | What does it mean by legacy gNB-UE & UE-gNB interference?  Even for legacy, there is inter-site gNB-gNB interference in flexible/dynamic TDD. |
| Samsung | In general, the SINR distribution can be used for all cases, not SBFD deployment case 1. |
| CATT | Is the intention to have separate CDFs of SINR for SBFD slot and non-SBFD slot? |
| Xiaomi | Is the intention of this metric for calibration? |
| Spreadtrum | Is the transmite power differnent between DL slots and SBFD slots, since the DL bandwidth is differnent? |
| Ericsson | Isnt it better to first agree on a higher level if we want to perform SLS calibration or not? We can focus on the details of the calibration separately. (The channel models/deployments for calibration/ metrics for calibration).   Regarding the proposal, there are no DL slots in SBFD system. Are DL slots in this proposal, DL-only slots? |
| New H3C | For SLS calibration, we need consider not only legacy gNB-UE interference but also other parameters/metric related to SINR calculation such as UE to UE or gNB to gNB |
| QC | We are fine for SLS calibration and goot to align between companies. |
| Intel | We think that calibration for SLS may be helpful at the end of this study to be ebale to converge into a meaningful comparison of results across companies. However, it may not be necessary to split SINR statics between SBFD and non-SBFD slots. |

#### ***Updated proposal 2-2-7-r1(Closed):***

For evaluation of SBFD operation, the DL SINR of UE *B* in DL slots in severing cell *A* can be expressed as

where,

wherein,

* is the total DL transmit power (over the *S* Tx antenna ports) per subcarrier.
* is the antenna port number of gNB and is the Rx antenna port number of UE.
* is the coupling loss from Tx antenna port *p* of gNB *A* (serving cell) to Rx antenna port *u* of UE *B*, and is the coupling loss from Tx antenna port *p* of gNB (neighboring cell) to Rx antenna port *u* of UE *B*
* The complex weight vector (used for virtualization of one Tx antenna port at gNB ) and (used for virtualization of one Rx antenna port at UE ) are selected by selecting the best beam pair of gNB and UE , based on the criteria of maximizing receive power after beamforming.
* The complex weight vector (used for virtualization of one Tx antenna port at gNB ) is randomly selected.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | We are not clear why we need to model this in the SLS? Could you please clarify? |
| QC | Support |
| Moderator | Postponed  @Ericsson, this is for SLS calibration. |

#### ***Initial proposal 2-2-8(Closed):***

For SLS of SBFD operation, introduce an evaluation metric for the additional energy consumption of SBFD at the BS side, which can be defined as follows:

* Percentage of the additional energy consumption for SBFD.
* Total energy consumption from all DPDs used in SBFD (including energy consumption from all feedback chains).
* Total energy consumption from all PAs used in SBFD.
* Total energy consumption from SIC used in SBFD (including any additional associated components).
* Total energy consumption from all DPDs used in legacy TDD that was compared with SBFD (including energy consumption from all feedback chains).
* Total energy consumption from all PAs used in legacy TDD that was compared with SBFD.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | We think this is an important metric and support this proposal as it provides a means to estimate the cost involved in deploying SBFD while the system level simulations could provide the potential benefits.  We also want to add the power consumption of the analog front end of the receive chain to the metric, since handling strong self-interference could require a significant upgrade of the LNA(s) to increase their linearity. This should be captured in the above metric like this: |
| Vodafone | We agree with Ericsson’s updated equation on how to calculate the additional power consumption associated with SBFD. |
| QC | This proposal needs further discussion. |
| Deutsche Telekom | We generally support this proposal. |

### 3rd Round Proposals

#### ***Updated proposal 2-2-2-r2(Open):***

For latency related performance metric for FTP model 3 in SLS, option 1 is baseline, it is up to companies to report the latency with option 2.

* Packet latency: defined as the time which starts when the packet is received in the transmit buffer and ends when the last bit of the packet is correctly delivered to the receiver.
  + (baseline) Option 1: Calculate the latency for each packet for each UE, and then generate CDF of latency for all these packets from all the UEs.
    - Packet-Latency CDF: The CDF of the packet latencies of all the packets from all the UEs.
    - Mean/5%/50%/95% Packet-Latency: The mean/5%/50%/95% value of Packet-Latency of all the packets from all the UEs.
  + (optional) Option 2: Calculate the latency for each packet for each UE, and then calculate the average latency for each UE, then generate the CDF for these average latency for each UE
    - UE-Average-Latency: defined as the average packet latency for a UE
    - UE-Average-Latency CDF: The CDF of the UE-Average-Latency for all users.
    - Mean/5%/50%/95% UE-Average-Latency: The mean/5%/50%/95% value of UE-Average-Latency for all users.
* Note: HARQ re-transmission should be considered for latency evaluation.
* Unfinished FTP packets are not incorporated in the packet latency calculation.
  + Unfinished Packet Rate is defined as the number of the unfinished packets for all users divided by the total number of generated packets for all users

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Updated |
| Ericsson | Ok with the proposal with a slight modification that Unfinished Packet Rate needs to be reported. |
| Intel | OK with the report |

#### ***Updated proposal 2-2-4-r2(Open):***

RAN1 to conduct a SLS calibration for evaluation of SBFD operation.

* The calibration focus on a subset of scenarios of SBFD deployment case 1
  + FR1: Indoor office, Urban Macro, Dense Urban with 2-layer
  + FR2: Indoor office, Dense Urban Macro layer
* The metrics used for SLS calibration includes:
  + CDF of DL SINR in DL-only slots
  + CDF of DL SINR in SBFD slots
  + CDF of UL SINR in UL-only slots
  + CDF of UL SINR in SBFD slots
* FFS: other details

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | If we agree on parameters that needs to be assumed the same, we think that calibration of the simulators need not be done. However, we are ok to compromise calibration using single operator case 1, but the actual analysis of SBFD performance gains must be evaluated for real life deployments in Case 4. |
| Intel | In our view, companies’ calibration through indoor office scenario for only FR-1 should be sufficient. This exercise should be only meant to make sure final set of evaluation results provided by companies would be comparable by providing an initial sanity check. |

#### ***Initial proposal 2-2-8(Open):***

For SLS of SBFD operation, introduce an evaluation metric for the additional energy consumption of SBFD at the BS side, which can be defined as follows:

* Percentage of the additional energy consumption for SBFD.
* Total energy consumption from all DPDs used in SBFD (including energy consumption from all feedback chains).
* Total energy consumption from all PAs used in SBFD.
* Total energy consumption from SIC used in SBFD (including any additional associated components).
* Total energy consumption from all DPDs used in legacy TDD that was compared with SBFD (including energy consumption from all feedback chains).
* Total energy consumption from all PAs used in legacy TDD that was compared with SBFD.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | No update. I copied the comments in previous round here. |
| Ericsson | We think this is an important metric and support this proposal as it provides a means to estimate the cost involved in deploying SBFD while the system level simulations could provide the potential benefits.  We also want to add the power consumption of the analog front end of the receive chain to the metric, since handling strong self-interference could require a significant upgrade of the LNA(s) to increase their linearity. This should be captured in the above metric like this: |
| Vodafone | We agree with Ericsson’s updated equation on how to calculate the additional power consumption associated with SBFD. |
| QC | This proposal needs further discussion. |
| Deutsche Telekom | We generally support this proposal. |
| Ericsson 2 | We think that the SLS does not provide such details and hence “For SLS” needs to be removed at least from this proposal.   In addition, we think this proposal needs to be discussed along with the feasibility aspects of SBFD, so perhaps this can be done in 9.3.2 agenda. |

## Issue#2-3: Layout and UE distribution

### Submitted proposal

### Summary

There was a discussion in RAN1#109-e on scenarios, with agreements as following.

|  |
| --- |
| Agreement  For SBFD Deployment Case 1, at least consider the following scenarios for evaluation:   * For FR1,   + Indoor office (use Indoor office defined in TR38.802/TR38.901 as starting point)   + Urban macro (use Urban macro defined in TR38.802/TR38.901 as starting point)     - FFS: UE outdoor/indoor proportion, clustering, etc   + Optional: Dense Urban with 1-layer or 2-layer (use Dense Urban defined in TR38.802/TR38.901 as starting point)   + FFS: Rural * For FR2-1,   + Indoor office (use Indoor office defined in TR38.802/TR38.901 as starting point)   + Dense Urban Macro layer (use Dense Urban defined in TR38.802 as starting point)     - FFS: UE outdoor/indoor proportion, clustering, etc   + Optional: Dense Urban micro (use Dense Urban micro defined in TR38.802/TR38.901 as starting point) * FFS: Whether FR2-2 is considered or not in Rel-18.   Note: For optional scenarios, they can be captured in TR and it is up to each company to provide the results. The results can be used to draw conclusion/recommendation depending on the number of companies providing the results.  Agreement  For SBFD Deployment Case 4, at least consider the following scenarios for evaluation from RAN1 perspective:   * FR1: Urban Macro * FR2-1: Dense Urban Macro layer * FFS: UE outdoor/indoor proportion, clustering, etc * FFS: the grid shift between two networks, e.g., 0%, 100%   FFS: Indoor hotspot, Dense Urban Micro layer |

**UE clustering**

Uniform UE distribution for Urban Macro and Dense Urban Macro layer scenarios can be considered as the baseline [Huawei, CATT, Samsung, CMCC], and UE clustering as well as the corresponding UE outdoor/indoor proportion needs to be considered as an alternative to accurately capture the impact of inter-UE CLI [Huawei, Ericsson, ZTE, Qualcomm, Nokia, MediaTek, Spreadtrum, Intel, CMCC].

Regarding UE clustering, two options are proposed:

* Opt 1: UE clustered in one or more buildings with the building topology explicitly modelled [Huawei, Ericsson, Nokia]
* Opt 2: UE clustered in one or more hotspots, and each hotspot is modelled with a randomly dropped cluster center and a radius R [Qualcomm, Nokia, CMCC]

For each option, the following details should to be determined [ZTE]:

* What’s the area of this UE cluster
* How many UE clusters are there per macro cell geographical area
* How many UEs are dropped within each cluster

The UE clustering methods proposed by Huawei and CMCC can be a starting point for discussion.

* Method based on Option 1 [Huawei]:
  + Step 1: Randomly drop one cluster within a macro cell geographical area considering the minimum distance between macro TRP to cluster center, e.g., 100m, where the size of each cluster is 120×50 (m);
  + Step 2: 80% UEs are randomly and uniformly dropped within the clusters, and 20% UEs are randomly and uniformly dropped outside the clusters and throughout the macro geographical area;
  + Note: All UEs within the UE cluster are indoor with 3km/h
* Option 2 based on Option 2 [CMCC]:
  + Step 1: Randomly drop [3] UE cluster center within one macro cell geographical area considering the minimum distance between macro TRP to UE cluster center as Dmacro-to-cluster and the minimum distance between to UE cluster centers as Dinter-cluster
  + Step 2: 2/3 users randomly and uniformly dropped within the UE clusters with the radius of R, 1/3 users randomly and uniformly dropped throughout the macro geographical area, and 10 users per macro geographical area.
  + For Urban Macro for FR1: Dmacro-to-cluster = [262.5 m], Dinter-cluster = [114.8 m], R = [72.3 m]
  + For Dense Urban Macro layer for FR1 and FR2-1: Dmacro-to-cluster = [105 m], Dinter-cluster = [57.9 m], R = [28.9 m]
  + Note: there are both outdoor and indoor UEs in the UE cluster.

Moderator suggests **Initial proposal 2-3-1.**

**Micro TRP dropping method in Dense Urban**

In TR 38.802, two options of one sector deployment for micro cell TRP are considered as following.

|  |
| --- |
| [TR 38.802, Clause A.2.1]  For Dense urban, the following Option 1 and Option 2 are adopted with one sector deployment for micro cell TRP deployment in dense urban scenario, i.e.,  - Option 1 : Omni in horizontal, directional in vertical (5dBi gain, HPBW 40°, vertical tilt 90°, Am =20dB, SLAV=30dB)  - Dropping in the center of the hotspot area  - Option 2: Directional in horizontal, directional in vertical (8dBi gain, HPBW = 65°, vertical tilt 90°, Am =30dB, SLAV=30dB)  - One-sector deployment  - Dropping of TRP and TRP antenna orientation according to the following three steps as described in TR 36.897 (non co-channel hetnet deployment)  Step 1: Randomly drop TRP centers around the TRP cluster center within a radius of R; and consider the minimum distance between TRP centers (Dmicro-TRP).  Step 2: Randomly deploy TRP antennas on area circle with the radius of half of Dmicro-TRP.  Step 3: Determine the horizontal angle of the TRPs with the planer facing to the TRP center.  - Number of Tx antennas at micro cell TRP:  - Baseline: (M, N, P, Mg, Ng) = (8, 8, 2, 1, 1), (0.5, 0.8)λ for 4GHz |

CMCC observes that

* For Option 1, the micro cell TRP with omni horizontal antenna radiation pattern is dropped in the center of the hotspot area. However, it is hard to understand how to realize omni horizontal antenna radiation pattern with antenna configuration (M, N, P, Mg, Ng) = (8, 8, 2, 1, 1). Thus, it is more realistic to consider directional horizontal antenna radiation pattern with the horizontal beamforming always points to the center of the hotspot area as in Option 2.
* Nevertheless, the description of Option 2 is not so clear especially regarding to how to drop TRP cluster center. To make it clear, the following TRP dropping method can be considered in Dense Urban with 2-layer scenario and Dense Urban Micro layer scenario.
  + One-sector deployment
  + Step 1: Randomly drop [3] micro TRP centers within one macro cell geographical area considering the minimum distance between micro TRP centers (Dinter-micro-center) and the minimum distance between macro TRP to micro TRP center (Dmacro-to-micro-center).
  + Step 2: Randomly deploy one micro TRP on the area circle around each micro TRP center with the radius of half of Dinter-micro-center
  + Step 3: Determine the horizontal angle of the micro TRPs with the planer facing to the micro TRP center.
  + Dinter-micro-center =[57.9 m], Dmacro-to-micro-center = [105 m]



Moderator suggests **Initial proposal 2-3-2.**

**Dense Urban Micro layer for FR2-1**

CMCC observes that Dense Urban Micro layer is not defined in TR 38.802. Dense Urban with Micro layer defined in TR 38.828 for FR2-1 can be considered as starting point for SBFD evaluation, i.e.,

* Regarding layout, only consider the Micro layer within a 2-layer Dense Urban network. All users communicate with micro cell, i.e. macro cell is only used for determining position of micro cell. As a layout of macro cell and micro cell, adopt the same layout as Dense Urban with 2-layer for FR1.
* Regarding UE distribution, 10 users per Micro TRP, and all users are randomly and uniformly dropped around Micro TRP center with the radius of R (R = [28.9m]).

Moderator suggests **Initial proposal 2-3-3.**

**Grid shift between two networks, e.g., 0%, 100%, for SBFD Deployment Case 4**

Most companies [Qualcomm, Huawei, ZTE, Ericsson, Samsung, CATT, MediaTek, CMCC] propose 0% and 100% grid shift between two networks can be considered as starting point, since 0% and 100% grid shift between two networks are sufficient to study best case and worst-case adjacent channel coexistence between the SBFD and static TDD operator.

Moderator suggests **Initial proposal 2-3-4.**

**HetNet with Urban Macro and Indoor office**

For HetNet with Urban Macro and Indoor office, the following topology is suggested by companies:

* Macro layer: Hexagonal grid, 7 micro sites, 3 sectors per site, ISD=500m
* Indoor layer: One building randomly dropped per macro cell
  + Minimum distance
    - Option 1: The minimum distance between Macro to Indoor TRxP: [35 m] [CMCC]
    - Option 2: The minimum distance between Macro to indoor office center: [100 m] [Huawei]
  + Layout for each building:
    - Indoor with single floor ([3] BSs per 120m x 50m) [Qualcomm, CMCC]
    - Indoor with single floor ([12] BSs per 120m x 50m) [Huawei]
* UE distribution:
  + Option 1 [CMCC]
    - 2/3 users randomly and uniformly dropped within the building, 1/3 users randomly and uniformly dropped throughout the macro geographical area, and [60] users per macro geographical area
  + Option 2 [Huawei]
    - Urban Macro layer
      * 10 users per macro TRP for FTP traffic model 3
      * 20% outdoor in cars: 30km/h; 80% indoor in houses: 3km/h
    - Indoor office layer:
      * 6 users per Pico TRP for FTP traffic model model 3
      * 100% indoor in houses: 3km/h

|  |  |  |
| --- | --- | --- |
| CMCC | Huawei | Qualcomm |
|  |  |  |

Moderator suggests **Initial proposal 2-3-5.**

**Others**

Two companies [Qualcomm, CMCC] consider 100% outdoor UE locations as an alternative to evaluate outdoor scenarios for FR2.

Huawei suggests for SBFD Deployment Case 1 to 4, a cell layout of hexagonal grid with 7 macro sites and 3 sectors per site with wrap around is adopted for Urban Macro and Dense Urban Macro layer.

Two campanies [Samsung, CATT] consider the minimum UE-to-UE distance as 3m for macro/micro cell and 1~3m for indoor.

Moderator suggests **Initial proposal 2-3-6, 2-3-7 and 2-3-8.**

### 1st Round Proposals

#### ***Initial proposal 2-3-1 (Closed):***

For UE distribution of Urban Macro and Dense Urban Macro layer,

* Baseline:
  + 10 users per macro TRP, and all users are randomly and uniformly dropped within the macro cell
  + 20% outdoor in cars: 30km/h; 80% indoor in houses: 3km/h
* Optional (UE clustering): adopt option 2 of the following
  + 10 users per macro TRP
  + Option 1:
    - Step 1: Randomly drop *X* UE cluster centers within one macro cell geographical area considering the minimum distance between macro TRP to UE cluster center as Dmacro-to-cluster, where the size of each cluster is *L*×*W*
    - Step 2: *Y%* UEs are randomly and uniformly dropped within the UE clusters, and (1-*Y%*) UEs are randomly and uniformly dropped outside the clusters and throughout the macro geographical area
    - Note: UEs dropped within the UE cluster are indoor with 3km/h; UEs dropped outside the UE cluster are outdoor in car with 30km/h
    - FFS the values of X*, L, W,* Dmacro-to-cluster,*Y%*
      * E.g., for Urban Macro for FR1: *X* = 1, *L* = [120m], *W* = [50m], Dmacro-to-cluster = [100 m], *Y%* = [80%]
      * FFS for Dense Urban Macro layer
  + Option 2:
    - Step 1: Randomly drop *X* UE cluster centers within one macro cell geographical area considering the minimum distance between macro TRP to UE cluster center as Dmacro-to-cluster and the minimum distance between two UE cluster centers as Dinter-cluster
    - Step 2: *Y%* UEs are randomly and uniformly dropped within the UE clusters with the radius of R, (1-*Y%*) users randomly and uniformly dropped throughout the macro geographical area
    - Note: Each UE is assigned as indoor or outdoor based on the UE outdoor/indoor proportion, regardless whether the UE is dropped within the UE cluster or not.
    - UE outdoor/indoor proportion: 20% outdoor in cars: 30km/h; 80% indoor in houses: 3km/h
    - FFS the values of X*,* Dmacro-to-cluster, Dinter-cluster*,* R*, Y%*
      * *X*=[3], *Y%*=[2/3]
      * For Urban Macro for FR1: Dmacro-to-cluster = [262.5 m], Dinter-cluster = [114.8 m], R = [72.3 m]
      * For Dense Urban Macro layer for FR1 and FR2-1: Dmacro-to-cluster = [105 m], Dinter-cluster = [57.9 m], R = [28.9 m]

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Intel | We are OK with the proposal, but we feel that one between option 1 and 2 could be downselected, and there is no need to support both even if these are optional. |
| Spreadtrum | Agree with Intel. |
| Ericsson | We support Option 1. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | We think either Option 1 or Option 2 can be used to mimic the effect that UEs may be closed to each other in practical scnearios. |
| Samsung | We are ok with the baseline.  For UE cluster model, we have several questions.   1. How many clusters are needed? To capture and provide more scheduling flexibility to handle inter-UE interfernce, two or more clusters should be taken into account. Single cluster is not a good option since it over-estimate inter-UE interference   If two clusters are assumed, the interference between two UEs with different clusters may experience I-to-O penentrate loss and O-to-I penentrate loss (e.g., two clusters are like buildings) So, when we introduce UE cluster model with more than one cluster, we need to consider how to model penentrate loss |
| ZTE | We prefer Option2. |
| NEC | Agree with the proposal. We prefer option 2 for UE clustering |
| CATT | We are fine with both options and are fine to follow majority view. |
| Nokia, NSB | Support Option 2. |
| NTT DOCOMO | We support the proposal and are fine with both options for UE cluster. |
| QC | We are fine with the proposal and support Option 1 as it simpler than Option 2. We prefer prefer X = 1 (single cluster) where the cluster is defined by a center and radius. |
| LG Electronics | We are fine with initial pproposla 2-3-1. Also, we are on the same page with Intel. |
| Moderator | Agreement  For UE distribution of Urban Macro and Dense Urban Macro layer,   * Baseline: (UE clustering)   + 10 users per macro TRP     - Step 1: Randomly drop *X* UE cluster centers within one macro cell geographical area considering the minimum distance between macro TRP to UE cluster center as Dmacro-to-cluster and the minimum distance between two UE cluster centers as Dinter-cluster     - Step 2: *Y%* UEs are randomly and uniformly dropped within the UE clusters with the radius of R, (1-*Y%*) users randomly and uniformly dropped throughout the macro geographical area     - UE outdoor/indoor proportion: 20% outdoor in cars: 30km/h; 80% indoor in houses: 3km/h     - FFS the values of X*,* Dmacro-to-cluster, Dinter-cluster*,* R*, Y%* * Optional:   + 10 users per macro TRP, and all users are randomly and uniformly dropped within the macro cell   + At least for FR1: 20% outdoor in cars: 30km/h; 80% indoor in houses: 3km/h     - FFS: FR2 details |

#### ***Initial proposal 2-3-2 (Closed):***

For Dense Urban with 2-layer for FR1 and Dense Urban Micro layer for FR2-1, consider micro cell TRPs are deployed as following

* One-sector deployment
* Step 1: Randomly drop [3] micro TRP centers within one macro cell geographical area considering the minimum distance between micro TRP centers (Dinter-micro-center) and the minimum distance between macro TRP and micro TRP center (Dmacro-to-micro-center).
* Step 2: Randomly deploy one micro TRP on the area circle around each micro TRP center with the radius of half of Dinter-micro-center
* Step 3: Determine the horizontal angle of the micro TRPs with the planer facing to the micro TRP center.
* Dinter-micro-center =[57.9 m], Dmacro-to-micro-center = [105 m]



Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | We support the proposal in principle. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-3-2. |
| QC | To avoid confusion, this proposal may be limited to Dense Urban with 2-layer for FR1. The Dense Urban Micro layer for FR2-1 should be discussioned under proposal 2-3-3. |
| LG Electronics | We are fine with the initial proposal 2-3-2. |
| Moderator | Initial proposal 2-3-2: For Dense Urban with 2-layer for FR1, consider micro cell TRPs are deployed as following   * Step 1: Randomly drop [3] micro TRP centers within one macro cell geographical area considering the minimum distance between micro TRP centers (Dinter-micro-center) and the minimum distance between macro TRP and micro TRP center (Dmacro-to-micro-center). * Step 2: Randomly deploy one micro TRP on the area circle around each micro TRP center with the radius of half of Dinter-micro-center * Step 3: Determine the horizontal angle of the micro TRPs with the planer facing to the micro TRP center. * Dinter-micro-center =[57.9 m], Dmacro-to-micro-center = [105 m] |

#### ***Initial proposal 2-3-3 (Closed):***

For Dense Urban Micro layer for FR2-1,

* Regarding the layout, only consider the Micro TRPs of Dense Urban 2-layer network. All users communicate with micro TRPs, i.e. macro cell is only used for determining position of micro TRP.
* Regarding UE distribution, 10 users per Micro TRP, and all users are randomly and uniformly dropped around Micro TRP center with the radius of R (R = [28.9m]).

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-3-3. |
| LG Electronics | We are fine with initial proposal 2-3-3. |
| CATT | Fine with the FL proposal. |
| Xiaomi | OK |
| Ericsson | We need to clarify few questions regarding proposals 2-3-1 and 2-3-2 that were agreed and has impacts on this proposal.  @Moderator: In 2-3-1, our understanding was that it corresponds to the deployment of MACRO layer in Urban Macro and Dense Urban 2-layer scenario (or was the Dense Urban Macro layer a single layer deployment?). If it was the latter, we need to provide details for for the deployment of Macro layer in the 2-layer deployment as done in the agreed 2-3-2.  Similarly, 2-3-2 provides the Micro layer deployment in Dense Urban 2-layer scenario. However, it does not provide the UE distribution for the Micro layer and the UE association algorithm. Therefore, we propose the following- ***Initial proposal 2-3-3 (Open):*** *For Dense Urban Micro layer for FR2-1 and Micro layer in Dense Urban 2-layer scenario for FR1,*   * *For FR2-1, regarding the layout, only consider the Micro TRPs of Dense Urban 2-layer network. All users communicate with micro TRPs, i.e. macro cell is only used for determining position of micro TRP.* * *Regarding UE distribution, 10 users per Micro TRP, and all users are randomly and uniformly dropped around Micro TRP center with the radius of R (R = [28.9m]).*  ***Updated proposal 2-3-1-r1(Open):*** *For UE distribution of Urban Macro and Macro layer in Dense Urban ~~Macro~~ 2-layer,*   * *Baseline (UE clustering):*    + - *Step 1: Randomly drop X UE cluster centers within one macro cell geographical area considering the minimum distance between macro TRP to UE cluster center as Dmacro-to-cluster and the minimum distance between two UE cluster centers as Dinter-cluster*     - *Step 2: Y% UEs are randomly and uniformly dropped within the UE clusters with the radius of R, (1-Y%) users randomly and uniformly dropped* *outside the clusters and throughout the macro geographical area*     - *Note: UEs dropped within the UE cluster are indoor with 3km/h; UEs dropped outside the UE cluster are outdoor in car with 30km/h*     - *UE outdoor/indoor proportion:*        * *For FR1: 20% outdoor in cars: 30km/h; 80% indoor in houses: 3km/h*     - *FFS the values of X, Dmacro-to-cluster, Dinter-cluster, R, ~~Y%~~* * *Optional:*    + *10 users per macro TRP, and all users are randomly and uniformly dropped within the macro cell*   + *UE outdoor/indoor proportion:*      - *20% outdoor in cars: 30km/h; 80% indoor in houses: 3km/h*   + *FFS Details for FR2*   For single layer scenario in FR1: 10 users per Macro TRP, split into indoor cluster and outdoor UEs  For 2-layers scenario in FR1: 10 users per Macro TRP and 10 users per Micro TRP with the deployment of micro cell already agreed. |

#### ***Initial proposal 2-3-4 (Closed):***

For evaluation of adjacent-channel coexistence between two networks for Urban Macro and Dense Urban Macro layer scenarios in RAN1, consider grid shifts between two networks of 0% and 100%.

* the topologies shown below can be used for the 0% and 100% grid shift for RAN1 evaluation.



Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | We support the proposal. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-3-4. |
| CATT | We are fine with the proposal. |
| Nokia, NSB | Support |
| QC | Support. Also, it is good to have some figures for the 7-sector deployment showing the 100% grid shift. |
| LG Electronics | We are fine with initial proposal 2-3-4. |
| Xiaomi | We are fine with the proposal. |

#### ***Initial proposal 2-3-5 (Closed):***

For HetNet with Urban Macro and Indoor office, consider the following topology

* Macro layer: Hexagonal grid, 7 micro sites, 3 sectors per site, ISD=500m
* Indoor layer:
  + One building randomly dropped per macro cell
  + Layout for each building: Indoor with single floor ([3] BSs per 120m x 50m)
  + The minimum distance between Macro to indoor office center: [100 m]
* UE distribution: Y% UEs are randomly and uniformly dropped within the building, and (1-Y%) UEs are randomly and uniformly dropped outside the building and throughout the macro geographical area, and N users per macro geographical area.
  + Note: UEs dropped within the building are indoor with 3km/h; UEs dropped outside the building are outdoor in car with 30km/h
  + Y%=[80%], N=[30]

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Spreadtrum | We want to clarify the position of indoor layer, is it played horizon or randomly? |
| Ericsson | We need some clarifications. Do HetNets scenario deploy CoMP ? what are the cell-range extension settings ? Do users associate only with one layer?  Furthermore, if the intention of the study is to compare Static TDD and SBFD/Dynamic TDD, the mobility setting does not matter. |
| Huawei, HiSilicon | On the following bullet, we are not sure whether there will be a big difference compared to the case where only one build ing is randomly dropped within the whole macro geophical area.   * + One building randomly dropped per macro cell |
| Samsung | We support FL initial proposal 2-3-5. |
| Nokia, NSB | Support |
| QC | Support in general.   * One important aspect is how to define the servings cells for the UEs within. For example, an indoor labeled (out of the 80%) UE could be dropped outside. Then, suggest adding an FFS on this point.   + FFS: servings cells for indoor/outdoor UEs and the virtual indoor (Indoor-labeled UE dropped outside building) and the Penetration loss calculation.   Also, it is good to clarify that the indoor office is fully contained within the macro sector and not partially overlapping with another sector. |
| Moderator | Postponed |

#### ***Initial proposal 2-3-6 (Closed):***

For UE outdoor/indoor proportion in Dense Urban Macro layer scenario and Dense Urban Micro layer scenario for FR2-1, consider the following:

* Baseline: 20% Outdoor in cars: 30km/h, 80% Indoor in houses: 3km/h
* Optional: 100% Outdoor in cars: 30km/h

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | Need further clarification. Are indoor users all on the same floor? |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-3-6. |
| CATT | We are fine with the proposal. |
| Nokia, NSB | Support under the assumption that ‘80% Indoor in houses’ is following the model from TR 38.901 (UE in different floors, etc.) |
| QC | We think that baseline should be 100% outdoor UEs for FR 2-1 |

#### ***Initial proposal 2-3-7 (Closed):***

For SBFD Deployment Case 1 to 4, a cell layout of hexagonal grid with 7 macro sites and 3 sectors per site with wrap around is considered for Urban Macro and Dense Urban Macro layer.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Intel | For this option classical 19 hexagonal cell (i.e., 2-tier instead of 1-tier) with wrap around could be also considered. |
| Spreadtrum | We are open with this proposal. 7 hexagonal macro cells and 3 sectors per site or 19 hexagonal cell and 3 sectors per site are OK for us. |
| Ericsson | We support the proposal |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-3-7. |
| CATT | We are fine with the proposal. |
| Nokia, NSB | Support |
| QC | Support. |
| LG Electronics | We are fine with initial proposal 2-3-7. Also, we are on the same page with Intel. |
| Fujitsu | We agree with the proposal. |
| Xiaomi | We are fine with the proposal. |
| Ericsson 2 | We support the proposal in principle, but we have the same question, is “Dense Urban Macro layer” a single -layer deployment? If yes, the only difference between the Urban Macro and the Dense Urban Macro layer is the Inter-site distance? Or is this also applicable to the Macro layer in a Dense Urban 2-layer scenario? We can support the latter too, but it needs to be clarified. |

#### ***Initial proposal 2-3-8 (Closed):***

For NR duplex evolution evaluation, consider the minimum UE-to-UE distance as 3m for macro/micro cell and 1~3m for indoor.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Intel | We are generally OK with the proposal. However, it may be more practical to set the UE-to-UE distance to a fixed value (i.e, 3m) regardless of the deployment. |
| Spreadtrum | Agree with Intel. |
| Ericsson | We are ok with the proposal. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-3-8. |
| CATT | We are fine with the proposal. |
| Nokia, NSB | Support |
| QC | For accurate CLI modeling, accurate modeling of minimum distance between UE should be conssidred. Our initial thoughts that there should be no requirements on minimum distance between UEs. |
| LG Electronics | We are fine with initial proposal 2-3-8. |
| Fujitsu | We agree with Intel & Spreadtrum. |
| Xiaomi | We are fine with the proposal. |
| Ericsson | We are ok with having no minimum distance requirement (min distance is 0) between UEs in the system level simulation. |

### 2nd Round Proposals

#### ***Updated proposal 2-3-6 (Closed):***

For UE outdoor/indoor proportion in Dense Urban Macro layer scenario and Dense Urban Micro layer scenario for FR2-1, consider the following:

* Baseline: 20% Outdoor in cars: 30km/h, 80% Indoor in houses: 3km/h
  + Outdoor UEs: 1.5 m;
  + Indoor UEs: 3(nfl – 1) + 1.5; nfl ~ uniform(1, Nfl) where Nfl ~ uniform(4,8) [refer to TR 36.873 Table 6-1]
* Optional: 100% Outdoor in cars: 30km/h

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Samsung | We are generally ok with the proposal.  On clarification question is when two indoor UEs are positioned in different floors, is panentrate loss applicable for UE-to-UE CLI? |
| CATT | Fine with the FL proposal. |
| Xiaomi | Fine with the FL proposal. |
| Ericsson | We support the proposal in principle; however, we need to clarify if the indoor UEs are all on the same floor or different floor. On that regard, we agree with Samsung that to better highlight UE-UE CLI impacts, it would be beneficial to have all UE indoors on the same floor without penetration losses in between them. Furthermore, the text in the red refers to the height of the UEs indoors, that needs to be clearly mentioned. |
| New H3C | Support |
| QC | We believe that baseline should be 100% outdoor UEs. In order to have 80% indoor UE, then it requires Indoor hotspot, they can’t be served by outdoor gNB. |
| Huawei, Hisilicon | We feel that the simulation will be very complicated. And we have the similar question on the penetration loss between UEs, how to set this parameters for the UE-UE link. |
| Intel | We have similar concerns as Huawei, and also share the same question. |

### 3rd Round Proposals

#### ***Updated proposal 2-3-1-r1 (Open):***

Update the previous agreement as below:

For UE distribution of Urban Macro and Dense Urban Macro layer,

* Baseline: (UE clustering)
  + 10 users per macro TRP
    - Step 1: Randomly drop *X* UE cluster centers within one macro cell geographical area considering the minimum distance between macro TRP to UE cluster center as Dmacro-to-cluster and the minimum distance between two UE cluster centers as Dinter-cluster
    - Step 2: *Y%* UEs are randomly and uniformly dropped within the UE clusters with the radius of R, (1-*Y%*) users randomly and uniformly dropped outside the clusters and throughout the macro geographical area
    - Note: UEs dropped within the UE cluster(s) are indoor with 3km/h; UEs dropped outside the UE cluster(s) are outdoor in car with 30km/h
    - UE outdoor/indoor proportion: 20% outdoor in cars: 30km/h; 80% indoor in houses: 3km/h
      * Outdoor UEs: 1.5 m;
      * Indoor UEs: 3(nfl – 1) + 1.5; nfl ~ uniform(1, Nfl) where Nfl ~ uniform(4,8) [refer to TR 36.873 Table 6-1]
    - FFS the values of X*,* Dmacro-to-cluster, Dinter-cluster*,* R*, Y%*
* Optional:
  + 10 users per macro TRP, and all users are randomly and uniformly dropped within the macro cell
  + At least for FR1: 20% outdoor in cars: 30km/h; 80% indoor in houses: 3km/h
    - Outdoor UEs: 1.5 m;
    - Indoor UEs: 3(nfl – 1) + 1.5; nfl ~ uniform(1, Nfl) where Nfl ~ uniform(4,8) [refer to TR 36.873 Table 6-1]
  + FFS: FR2 details

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | We support this proposal on clarifying the 1-Y %Users are deployed outside the clusters, which is very important. |
|  |  |
|  |  |

#### ***Initial proposal 2-3-3 (Open):***

For Dense Urban Micro layer for FR2-1,

* Regarding the layout, only consider the Micro TRPs of Dense Urban 2-layer network. All users communicate with micro TRPs, i.e. macro cell is only used for determining position of micro TRP.
* Regarding UE distribution, 10 users per Micro TRP, and all users are randomly and uniformly dropped around Micro TRP center with the radius of R (R = [28.9m]).

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | No update.  @Ericcson, the previous agreed 2-3-1 corresponds to Urban Macro and Dense Urban Macro layer (Dense Urban Macro layer is a single layer deployment). Regarding the UE distribution for Dense Urban 2-layer, since there is mature model in TR38.802, I think we can directly use that. But there is no mature UE disctribution model for Dense Urban Macro layer and Dense Urban Micro layer, that why we separately disscuss the UE distribution for Dense Urban Macro layer in P2-3-1 and Dense Urban Micro layer in P2-3-3. |
| Ericsson | We thank the moderator for clarifying our doubt.  For Dense Urban 2-layer, do you think it would be good to get an agreement to use the TR 38.802 model? |
|  |  |

#### ***Initial proposal 2-3-4 (Open):***

For evaluation of adjacent-channel coexistence between two networks for Urban Macro and Dense Urban Macro layer scenarios in RAN1, consider grid shifts between two networks of 0% and 100%.

* the topologies shown below can be used for the 0% and 100% grid shift for RAN1 evaluation.



Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | No update. |
|  |  |
|  |  |

#### ***Updated proposal 2-3-6 (Open):***

For UE outdoor/indoor proportion in Dense Urban Macro layer scenario and Dense Urban Micro layer scenario for FR2-1, consider the following:

* Baseline: 20% Outdoor in cars: 30km/h, 80% Indoor in houses: 3km/h
  + Outdoor UEs: 1.5 m;
  + Indoor UEs: 3(nfl – 1) + 1.5; nfl ~ uniform(1, Nfl) where Nfl ~ uniform(4,8) [refer to TR 36.873 Table 6-1]
* Optional: 100% Outdoor in cars: 30km/h

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | No update.  @Samsung/Huawei/Ericsson, regarding the UE-UE panentrate loss, there is mature model in Table A.2.1-13 in TR38.802 for FR1, e.g.,  for UEs on different floors TR 36.872; otherwise 0dB. For FR2, refer to Table A.2.1-12. |
|  |  |
|  |  |

#### ***Updated proposal 2-3-7-r1 (Open):***

For SBFD Deployment Case 1 to 4, a cell layout of hexagonal grid with 7 macro sites and 3 sectors per site with wrap around is considered as baseline for Urban Macro and Dense Urban Macro layer.

* hexagonal grid with 19 macro sites and 3 sectors per site with wrap around can be optionally considered.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | We can support this proposal. |
| Intel | We are ok with the proposal. |
|  |  |

#### ***Initial proposal 2-3-8 (Open):***

For NR duplex evolution evaluation, consider the minimum UE-to-UE distance as 3m for macro/micro cell and 1~3m for indoor.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | No Update |
| Ericsson | We are ok to have no minimum distance requirement (min distance is 0) between UEs in the system level simulation. |
| Intel | Semplified modelling is also preferred, and we would ba also OK to have no minimum distance. |

## Issue#2-4: SBFD subband and slot configurations

### Submitted proposal

### Summary

In RAN1#109-e meeting, four alternatives were agreed for comparison between baseline legacy TDD operation and SBFD operation under SBFD Deployment Case 1.

|  |
| --- |
| Agreement  For performance evaluation and comparison between baseline legacy TDD operation and SBFD operation under SBFD Deployment Case 1 (Non-coexistence case with single SBFD subband configuration), consider the following alternatives:   * Alt 2 (No SBFD DL subband in the slots/symbols that correspond to UL slots/symbols in legacy TDD):   + Legacy TDD: Static TDD UL/DL configuration with {DDDSU}, where S=[12D:2G:0U]   + SBFD: Frame structure#2 (XXXXU), where X denotes a SBFD slot. In time domain, SBFD UL subband spans all the symbols in a SBFD slot. In frequency domain, SBFD UL subband is about [20%] of the channel bandwidth. * Alt 4 (strive for the same UL/DL resource ratio between Legacy TDD and SBFD):   + Legacy TDD: Static TDD UL/DL configuration with {DDDSU}, where S=[12D:2G:0U]   + SBFD: Frame structure#3 (XXXXX), where X denotes a SBFD slot. In time domain, SBFD UL subband spans all the symbols in a SBFD slot. In frequency domain, SBFD UL subband is about [20%] of the channel bandwidth. * Alt 1 (No SBFD DL subband in the slots/symbols that correspond to UL slots/symbols in legacy TDD):   + Legacy TDD: Static TDD UL/DL configuration with {DDDSU}, where S=[12D:2G:0U]   + SBFD: Frame structure#1 (DXXXU), where X denotes a SBFD slot. In time domain, SBFD UL subband spans all the symbols in a SBFD slot. In frequency domain, SBFD UL subband is about [20%] of the channel bandwidth. * Alt 3 (strive for the same UL/DL resource ratio between Legacy TDD and SBFD):   + Legacy TDD: Static TDD UL/DL configuration with {DDSUU}, where S=[12D:2G:0U]   + SBFD: Frame structure#2 (XXXXU), where X denotes a SBFD slot. In time domain, SBFD UL subband spans all the symbols in a SBFD slot. In frequency domain, SBFD UL subband is about [20%] of the channel bandwidth.   FFS: whether dynamic TDD can optionally be used for legacy TDD for comparison. |

**Ratio of SBFD UL subband over channel bandwidth for Alt 3**

4 companies [ZTE, Samsung, Intel, CMCC] observe that for Alt 3,

* For legacy TDD with static TDD UL/DL configuration with {DDSUU}, where S=[12D:2G:0U], the UL/DL resource ratio for ({DDSUU}, S=[12D:2G:0U]) is about 70%
* While for SBFD with frame structure#2 (XXXXU), and if the SBFD UL subband is about [20%] of the channel bandwidth, the UL/DL resource ratio for ({DDSUU}, S=[12D:2G:0U]) is about 56%

In order to strive for the same UL/DL resource ratio between Legacy TDD and SBFD, the SBFD UL subband is adjusted to about X of the channel bandwidth in Alt3.

* X = 25% [ZTE, Samsung, Intel]
* X = 26% [CMCC]

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Frame structure** | **DL symbol#** | **UL symbol#** | **SBFD (X) symbol#** | **The ratio of SBFD UL subband over channel bandwidth** | **UL/DL resource ratio** |
| **Alt 2** | legacy TDD | DDDSU, S=[12D:2G:0U] | 54 | 14 | 0 |  | 25.9% |
| SBFD | XXXXU |  | 14 | 56 | 20% | 56.3% |
| **Alt 4 (same UL/DL resource ratio)** | legacy TDD | DDDSU, S=[12D:2G:0U] | 54 | 14 | 0 |  | 25.9% |
| SBFD | XXXXX |  | 0 | 70 | 20% | 25.0% |
| **Alt 1** | legacy TDD | DDDSU, S=[12D:2G:0U] | 54 | 14 | 0 |  | 25.9% |
| SBFD | DXXXU | 14 | 14 | 42 | 20% | 47.1% |
| **Alt 3 (same UL/DL resource ratio)** | legacy TDD | DDSUU, S=[12D:2G:0U] | 40 | 28 | 0 |  | 70.0% |
| SBFD | XXXXU | 0 | 14 | 56 | 20% [🡪 26%] | 56.3% [🡪 68.9%] |

Moderator suggests **Initial proposal 2-4-1.**

**SBFD subband configuration**

In RAN1#109-e meeting, two SBFD subband configurations were agreed.

|  |
| --- |
| Agreement  For SBFD evaluation, consider the following for SBFD subband configurations:   * SBFD Subband configuration#1 with {DUD} pattern, which means one SBFD slot consists of one UL subband at the center of the channel bandwidth and two DL subbands at two sides of the channel bandwidth. * SBFD Subband configuration#2 with {DU} pattern, which means one SBFD slot consists of one UL subband at one side of the channel bandwidth and one DL subband at the other side of the channel bandwidth. * Use the following parameters for description of SBFD subband configuration in evaluation assumptions:   + ND: the number of RBs in one DL subband   + NU: the number of RBs in one UL subband   + NG: the number of RBs in one guard band between one UL subband and one DL subband |

 

(a) SBFD Subband configuration#1 with {DUD} pattern (b) SBFD Subband configuration#2 with {DU} pattern

Note that the detailed SBFD DL/UL subband sizes in SBFD symbols for Alt 1/2/3/4 can be determined based on the ratio of SBFD UL subband over channel bandwidth and the guard band sizes.

Regarding the guard band sizes (NG) in each side, the following options are proposed by companies:

* 6 RB for FR1 and 3 RB for FR2-1 [CMCC]
* 6 RB for FR1 and FR2-1 [ZTE]
* 0 RB for FR1 [Qualcomm]
* 2-4 RB for FR1 and 2-7 RB for FR2-1 [KT]
* 3 RB for FR1 and 7 RB for FR2-1 [vivo]
* 14 RB for FR1 [LG]

In moderator’s view, the guard band size (i.e. NG) can be reported by companies for SBFD evaluation. For calibration purpose, we can have simple assumption, e.g., SBFD Subband configuration#1 with {DUD} pattern and NG=5 for both FR1 and FR2-1. Here, we list the corresponding values of {ND, NU,NG} for the 4 alternatives with the assumption that NG=5 for both FR1 and FR2-1, and SBFD UL subband is about [25%] of the channel bandwidth for Alt3. Note that guard symbols are not assumed here.

* Alt 1/2/4:
  + For FR1 with 100MHz channel bandwidth and 30kHz SCS (273 PRB)
    - SBFD Subband configuration#1: DUD with < ND, NU,NG > = <104, 55, 5>
    - SBFD Subband configuration#2: DU with < ND, NU,NG > = <213, 55, 5>
  + For FR2-1 with 200MHz channel bandwidth and 60kHz SCS (264 PRB)
    - SBFD Subband configuration#1: DUD with < ND, NU,NG > = <101, 52, 5>
    - SBFD Subband configuration#2: DU with < ND, NU,NG > = <206, 53, 5>
* Alt 3:
  + For FR1 with 100MHz channel bandwidth and 30kHz SCS (273 PRB)
    - SBFD Subband configuration#1: DUD with < ND, NU,NG > = <97, 69, 5>
    - SBFD Subband configuration#2: DU with < ND, NU,NG > = <199, 69, 5>
  + For FR2-1 with 200MHz channel bandwidth and 60kHz SCS (264 PRB)
    - SBFD Subband configuration#1: DUD with < ND, NU,NG > = <94, 66, 5>
    - SBFD Subband configuration#2: DU with < ND, NU,NG > = <193, 66, 5>

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Frame structure** | **<DL:UL:SBFD (X) > symbol#** | **SBFD configurations** | **< ND, NU, NG >** | **The ratio of SBFD UL subband over channel bandwidth** | **UL/DL resource ratio considering guard band** |
| **Alt 2** | legacy TDD | DDDSU, S=[12D:2G:0U] | <54, 14, 0> |  |  |  | 25.9% |
| SBFD | XXXXU | <0, 14, 56> | DUD for FR1 | <104, 55, 5> | 20.1% | 59.3% |
| DU for FR1 | <213, 55, 5> | 20.1% | 57.9% |
| DUD for FR2-1 | <101, 52, 5> | 19.7% | 59.5% |
| DU for FR2-1 | <206, 53, 5> | 20.1% | 58.9% |
| **Alt 4 (same UL/DL resource ratio)** | legacy TDD | DDDSU, S=[12D:2G:0U] | <54, 14, 0> |  |  |  | 25.9% |
| SBFD | XXXXX | <0, 0, 70> | DUD for FR1 | <104, 55, 5> | 20.1% | 26.4% |
| DU for FR1 | <213, 55, 5> | 20.1% | 25.8% |
| DUD for FR2-1 | <101, 52, 5> | 19.7% | 25.7% |
| DU for FR2-1 | <206, 53, 5> | 20.1% | 25.7% |
| **Alt 1** | legacy TDD | DDDSU, S=[12D:2G:0U] | <54, 14, 0> |  |  |  | 25.9% |
| SBFD | DXXXU | <14, 14, 42> | DUD for FR1 | <104, 55, 5> | 20.1% | 48.8% |
| DU for FR1 | <213, 55, 5> | 20.1% | 48.0% |
| DUD for FR2-1 | <101, 52, 5> | 19.7% | 48.8% |
| DU for FR2-1 | <206, 53, 5> | 20.1% | 48.5% |
| **Alt 3 (same UL/DL resource ratio)** | legacy TDD | DDSUU, S=[12D:2G:0U] | <40, 28, 0> |  |  |  | 70.0% |
| SBFD | XXXXU | <0, 14, 56> | DUD for FR1 | <97, 69, 5> | 25.3% | 70.7% |
| DU for FR1 | <199, 69, 5> | 25.3% | 69.0% |
| DUD for FR2-1 | <94, 66, 5> | 25.0% | 71.4% |
| DU for FR2-1 | <193, 66, 5> | 25.0% | 69.6% |

Moderator suggests **Initial proposal 2-4-2.**

**Others**

Two companies [Ericsson, LG] considers for SBFD evaluations with configuration XXXXU, the time domain pattern should be changed to XXXSU where S includes 2 guard symbols and 12 OFDM symbols in the SBFD slot.

In Moderator’s view, whether guard symbols are needed for SBFD is related to the connection method between TXRUs and panel groups for separate-Tx/Rx antenna array. For example, for method 1-1/1-2, guard symbols may not be needed.



Moderator suggests **Initial proposal 2-4-3.**

### 1st Round Proposals

#### ***Initial proposal 2-4-1 (Closed):***

For performance evaluation and comparison between baseline legacy TDD operation and SBFD operation under SBFD Deployment Case 1, make the following update for Alt 3:

* Alt 3 (strive for the same UL/DL resource ratio between Legacy TDD and SBFD):
  + Legacy TDD: Static TDD UL/DL configuration with {DDSUU}, where S=[12D:2G:0U]
  + SBFD: Frame structure#2 (XXXXU), where X denotes a SBFD slot. In time domain, SBFD UL subband spans all the symbols in a SBFD slot. In frequency domain, SBFD UL subband is about 25% of the channel bandwidth.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | Do we need Alt 3? Wonder if we can just remove Alt 3. |
| Intel | We are OK to revise the text of Alt-3 of this agreement, since clearly the calculation of the percentage of the SBFD UL subbad in respect to the channel bandwidth was wrongly evaluated. |
| Spreadtrum | It’s OK for us, though Alt3 and Alt4 are the second priority. |
| Ericsson | We can support in principle. However, we also think that these alternatives need to be discussed even for Case 4. Furthermore, if UL latency is to be considered as one of the potential gains of SBFD, perhaps DUDDU could be one solution as we proposed in our contribution. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-4-1. |
| CATT | We are fine with the proposal. |
| Nokia, NSB | Support |
| QC | Support |
| LG Electronics | We are fine with initial proposal 2-4-1 fo updating the value of SBFD UL subbands. |
| Fujitsu | We agree with Sony’s comment. |
| Xiaomi | We are wondering what is the SBFD configuration on the UL slot. The subband in UL slot is a UL subband or a DL subband?  We agree with sony. |
| Ericsson 2 | WE have two comments. If for static TDD we assume DDSUU, we need to consider XXXSU for SBFD for all Alt too.These alternatives in general should be applicable for all cases and not just Case 1.Please see our previous comment regarding a new alternative DUDDU, that has improved latency and also provide similar DL-UL split as DDDUU |

#### ***Initial proposal 2-4-2 (Closed):***

For SBFD evaluation, the guard band size (i.e. NG) should be reported by companies.

* For calibration purpose, SBFD Subband configuration#1 with {DUD} pattern and NG=5 is assumed for both FR1 and FR2-1.
  + Alt 1/2/4 (SBFD UL subband is about 20% of the channel bandwidth):
    - For FR1 with 100MHz channel bandwidth and 30kHz SCS (273 PRB): < ND, NU,NG > = <104, 55, 5>
    - For FR2-1 with 200MHz channel bandwidth and 60kHz SCS (264 PRB): < ND, NU,NG > = <101, 52, 5>
  + Alt 3 (SBFD UL subband is about 25% of the channel bandwidth):
    - For FR1 with 100MHz channel bandwidth and 30kHz SCS (273 PRB): < ND, NU,NG > = <97, 69, 5>
    - For FR2-1 with 200MHz channel bandwidth and 60kHz SCS (264 PRB): < ND, NU,NG > = <94, 66, 5>

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | Fine with proposal. |
| Intel | We are Ok with the proposal, and to align on specific frequency domain configurations. Although, in this case the first sentence could be removed. |
| Spreadtrum | Fine with proposal. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-4-2. |
| CATT | We are fine with the proposal. |
| Nokia, NSB | Support |
| NTT DOCOMO | We prefer to use 120 kHz SCS for FR2-1 which is widly used for current operation. |
| QC | For the 20% UL-SB, we prefer having 56 RBs. Also, based on measurement results, we found out 6RBs are needed to have frequency flat self-interfernce within the UL-SB. Suggest the following configuration instead   * + < ND, NU,NG > = <102, 56, 6> for 30 KHz SC   For FR2, we think that SCS 120KHz with 100MHz should be baseline not 60 KHz with 200 MHz. |
| LG Electronics | We are fine with initial proposal 2-4-2. |
| Xiaomi | Per the guidence from RAN1#96, DL subband in UL slot is deprioritized. We don’t think we need to consider alt 3 and alt 4 for simulation. |

#### ***Initial proposal 2-4-3 (Closed):***

For SBFD evaluation, companies should report the guard symbols assumed in the SBFD slots

* For calibration purpose, no guard symbol is assumed

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | Fine with proposal |
| Ericsson | We needl to consider guard symbols for SBFD when comparing with Static TDD. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Not clear what is the relationship between guard symbol and SBFD slots. |
| Samsung | We support FL initial proposal 2-4-3. |
| Nokia, NSB | Support |
| NTT DOCOMO | We are fine with the proposal. |
| QC | Support. |
| LG Electronics | We are fine with initial proposal 2-4-3. |
| Xiaomi | Fine with proposal |

### 2nd Round Proposals

#### ***Updated proposal 2-4-3-r1 (Closed):***

For SBFD evaluation, companies should report the guard symbols assumed in the SBFD operation

* For calibration purpose, no guard symbol is assumed

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | Support. |
| Samsung | Support |
| CATT | Fine with the FL proposal. |
| xiaomi | Fine with the FL proposal. |
| Spreadtrum | Fine with the FL proposal. |
| Ericsson | For the evaluation, we assume guard symbols for D-U switching in static TDD as DDDSU.  Similar approach needs to be followed for SBFD operation as well. Switching time is needed between an SBFD X slot and U-only slot in XXXXU as the device needs time to change the analog filters to adapt to the UL bandwidth and change the RX chains for UL reception in U-only slot, which could use both the panels as opposed to an SBFD slot. |
| New H3C | Support |
| QC | Support |
| Huawei, Hisilicon | We are Ok with this proposal, and for simulation simpliplicity, the gard symbol can be zero. |
| Intel | Support |

### 3rd Round Proposals

#### ***Initial proposal 2-4-1 (Open):***

For performance evaluation and comparison between baseline legacy TDD operation and SBFD operation under SBFD Deployment Case 1, make the following update for Alt 3:

* Alt 3 (strive for the same UL/DL resource ratio between Legacy TDD and SBFD):
  + Legacy TDD: Static TDD UL/DL configuration with {DDSUU}, where S=[12D:2G:0U]
  + SBFD: Frame structure#2 (XXXXU), where X denotes a SBFD slot. In time domain, SBFD UL subband spans all the symbols in a SBFD slot. In frequency domain, SBFD UL subband is about 25% of the channel bandwidth.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | No Update |
|  |  |
|  |  |

#### ***Updated proposal 2-4-2-r1 (Open):***

For SBFD evaluation, the guard band size (i.e. NG) should be reported by companies.

* For calibration purpose, SBFD Subband configuration#1 with {DUD} pattern and NG=5 is assumed for both FR1.
  + Alt 1/2/4 (SBFD UL subband is about 20% of the channel bandwidth):
    - For FR1 with 100MHz channel bandwidth and 30kHz SCS (273 PRB): < ND, NU,NG > = <104, 55, 5>
  + Alt 3 (SBFD UL subband is about 25% of the channel bandwidth):
    - For FR1 with 100MHz channel bandwidth and 30kHz SCS (273 PRB): < ND, NU,NG > = <97, 69, 5>
  + FFS: FR2-1

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | FR2-1 can be decided after we have conclusion on the bandwidth and SCS. |
| Ericsson | We propose to use < ND, NU,NG > = <106, 51, 5>.  51 is the allocated number of PRBs for a UL carrier of 20 MHz according to 38.101 and this is most realistic to start with. |
| Intel | OK with the proposal. |
|  |  |

#### ***Updated proposal 2-4-3-r1 (Open):***

For SBFD evaluation, companies should report the guard symbols assumed in the SBFD operation

* For calibration purpose, no guard symbol is assumed

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | No Update |
|  |  |
|  |  |
|  |  |

## Issue#2-5: Traffic model

### Submitted proposal

### Summary

Regarding the traffic model of FTP model 3 for scenarios in deployment case 1 for SBFD evaluation, moderator suggests **Initial proposal 2-5-1** based on the submitted proposals.

The traffic model for other deployment cases for SBFD evaluation and the traffic model for dynamic/flexible TDD evaluation can be discussed later after we have conclusion on this proposal.

### 1st Round Proposals

#### ***Initial proposal 2-5-1 (Closed):***

Adopt the following table for traffic model of FTP model 3 for scenarios in deployment case 1 for SBFD.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Indoor office (FR1&FR2) | Urban Macro (FR1) | Dense Urban Macro layer (FR1&FR2) | Dense Urban Micro layer (FR2) | Dense Urban with 2-layer (FR1) |
| General | UL and DL are simulated simultaneously. Option 1 is used.   * Option 1: Each UE is assigned both UL traffic and DL traffic. * Option 2: Each UE is either assigned UL traffic or DL traffic. | | | | |
| FTP packet size | Both symmetric and asymmetric packet size for UL and DL can be considered.   * Option 1: Symmetric packet size: 0.5Mbytes for DL/UL (baseline), 0.1Mbytes or 2Mbytes for DL/UL (optional)   + FFS: 1Kbyte for DL/UL * Option 2: Asymmetric packet size: 0.5Mbyte for DL and 0.125 Mbytes for UL.   + FFS: 1Kbyte for UL | | | | |
| DL arrival rate for legacy TDD | * The DL arrival rate is selected to reach a target DL traffic load (RU). * DL Traffic load: low DL RU (20%-25%), medium DL RU (40%-50%), and high DL RU (60%-80%). * Note: Type-2 RU definition (calculated per link direction) is used | | | | * The DL arrival rate#1 of Macro cell and DL arrival rate#2 of Micro cell are selected to reach target DL traffic load (RU)#1 of Macro cell and target DL traffic load (RU)#2 of Micro cell, respectively * DL Traffic load: low DL RU (20%-25%), medium DL RU (40%-50%), and high DL RU (60%-80%). * Note: Type-2 RU definition (calculated per link direction) is used |
| UL arrival rate for legacy TDD | * The UL arrival rate is determined by the ratio of DL/UL traffic * Ratio of DL/UL traffic: {2:1}, {4:1}, {1:1} | | | | * The UL arrival rate#1 is determined by the DL arrival rate#1 and ratio of DL/UL traffic of Macro cell. UL arrival rate#2 is determined by the DL arrival rate#2 and ratio of DL/UL traffic of Micro cell * Ratio of DL/UL traffic: {2:1}, {4:1}, {1:1}. |
| Arrival rate for SBFD | The UL and DL FTP packet arrival rate for SBFD are the same as legacy TDD. | | | | |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Intel | We are generally OK with the proposal. However,   * In the “general” row, while our preference is for option 2, and that for each slot a UE should be either associated with DL or UL traffic, this could be left up to companies to decide based on their on implementation.   For FTP packet size, symmetric traffic with smaller packet size could be used a a baseline to reduce simulation run time, and other packet sizes and asymmetric traffic could be optionally considered. |
| Spreadtrum | We prefer option 1 in general. About ratio of DL/UL traffic, we think it can be listed for Symmetric packet size and Asymmetric packet size, respectively. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-5-1. |
| ZTE | From our perspective, 0.5Mbytes may be a too large packet size. 0.1 Mbytes could be the baseline. |
| CATT | We are fine with the proposal. |
| Nokia, NSB | We support the proposal. For the ratio of DL/UL traffic we think it would be beneficial to agree on either {2:1} or {4:1} as ‘baseline’ in order to ensure more companies provide results under similar assumptions. |
| LG Electronics | We prefer option in initial proposal 2-5-1. Also, as mentioned by ZTE, small size of packet size is preferred for SLS evaluation.  Regarding UL arrival rate for legacy TDD, one value of ratio of DL/UL traffic is preferred considering on simulation work load. |

### 2nd Round Proposals

#### ***Updated proposal 2-5-1-r1 (Closed):***

Adopt the following table for traffic model of FTP model 3 for scenarios in deployment case 1 for SBFD.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Indoor office (FR1&FR2) | Urban Macro (FR1) | Dense Urban Macro layer (FR1&FR2) | Dense Urban Micro layer (FR2) | Dense Urban with 2-layer (FR1) |
| General | UL and DL are simulated simultaneously.   * Baseline: Each UE is either assigned UL traffic or DL traffic. * Optional: Each UE is assigned both UL traffic and DL traffic. | | | | |
| FTP packet size | Both symmetric and asymmetric packet size for UL and DL can be considered.   * Option 1: Symmetric packet size: 0.1Mbytes for DL/UL (baseline), 0.5Mbytes or 2Mbytes for DL/UL (optional)   + FFS: 1Kbyte for DL/UL * Option 2: Asymmetric packet size: 0.5Mbyte for DL and 0.125 Mbytes for UL.   + FFS: 1Kbyte for UL | | | | |
| DL arrival rate for legacy TDD | * The DL arrival rate is selected to reach a target DL traffic load (RU). * DL Traffic load: low DL RU (20%-25%), medium DL RU (40%-50%), and high DL RU (60%-80%). * Note: Type-2 RU definition (calculated per link direction) is used | | | | * The DL arrival rate#1 of Macro cell and DL arrival rate#2 of Micro cell are selected to reach target DL traffic load (RU)#1 of Macro cell and target DL traffic load (RU)#2 of Micro cell, respectively * DL Traffic load: low DL RU (20%-25%), medium DL RU (40%-50%), and high DL RU (60%-80%). * Note: Type-2 RU definition (calculated per link direction) is used |
| UL arrival rate for legacy TDD | * The UL arrival rate is determined by the ratio of DL/UL traffic * Ratio of DL/UL traffic: {2:1} as baseline, {4:1} and {1:1} as optional. | | | | * The UL arrival rate#1 is determined by the DL arrival rate#1 and ratio of DL/UL traffic of Macro cell. UL arrival rate#2 is determined by the DL arrival rate#2 and ratio of DL/UL traffic of Micro cell * Ratio of DL/UL traffic: {2:1} as baseline, {4:1} and {1:1} as optional. |
| Arrival rate for SBFD | The UL and DL FTP packet arrival rate for SBFD are the same as legacy TDD. | | | | |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Spreadtrum | We are little confused that since the DL/UL resource ratio in slot configuration Alt1, Alt2 and Alt4 is 4:1, why choose DL/UL traffic ratio {2:1} as baseline. |
| Ericsson | We also have similar question as Spreadtrum. If we assume DL/UL resource ratio = 4:1 while the traffic ratio as 2:1 or 1:1, the UL resource utilization will be very high.  For Dense Urban with 2-layer scenario, hows the traffic generated for Macro and micro layer? Are they independently generated? Or Is traffic steering or load-balancing done ? |
| New H3C | We are fine with this proposal. |
| QC | Few comments:   * A smaller packet size should be considered for evaluation. In our study, we found there is different observation on the gains of SBFD/TDD based on the packet size. Compnaies can report what they simulate for packet size. * In addition, Option 2: Asymmetric packet size: 0.5Mbyte for DL and 0.125 Mbytes for UL. * FFS: 1Kbyte for UL and 4 Kbyte for DL * Independent RUs for each traffic direction. * The suggested number of RUs are too high. In our view, Low <10%, medium (20-30%) and high is ~50%. * Ratio of DL/UL traffic: {4:1} shall be baseline.   HetNet (Urban Macro + InH) should be considered and make proposal general, not only for case 1 SBFD. |
| Huawei, Hisilicon | For Macro layer deployment, the current TDD configuration is to adapt to the traffic load ratio, and the benefit for the SBFD is mainly coverage so we suggest the basline traffic ratio is 4:1 for Macro networks (Uma, and dense urban). For indoor networks, the baseline can be 1:1 for the traffic ratio. |
| Intel | We are OK with the proposal. |

### 3rd Round Proposals

#### ***Updated proposal 2-5-1-r2 (Open):***

Adopt the following table for traffic model of FTP model 3 for scenarios in deployment case 1 for SBFD.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Indoor office (FR1&FR2) | Urban Macro (FR1) | Dense Urban Macro layer (FR1&FR2) | Dense Urban Micro layer (FR2) | Dense Urban with 2-layer (FR1) |
| General | UL and DL are simulated simultaneously.   * Baseline: Each UE is either assigned UL traffic or DL traffic. * Optional: Each UE is assigned both UL traffic and DL traffic. | | | | |
| FTP packet size | Both symmetric and asymmetric packet size for UL and DL can be considered.   * Option 1: Symmetric packet size:   + Baseline: 0.1Mbytes for DL/UL   + Optional: 0.5Mbytes or 2Mbytes or 1Kbyte for DL/UL (optional) * Option 2: Asymmetric packet size:   + Baseline: 0.5Mbyte for DL and 0.125 Mbytes for UL   + Optional: 4Kbytes for DL and 1Kbyte for UL | | | | |
| DL arrival rate for legacy TDD | * The DL arrival rate is selected to reach a target DL traffic load (RU). * DL Traffic load: low DL RU ([20%-25%]), medium DL RU ([40%-50%]), and high DL RU ([60%-80%]). * Note: Type-2 RU definition (calculated per link direction) is used | | | | * The DL arrival rate#1 of Macro cell and DL arrival rate#2 of Micro cell are selected to reach target DL traffic load (RU)#1 of Macro cell and target DL traffic load (RU)#2 of Micro cell, respectively * DL Traffic load: low DL RU ([20%-25%]), medium DL RU ([40%-50%]), and high DL RU ([60%-80%]). * Note: Type-2 RU definition (calculated per link direction) is used |
| UL arrival rate for legacy TDD | * The UL arrival rate is determined by the ratio of DL/UL traffic * Ratio of DL/UL traffic: {2:1}, {4:1} and {1:1} | | | | * The UL arrival rate#1 is determined by the DL arrival rate#1 and ratio of DL/UL traffic of Macro cell. UL arrival rate#2 is determined by the DL arrival rate#2 and ratio of DL/UL traffic of Micro cell * Ratio of DL/UL traffic: {2:1}, {4:1} and {1:1} |
| Arrival rate for SBFD | The UL and DL FTP packet arrival rate for SBFD are the same as legacy TDD. | | | | |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | Do we propose to consider DL traffic only? We think we need to consider UL traffic as well as we wont be able to study the SBFD gains based on Low load /Medium Load and High load in UL traffic. For this purpose,we proposed a combined RU based on the reference static TDD system, we think that could be used for this purpose. |
| Intel | OK with the proposal |
|  |  |
|  |  |

## Issue#2-6: Antenna configurations

### Submitted proposal

### Summary

Regarding the details of separate-Tx/Rx antenna array of SBFD operation, moderator suggests **Initial proposal 2-6-1 and 2-6-2** based on the submitted proposals.

Regarding BS antenna radiation pattern, moderator suggests **Initial proposal 2-6-3** based on the submitted proposals.

Regarding UE antenna radiation pattern, moderator suggests **Initial proposal 2-6-4** based on the submitted proposals.

Regarding BS antenna configuration, moderator suggests **Initial proposal 2-6-5** based on the submitted proposals.

Regarding UE antenna configuration, moderator suggests **Initial proposal 2-6-6** based on the submitted proposals.

### 1st Round Proposals

#### ***Initial proposal 2-6-1 (Open):***

For evaluation of SBFD operation, separate-Tx/Rx antenna array can be modelled by two panel groups.

* Legacy parameters , and are used for description of each panel group:
  + M: Number of vertical antenna elements within a panel, on one polarization
  + N: Number of horizontal antenna elements within a panel, on one polarization
  + P: Number of polarizations
  + : Number of panels in a column within a panel group.
  + : Number of panels in a row within a panel group.
  + : Antenna panel spacing in horizontal direction within a panel group.
  + : Antenna panel spacing in vertical direction within a panel group.
* Companies report the separation of the two panel groups. Introduce new parameters as illustrated in the following figure.
  + : Panel group spacing in the horizontal direction. Typically, = 0.
  + : Panel group spacing in the vertical direction.



Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | We support the proposal |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-6-1. |
| Nokia, NSB | Similar proposal was discussed in RAN1#109-e and many companies did not think this was necessary (at least for SLS). Before agreeing on this, it would be preferred to clarify for which specific simulations such explicit modeling of Tx-Rx panel separation would be needed.  At least from our understanding, it seems this explicit definition of the two antenna groups would be needed for modeling some of the TxRU mapping methods discussed under proposal 2-6-2?, e.g. in cases when both panel groups would be used for Tx or Rx in DL-only or UL-only slots. |
| QC | Fine with the proposal |
| LG Electronics | We are fine with initial proposal 2-6-1. |
| Moderator | @Nokia, Yes, as you can see in proposal 2-6-2/2-6-5, proposal 2-6-1 is applied. |
| Kumu Networks | BS antenna configuration should support the inclusion of RF self-interference cancellation. To capture RF cancellation, we suggest including a parameter for number of RF taps per antenna element. |

#### ***Initial proposal 2-6-2 (Open):***

For evaluation and comparison between SBFD and legacy TDD, the two options for the SBFD antenna configuration agreed in RAN1#109 are further clarified as below:

* **SBFD antenna configuration option-1** (same as Opt 1 in RAN1#109 agreement): The total number of antenna elements of the antenna array for SBFD is the same as the total number of antenna elements of the antenna array for legacy TDD. The total number of TxRUs of the antenna array for SBFD is the same as the total number of TxRUs of the antenna array for legacy TDD.
* **SBFD antenna configuration option-2** (same as Opt 2 in RAN1#109 agreement): The total number of antenna elements of the antenna array for SBFD is two times of the total number of antenna elements of the antenna array for legacy TDD. The total number of TxRUs of the antenna array for SBFD is the same as the total number of TxRUs of the antenna array for legacy TDD.
* **SBFD antenna configuration option-3** (new): The total number of antenna elements of the antenna array for SBFD is the same as the total number of antenna elements of the antenna array for legacy TDD. The total number of TxRUs of the antenna array for SBFD is half of the total number of TxRUs of the antenna array for legacy TDD.

These options are further clarified with examples in the following:

* For legacy TDD with shared-Tx/Rx antenna array, assume the antenna configuration is . The total number of TxRUs is , and the total number of antenna elements is .



* For SBFD antenna configuration option-1, the separate-Tx/Rx antenna array has two panel groups, and the antenna configuration for each panel group is . The total number of TXRUs is (same as legacy TDD), and the total number of antenna elements is (same as legacy TDD). One method on the usage of TXRUs and antenna elements in DL/UL/SBFD slots/symbols is illustrated as below. Other methods are not precluded and can be reported by companies.
  + Method 1:
    - In DL slots, L⁄2 antenna elements on panel group#1 are connected to K⁄2 Tx chains in TxRU group#1, and L⁄2 antenna elements on panel group#2 are connected to K⁄2 Tx chains in TxRU group#2.
    - In UL slots, L⁄2 antenna elements on panel group#1 are connected to K⁄2 Rx chains in TxRU group#1, and L⁄2 antenna elements on panel group#2 are connected to K⁄2 Rx chains in TxRU group#2.
    - In SBFD slots, L⁄2 antenna elements on panel group#1 are connected to K⁄2 Tx chains in TxRU group#1, and L⁄2 antenna elements on panel group#2 are connected to K⁄2 Rx chains in TxRU group#2.



* For SBFD antenna configuration option-2, the separate-Tx/Rx antenna array has two panel groups, and the antenna configuration for each panel group is . The total number of TXRUs is (same as legacy TDD), and the total number of antenna elements is (two times of that for legacy TDD). Two methods on the usage of TXRUs and antenna elements in DL/UL/SBFD slots/symbols are illustrated as below. Other methods are not precluded and can be reported by companies.
  + Method 2-1:
    - In DL slots, L antenna elements on panel group#1 are connected to K Tx chains.
    - In UL slots, L antenna elements on panel group#2 are connected to K Rx chains.
    - In SBFD slots, L antenna elements on panel group#1 are connected to K Tx chains, and L antenna elements on panel group#2 are connected to K Rx chains.



* + Method 2-2:
    - In DL slots, L antenna elements on panel group#1 are connected to K Tx chains.
    - In UL slots, L antenna elements on panel group#1 are connected to K Rx chains.
    - In SBFD slots, L antenna elements on panel group#1 are connected to K Tx chains, and L antenna elements on panel group#2 are connected to K Rx chains.



* For SBFD antenna configuration option-3, the separate-Tx/Rx antenna array has two panel groups, and the antenna configuration for each panel group is . The total number of TXRUs is (half of that for legacy TDD), and the total number of antenna elements is (same as legacy TDD). The method on the usage of TXRUs and antenna elements in DL/UL/SBFD slots/symbols are illustrated as below. Other methods are not precluded and can be reported by companies.
  + Method 3-1:
    - In DL slots, L⁄2 antenna elements on panel group#1 are connected to K⁄2 Tx chains.
    - In UL slots, L⁄2 antenna elements on panel group#2 are connected to K⁄2 Rx chains.
    - In SBFD slots, L⁄2 antenna elements on panel group#1 are connected to K⁄2 Tx chains, and L⁄2 antenna elements on panel group#2 are connected to K⁄2 Rx chains.



* + Method 3-2:
    - In DL slots, L⁄2 antenna elements on panel group#1 are connected to K⁄2 Tx chains in TxRU group#1.
    - In UL slots, L⁄2 antenna elements on panel group#1 are connected to K⁄2 Rx chains in TxRU group#1.
    - In SBFD slots, L⁄2 antenna elements on panel group#1 are connected to K⁄2 Tx chains in TxRU group#1, and L⁄2 antenna elements on panel group#2 are connected to K⁄2 Rx chains in TxRU group#1.



Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Sony | Method 3, for non-SBFD slot, it has half the number of Tx & Rx chain compared to legacy TDD, which doesn’t seems like a fair comparison. Why do we need to introduce Method 3 (or Option 3)? |
| Intel | We have similar comments as Sone, and we also are not very clear why method 3 must be introduced. It seems indeed an unfair method given that this would lead to half the TxRU for SBFD compared to legacy TDD. Perhaps, more explanation may be required. |
| Spreadtrum | Agree with Sony and Intel. |
| Ericsson | We can support the proposal in principle. It is worthy to note that for a BS with medium range or wide area power levels where self-interference cancellation or hardware component upgrades are needed, the RX chains needed for SBFD operation are more complicated than for a static TDD network, as it requires more or better hardware, higher energy consumption and higher heat dissipation. Therefore, introducing the constraint that the number of TxRUs should be the same for static TDD and SBFD will lead to an apples-to-orange comparison of performance in which the systems being compared have different complexity. We think that it should be allowed to compare performance based on similar complexity levels, which implies that the number of TxRUs (and antenna elements) could be different between the two systems to equalize the complexity. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Same question as Sony and Intel. |
| Samsung | We support FL initial proposal 2-6-2. |
| ZTE | We support FL initial proposal 2-6-2. |
| Nokia, NSB | Support |
| QC | Fine with the added option 3 at least for FR1. For FR2, there could be issue with model 3 when #TxRus is only 2. |
|  |  |
| Moderator | @Sony/Huawei/Intel, some companies categrized option 3 and option 1 in the same option (i.e., Opt1 in RAN1#109), in order to align companies’ understandings, it is better to have this clarification. Otherwise, it may happen that two companies report they both use Opt1, but in fact one use Method 1 and another use method 3-1/3-2. Directly compare their evaluation results is not so fair in this case. |
| Ericsson 2 | We use the following but we have not defined to agree the last two parameters in this list. Proposal 2-6-1 does not include it, so we must define it too. |

#### ***Initial proposal 2-6-3 (Open):***

For evaluation of SBFD and dynamic/flexible TDD, use BS antenna radiation pattern as following:

* InH: reuse Table 10 in Report ITU-R M.2412 for both FR1&FR2-1 (same as Wall-mount model in Table A.2.1-7 in TR 38.802)
* Urban Macro/ Dense Urban Macro layer / Dense Urban Micro layer: reuse Table 9 in Report ITU-R M.2412 for both FR1&FR2-1 (same as 3-sector BS antenna radiation model in Table A.2.1-6 in TR 38.802)

Indoor BS antenna radiation pattern (Table 10 in Report ITU-R M.2412)

|  |  |
| --- | --- |
| **Parameter** | **Values** |
| Antenna element vertical radiation pattern (dB) |  |
| Antenna element horizontal radiation pattern (dB) |  |
| Combining method for 3D antenna element pattern (dB) |  |
| Maximum directional gain of an antenna element GE,max | 5dBi |

|  |  |
| --- | --- |
| **Parameter** | **Values** |
| Antenna element vertical radiation pattern (dB) |  |
| Antenna element horizontal radiation pattern (dB) |  |
| Combining method for 3D antenna element pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 8dBi |

3-TRxP BS antenna radiation pattern (Table 9 in Report ITU-R M.2412)

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | Fine with the FL proposal. In addition, releastic BS antenna patterns can be considered. |
| Samsung | We support FL initial proposal 2-6-3. |
| Nokia, NSB | Support |
| QC | We prefer one sector, ceiling mounted. Fine with the antenna pattern. |
| Ericsson | We support the proposal. |

#### ***Initial proposal 2-6-4 (Open):***

For evaluation of SBFD and dynamic/flexible TDD, use UE antenna radiation pattern as following:

* FR1: Omni-directional with 0 dBi element gain
* FR2: reuse Table 11 in Report ITU-R M.2412 (same as UE antenna radiation pattern model 1 in Table A.2.1-8 in TR 38.802)

UE antenna radiation pattern model (Table 11 in Report ITU-R M.2412)

|  |  |
| --- | --- |
| **Parameter** | **Values** |
| **Antenna element radiation pattern in**  **dim (dB)** |  |
| **Antenna element radiation pattern in**  **dim (dB)** |  |
| **Combining method for 3D antenna element pattern (dB)** |  |
| **Maximum directional gain of an antenna element *GE,max*** | 5dBi |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-6-4. |
| Nokia, NSB | Support |
| QC | Fine with FL proposal. |
| Ericsson | Fine with the FL proposal. |

#### ***Initial proposal 2-6-5 (Open):***

For evaluation of SBFD operation, companies report the BS antenna configurations used in their simulations. The BS antenna configurations in the following table can be considered for calibration purpose.

|  |  |  |  |
| --- | --- | --- | --- |
| **Scenarios** | **FR** | **Legacy TDD** | **SBFD** |
| **BS antenna configuration for Indoor office** | FR1 | = (4,4,2,1,1; 4,4)  = (0.5, 0.5)λ, +45°/-45° polarization | * SBFD antenna configuration option-3 (Method 3-1)   + Two panel groups   + For each panel group: = (2,4,2,1,1).   + Number of TxRUs: half of legacy TDD   + = (0.5, 0.5)λ, +45°/-45° polarization, (da,H,da,V) = (0, 4)λ |
| FR2-1 | =(4,8,2,1,1; 4,4)  = (0.5, 0.5)λ, +45°/-45° polarization | * SBFD antenna configuration option-3 (Method 3-1)   + Two panel groups   + For each panel group: = (2,8,2,1,1).   + Number of TxRUs: half of legacy TDD   + = (0.5, 0.5)λ, +45°/-45° polarization, (da,H,da,V) = (0, 30)λ |
| **BS antenna configuration for Urban Macro/ Dense Urban Macro layer/ Dense Urban Micro layer** | FR1 | =  (8,8,2,1,1;2,8)  = (0.5, 0.8)λ, +45°/-45° polarization | * SBFD antenna configuration option-3 (Method 3-1)   + Two panel groups   + For each panel group: = (4,8,2,1,1).   + Number of TxRUs: half of legacy TDD   + = (0.5, 0.8)λ, +45°/-45° polarization, (da,H,da,V) = (0, 4)λ |
| FR2-1 | =  (4,8,2,2,2; 1,1)  = (0.5, 0.5)λ, +45°/-45° polarization | * SBFD antenna configuration option-3   + Two panel groups   + For each panel group: = (4,8,2,1,2).   + Number of TxRUs: half of legacy TDD   + = (0.5, 0.5)λ, +45°/-45° polarization, (da,H,da,V) = (0, 30)λ |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-6-5. |
| NEC | We slightly prefer to consider SBFD antenna configuration option-1 (Method-1-1) for calibration. |
| Nokia, NSB | Support |
| QC | For InH FR2, we prefer =(8,8,2,1,1; 1,1) ; For UMa FR2, current is fine. Also, it should be up to company to report inter-panel spacing. |

#### ***Initial proposal 2-6-6 (Open):***

For evaluation of SBFD and dynamic/flexible TDD, companies report the UE antenna configurations used in their simulations. The UE antenna configurations in the following can be considered for calibration purpose.

* FR1:
  + 2Tx/Rx: (M,N,P,Mg,Ng;Mp,Np) = (1,1,2,1,1;1,1), (dH,dV) = (N/A, N/A)λ, 0°/90° polarization
* FR2-1:
  + 4Tx/Rx: (M,N,P,Mg,Ng;Mp,Np) = (2,4,2,1,2;1,1); (dH,dV) = (0.5,0.5)λ,(dg,V,dg,H) = (0, 0)λ, 0°/90° polarization

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-6-6. |
| Nokia, NSB | It would be prefererable to at least try to agree on the BS antenna configurations not only for calibration but for the actual performance evaluation. If there is no agreement, then we could fall back to this proposal |
| QC | For FR1, we should have 4Rx UE with 2Tx anteanna.  For FR2, we need to clarify how many UE panels. FR2 prefer 3 panels (left, right, top).  And FR2 prefer to use (M,N,P,Mg,Ng;Mp,Np) = (1,4,2,1,1;1,1) |

## Issue#2-7: Channel model and penetration loss

### Submitted proposal

### Summary

In RAN1#109-e meeting, the following agreements were achieved on gNB-gNB co-channel/adjacent-channel channel model.

|  |
| --- |
| Agreement  For gNB-gNB co-channel/adjacent-channel channel model and UE-UE co-channel/adjacent-channel channel model in RAN1 SLS,   * Large scale fading (e.g., path loss, penetration loss, shadowing) should be modelled, and companies report whether small scale fading (e.g., fast fading including antenna gain) is also modelled in their simulation. * Note: Antenna gain is calculated based on the gNB-gNB or UE-UE LOS direction instead on the multi-path directions if fast fading is not modelled. * FFS: how to model realistic LOS probability for gNB-gNB and UE-UE channel model. * FFS: How to set aligned channel model amongst companies for SLS calibration (if needed).   Agreement  For gNB-gNB channel model, reuse gNB-to-UE channel model in TR 38.901 with necessary modification   * Replacing the UE’s antenna height with gNB’s antenna height, updating the angular spread * FFS: whether/how to update LOS probability. * FFS: Other details and necessary modifications |

**gNB-gNB channel model**

Regarding the LOS probability for gNB-gNB channel model,

* Some companies [CATT, Nokia, Intel] suggest to reuse the gNB-to-UE LOS probability equation in TR 38.901 for gNB-to-gNB channel for all cases.
* Some companies [vivo, Sharp, CMCC] suggest to reuse the gNB-to-UE LOS probability equation in TR 38.901 for InH scenario.
* Some companies [Huawei, ZTE, Qualcomm, vivo, CMCC] consider modified LOS probability for Macro-gNB-to-Macro-gNB channel.
  + [Qualcomm] Optional higher LOS probability for nearby gNBs
  + [CMCC] Higher LOS probability for nearby Macros, i.e., if the2D distance between Macros <= ISD
  + [Huawei] Higher LOS probability if these two gNBs have a same type
  + [Sharp, Ericsson] Higher LOS probability for Urban Macro
* Regarding how to update the LOS probability for gNB-to-gNB channel, the following options are proposed [Samsung, Qualcomm, Huawei, ZTE, CMCC]
  + Option 1. Use fixed LOS probability value, e.g.,
    - 0.7 [CMCC]
    - 0.8 [Huawei, ZTE]
    - 1.0 [Sharp, Ericsson]
  + Option 2. Changed some coefficient in the gNB-to-UE LOS probability equation, e.g.,
    - Instead of d2D-out, smaller (e.g., half of d2D-out) is used [Samsung]

Regarding other details and necessary modifications for gNB-gNB channel model,

* ASA and ZSA statistics are updated to be the same as ASD and ZSD [Huawei, CMCC]
* Set ZoD offset = 0 [Huawei, ZTE]
  + CMCC proposes to set ZoD offset = 0 only for Macro-to-Macro and Micro-to-Micro

Moderator suggests **Initial proposal 2-7-1 and 2-7-2.**

**UE-UE channel model**

In RAN1#109-e meeting, there was a discussion on UE-UE channel model, but no agreement was achieved.

|  |
| --- |
| Updated proposal 4-4-3b  For UE-UE channel model, select option 1:   * Option 1: Reuse the gNB-UE 5GCM in TR 38.901 with necessary modifications for both FR1 and FR2, similar as the UE-UE channel model for flexible duplex evaluation in TR38.802 for FR2.   + For Indoor hotspot, reuse the gNB-UE 5GCM Indoor-office in TR38.901, and for Dense urban and Urban macro, reuse the gNB-UE 5GCM Umi-Street canyon in TR38.901 with necessary modification, e.g.,     - Replacing the gNB’s antenna height with UE’s antenna height, updating ASD and ZSD.     - FFS: Other details and necessary modifications. * Option 2: Reuse the UE-UE channel model for flexible duplex evaluation in TR 38.802 for both FR1 and FR2 with necessary modifications. |

In RAN#110, some companies expressed their preferences as below. Companies who support Option 2 think if we go with option 1, more modifications need to be discussed.

* For Option 1: Intel, Huawei
* For Option 2: Qualcomm, CATT, Nokia, LG, CMCC

Two companies [Huawei, CMCC] propose to reuse the penetration loss between UEs in Table A.2.1-13 and Table A.2.1-12 in TR38.802, with minor modifications for HetNet scenario, since in such scenario, whether indoor UEs are in the same or different building is not related to the inter-UE 2D distance, but related to the building topology.

Moderator suggests **Initial proposal 2-7-3.**

**gNB-UE channel model**

Two companies [Huawei, CMCC] propose to consider the following gNB-UE O2I building penetration loss

* Indoor office: penetration loss is not modeled.
* Other cases:
  + 80% low-loss model;
  + 20% high-loss model.

Moderator suggests **Initial proposal 2-7-4.**

### 1st Round Proposals

#### ***Initial proposal 2-7-1 (Closed):***

For LOS probability of gNB-gNB channel,

* For Macro-gNB-to-Macro-gNB case, Option 3 is used
  + Option 1: Reuse the gNB-to-UE LOS probability equation in TS38.901
  + Option 2: Modify the gNB-to-UE LOS probability equation to provide higher LOS probability
    - Instead of d2D-out, smaller (e.g., half of d2D-out) is used
  + Option 3: If the 2D distance between two Macro gNBs are less than or equal to the ISD (200m for Dense Urban, and 500m for Urban Macro), set the LOS probability to X; Otherwise, reuse gNB-to-UE LOS probability equation in TR 38.901.
    - FFS: X = [0.7, 0.8, 1]
* For other cases, reuse gNB-to-UE LOS probability equation in TR 38.901.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Intel | Option 1 is preferred, and we do not think we may need to over-complicate the model. |
| Spreadtrum | Prefer Option 3. |
| Ericsson | We support the proposal and think that Option 3 is a good compromise. However, Option 2 with a scaling factor of about 10 can also work. Option 1 provides very low LOS probability at 500m, and this is not realistic in our opinion. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-7-1 and prefer to option 1. |
| NEC | Agree with the proposal |
| CATT | We prefer Option 1 but can be fine with Option 3. |
| Nokia, NSB | Fine with Option 1 or Option 2.  The proposed values for option 3 seem a bit too high from our point of view. We think Option 2 is a more elegant way of increasing the LoS probability for gNB-gNB links. |
| QC | Option 1 is baseline. Option 2 and 3 are optinal where X no more than 0.7 |
| LG Electroncis | We are fine with initial proposal 2-7-1. |

#### ***Initial proposal 2-7-2 (Closed):***

Adopt the following table for gNB-gNB channel model and gNB-UE channel model.

gNB-UE channel model and gNB-gNB channel model

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Dense urban, Urban macro** | **Indoor office** | **HetNet with Urban Macro and Indoor office** |
| Large-scale channel parameters | FR1:   * Macro-to-UE: UMa in TR 38.901 * Micro-to-UE: UMi-Street canyon in TR 38.901 * Macro-to-Macro: UMa in TR 38.901 (hUE =25m), * Macro-to-Micro: UMa in TR 38.901 (hUE =10m) * Micro-to-Micro: UMi-Street canyon in TR 38.901 (hUE =10m)   FR2-1:   * Macro-to-UE: UMa in TR 38.901 * Micro-to-UE: UMi-Street canyon in TR 38.901 * Macro-to-Macro: UMa in TR 38.901 (hUE =25m) * Macro-to-Micro: UMa in TR 38.901 (hUE =10m) * Micro-to-Micro: UMi-Street canyon in TR 38.901 (hUE =10m) | FR1:   * TRP-to-UE: InH-Office in TR 38.901 * TRP-to-TRP: InH-Office in TR 38.901 (hUE =3m)   FR2-1:   * TRP-to-UE: InH-Office in TR 38.901 * TRP-to-TRP: InH-Office in TR 38.901 (hUE =3m) | FR1:   * Macro-to-UE: UMa in TR 38.901 * Indoor-TRP-to-UE: InH-Office in TR 38.901 * Macro-to-Macro: UMa in TR 38.901 (hUE =25m) * Macro-to-Indoor-TRP: UMa in TR 38.901 (hUE =3m) * Indoor-TRP-to-Indoor-TRP: InH-Office in TR 38.901 (hUE =3m)   FR2-1:   * Macro-to-UE: UMa in TR 38.901 * Indoor TRxP -to-UE: InH-Office in TR 38.901 * Macro-to-Macro: UMa in TR 38.901 (hUE =25m) * Macro-to-Indoor-TRP: UMa in TR 38.901 (hUE =3m) * Indoor-TRP-to-Indoor-TRP: InH-Office in TR 38.901 (hUE =3m) |
| Fast fading parameters | FR1:   * Macro-to-UE: UMa in TR 38.901 * Micro-to-UE: UMi-Street canyon in TR 38.901 * Macro-to-Macro: UMa O2O in TR 38.901 (hUE =25m); ASA and ZSA statistics updated to be the same as ASD and ZSD; ZoD offset = 0 * Macro-to-Micro: UMa O2O in TR 38.901 * Micro-to-Micro: UMi-Street canyon O2O in TR 38.901 (hUE=10m); ASA and ZSA statistics updated to be the same as ASD and ZSD; ZoD offset = 0   FR2-1:   * Macro-to-UE: UMa in TR 38.901 * Micro-to-UE: UMi-Street canyon in TR 38.901 * Macro-to-Macro: UMa O2O in TR 38.901 (hUE=25m); ASA and ZSA statistics updated to be the same as ASD and ZSD; ZoD offset = 0 * Macro-to-Micro: UMa O2O in TR 38.901 * Micro-to-Micro: UMi-Street canyon O2O in TR 38.901 (hUE=10m); ASA and ZSA statistics updated to be the same as ASD and ZSD; ZoD offset = 0 | FR1:   * TRP-to-UE: InH-Office in TR 38.901 * TRP-to-TRP: InH-Office in TR 38.901 (hUE=3m), ASA and ZSA statistics updated to be the same as ASD and ZSD   FR2-1:   * TRP-to-UE: InH-Office in TR 38.901 * TRP-to-TRP: InH-Office in TR 38.901 (hUE =3m), ASA and ZSA statistics updated to be the same as ASD and ZSD | FR1:   * Macro-to-UE: UMa in TR 38.901 * Indoor-TRP-to-UE: InH-Office in TR 38.901 * Macro-to-Macro: UMa O2O in TR 38.901 (hUE =25m); ASA and ZSA statistics updated to be the same as ASD and ZSD; ZoD offset = 0 * Macro-to-Indoor-TRP: UMa O2O in TR 38.901 * Indoor-TRP-to-Indoor-TRP: InH-Office in TR 38.901 (hUE=3m), ASA and ZSA statistics updated to be the same as ASD and ZSD   FR2-1:   * Macro-to-UE: UMa in TR 38.901 * Indoor-TRP-to-UE: InH-Office in TR 38.901 * Macro-to-Macro: UMa O2O in TR 38.901 (hUE=25m); ASA and ZSA statistics updated to be the same as ASD and ZSD; ZoD offset = 0 * Macro-to-Indoor-TRP: UMa O2O in TR 38.901 * Indoor-TRxP-to-Indoor-TRP: InH-Office in TR 38.901 (hUE =3m), ASA and ZSA statistics updated to be the same as ASD and ZSD |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Spreadtrum | For Hetnet gNB-UE channel, only Macro-to-UE and Indoor-TRP-to-UE are taken into account. Does it mean, UE in Indoor can only select indoor as serving cell and UE outside indoor can only select Macro as serving cell? |
| Ericsson | We have same questions regarding HetNets scenario as discussed in our previous comments. Furthermore, Macro -to-Micro and Macro-to-Indoor will also have a reverse link which needs to be modelled. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-7-2. |
| CATT | We are fine with the proposal. |
| Nokia, NSB | Support in principle, but also agree with Spreadtrum’s question/concern. |
| LG Electroncis | We are fine with initial proposal 2-7-2. |
| Moderator | The proposal was updated. Hetnet related discussion was postponed. |

#### ***Initial proposal 2-7-3 (Closed):***

For UE-UE channel model, reuse the UE-UE channel model for flexible duplex evaluation in TR 38.802 for both FR1 and FR2, and adopt the following tables.

UE-UE channel model

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Dense urban, Urban macro** | **Indoor hotspot** | **HetNet with Urban Macro and Indoor office** |
| Large-scale channel parameters | FR1:   * UE-to-UE: A.2.1.2 in TR36.843(\*), penetration loss between UEs follows Table X   FR2-1:   * UE-to-UE: UMi-Street canyon in TR 38.901 (hBS =1.5m ~ 22.5m), penetration loss between UEs follows Table Y | FR1:   * UE-to-UE: A.2.1.2 in TR36.843 (\*)   FR2-1:   * UE-to-UE: InH-Office in TR 38.901 (hBS =1.5m) | FR1:   * UE-to-UE: A.2.1.2 in TR36.843(\*), penetration loss between UEs follows Table X   FR2-1:   * UE-to-UE: UMi-Street canyon in TR 38.901 (hBS =1.5m), penetration loss between UEs follows Table Y |
| Fast fading parameters | FR1:   * UE-to-UE: A.2.1.2 in TR36.843 (ITU InH) for indoor to indoor, and 3D UMi for other cases. ASD and ZSD statistics updated to be the same as ASA and ZSA.   FR2-1:   * UE-to-UE: UMi-Street canyon in TR 38.901; ASD and ZSD statistics updated to be the same as ASA and ZSA. | FR1:   * UE-to-UE: A.2.1.2 in TR36.843 (ITU InH), ASD statistics updated to be the same as ASA.   FR2-1:   * UE-to-UE: InH-Office in TR 38.901 (hBS =1.5m), ASD and ZSD statistics updated to be the same as ASA and ZSA | FR1:   * UE-to-UE: A.2.1.2 in TR36.843 (ITU InH) for indoor to indoor, and 3D UMi for other cases. ASD and ZSD statistics updated to be the same as ASA and ZSA.   FR2-1:   * UE-to-UE: UMi-Street canyon in TR 38.901 ; ASD and ZSD statistics updated to be the same as ASA and ZSA. |
| (\*): For outdoor to indoor case, and indoor to indoor case, use “Remaining Layout Options” in A.2.1.2 of TR36.843 for pathloss calculation, and “ITU-R IMT UMi” for LOS Probability derivation. For outdoor to indoor case, the penetration loss term “20.0+0.5\* din” is excluded in pathloss formula given in A.2.1.2 of TR36.843, and the penetration loss is derived according to Table X. | | | |

Table X: Penetration loss for UE-to-UE link for FR1 (follow Table A.2.1-13 in TR38.802 with difference highlighted in red)

|  |  |  |  |
| --- | --- | --- | --- |
| Location of UE\_x | Location of UE\_y | Sub-scenario | Penetration loss (for around 4GHz and 2GHz) |
| Indoor | Indoor | In different building (if inter-user 2D distance > 50m for Urban macro and Dense urban scenario; or if two UEs within different buildings for HetNet with Macro and InH) | where PLtw=20dB, and  in meter TR 36.814 is the distance from user to internal wall, *i*=*x*, *y,* and *U(a,b)* indicates uniform distribution. |
| In the same building (if inter-user 2D distance ≤ 50m for Urban macro and Dense urban scenario; or if two UEs within the same building for HetNet with Macro and InH) | for UEs on different floors TR 36.872; otherwise 0dB. |
| Indoor | Outdoor | N.A. | with PLtw=20dB and  in meter is the building penetration loss as given by TR 36.814.  is the car penetration loss as given by subclause 7.4.3 in TR 38.901 [15]. |
| Outdoor | Indoor | N.A. | is the car penetration loss as given by subclause 7.4.3 in TR 38.901 [15].  with PLtw=20dB and  in meter is the building penetration loss as given by TR 36.814. |
| Outdoor | Outdoor | N.A. | is the car penetration loss as given by subclause 7.4.3 in TR 38.901 [15].  *i*=*x*, *y* |

Table Y: Penetration loss for UE-to-UE link for FR2-1 (follow Table A.2.1-12 in TR38.802 with difference highlighted in red)

|  |  |  |  |
| --- | --- | --- | --- |
| Location of UE\_x | Location of UE\_y | Sub-scenario | Penetration loss (for around 30GHz) |
| Indoor | Indoor | In different building (if inter-user 2D distance > 50m for Urban macro and Dense urban scenario; or if two UEs within different buildings for HetNet with Macro and InH) | is the building penetration loss as given by subclause 7.4.3 in TR 38.901 [15].  *i*=*x*, *y* |
| In the same building (if inter-user 2D distance ≤ 50m for Urban macro and Dense urban scenario; or if two UEs within the same building for HetNet with Macro and InH) | where *L*concrete is given by Table 7.4.3-1 in TR 38.901 [15], and *ni* is the floor number for UE\_i, *i*=*x*, *y*. |
| Indoor | Outdoor | N.A. | is the building penetration loss as given by subclause 7.4.3 in TR 38.901 [15].  is the car penetration loss as given by subclause 7.4.3 in TR 38.901 [15]. |
| Outdoor | Indoor | N.A. | is the car penetration loss as given by subclause 7.4.3 in TR 38.901 [15].  is the building penetration loss as given by subclause 7.4.3 in TR 38.901 [15]. |
| Outdoor | Outdoor | N.A. | is the car penetration loss as given by subclause 7.4.3 in TR 38.901 [15].  *i*=*x*, *y* |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Ericsson | It is not clear to us why UMi is ok for FR2-1 but not FR1? |
| Huawei, HiSilicon | Fine with the FL proposal. For UE-UE channel model, we propose to reuse the gNB-UE channel model in 38.901 for both FR1 and FR2-1. |
| Samsung | We support FL initial proposal 2-7-3 |
| CATT | We are fine with the proposal. |
| QC | Support to use 38.802 for UE-to-UE channel model. As highlinted in our tdoc, there are many drawbacks for using gNB-UE channel in 38.901. |
| LG Electroncis | We are fine with initial proposal 2-7-3. |
| Moderator | The proposal was updated. Hetnet related discussion was postponed. |

#### ***Initial proposal 2-7-4 (Open):***

Adopt the following gNB-UE O2I building penetration loss model:

* Indoor office: penetration loss is not modeled.
* Percentage of high loss and low loss building type for Urban Macro / Dense Urban [refer to table 5B of ITU M.2412]:
  + 80% low-loss model
  + 20% high-loss model
  + Note: The building type is determined by comparing the random variable with P1, where P1 is the probability of the building type with low loss penetration. If the realization of the random variable is less than P1, the building type is low loss; otherwise the building type is high loss [refer to section 5.3.3 of ITU M.2412].
* FFS: HetNet with Urban Macro and Indoor office

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Spreadtrum | Fine with this proposal. |
| Ericsson | We are ok with the proposal. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We do not support the FL proposal. It is not clear to us if the proposed low loss / high loss additional gNB-UE O2I penetration loss modeling would impact CLI significantly enough to become meaningful for conclusions. |
| CATT | We are fine with the proposal. |
| LG Electroncis | We are fine with initial proposal 2-7-4. |

### 2nd Round Proposals

#### ***Updated proposal 2-7-1 (Open):***

For LOS probability of gNB-gNB channel,

* For Macro-gNB-to-Macro-gNB case, option 1 is baseline, it is up to companies to use option 3
  + Option 1: Reuse the gNB-to-UE LOS probability equation in TS38.901
  + Option 2: Modify the gNB-to-UE LOS probability equation to provide higher LOS probability
    - Instead of d2D-out, smaller (e.g., half of d2D-out) is used
  + Option 3: If the 2D distance between two Macro gNBs are less than or equal to the ISD (200m for Dense Urban, and 500m for Urban Macro), set the LOS probability to X; Otherwise, reuse gNB-to-UE LOS probability equation in TR 38.901.
    - FFS: X = [0.7~~, 0.8, 1~~]
* For other cases, reuse gNB-to-UE LOS probability equation in TR 38.901.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Samsung | We are ok with the proposal. Note that Option 2 can be removed based on the main bullet. |
| Fujitsu | Support the proposal. |
| CATT | Fine with the FL proposal. |
| Ericsson | We cannot support this proposal. gNB-gNB LOS probability is very small using option 1 for ISD of 500m and its probably not realistic. |
| New H3C | Support |
| QC | Support |
| Huawei, Hisilicon | We agree with Ericsson that the LOS probability should be higher than TS38.901. |
| Intel | We are fine with the proposal. |

#### ***Updated proposal 2-7-2-r1 (Open):***

Adopt the following table for gNB-gNB channel model and gNB-UE channel model.

gNB-UE channel model and gNB-gNB channel model

|  |  |  |
| --- | --- | --- |
|  | **Dense urban, Urban macro** | **Indoor office** |
| Large-scale channel parameters | FR1:   * Macro-to-UE: UMa in TR 38.901 * Micro-to-UE: UMi-Street canyon in TR 38.901 * Macro-to-Macro: UMa in TR 38.901 (hUE =25m), * Macro-to-Micro: UMa in TR 38.901 (hUE =10m) * Micro-to-Micro: UMi-Street canyon in TR 38.901 (hUE =10m)   FR2-1:   * Macro-to-UE: UMa in TR 38.901 * Micro-to-UE: UMi-Street canyon in TR 38.901 * Macro-to-Macro: UMa in TR 38.901 (hUE =25m) * Macro-to-Micro: UMa in TR 38.901 (hUE =10m) * Micro-to-Micro: UMi-Street canyon in TR 38.901 (hUE =10m) | FR1:   * TRP-to-UE: InH-Office in TR 38.901 * TRP-to-TRP: InH-Office in TR 38.901 (hUE =3m)   FR2-1:   * TRP-to-UE: InH-Office in TR 38.901 * TRP-to-TRP: InH-Office in TR 38.901 (hUE =3m) |
| Fast fading parameters | FR1:   * Macro-to-UE: UMa in TR 38.901 * Micro-to-UE: UMi-Street canyon in TR 38.901 * Macro-to-Macro: UMa O2O in TR 38.901 (hUE =25m); ASA and ZSA statistics updated to be the same as ASD and ZSD; ZoD offset = 0 * Macro-to-Micro: UMa O2O in TR 38.901 * Micro-to-Micro: UMi-Street canyon O2O in TR 38.901 (hUE=10m); ASA and ZSA statistics updated to be the same as ASD and ZSD; ZoD offset = 0   FR2-1:   * Macro-to-UE: UMa in TR 38.901 * Micro-to-UE: UMi-Street canyon in TR 38.901 * Macro-to-Macro: UMa O2O in TR 38.901 (hUE=25m); ASA and ZSA statistics updated to be the same as ASD and ZSD; ZoD offset = 0 * Macro-to-Micro: UMa O2O in TR 38.901 * Micro-to-Micro: UMi-Street canyon O2O in TR 38.901 (hUE=10m); ASA and ZSA statistics updated to be the same as ASD and ZSD; ZoD offset = 0 | FR1:   * TRP-to-UE: InH-Office in TR 38.901 * TRP-to-TRP: InH-Office in TR 38.901 (hUE=3m), ASA and ZSA statistics updated to be the same as ASD and ZSD   FR2-1:   * TRP-to-UE: InH-Office in TR 38.901 * TRP-to-TRP: InH-Office in TR 38.901 (hUE =3m), ASA and ZSA statistics updated to be the same as ASD and ZSD |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
|  |  |
|  |  |
|  |  |

#### ***Updated proposal 2-7-3-r1 (Open):***

For UE-UE channel model, reuse the UE-UE channel model for flexible duplex evaluation in TR 38.802 for both FR1 and FR2, and adopt the following tables.

UE-UE channel model

|  |  |  |
| --- | --- | --- |
|  | **Dense urban, Urban macro** | **Indoor hotspot** |
| Large-scale channel parameters | FR1:   * UE-to-UE: A.2.1.2 in TR36.843(\*), penetration loss between UEs follows Table A.2.1-13 in TR38.802   FR2-1:   * UE-to-UE: UMi-Street canyon in TR 38.901 (hBS =1.5m ~ 22.5m), penetration loss between UEs follows Table A.2.1-12 in TR38.802 | FR1:   * UE-to-UE: A.2.1.2 in TR36.843 (\*)   FR2-1:   * UE-to-UE: InH-Office in TR 38.901 (hBS =1.5m) |
| Fast fading parameters | FR1:   * UE-to-UE: A.2.1.2 in TR36.843 (ITU InH) for indoor to indoor, and 3D UMi for other cases. ASD and ZSD statistics updated to be the same as ASA and ZSA.   FR2-1:   * UE-to-UE: UMi-Street canyon in TR 38.901; ASD and ZSD statistics updated to be the same as ASA and ZSA. | FR1:   * UE-to-UE: A.2.1.2 in TR36.843 (ITU InH), ASD statistics updated to be the same as ASA.   FR2-1:   * UE-to-UE: InH-Office in TR 38.901 (hBS =1.5m), ASD and ZSD statistics updated to be the same as ASA and ZSA |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| QC | Support |
|  |  |
|  |  |

## Issue#2-8: Others

### Submitted proposal

### Summary

Regarding other evaluation assumptions, Moderator suggests **Initial proposal 2-8-1.**

Regarding the BS transmit power for legacy TDD, various values are proposed as below. Moderator suggests **Initial proposal 2-8-2.**

|  |  |  |
| --- | --- | --- |
|  | **FR1** | **FR2-1** |
| **Urban macro** | * Option 1: [53] dBm for 100MHz [Huawei, Nokia, ZTE, CMCC] * Option 2: [49] dBm for 100MHz [vivo, CATT, Spreadtrum] [refer to TR 38.828 Table 5.2.1.4-1] * Option 3: [45] dBm for 100MHz [Qualcomm] * Option 4: [50] dBm for 100MHz (same antenna gain), [47] dBm for 100MHz (same antenna area) [Ericsson (per polarization)] * Option 5: [56] dBm for 100MHz [MediaTek] * Option 6: [52] dBm for 100MHz [LG] * Option 7: [51] dBm for 100MHz [NEC] | N.A. |
| **Dense Urban Macro layer** | * Option 1: [53] dBm for 100MHz [Huawei] * Option 2: [49] dBm for 100MHz [vivo] * Option 3: [44] dBm for 100MHz [CMCC] [refer to TR 38.802 Table A.2.1-1] * Option 4: [45] dBm for 100MHz [Qualcomm] * Option 5: [47] dBm for 100MHz [LG] * Option 6: [51] dBm for 100MHz [Xiaomi] | * Option 1: [43] dBm for 200MHz [vivo] [refer to TR 38.828 Table 5.2.2.4-1] * Option 2: [40] dBm for 200MHz. EIRP should not exceed 73 dBm. [CATT, CMCC] [refer to TR 38.802 Table A.2.1-1] |
| **Dense Urban Micro layer** | * Option 1: [49] dBm for 100MHz [vivo] * Option 2: [44] dBm for 100MHz [CATT] * Option 3: [40] dBm for 100MHz [ZTE, CMCC] [refer to TR 38.802 Table A.2.1-1] * Option 4: [45] dBm for 100MHz [Qualcomm] | * Option 1: [43] dBm for 200MHz [vivo, Qualcomm] * Option 2: [33] dBm for 200MHz. EIRP should not exceed 68 dBm. [CMCC] [refer to TR 38.802 Table A.2.1-1 and TR 38.828 Table 5.2.2.4-1] * Option 3: [35] dBm for 200MHz [CATT] * Option 4: [40] dBm per 80 MHz. EIRP should not exceed 73 dBm [Qualcomm] |
| **Indoor hotspot** | * Option 1: [31] dBm for 100MHz [ZTE, Nokia] * Option 2: [24] dBm for 100MHz [Spreadtrum, Apple, CMCC] [refer to TR 38.802 Table A.2.1-1 and TR 38.828 Table 5.2.1.1.2-1] * Option 3: [23] dBm for 100MHz [Qualcomm] | * Option 1: [23] dBm for 200MHz. EIRP should not exceed 58 dBm. [Huawei, vivo, Spreadtrum, CMCC] [refer to TR 38.802 Table A.2.1-1 and TR 38.828 Table 5.2.2.4-1] * Option 2: [24] dBm for 200MHz [CATT] * Option 3: [23] dBm per 80 MHz. EIRP should not exceed 58 dBm [Qualcomm] |

Regarding the BS transmit power forSBFD, two alternatives are proposed.

* Alt 1: Keep the same BS transmit power spectrum density for SBFD and legacy TDD. BS transmit power is proportional to the RBs used for DL transmission
* Alt 2: The BS transmit power spectrum density in SBFD symbols can be boosted compared to that in DL-only symbols or for legacy TDD, e.g., the following is proposed by [Huawei]

Moderator suggests **Initial proposal 2-8-3.**

### 1st Round Proposals

#### ***Initial proposal 2-8-1 (Closed):***

For evaluation of SBFD and dynamic/flexible TDD, adopt the following evaluation assumptions.

|  |  |  |
| --- | --- | --- |
|  | **FR1** | **FR2-1** |
| System bandwidth | 100MHz | 200MHz |
| Numerology | 14 OFDM symbol slot  SCS = 30kHz | 14 OFDM symbol slot  SCS = 60kHz |
| UE Tx power | 23dBm | 23 dBm. EIRP should not exceed 43 dBm  [refer to TR 38.802 Table A.2.1-1] |
| Open loop power control parameters | Companies to report power control parameters.  For calibration:   * P0= -60 dBm, alpha = 0.6 for InH [refer to TR 37.910, evaluation assumption in B.4.1\_eMBB\_SE.zip] * P0= -86 dBm, alpha = 0.9 for Dense Urban [refer to TR 37.910, evaluation assumption in B.4.1\_eMBB\_SE.zip] * P0= -80 dBm, alpha = 0.8 for Urban Macro | |
| BS receiver noise figure | 5dB  [refer to TR 38.802 Table A.2.1-1] | 7dB  [refer to TR 38.802 Table A.2.1-1] |
| UE receiver noise figure | 9 dB  [refer to TR 38.802 Table A.2.1-1] | 13 dB (baseline), 10 dB (optional)  [refer to TR 38.802 Table A.2.1-1] |
| UE receiver | MMSE-IRC as the baseline receiver.  Note: Advanced receiver is not precluded.  [refer to TR 38.802 Table A.2.1-1] | |
| Feedback assumption | Realistic [refer to TR 38.802 Table A.2.1-1] | |
| Channel estimation | Realistic [refer to TR 38.802 Table A.2.1-1] | |
| UE processing capability | UE processing capability 1 as baseline   * PDSCH decoding time N1 [symbols]: 13 for FR1 (30kHz SCS) * PUSCH preparation time N2 [symbols]: 12 for FR1 (30kHz SCS) | UE processing capability 1 as baseline   * PDSCH decoding time N1 [symbols]: 20 for FR2 (60kHz SCS) * PUSCH preparation time N2 [symbols]: 23 for FR2 (60kHz SCS) |
| Handover margin | 3 dB [refer to TR 38.828 Table 5.2.1.4-1] | |
| UE attachment | Based on RSRP from port 0  [refer to TR 37.910, evaluation assumption in B.4.1\_eMBB\_SE.zip] | Based on RSRP from port 0. The UE panel with the best receive SNR is chosen. i.e. no combining is done between panels.  [refer to TR 37.910, evaluation assumption in B.4.1\_eMBB\_SE.zip] |
| Polarized antenna model | Model-1 in clause 7.3.2 in TR 38.901 | |
| DL/UL Modulation | Up to 256QAM | |
| Transmission scheme | Companies to report transmission schemes (e.g., SU-MIMO, MU-MIMO, maximum layers for SU-MIMO/MU-MIMO, etc)  For calibration, consider SU-MIMO with single layer for both DL and UL | |
| Scheduling | PF | |
| Overhead | Companies to report the overhead assumption | |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Spreadtrum | Fine with this proposal. |
| Ericsson | Support the proposal in principle |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | For channel estimation, we think idea channel estimation can be the baseline while releastic channel estimation can be optional. |
| Samsung | We support FL initial proposal 2-8-1. |
| CATT | We are fine with the proposal. |
| Nokia, NSB | Support |
| NTT DOCOMO | We prefer to use 120 kHz SCS for FR2-1 which is widly used for current operation. |
| QC | For FR2, 120 KHz should be used with 100MHz BW. |
| LG Electronics | We are fine with the initial proposal 2-8-1. As mentioned by Huawei, ideal channel estimation can be considered as baseline for evaluation. |
| Fujitsu | We have the same opinion as Huawei & LG. |

#### ***Initial proposal 2-8-2 (Open):***

For evaluation of SBFD and dynamic/flexible TDD, the following BS transmit power for legacy TDD are considered. Further down-selection is needed.

|  |  |  |
| --- | --- | --- |
|  | **FR1** | **FR2-1** |
| **Urban macro** | * Option 1: [53] dBm for 100MHz * Option 2: [49] dBm for 100MHz [refer to TR 38.828 Table 5.2.1.4-1] * Option 3: [45] dBm for 100MHz | N.A. |
| **Dense Urban Macro layer** | **Option 3 is adopted.**   * Option 1: [53] dBm for 100MHz * Option 2: [49] dBm for 100MHz * Option 3: [44] dBm for 100MHz [refer to TR 38.802 Table A.2.1-1] | **Option 1 is adopted.**   * Option 1: [43] dBm for 200MHz [refer to TR 38.828 Table 5.2.2.4-1] * Option 2: [40] dBm for 200MHz. EIRP should not exceed 73 dBm. [refer to TR 38.802 Table A.2.1-1] |
| **Dense Urban Micro layer** | **Option 3 is adopted.**   * Option 1: [49] dBm for 100MHz * Option 2: [44] dBm for 100MHz * Option 3: [40] dBm for 100MHz [refer to TR 38.802 Table A.2.1-1] | **Option 2 is adopted.**   * Option 1: [43] dBm for 200MHz * Option 2: [33] dBm for 200MHz. EIRP should not exceed 68 dBm. [refer to TR 38.802 Table A.2.1-1 and TR 38.828 Table 5.2.2.4-1] |
| **Indoor hotspot** | **Option 2 is adopted.**   * Option 1: [31] dBm for 100MHz * Option 2: [24] dBm for 100MHz [refer to TR 38.802 Table A.2.1-1 and TR 38.828 Table 5.2.1.1.2-1] * Option 3: [23] dBm for 100MHz | **Option 1 is adopted.**   * Option 1: [23] dBm for 200MHz. EIRP should not exceed 58 dBm. [refer to TR 38.802 Table A.2.1-1 and TR 38.828 Table 5.2.2.4-1] |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Intel | No strong preference, although it may be preferable to align with the values used in 38.802. |
| Spreadtrum | We are open to those options. But for indoor hotspot, we prefer option 2 with low transmit power. |
| Ericsson | We are open to these options. |
| New H3C | We are open to discus about these options. |
| Huawei, HiSilicon | For Dense Urban Macro, we prefer a large Tx power given the releatic deployment. |
| Samsung | We support FL initial proposal 2-8-2. |
| CATT | We are fine with the proposal. |
| NTT DOCOMO | We support the proposal. |
| QC | Further discussion is needed first on the target power level and whether SBFD slot can have larger EPRE compared to TDD slots. |
| LG Electronics | We are fine with initial proposal 2-8-2. |

#### ***Initial proposal 2-8-3 (Open):***

For comparison between legacy TDD and SBFD, companies should report the assumption of BS transmit power on DL slots and SBFD slots in SBFD operation.

* For calibration purpose, assume the BS transmit power spectrum density is kept the same for SBFD operation and legacy TDD operation. BS transmit power is proportional to the RBs used for DL transmission.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Spreadtrum | We prefer to adopt power density spectrum boosting for SBFD to see the impact of CLI. Also, the coupling loss would not be able to align with legacy TDD. |
| Ericsson | We support the proposal in principle to report the BS transmit power on DL slots for SBFD operation. We need further clarification for the calibration purpose. |
| New H3C | We are fine with the proposal |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 2-8-3. |
| CATT | We are fine with the proposal. |
| Nokia, NSB | Support |
| NTT DOCOMO | We are fine with the proposal. |
| QC | Generally fine |
| LG Electronics | We are fine with initial proposal 2-8-3 in principle. But, regarding the BS transmit power on DL slots and SBFD slots in SBFD operation, RAN4 input regarding Tx power range could be necessary. |

### 2nd Round Proposals

#### ***Updated proposal 2-8-1-r1(Open):***

For evaluation of SBFD and dynamic/flexible TDD, adopt the following evaluation assumptions.

|  |  |  |
| --- | --- | --- |
|  | **FR1** | **FR2-1** |
| System bandwidth | 100MHz | 100MHz |
| Numerology | 14 OFDM symbol slot  SCS = 30kHz | 14 OFDM symbol slot  SCS = 120kHz |
| UE Tx power | 23dBm | 23 dBm. EIRP should not exceed 43 dBm  [refer to TR 38.802 Table A.2.1-1] |
| Open loop power control parameters | Companies to report power control parameters.  For calibration:   * P0= -60 dBm, alpha = 0.6 for InH [refer to TR 37.910, evaluation assumption in B.4.1\_eMBB\_SE.zip] * P0= -86 dBm, alpha = 0.9 for Dense Urban [refer to TR 37.910, evaluation assumption in B.4.1\_eMBB\_SE.zip] * P0= -80 dBm, alpha = 0.8 for Urban Macro | |
| BS receiver noise figure | 5dB  [refer to TR 38.802 Table A.2.1-1] | 7dB  [refer to TR 38.802 Table A.2.1-1] |
| UE receiver noise figure | 9 dB  [refer to TR 38.802 Table A.2.1-1] | 13 dB (baseline), 10 dB (optional)  [refer to TR 38.802 Table A.2.1-1] |
| UE receiver | MMSE-IRC as the baseline receiver.  Note: Advanced receiver is not precluded.  [refer to TR 38.802 Table A.2.1-1] | |
| Feedback assumption | Realistic [refer to TR 38.802 Table A.2.1-1] | |
| Channel estimation | Baseline: Ideal  Optional: Realistic [refer to TR 38.802 Table A.2.1-1] | |
| UE processing capability | UE processing capability 1 as baseline   * PDSCH decoding time N1 [symbols]: 13 for FR1 (30kHz SCS) * PUSCH preparation time N2 [symbols]: 12 for FR1 (30kHz SCS) | UE processing capability 1 as baseline   * PDSCH decoding time N1 [symbols]: 20 for FR2 (60kHz SCS) * PUSCH preparation time N2 [symbols]: 23 for FR2 (60kHz SCS) |
| Handover margin | 3 dB [refer to TR 38.828 Table 5.2.1.4-1] | |
| UE attachment | Based on RSRP from port 0  [refer to TR 37.910, evaluation assumption in B.4.1\_eMBB\_SE.zip] | Based on RSRP from port 0. The UE panel with the best receive SNR is chosen. i.e. no combining is done between panels.  [refer to TR 37.910, evaluation assumption in B.4.1\_eMBB\_SE.zip] |
| Polarized antenna model | Model-1 in clause 7.3.2 in TR 38.901 | |
| DL/UL Modulation | Up to 256QAM | |
| Transmission scheme | Companies to report transmission schemes (e.g., SU-MIMO, MU-MIMO, maximum layers for SU-MIMO/MU-MIMO, etc)  For calibration, consider SU-MIMO with single layer for both DL and UL | |
| Scheduling | PF | |
| Overhead | Companies to report the overhead assumption | |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
|  |  |
|  |  |
|  |  |

# Issue#3: LLS Evaluation Methodology and link budget analysis

## Issue#3-1: Coverage performance of SBFD

### Submitted proposal

### Summary

Regarding LLS methodology and the motivation of LLS in this SI,

* 1 company [Ericsson] provides the models for the TX chains, antenna coupling, and RX chains for typical BS implementations. Ericsson thinks these example models can be used in LLS to evaluate performance of self-interference suppression and to verify/justify assumptions used in system-level evaluations, or can be used to assess the suitability of current base station implementations for SBFD operation. Ericsson also proposes to send an LS to RAN4 requesting feedback on various radio and antenna modelling aspects that are required for RAN1 to establish evaluation assumptions for link-level simulations. Request feedback on the following gNB aspects:
  + Realistic net effect model that captures the essential behavior of a realistic DPD and PA combination with -45 dBc ACLR compliance, e.g., a net effect model based on a generalized memory polynomial
  + Simple model of crest factor reduction (CFR) processing, e.g., hard clipping with filtering, that captures the essential behaviors of a practical BS designed for PA efficiency and ACLR compliance.
  + Realistic model for non-linearities in the gNB Rx chain, e.g., LNA, mixers, AGC
  + Phase stability of LO for downconversion of received signal
  + Characteristics of realistic analog filter for suppression of DL subbands to avoid saturation of ADC
  + Practical ADC aspects
    - Dynamic range
    - Impact on BS implementation of increased bitwidth
* 1 company [Samsung] propose to consider the following simplified self-interference model for LLS
  + The self-interference seen at RX baseband chain is modeled as white Gaussian interference with the interference power. Its interference power is decided as in SLS
* 1 company [Huawei] thinks LLS can be used to evaluate link level algorithm for SBFD and dynamic/ flexible TDD enhancement.

Regarding coverage performance evaluation,

* 7 companies [Huawei, Samsung, Docomo, CATT, New H3C, Intel, Xiaomi, CMCC] propose to reuse the link level evaluation methodology in TR 38.830 (i.e., LLS + Link budget analysis) as a starting point to evaluate the coverage performance of SBFD.
* 1 company [Ericsson] proposes to define the coverage metric as the target path loss corresponding to a certain (smoothed) average bit rate determined from system simulations: 10Mbps for DL and 1Mbps for UL.
* 1 company [ZTE] proposes another method for coverage performance evaluation in addition to the evaluation methodology in TR 38.830.

Regarding the target channel for coverage performance evaluation,

* PUSCH [Huawei, Samsung, Intel, CMCC]
* PUCCH [Samsung]

Moderator suggests **Initial proposal 3-1-1.**

Regarding gNB self-interference modelling in LLS used for coverage performance evaluation, the following two options can be considered:

* Opt 1: The self-interference seen at Rx baseband chain is modeled as white Gaussian interference, and the interference power is modelled in a similar way as in SLS.
* Opt 2: Generation of the self-interference signals and self-interference cancellation at the gNB are modelled in LLS, e.g., the following components need to be considered [Ericsson]
  + gNB Transmitter Modeling
    - Realistic net effect model that captures the essential behavior of a realistic DPD and PA combination to the base station ACLR requirements, e.g., a net effect model based on a generalized memory polynomial
    - Simple model of crest factor reduction (CFR) processing, e.g., hard clipping with filtering, that captures the essential behaviors of a practical BS designed for PA efficiency and ACLR compliance
  + gNB Receiver Modeling
    - Realistic model for non-linearities in the gNB Rx chain, e.g., LNA, mixers, AGC
    - Phase stability of LO for downconversion of received signal
    - Characteristics of realistic analog filter for suppression of DL subbands to avoid saturation of ADC
    - Practical ADC aspects, e.g., dynamic range, impact on BS implementation of increased bitwidth
  + gNB Antenna and self-interference channel

Moderator suggests **Initial proposal 3-1-2.**

1 company proposes that, for link level simulation and Link budget analysis for coverage performance evaluation, the following options for inter-site gNB-gNB co-channel inter-subband CLI modelling can be considered.

* Opt 1: Inter-site gNB-gNB co-channel inter-subband CLI is modelled as an interference margin in the Link budget template. E.g., the interference margin can be obtained by the average IoT degradation due to Inter-site gNB-gNB co-channel inter-subband CLI in SLS.
* Opt 2: Separate gNB-gNB links are modelled in LLS for modelling inter-site gNB-gNB co-channel inter-subband CLI. Receiver algorithms (e.g., MMSE-IRC) can be used to mitigate the inter-site gNB-gNB co-channel inter-subband CLI.

This issue can be discussed later.

### 1st Round Proposals

#### ***Initial proposal 3-1-1:***

For coverage performance evaluation for SBFD, use option 1 of the following options.

* Option 1: Take link level evaluation methodology in TR 38.830 (i.e., LLS + Link budget analysis) as starting point to evaluate the coverage performance (e.g., MPL, MCL, MIL) for SBFD.
* Option 2: Define the coverage metric as the target path loss corresponding to a certain (smoothed) average bit rate determined from system simulations: 10Mbps for DL and 1Mbps for UL. This is called “10 Mbps coverage” for DL and “1 Mbps coverage” for UL.
* Option 3:
  + Step1: Perform SLS for legacy TDD system and get the 5% SINR (SINR#1);
  + Step2: Perform LLS for legacy TDD system to get the target SINR (SINR#2), with which UE can achieve a certain bit rate in UL and DL;
  + Step3: Perform SLS for SBFD system and consider the SBFD interferences in the SLS to get the 5% SINR (SINR#3);
  + Step4: Perform LLS for SBFD system to get the target SINR (SINR#4), with which UE can achieve a certain bit rate in UL and DL;
  + Step5: Compare the gap (SINR#1 – SINR#2) with gap (SINR#3 – SINR#4) to determine if SBFD system can improve the coverage.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 3-1-1. |
| CATT | We are fine with the proposal. |
| NTT DOCOMO | We are fine with the proposal. |
| QC | For accurate modeling and evaluation of the expected coverage gain, Inter-cell interference impact and modelling in LLS. We suggest adding a third option by using SLS where inter-gNCL is accurately modelled and coverage metric can be obtained from some analysis e.g. (UPT vs LC or latency vs CL).  Suggest option 4 where coverage metric is obtained from SLS evaluation e.g latency vs CL or (UPT 5% vs CL). |
| LG Electronics | We are fine with initial proposal 3-1-1. |
| Kumu Networks | Fine with the proposal but suggest in step3 and step4 we should consider the impact on antenna gain when using beam nulling to reduce self interference |

#### ***Initial proposal 3-1-2:***

Regarding gNB self-interference modelling in LLS used for coverage performance evaluation, the following two options can be considered:

* Opt 1: The self-interference seen at Rx baseband chain is modeled as white Gaussian interference, and the interference power is modelled in a similar way as in SLS.
* Opt 2: Generation of the self-interference signals and self-interference cancellation at the gNB are explicitly modelled in LLS, e.g., gNB transmitter modeling (e.g., model for DPD, PA, CFR), gNB receiver modeling (e.g., model for non-linearities in the gNB Rx chain, phase stability, practical ADC), self-interference channel, etc.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Intel | In this regards, we may prefer to wait for the reply from RAN4. |
| Ericsson | In response to Intel's comment, above, the reply LS from RAN4 will not include link-level aspects, since that was FFS in the agreement from last meeting:  **Agreement**  Regarding gNB self-interference modelling for system level simulation purpose, consider introducing ratio of self-interference (RSI) to represent the overall self-interference suppression capability of gNB by means of spatial isolation, subband frequency isolation, digital interference cancellation and beamform nulling/isolation, etc  …   * FFS: Model for link level simulations and relevant questions to ask RAN4   First of all, we think the primary use of gNB self-interference modelling is so that an accurate assessment of self-interfernce cancellation can be obtained (via link simulation). This is important for verifying what level of self-IC should be used as input for SLS, i.e., how many dB suppression should be assumed in SLS.  For accurate assessment of self-IC algorithms, it is important to model the spectral shape (frequency variation) of the self-interference, and to this end we have found that it is important to model memory effects in the transmit chain. Hence, in our view, Opt. 1 is not a useful option as it won't provide a realistic assessment of self-IC since it ignores the structure of the interference.  For Opt. 2, we think it should be reformulated. It is not necessary to have detailed modeling of each component of the Tx chain and of the Rx chain separately. A "net effect" model is sufficient for link simulations.  Finally, we think that it is necessary to send an LS to RAN4 to ask about what net-effect models shall be used.  Based on the above, we propose the following changes to the proposal: ***Initial proposal 3-1-2:*** Regarding gNB self-interference modelling in LLS ~~used for coverage performance evaluation,~~ the following ~~two options can be considered~~ should be discussed in this meeting:   * ~~Opt 1: The self-interference seen at Rx baseband chain is modeled as white Gaussian interference, and the interference power is modelled in a similar way as in SLS.~~ * ~~Opt 2:~~ Generation of the self-interference signals and self-interference cancellation at the gNB are explicitly modelled in LLS, e.g., gNB transmitter modeling (e.g., net-effect model for DPD, PA, CFR including memory effects), gNB receiver modeling (e.g., net-effect model for non-linearities in the gNB Rx chain, plus phase stability, practical analog filter, and practical ADC characteristics), self-interference channel etc.   Send an LS to RAN4 requesting a suitable net-effect model of the gNB transmitter and a suitable net-effect model of the gNB receiver. |
| New H3C | It is better to wait for RAN ‘s input. |
| Huawei, HiSilicon | Fine with the FL proposal. |
| Samsung | We support FL initial proposal 3-1-2. |
| QC | Not only gNB self-interferenc need modeling, iInter-cell interference is a big factor. We shouldn’t go with the easier model but discuss the accurate model. For either listed option, some factor should be considered for effect of inter-gNB CLI (e.g. some desense amount based on SLS study). |
| LG Electronics | If the main purpose of LLS evaluation is to analize link budget, option 1 in initial proposal 3-1-2 seems enough. Option 2 could be useful to see the performance of gNB receiver design.  And, it seems better that RAN1 wait a response from RAN4. |

# Proposals for GTW

# 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
3. R1-2205810 On deployment scenarios and evaluation methodology of NR full duplex Dell Technologies
4. R1-2205814 Evaluation methodolgy for NR duplex evolution Kumu Networks
5. R1-2205896 Evolution of NR duplex operation Huawei, HiSilicon
6. R1-2205936 Discussion on evaluation methodology for NR-duplex InterDigital, Inc.
7. R1-2205959 Discussion of evaluation on NR duplex evolution ZTE
8. R1-2205988 Discussion on evaluation on NR duplex evolution Spreadtrum Communications, BUPT
9. R1-2206038 Evaluation on NR duplex evolution vivo
10. R1-2206107 Discussion for Evaluation on NR duplex evolution New H3C Technologies Co., Ltd.
11. R1-2206237 Evaluation of UE-UE CLI for NR SBFD operation NEC
12. R1-2206321 Discussion on evaluation on NR duplex evolution OPPO
13. R1-2206397 Discussion on evaluation on NR duplex evolution CATT
14. R1-2206420 Deployment scenario and evaluation methodology for NR duplex evolution Samsung
15. R1-2206504 Discussion on evaluation on NR duplex evolution Sharp
16. R1-2206582 Evaluation of NR duplex evolution Intel Corporation
17. R1-2206641 Discussion on evaluation on NR duplex evolution Xiaomi
18. R1-2206857 Discussion on guardband evaluation of NR duplex evolution KT Corp.
19. R1-2206910 Discussion on evaluation on NR duplex evolution CMCC
20. R1-2206983 Deployment scenarios and evaluation methodology for NR duplex evolution MediaTek Inc.
21. R1-2207230 On Deployment scenarios and evaluation Methodology for NR duplex evolution Qualcomm Incorporated
22. R1-2207266 On the evaluation methodology for NR duplexing enhancements Nokia, Nokia Shanghai Bell
23. R1-2207334 Initial evaluation on NR duplex evolution Apple
24. R1-2207363 Study on Evaluation for NR duplex evolution LG Electronics
25. R1-2207405 Discussion on evaluation on NR duplex evolution NTT DOCOMO, INC.
26. R1-2207461 Evaluation of NR duplex evolution Ericsson
27. R1-2207571 Proposing New Energy Consumption Metric for SBFD Vodafone, China Telecom, Telecom Italia
28. R1-2207607 Additional considerations for NR Duplex evolution Charter Communications, Inc

# Appendix I: RAN1 agreements on evaluation on NR duplex evolution

|  |
| --- |
| **Deployment scenarios for SBFD**  Agreement  For discussion purpose for evaluation, define the following deployment cases for SBFD:   * Deployment Case 1 (Non-coexistence case with single SBFD subband configuration): One single operator using one single carrier is considered. All the cells belonging to the operator use SBFD operation with the same SBFD subband configuration. * Deployment Case 2 (Non-coexistence case with multiple SBFD subband configurations): One single operator using one single carrier is considered. All the cells belonging to the operator use SBFD operation, but different cells may use different SBFD subband configurations. * Deployment Case 3 (Co-channel co-existence case): One single operator using one single carrier is considered. Among the cells belonging to the operator, some of them use legacy TDD operation (static TDD operation) while the others use SBFD operation with the same SBFD subband configuration.   + Deployment Case 3-1: Only 1-layer is considered   + Deployment Case 3-2: 2-layer is considered * Deployment Case 4 (Adjacent-channel co-existence case): Two operators each using one carrier are considered and the two carriers are adjacent carriers. One operator uses legacy TDD operation (static TDD operation) while the other operator uses SBFD operation with the same SBFD subband configuration.   Note: This definition has no intention to preclude any potential solutions for SBFD in AI9.3.2  Note: SBFD subband configuration is from gNB perspective.  Agreement  For SBFD Deployment Case 1, at least consider the following scenarios for evaluation:   * For FR1,   + Indoor office (use Indoor office defined in TR38.802/TR38.901 as starting point)   + Urban macro (use Urban macro defined in TR38.802/TR38.901 as starting point)     - FFS: UE outdoor/indoor proportion, clustering, etc   + Optional: Dense Urban with 1-layer or 2-layer (use Dense Urban defined in TR38.802/TR38.901 as starting point)   + FFS: Rural * For FR2-1,   + Indoor office (use Indoor office defined in TR38.802/TR38.901 as starting point)   + Dense Urban Macro layer (use Dense Urban defined in TR38.802 as starting point)     - FFS: UE outdoor/indoor proportion, clustering, etc   + Optional: Dense Urban micro (use Dense Urban micro defined in TR38.802/TR38.901 as starting point) * FFS: Whether FR2-2 is considered or not in Rel-18.   Note: For optional scenarios, they can be captured in TR and it is up to each company to provide the results. The results can be used to draw conclusion/recommendation depending on the number of companies providing the results.  Agreement  For SBFD Deployment Case 4, at least consider the following scenarios for evaluation from RAN1 perspective:   * FR1: Urban Macro * FR2-1: Dense Urban Macro layer * FFS: UE outdoor/indoor proportion, clustering, etc * FFS: the grid shift between two networks, e.g., 0%, 100%   FFS: Indoor hotspot, Dense Urban Micro layer  **Interference modelling**  Agreement  For discussion for duplex evolution study (all agenda items), consider the following as RAN1’s common understanding:   * Co-channel interference: The interference is from the aggressor to the victim in the same carrier.   + Co-channel intra-subband interference: The interference is caused by transmission of the aggressor on a set of contiguous RBs in a carrier to reception of the victim on the same set of contiguous RBs in the same carrier.   + Co-channel inter-subband interference: The interference is caused by transmission of the aggressor in a first set of contiguous RBs in a carrier to reception of the victim in a second set of contiguous RBs in the same carrier, where the two contiguous RB sets are non-overlapping in frequency. * Adjacent channel interference: The interference is from the aggressor in carrier#1 to the victim in carrier#2, where the carrier#1 and carrier#2 are adjacent carriers.   Note 1: ‘Co-channel’ here means ‘co-carrier’. ‘Adjacent-channel’ here means ‘adjacent-carrier’.  Agreement  For discussion for duplex evolution study (all agenda items), consider the following as the common understanding in RAN1 on the definition of interference types for SBFD operation:   * gNB self-interference (SI): Interference caused by DL transmission on a set of DL RBs in a carrier to UL reception on a set of UL RBs in the same carrier at the gNB side, where the two RB sets are non-overlapping in frequency. * gNB-UE co-channel intra-subband interference: This is the same as the legacy DL interference type in legacy TDD network with static TDD UL/DL configuration. * UE-gNB co-channel intra-subband interference: This is the same as the legacy UL interference type in legacy TDD network with static TDD UL/DL configuration. * (inter-cell) inter-site gNB-gNB co-channel intra-subband CLI: CLI caused by DL transmission of the aggressor gNB on a set of RBs in one carrier to UL reception of the victim gNB in a different site on the same set of RBs in the same carrier. * (inter-cell) co-site inter-sector co-channel intra-subband CLI: CLI caused by DL transmission of the aggressor gNB on a set of RBs in one carrier to UL reception of the victim gNB in another sector of the same site on the same set of RBs in the same carrier. * (inter-cell) UE-UE co-channel intra-subband CLI: CLI caused by UL transmission of the aggressor UE on a set of RBs in one carrier to DL reception of the victim UE on the same set of RBs in the same carrier. * (inter-cell) inter-site gNB-gNB co-channel inter-subband CLI: CLI caused by DL transmission of the aggressor gNB on a first set of RBs in a carrier to UL reception of the victim gNB in a different site on a second set of RBs in the same carrier, where the two RB sets are non-overlapping in frequency. * (inter-cell) co-site inter-sector co-channel inter-subband CLI: CLI caused by DL transmission of the aggressor gNB on a first set of RBs in a carrier to UL reception of the victim gNB in another sector of the same site on a second set of RBs in the same carrier, where the two RB sets are non-overlapping in frequency. * (intra-cell/inter-cell) UE-UE co-channel inter-subband CLI: CLI caused by UL transmission of the aggressor UE on a first set of RBs in a carrier to DL reception of the victim UE on a second set of RBs in the same cell or neighboring cell in the same carrier, where the two RB sets are non-overlapping in frequency. * gNB-gNB adjacent-channel CLI: CLI caused by DL transmission of the aggressor gNB in a carrier to UL reception of the victim gNB in another adjacent carrier.   + This includes adjacent-channel CLI between gNBs in the same and different sectors of the same site, i.e., co-site intra and inter-sector adjacent-channel CLI. * UE-UE adjacent-channel CLI: CLI caused by UL transmission of the aggressor UE in a carrier to DL reception of the victim UE in another adjacent carrier.   Note: Some of the interferences may not be used according to the deployment scenarios, e.g, whether the SBFD subband configurations are the same or different across gNBs.  Note: This does not imply we need to consider all the above interference types in evaluation for SBFD.  Agreement:  Regarding gNB self-interference modelling for system level simulation purpose, consider introducing ratio of self-interference (RSI) to represent the overall self-interference suppression capability of gNB by means of spatial isolation, subband frequency isolation, digital interference cancellation and beamform nulling/isolation, etc. RSI also takes into account the impact of Tx/Rx antenna element gain on self-interference. The RSI, denoted as , can be defined as the ratio of the total power transmitted by gNB across all transmit chains on a frequency unit *m* (e.g., subband/RB/subcarrier *m*) in a SBFD carrier to the residual self-interference received by the same gNB on a single receiver chain on a different frequency unit *n* (e.g., another subband/RB/subcarrier *n*) in the same SBFD carrier.   * FFS: Model for link level simulations and relevant questions to ask RAN4 * FFS: details of gNB self-interference modelling using RSI in SLS. As one example based on per-RB-RSI, the gNB self-interference on a single receiver chain at UL RB *n* can be modelled as   + , wherein,     - is the gNB self-interference on a single receiver chain at UL RB *n* caused by DL transmission on DL RB *m.*     - *m* is the DL RB index in DL subbands.     - is gNB’s DL transmission power across all transmit chains at RB *m* (in dBm).     - is the per-RB-RSI.   + FFS: consider a statistical clutter model based on statistics of clutter strength and AoA. * The following should be asked to RAN4:   + What is the value range of RSI for each frequency range, and under what assumptions on the self-interference suppression means the value range of RSI is provided?     - RAN1 understands the RSI can be described per subband, per RB, or per subcarrier depending on the granularity of the frequency unit, and it is up to RAN4 to provide the RSI in which granularity.   + Whether it is possible for RAN4 to provide RAN1 the respective capabilities of different self-interference suppression means? e.g., is it possible to provide the separate estimates for spatial isolation, subband frequency isolation, beamform nulling/isolation, and digital cancellation, etc., as below?     - +…       * denotes the spatial isolation.       * denotes the suband frequency isolation between the Tx frequency unit *m* and the Rx frequency unit *n.*       * denotes the beamform nulling or beam isolation.       * denotes the digital cancellation capability.   + Whether it is possible to simplify the RSI as frequency flat model, and under which condition(s) the dependency of the RSI on frequency can be ignored?   + The feasibility of provided value range of RSI regarding factors such as blocking, AGC, etc.   + Does RSI have any dependency with the following factors or any other factors? What are the dependencies?     - gNB’s antenna aspects, e.g., the assumed antenna architecture, the number of transmit chains and receive chains, etc.     - Frequency aspects, e.g., the frequency distance between the Tx frequency unit *m* and the Rx frequency unit *n*,the number of RBs allocated for DL transmission, etc.     - Beam aspects, e.g., Tx/Rx beam-pair for FR1/FR2 especially for clutter echo, etc. * Note: RAN1’s consideration on the frequency locations and sizes of SBFD DL subband and SBFD UL subband assumed in SBFD operation can be provided to RAN4.   Agreement  For discussion of gNB-gNB and UE-UE co-channel inter-subband CLI modelling in system level simulation, RAN1 understands at least the following two aspects need to be considered:   * **Aspect 1:** The unwanted emissions due to Tx non-linearity at the transmitter of the aggressor from the allocated RBs to the non-allocated RBs in the same carrier. * **Aspect 2:** The receiver selectivity at the victim to receive the desired signal in the allocated RBs in the presence of the unwanted signals at the non-allocated RBs. (e.g. receiver blocking at the victim, overload of the receiver dynamic range, etc) * The following questions should be asked to RAN4: * Whether it is feasible to consider the above two aspects for gNB-gNB and UE-UE co-channel inter-subband CLI modelling in system level simulation? Are there any other aspects should also be taken into account? * For a specific pair of DL frequency unit *m* (e.g., subband/RB *m*) and UL frequency unit *n* (e.g., subband/RB *n*) of gNB-gNB link, where the DL frequency unit *m* and UL frequency unit *n* are in the same carrier and non-overlapping in frequency, and assuming the aggressor gNB transmits on the DL frequency unit *m* and the victim gNB receives on the UL frequency unit *n*,   + How to model the interference from DL frequency unit *m* to UL frequency unit *n* due to Aspect 1 (defined above) at the gNB transmitter?   + How to model the interference from DL frequency unit *m* to UL frequency unit *n* due to Aspect 2 (defined above) at the gNB receiver?   + How to model the above interferences for the following two cases:     - inter-site gNB-gNB co-channel inter-subband CLI     - co-site inter-sector co-channel inter-subband CLI * For a specific pair of DL frequency unit *m* (e.g., subband/RB *m*) and UL frequency unit *n* (e.g., subband/RB *n*) of UE-UE link, where the DL frequency unit *m* and UL frequency unit *n* are in the same carrier and non-overlapping in frequency, and assuming the aggressor UE transmits on the UL frequency unit *n* and the victim UE receives on the DL frequency unit *m*,   + How to model the interference from UL frequency unit *n* to DL frequency unit *m* due to Aspect 1 (defined above) at the UE transmitter?   + How to model the interference from UL frequency unit *n* to DL frequency unit *m* due to Aspect 2 at the UE receiver?   FFS: Usage of the above model provided by RAN4 in the evaluation  Agreement  Regarding gNB-gNB and UE-UE adjacent-channel CLI modelling for system level simulation, RAN1 understands at least the following aspects need to be considered:   * Aspect 1: The unwanted emissions due to Tx non-linearity at the transmitter of the aggressor from the allocated RBs in one carrier to the non-allocated RBs in the adjacent carrier. * Aspect 2: The receiver selectivity at the victim to receive the desired signal in the allocated RBs in one carrier in the presence of the unwanted signals at the non-allocated RBs in the adjacent carrier. (e.g. receiver blocking at the victim, overload of the receiver dynamic range, etc)   The following questions should be asked to RAN4:   * Whether it is feasible to consider the above two aspects for gNB-gNB and UE-UE adjacent-channel CLI modelling in system level simulation? Are there any other aspects should also be taken into account? * For a specific pair of DL frequency unit *m* (e.g., subband/RB *m*) and UL frequency unit *n* (e.g., subband/RB *n*) of gNB-gNB link, where the DL frequency unit *m* and UL frequency unit *n* are in adjacent carriers and non-overlapping in frequency, and assuming the aggressor gNB transmits on the DL frequency unit *m* and the victim gNB receives on the UL frequency unit *n*,   + How to model the interference from DL frequency unit *m* to UL frequency unit *n* due to Aspect 1 (defined above) at the gNB transmitter?   + How to model the interference from DL frequency unit *m* to UL frequency unit *n* due to Aspect 2 (defined above) at the gNB receiver?   + How to model the above interferences for the following cases:     - the two gNBs are from the same sector of the same site in adjacent carriers, i.e., co-site co-sector gNB-gNB adjacent-channel CLI     - the two gNBs are from different sectors of the same site in adjacent carriers, i.e., co-site inter-sector gNB-gNB adjacent-channel CLI     - the two gNBs are from different sites in adjacent carriers, i.e., inter-site gNB-gNB adjacent-channel CLI   + Whether it is feasible to define a similar interference ratio as BS-BS ACIR in TR38.828 but in the subband of the adjacent carrier, with finer granularity (e.g., per subband or per RB), to represent the overall effect of the Aspect 1 and Aspect 2 described above?     - For example, whether it is feasible to define gNB-gNB-adjacent-channel-per-RB/subband interference ratio as the ratio of the power transmitted by the aggressor gNB on DL frequency unit m to the interference received by the victim gNB on UL frequency unit *n*? If it is feasible, then what is the value range of the gNB-gNB-adjacent-channel-per-RB/subband interference ratio for each frequency range? * For a specific pair of DL frequency unit *m* (e.g., subband/RB *m*) and UL frequency unit *n* (e.g., subband/RB *n*) of UE-UE link, where the DL frequency unit *m* and UL frequency unit *n* are in adjacent carriers and non-overlapping in frequency, and assuming the aggressor UE transmits on the UL frequency unit *n* and the victim UE receives on the DL frequency unit *m*,   + How to model the interference from UL frequency unit n to DL frequency unit *m* due to Aspect 1 (defined above) at the UE transmitter?   + How to model the interference from UL frequency unit n to DL frequency unit *m* due to Aspect 2 at the UE receiver?   + Whether it is feasible to define a similar interference ratio as UE-UE ACIR in TR38.828 but in the subband of the adjacent carrier, with finer granularity (e.g., per subband or per RB), to represent the overall effect of the Aspect 1 and Aspect 2 described above?     - For example, whether it is feasible to define UE-UE-adjacent-channel-per-RB/subband interference ratio as the ratio of the power transmitted by the aggressor UE on UL frequency unit n to the interference received by the victim UE on DL frequency unit m? If it is feasible, then what is the value range of the UE-UE-adjacent-channel-per-RB/subband interference ratio for each frequency range?   FFS: How to make use of the interference model in RAN1  **Performance metrics**  Agreement  At least the following metrics are considered for SBFD and dynamic/flexible TDD evaluation.   * DL/UL UPT or user throughput (CDF or {mean, 5%, 50%, 95%}) using SLS * Latency (CDF or {mean, 5%, 50%, 95%}) using SLS * Resource utilization using SLS * DL/UL received SINR using SLS * Coverage metric   + FFS: MPL to achieve a certain bit rate in UL and DL * FFS: definitions of the above metrics * FFS: other metrics   **SBFD subband and slot configurations**  Agreement  For performance evaluation and comparison between baseline legacy TDD operation and SBFD operation under SBFD Deployment Case 1 (Non-coexistence case with single SBFD subband configuration), consider the following alternatives:   * Alt 2 (No SBFD DL subband in the slots/symbols that correspond to UL slots/symbols in legacy TDD):   + Legacy TDD: Static TDD UL/DL configuration with {DDDSU}, where S=[12D:2G:0U]   + SBFD: Frame structure#2 (XXXXU), where X denotes a SBFD slot. In time domain, SBFD UL subband spans all the symbols in a SBFD slot. In frequency domain, SBFD UL subband is about [20%] of the channel bandwidth. * Alt 4 (strive for the same UL/DL resource ratio between Legacy TDD and SBFD):   + Legacy TDD: Static TDD UL/DL configuration with {DDDSU}, where S=[12D:2G:0U]   + SBFD: Frame structure#3 (XXXXX), where X denotes a SBFD slot. In time domain, SBFD UL subband spans all the symbols in a SBFD slot. In frequency domain, SBFD UL subband is about [20%] of the channel bandwidth. * Alt 1 (No SBFD DL subband in the slots/symbols that correspond to UL slots/symbols in legacy TDD):   + Legacy TDD: Static TDD UL/DL configuration with {DDDSU}, where S=[12D:2G:0U]   + SBFD: Frame structure#1 (DXXXU), where X denotes a SBFD slot. In time domain, SBFD UL subband spans all the symbols in a SBFD slot. In frequency domain, SBFD UL subband is about [20%] of the channel bandwidth. * Alt 3 (strive for the same UL/DL resource ratio between Legacy TDD and SBFD):   + Legacy TDD: Static TDD UL/DL configuration with {DDSUU}, where S=[12D:2G:0U]   + SBFD: Frame structure#2 (XXXXU), where X denotes a SBFD slot. In time domain, SBFD UL subband spans all the symbols in a SBFD slot. In frequency domain, SBFD UL subband is about [20%] of the channel bandwidth.   FFS: whether dynamic TDD can optionally be used for legacy TDD for comparison.  Agreement  For SBFD evaluation, consider the following for SBFD subband configurations:   * SBFD Subband configuration#1 with {DUD} pattern, which means one SBFD slot consists of one UL subband at the center of the channel bandwidth and two DL subbands at two sides of the channel bandwidth. * SBFD Subband configuration#2 with {DU} pattern, which means one SBFD slot consists of one UL subband at one side of the channel bandwidth and one DL subband at the other side of the channel bandwidth. * Use the following parameters for description of SBFD subband configuration in evaluation assumptions:   + ND: the number of RBs in one DL subband   + NU: the number of RBs in one UL subband   + NG: the number of RBs in one guard band between one UL subband and one DL subband   **Traffic model**  Agreement  Regarding traffic model for SBFD and dynamic/flexible TDD evaluation, at least FTP3 is considered. Performance evaluation comparison between different duplex modes (e.g., legacy static TDD vs. SBFD) should be performed based on the same amount of input traffic.   * FFS: other traffic models, e.g., XR, VoIP * FFS: Packet size, traffic load, ratio of DL/UL traffic * FFS: additionally consider different amount of input traffic at least for adjacent-channel~~/co-channel~~ coexistence studies   **Antenna configuration**  Agreement  For evaluation of legacy TDD operation, BS uses the same antenna array for downlink transmission and uplink reception, we can call it shared-Tx/Rx antenna array for description of evaluation assumption.  Agreement  For evaluation of SBFD operation, BS uses separate panels for simultaneous downlink transmission and uplink reception, we can call it separate-Tx/Rx antenna array for description of evaluation assumption.   * Companies can report the separation of the Tx panel and Rx panel assumed in their simulation. * Companies can report how the antenna elements are used for transmission or reception in a slot if BS does not perform simultaneous downlink transmission and uplink reception.   Agreement  For evaluation and comparison between SBFD and legacy TDD, assume the total number of TxRUs of the antenna array for SBFD is the same as the total number of TxRUs of the antenna array for legacy TDD. Regarding antenna elements, both of the two options can be used.   * Opt 1: The total number of antenna elements of the antenna array for SBFD is the same as the total number of antenna elements of the antenna array for legacy TDD. * Opt 2: The total number of antenna elements of the antenna array for SBFD is two times of the total number of antenna elements of the antenna array for legacy TDD. * Companies report which option is assumed in their simulation.   **Channel model**  Agreement  For gNB-gNB co-channel/adjacent-channel channel model and UE-UE co-channel/adjacent-channel channel model in RAN1 SLS,   * Large scale fading (e.g., path loss, penetration loss, shadowing) should be modelled, and companies report whether small scale fading (e.g., fast fading including antenna gain) is also modelled in their simulation. * Note: Antenna gain is calculated based on the gNB-gNB or UE-UE LOS direction instead on the multi-path directions if fast fading is not modelled. * FFS: how to model realistic LOS probability for gNB-gNB and UE-UE channel model. * FFS: How to set aligned channel model amongst companies for SLS calibration (if needed).   Agreement  For gNB-gNB channel model, reuse gNB-to-UE channel model in TR 38.901 with necessary modification   * Replacing the UE’s antenna height with gNB’s antenna height, updating the angular spread * FFS: whether/how to update LOS probability. * FFS: Other details and necessary modifications   **Other issues**  Agreement  For SBFD simulation, consider 4GHz for FR1 and 30GHz for FR2-1. |